Genus **Tethocyathus** Kühn, 1933

Diagnosis. – Solitary, turbinate to ceratoid, fixed or free. Septotheca covered by thick, often wrinkled, epitheca. Discrete paliform lobes arranged opposite all but last cycle of septa in two crowns. Columella essential, papillose at surface. Type-species: *Thecocyathus microphyllus* Reuss, 1871, by original designation.

29. **Tethocyathus cylindraceus** (Pourtalès, 1868)

Plate XIII, figures 8–11

Thecocyathus cylindraceus POURTALÈS, 1868: 134; 1871: 13–14 (in part: not Bibb-173), pl. 2, figs. 14–15; 1874: 37; 1880: 96, 101 (in part: not BL-296). – AGASSIZ, 1888: 149, fig. 464.
Tethocyathus cylindraceus: WELLS, 1956: F423, figs. 1a, b.

Description. – The corallum is subcylindrical, tapering only slightly toward the expanded, polycyclic base. The calice is round; the largest corallum examined measures 14.6 mm in diameter and 15 mm tall. The wall is thick and usually covered by a smooth, thick epitheca terminating in a low rim at the calice and sometimes producing a circular groove between the outer, upper septal margins and the epithecal rim. Otherwise, the theca bears granulated, flat, indistinct costae that extend to the base.

Septa are usually arranged in six systems and four cycles; however, there are two S_5 in the largest corallum examined. S_1 are slightly larger than the S_2, which, in turn, are slightly larger than the S_3, all of which are considerably larger than the S_4. If the corallum is epithecate, the septa usually are not exsert; if costate, all septa are slightly exsert. The inner edges of all septa are broadly sinuous and those of the S_4 are sometimes dentate. Septal granulation is prominent, consisting of numerous tall, pointed granules often arranged in lines and short carinae oriented parallel to the trabeculae.

Stout paliform lobes occur before all but the last cycle. P_1 are small, low in the fossa, and closest to the columella. P_2 are two–three

times larger and slightly taller; their inner edges reach almost the same distance toward the columella as the P_1. P_3 are variable in size but usually are about the same size as the P_1 and are slightly recessed from the columella. Two crowns of paliform lobes are thus formed, the inner crown of 12 P_1 and P_2 and an outer crown of 12 P_3. In a fully developed specimen, the one P_2 and two P_3 of each system are grouped in a chevron; however, it is not unusual for some of the P_2 to be missing.

The papillose columella, which is slightly lower in the fossa than the pali, is composed of 5–30 irregular pillars arranged in a circular field. They are interconnected among themselves and also attached to the inner edges of the adjacent pali.

Discussion. – This species is provisionally placed in *Tethocyathus* because of its thick epithecal covering and its great similarity to the type-species *T. microphyllus* (pers. comm., J. W. WELLS). If the paliform lobes are found to be true pali, it may be necessary to transfer it to *Trochocyathus*.

Material. – G-694 (2) USNM 46069, (1) UMML 8: 241; G-708 (1) USNM 46070; G-1029 (1) USNM 46071; GS(G)-42 (1) USNM 46072; BL-296 (1) MCZ; Hassler, Barbados, 183 m (1) MCZ; Gos-112/27 (1); off Sand Key, Florida, 220 m (2); off Western Dry Rocks, Florida, 263 m (2). – Syntypes of *T. cylindraceus*.

Types. – Thirteen syntypes, divided into three lots numbered 2763 and 5611, are deposited at the MCZ. Neither labels with the syntypes nor information in the original description specify the stations at which they were collected.
Type-Locality. – Off the Florida Reef; 183–366 m.

Distribution. – Straits of Florida; Jamaica; Barbados (Map 18). 155–649 m.

30. **Tethocyathus recurvatus** (Pourtalès, 1878)

Plate XIV, figures 7–9

Thecocyathus recurvatus POURTALÈS, 1878: 202; 1880: 96.
Trochocyathus rawsonii: POURTALÈS, 1878: 199 (in part: BL-68).

Description. – The corallum is ceratoid and regularly curved between 30°–90°, tapering to a narrow, blunt, monocyclic base. The

corallum is usually free but is sometimes attached to a small object. The calice is circular to slightly elliptical; the largest specimen examined is 7.5 × 7.3 mm in calicular diameter and about 10.0 mm tall. The septotheca is moderately thick and covered by a smooth epitheca, which often forms a thin, circular rim at the calicular edge. The epitheca obscures the costae and costal granulation; however, intercostal striae, which delimit equal costae, can often be seen through the epitheca.

Septa are arranged in six systems and four cycles, but the fourth cycle is never complete. The largest specimen examined has only twelve S_4 (36 septa) equally distributed in all six systems, which is probably the adult condition. S_1 are exsert, with rounded upper and vertical inner edges. The higher cycle septa are progressively smaller and less exsert, but in every system the S_3 flanked by S_4 is enlarged to almost the same size as an S_2, whereas the other unflanked S_3 is only slightly larger than the S_4. All inner septal edges are sinuous, but those of the S_4 are less sinuous than those of the S_{1-3}. Low, pointed, randomly arranged granules cover the septal faces.

Two indistinct and incomplete crowns of paliform lobes stand before all but the last cycle of septa. P_1, the smallest and closest to the columella, are tall and narrow. P_2 and P_3 are twice as large, project higher in the fossa, and are slightly recessed from the columella. The outer calicular margins of some of the paliform lobes, especially the P_2 and P_3, are molded around the inner edge of the septa. The paliform lobes are separated from their corresponding septa by deep, narrow notches. They are granulated and bear short, horizontal carinae.

The papillose columella lies slightly deeper in the fossa than the pali. It is composed of 5–15 granulated pillars, which are interconnected basally and also attached to the adjacent pali. The columellar pillars are distinct from the paliform lobes.

Discussion. – This species is provisionally placed in *Tethocyathus* because of its prominent and complete epithecal exterior. However, like *T. cylindraceus*, if the paliform lobes are found to be true pali, *T. recurvatus* may have to be transferred to *Trochocyathus*.

Material. – P-600 (1) USNM 46103; G-254 (1) USNM 46101; G-688 (8) USNM 46102, (1) UMML 8: 244; G-912 (1) USNM 46105; BL-51 (1) MCZ; BL-68 (1) MCZ; E-43 (2) USNM 46104. – Syntypes of *T. recurvatus*.

Types. – Two syntypes (5610), taken at a Blake station off Havana during the dredging season of 1877–78, are deposited at the MCZ. The exact station cannot be determined.
Type-Locality. – Off Havana, Cuba; 320 m.

Distribution. – Straits of Florida; off Cozumel, Mexico; off Jamaica (Map 19). 320–488 m.

31. **Tethocyathus variabilis,** new species

Plate XV, figures 7–10

Thecocyathus cylindraceus POURTALÈS, 1868: 134 (in part); 1871: 13 (in part: Bibb-173); 1880: 101 (in part: BL-296).
Thecocyathus laevigatus: POURTALÈS, 1878: 202 (in part: BL-19).
Thecocyathus rawsonii: POURTALÈS, 1880: 101 (in part: BL-280).
Asterosmilia prolifera: SQUIRES, 1959: 12.
"*Thecocyathus*" sp. A ZIBROWIUS, 1976: 110–111, pl. 55, figs. A–N, pl. 56, figs. A–M.

Description. – The corallum is ceratoid, tapering to a wide pedicel, which measures up to 60% of the calicular diameter. The monocyclic base of attachment is only slightly expanded. The calice is round; larger specimens measure 10 mm in calicular diameter and are up to 22 mm tall. The theca is thick. Equal, slightly convex costae bear uniform, low, rounded granules, numbering, on the average, about three across the width of each costa near the calicular edge. Sometimes bands of epitheca or a solid epitheca obscure both the costae and costal granulation.

Septa are arranged in six systems and four cycles, but the last cycle is rarely complete. S_1 are exsert and reach closer to the columella than any of the other septa. S_2 are only slightly larger than the S_3, which, in turn, are considerably larger than the S_4. Each cycle is progressively less exsert. The inner edges of S_1 and S_4 are straight but the lower, inner edges of the S_2 and S_3 have numerous undulations in the proximity of the columella. The septa bear

small, pointed granules arranged in lines oriented parallel to the trabeculae.

All specimens have a round, deep-set, papillose columella composed of numerous tall, slender rods, which are round or elongate in cross section. In some specimens paliform teeth (lobes?) are regularly arranged before the S_1, S_2, and S_3. In rare cases, three indistinct crowns of paliform teeth, often identical in size and shape to the other columellar elements, are present. The paliform teeth before the S_3 are nearest the calicular edge, whereas those before the S_1 are nearest the axis. Palar elements, however, are usually completely absent, but, when they occur, they may be randomly arranged, occur in a triple crown, or occur only before the S_2.

Discussion. – This species is provisionally placed in the genus *Tethocyathus* because most of the large coralla examined are epithecate and few have paliform teeth (lobes?). However, because some specimens are definitely costate and others have prominent paliform teeth before the second and third cycles, both of which are considered to be generic or subgeneric level characters, a re-evaluation of these seemingly variable generic level characters is necessary.

Etymology. – The specific name *variabilis* (Latin, =changeable) refers to the variable phenotypic expression of this species.

Material. – P-587 (9); P-861 (5) UMML 8: 295; P-929 (5) UMML 8: 283; G-663 (2); G-664 (2); G-885 (1); BL-19 (1) MCZ; BL-173 (1) MCZ; BL-280 (1) MCZ; BL-296 (1) MCZ; Hudson-3A (11) NMC; Hudson-4B (3) NMC. – Squires's (1959) *A. prolifera* (AMNH – 4 specimens). – Types.

Types. – Holotype: P-861 (USNM 46980). – Paratypes: P-861 (20) USNM 46981; P-929 (16) USNM 46982; Caroline-38 (2) USNM 46983.
Type-Locality. – 12°42′N, 61°05.5′W (east of the Grenadine Islands); 18–744 m.

Distribution. – Western Atlantic: Antillean distribution; Arrowsmith Bank, Yucatan Channel (Map 19). 250–576 m. – Eastern Atlantic: off Spanish Sahara; Azores. 269–860 m.

Genus **Paracyathus** Milne Edwards & Haime, 1848

Diagnosis. – Solitary; turbinate; fixed or free. Septotheca costate. Paliform lobes often bi- or trilobed, opposite all but last cycle. Columella papillose, often indistinguishable from the inner paliform lobes. Type-species: *Paracyathus procumbens* Milne Edwards & Haime, 1848, by subsequent designation (Milne Edwards & Haime, 1850).

32. **Paracyathus pulchellus** (Philippi, 1842)

Plate XVI, figures 1–6

Synonymy complete for western Atlantic only:

Cyathina pulchella Philippi, 1842: 42.

Paracyathus pulchellus: Milne Edwards & Haime, 1857: 55. – Lewis, 1965: 1062.– Best, 1970: 306–308, fig. 8. – Zibrowius, 1976: 96–100, pl. 29, figs. A–K, pl. 30, figs. A–L. – Cairns, 1977b: 5, 11–13, pl. 2, figs. 2–3; 1978: 11.

Paracyathus defilippi Duchassaing & Michelotti, 1860: 60, pl. 9, figs. 2–3; 1864: 55. – Duchassaing, 1870: 25. – Pourtalès, 1874: 38; 1878: 200; 1880: 96, 105. – Moseley, 1881: 144 (in part: specimen from off Azores). – Vaughan, 1901; 292. – Gardiner & Waugh, 1938: 182. – Durham, 1949: 156. – Squires, 1959: 12–15. – Lewis, 1960: 12; 1965: 1062. – Goreau & Wells, 1967: 449. – Weisbord, 1968: 71. – Porter, 1972: 113. – Wells & Lang, 1973: 58. – Keller, 1975: 178. – Defenbaugh, 1976: 27, 39, fig. 58.

Paracyathus confertus Pourtalès, 1868: 134; 1871: 11, pl. 6, figs. 11–13. – Studer, 1878: 628. – Agassiz, 1888: 149–150, fig. 466. – Squires, 1958: 258.

Description. – The shape of the corallum is variable. Young specimens are often short and cylindrical but also may be conical. Larger specimens are usually trochoid to turbinate, tapering to a pedicel measuring one-fourth to one-half the calicular diameter and re-expanding into an encrusting polycyclic base. The calice is usually elliptical but can be perfectly round or strongly compressed. The largest corallum examined measures 15.5 × 13.3 mm in calicular diameter, 24.0 mm tall, and contains 76 septa. The expression of costae is also variable. The costae are usually only conspicuous near the calicular edge as low, slightly convex ridges separated by narrow, shallow intercostal furrows. In other cases, the costae are highly ridged, extend to the base, and are separated by broad, deep

furrows. Costal granules, when present, are low and rounded. The proximal two-thirds of the corallum is often covered by encrusting organisms (*e.g.*, bryozoans, algae, foraminifera), giving it a white appearance. Occasionally, bands of epitheca are deposited in this area, also giving the exterior a milky-white color. Otherwise, the distal part of the corallum and septa are usually brown or reddish-brown.

Septa are arranged in six systems and five cycles. Above a calicular diameter of about 8 mm, S_5 begin to appear, but a full fifth cycle (96 total septa) is never attained. A pair of S_5 usually occurs in all twelve half-systems before a second pair is added to any half-system. S_1 and S_2 are equal in size and moderately exsert. The higher cycle septa are progressively smaller and less exsert. The inner edges of all septa are straight to slightly sinuous. The septal and palar faces bear prominent, pointed or rounded granules, which sometimes fuse at the axial margin to form horizontal or oblique carinae, giving the septa a thick appearance.

The paliform lobes are the most variable character of this species and occur before all but the last cycle. They are tall and usually more prominently granulated than the septa. Each is separated from its respective septum by a deep, narrow notch. P_1 and P_2 are equal in size, lowest in the fossa, and closest to the columella. P_3 are usually twice as large, terminate higher in the fossa, and are often wedge-shaped: their outer (calicular) edges are considerably broader than their inner (axial) edges. P_4 are about the same size as the P_3, recessed from the columella, and terminate even higher in the fossa than the P_3. In the space between the inner edge of a P_4 and the columella there are often two–four additional paliform lobes (multilobate condition) of progressively smaller size nearer the columella.

The fossa is extremely variable in depth. It is usually deep but can range from very deep to level with the upper edges of the septa, the latter condition being rare. The papillose columella is large and usually elliptical in outline, composed of up to 60 close-set, uniform, slender rods. The rods all terminate at the same level, sometimes forming a convex bulge in larger specimens. The columellar elements are interconnected basally and fused to the inner edges of the paliform lobes, from which they can be indistinguishable.

Material. – P-199 (1) USNM 46127; P-389 (5) USNM 46147; P-392 (14) USNM 46148; P-403 (1) USNM 46149; P-405 (1) USNM 46150; P-420 (1) USNM 46151; P-581 (1) USNM 46154; P-596 (2) USNM 46155; P-629 (1) USNM 46153; P-650 (18) USNM 46156; P-1140 (6) USNM 46158; 77 specimens from 23 additional Pillsbury stations throughout the Antilles; G-681 (1) USNM 46121; G-692 (1) USNM 46122; G-882 (1) USNM 46124; G-946 (1) USNM 46125; G-950 (1) USNM 46126; G-1329 (3) USNM 46123; 119 specimens from 18 additional Gerda stations in the Straits of Florida; CI-6 (1) USNM 46163; CI-7 (1) USNM 46164; O-1348 (2); O-2286 (1); O-4225 (1); SB-2263 (1); SB-2523 (2); SB-3407 (1); SB-3494 (13); BL-2 (1); BL-22 (1); BL-23 (1); BL-32 (1); BL-45 (19); BL-50 (1); BL-62 (1); BL-132 (2); BL-155 (1); BL-157 (1); BL-164 (1); BL-203 (1); BL-246 (1); BL-247 (1); BL-271 (5); BL-272 (1); BL-278 (1); BL-290 (1); BL-292 (3); BL-293 (1), all specimens from Blake stations at MCZ; Hassler, off Barbados, 183 m (15) MCZ; Alb-2167 (1) USNM 16128; Alb-2316 (10) USNM 10077; Alb-2318 (3) USNM 14003; Gos-1533 (3); Gos-1591 (1); Gos-1785 (1); Gos-1860 (1); Caroline-17 (1); TAMU 65A9–15A (11) TAMU; TAMU 65A9–20 (3) TAMU; TAMU 65A14–9 (1) TAMU; TAMU 67A5–11C (22) TAMU; TAMU 70A10–39 (1) TAMU; TAMU 72F1–48 (5) TAMU; 27°54′53″N, 93°26′50″W, 100 m (10) BLM-Texas. – Holotype of *P. defilippi*; syntypes of *P. confertus*; Moseley's (1881) *P. defilippi*.

Types. – The types of *C. pulchella* are at the Berlin Museum. The holotype of *P. defilippi*, a small specimen of 44 septa and only 4.0 × 4.4 mm in calicular diameter, is at the MIZS (Coel. 229). Eight syntypes of *P. confertus*, divided into three lots, are at the MCZ (all numbered 5481). One lot is from Bibb-39; the locality of the other two is unknown. Another syntype is at the YPM (4769).
Type-Locality. – Off Naples and Trapani, Mediterranean.

Distribution. – Western Atlantic: common throughout Caribbean and Gulf of Mexico, ranging from North Carolina to off the Amazon, Brazil (Map 20). 17–838 m. Most common, however, between 50–250 m. 18–24°C, based on six records. – Eastern Atlantic: Mediterranean; area bounded by Portugal, the Azores, and the Gulf of Guinea.

Genus **Deltocyathus** Milne Edwards & Haime, 1848

Diagnosis. – Solitary, discoid to patellate, free (sometimes with a scar of previous attachment at center of base). Costae present. Pali opposite all but last cycle; inner edges of P_3 join P_2 near columella, forming deltas. Columella papillose. Type-species: *Turbinolia italica* Michelotti, 1838, by monotypy.

KEY TO THE SIX WESTERN ATLANTIC SPECIES OF *Deltocyathus*

1′ Center of base bears distinct, circular scar; intercostal furrows near calicular edge extremely deep . . . . *D. moseleyi*, n. sp.
1′ Center of base not scarred; intercostal furrows moderately deep or shallow 2

2 Shape of base conical (apical angle: 80°–110°–120°); no elongate costal spines; only species known from deeper than 1200 m . . . . . *D.* sp. cf. *D. italicus* (Michelotti)
2′ Shape of base flat, convex, or slightly conical (apical angle: 140°–180°); may or may not have costal spines; found shallower than 1200 m 3

3 Calicular rim usually thickened; S_4 rudimentary, attached to S_3 near columella by several slender processes; often more than 48 septa . . . . . *D. eccentricus*, n. sp.
3′ Calicular rim not thickened; S_4 not rudimentary; usually 48 septa 4

4 C_1 always broader than other costae and usually projecting outward as large spines; S_2 and C_2 usually black . . . . . *D. calcar* Pourtalès, 1874
4′ Equicostate, no projecting costal spines; corallum white. . . 5

5 S_4 more exsert and extending farther toward columella than S_3; inner edge of each S_4 unites with its adjacent P_3 well above the notch that separates the S_3 from its corresponding P_3. . . . . *D. pourtalesi*, n. sp.
5′ S_4 less exsert and smaller than S_3; inner edge of each S_4 unites with its adjacent P_3 below the notch that separates the S_3 from its corresponding P_3 . . . . . *D. agassizii* Pourtalès, 1867

33. **Deltocyathus agassizii** Pourtalès, 1867

Plate XVII, figures 4–6

Deltocyathus agassizii POURTALÈS, 1867: 113–114; 1871: 15 (in part: four specimens from "Florida and Cuba, 60–327 fms"). – ZIBROWIUS, 1976: 161–162.
Not *Deltocyathus agassizii*: POURTALÈS, 1874: 35; 1878: 200. – MOSELEY, 1876: 546, 551. – LINDSTRÖM, 1877: 10. – BOONE, 1928: 8.
Deltocyathus italicus variety *agassizii*: POURTALÈS, 1880: 102 (in part).

Description. – [The following description is based on the best-preserved of the four syntypes.] The base of the corallum is flat and bears no scar of attachment. The calice is round, measuring 10.8 mm in diameter. At the calicular edge the costae are equal in width, rounded, and separated by moderately deep furrows. Toward the center of the base the C_4 become much narrower and all of the intercostal furrows become much shallower. All but the C_4 reach the center of the base. The costae bear large, worn granules on their outer surface and finer, pointed granules laterally.

Septa are arranged in six systems and four complete cycles. The S_4 are smaller than the S_3 and are joined to the S_3 by several broad trabeculae at or slightly below the notch separating the S_3 from their corresponding pali. The P_3 join the P_2 closer to the columella. The inner edges of all septa are slightly sinuous. Both septa and pali bear prominent, pointed granules. The columella is composed of 15–17 slender rods loosely fused together basally.

Discussion. – *D. agassizii* has been collected very rarely, known from only eight worn specimens. Subsequent records of this species made by POURTALÈS (1874, 1878), MOSELEY (1876), LINDSTRÖM (1877), BOONE (1928), and probably PACKARD (1873), VERRILL (1874, 1883), and LEWIS (1965) pertain to one or more of the five other species of *Deltocyathus* known from the western Atlantic.

D. agassizii most closely resembles *Deltocyathus pourtalesi*, particularly in shape, costae, costal granulation, and absence of a basal scar. It can be distinguished by its lower connection of the S_4 to the S_3 and larger S_3 than S_4.

Material. – Two specimens labelled "Florida and Cuba, 60–327 fms," collected by Bibb (MCZ); Alb-2750 (1); E-26023 (1) USNM 46243. – Syntypes.

Types. – There are four complete specimens and one fragment (syntypes) deposited at the MCZ, all in worn condition. They were collected at Bibb-4 in 1867.
Type-Locality. – 1.6 miles (2.6 km) off Chorrera, Cuba; 494 m.

Distribution. – Known only from the Straits of Florida and off Anguilla, Lesser Antilles (Map 21). 494–907 m.

34. **Deltocyathus calcar** Pourtalès, 1874

Plate XVII, figures 7–10; Plate XVIII, figure 7

Deltocyathus agassizii: Pourtalès, 1871: 15–16 (in part: Bibb-201), pl. 2, figs. 4–5, pl. 5, figs. 9–10; 1878: 200 (in part). – Lindström, 1877: 10–11 (in part: specimen from Anguilla), pl. 1, fig. 13, pl. 2, figs. 14, 18, 19.
Deltocyathus agassizii variety *calcar* Pourtalès, 1874: 35–36, pl. 6, fig. 11.
Deltocyathus italicus: Pourtalès, 1880: 101–103 (in part: variety *beta* and *delta*), pl. 1, figs. 4–5. – Moseley, 1881: 145–147 (in part: off Bermuda, 200 fms), text-fig., page 145 (lower pair). – Tizard, *et al.*, 1885: fig. 277. – Vaughan, 1901: 293. – Tommasi, 1970: 56, figs. 5e, 7b. – Laborel, 1970: 153; 1971: 175.
Deltocyathus calcar: Zibrowius, 1976: 157. – Cairns, 1977: 86–87, 2 figs.; 1977b: 5; 1978: 11.

Description. – The shape of the corallum base varies, ranging from conical to slightly rounded to almost flat. There is no scar of attachment at the apex. The calice is round; the largest specimen examined measures 14.8 mm in diameter, exclusive of costal spines. The corallum is usually pigmented in a distinct pattern. The most common scheme is for all or part of the S_2 and C_2 to be dark brown. Other patterns, in order of frequency, are: completely white; completely light brown; only the spines pigmented dark brown; and S_2 and P_1 dark brown.

The C_1 are thick and rounded, substantially larger than the other costae. Each C_1 usually bears a large accessory spine, which can project a distance equal to the radius of the calice from the calicular edge, giving the corallum a stellate appearance; sometimes, however, these spines are much reduced, expressed only as incipient nubs, or absent altogether. The costae of the higher cycles are thinner but also reach the apex, except for the C_4, which extend about

0.9 of that distance. All costae are separated by shallow striae and bear large, rounded, blunt granules, which give the appearance of a beaded margin to the higher cycle costae. The large costal spines are finely granulated. C_{2-4} are usually rounded but may be flattened or ridged also.

Septa are arranged in six systems and four cycles in typical *Deltocyathus* fashion. S_1 and S_2 are about equal in size and exsertness; they are larger than the S_3, which, in turn, are slightly larger than the S_4. The S_4 are joined to the S_3 by four-six thin processes just below the notch that separates the S_3 from its P_3. P_{1-3} are separated from their corresponding septa by deep, narrow notches. Septal granules are usually broad and arranged in lines parallel to the trabeculae. Palar granulation is higher than that of the septa, composed of broad, often bifid granules one–three times the palar thickness in height.

The fossa is shallow with a prominent columella, which is round to elliptical in outline, and composed of numerous compressed rods united at their bases and to the inner edges of the S_{1-3}.

Discussion. – POURTALÈS (1874, 1880) was essentially correct in assuming that there was a species of *Deltocyathus* with a continuous gradation from prominent costal spines to the spineless condition. He was wrong, however, in assuming that this species was *D. agassizii* or *D. italicus* and overlooked the four other distinct species of *Deltocyathus* in his own collection. Evaluation of characters not studied by POURTALÈS, such as the junction of the S_3 to the S_4, width of the costae, presence or absence of a basal scar, and relative size of S_3 and S_4 distinguishes these species.

The distinctive costal spines and pigment pattern are known only in this species. However, when both spines and pigment are lacking, it still can be differentiated from the other western Atlantic *Deltocyathus* by its prominent C_1 and the nature of the junction of the S_3 to the S_4.

Material. – P-198 (2) USNM 46274; P-340 (7) USNM 46269; P-446 (1) USNM 46273; P-737 (1) USNM 46271; P-797 (3) USNM 46262; P-874 (7) USNM 46261; P-876 (3) USNM 46263; P-890 (4) USNM 46259; P-904 (1) USNM 46264; P-931 (1) USNM 46260; P-943 (187) USNM 46268; P-969 (2) USNM 46277; P-1140 (1) USNM

46266; P-1232 (1) USNM 46258; P-1303 (2) USNM 46272; P-1354 (475) USNM 46267, (46) UMML 8: 377; P-1357 (34) USNM 46280; 213 specimens from 14 Gerda stations in the Straits of Florida (USNM); O-1251 (6); O-1867 (7); O-3203 (5); O-3621 (2); O-4226 (300) USNM 46283; O-4301 (1) USNM 46282; O-4832 (5); O-4833 (1); O-4928 (3); O-5733 (1); O-5915 (2); O-5955 (10); SB-50 (2); SB-2443 (1); SB-2445 (1); SB-3494 (19); specimens from 37 Blake stations throughout Antilles (MCZ); Bibb-201 (1) MCZ; Alb-2135 (1) USNM 16092; Alb-2323 (1) USNM 10122; Alb-2338 (1) USNM 10222; Alb-2342 (1) USNM 16093; Alb-2345 (1) USNM 10250; Alb-2347 (1) USNM 10257; Alb-2399 (1) USNM 10442; Combat-447 (3); Gos-1590 (2); Gos-1657 (1); Gos-1811 (1); Gos-1824 (3); Gos-1842 (2); Caroline-12 (4); Caroline-13 (1); Caroline-25 (14); Caroline-81 (7); Caroline-99 (1); Caroline-102 (2); E-30150 (1); E-30178 (2); MAFLA-2106 (3) FDNR; MAFLA-2746 (1) FDNR; WB-1 (9) USNM 46276; WB-2 (2) USNM 46275; WB-318 (10) USNM 46281; TAMU 65A9–15A (4) TAMU; TAMU 67A5–13B (59) TAMU; TAMU 68A7–9A (3) TAMU; Explorer-1a (30); Explorer-1b (2); Chain-36 (1); Chain-38 (3); Chain-39 (1); Chain-43 (1); SME-1778 (8) SME; Akaroa-185 (1) SME; Hummelinck-1443 (7); 225 km southwest of Egmont Key, Florida (50) AMNH. – Syntypes; Lindström's (1877) specimens (NRM); Moseley's (1881) specimens (BM); Vaughan's (1901) specimens (USNM).

Types. – One hundred forty-one specimens, divided into three lots of 122, 18, and 1 specimens, are deposited at the MCZ. They were collected at an undetermined Hassler station off Barbados. No types were designated by POURTALÈS since he considered this species to be a variety of *D. agassizii*. Therefore, one specimen is chosen as holotype and the remaining specimens are designated as paratypes.
Type-Locality. – Off Barbados; 183 m.

Distribution. – Widespread in Caribbean and eastern Gulf of Mexico, ranging from off North Carolina to off Rio de Janeiro, Brazil; off Bermuda (Map 22). 81–675 m. 8°–19°C, based on six records.

35. **Deltocyathus** sp. cf. **D. italicus** (Michelotti, 1838)

Plate XVII, figures 1–3

?*Turbinolia italica* MICHELOTTI, 1838: 51, pl. 1, fig. 8.
Deltocyathus agassizii: POURTALÈS, 1871: 15 (in part: Bibb-95, Bibb-141, Bibb-191); 1878: 200 (in part: BL-46). – MOSELEY, 1876: 546, 551 (in part). – BOONE, 1928: 8.
Deltocyathus italicus: POURTALÈS, 1880: 101 (in part: variety *agassizii*), pl. 1, figs. 2–3. – MOSELEY, 1881: 145–147 (in part: Chall. stations 24, 56, 78, 120). – MARENZELLER, 1904: 281 (in part: Valdivia-56). – GRAVIER, 1920: 34–36 (in part). – KELLER, 1975: 177, pl. 2, figs. 1–4b. – CAIRNS, 1977b: 5; 1978: 11.
Deltocyathus sp. A ZIBROWIUS, 1976: 156–157, pl. 49, figs. A–L.

Description. – The patellate corallum is small and unattached, with an apical angle between 80°–120°. The apex of the base is

bluntly pointed, with no scar or other sign of previous attachment. The largest specimen examined has a round calice measuring 16.5 mm in diameter, although 10–11 mm is more typical. C_1 and C_2 are equal in size, narrow, and highly ridged, especially toward the calicular edge. C_3 are less prominent and usually rudimentary. C_{1-3} reach the apex but the C_4 do not. Costal granulation is variable. C_1 and C_2 usually bear coarse granules on their outer edges, producing a serrated or sometimes a beaded margin. Smaller granules are present on the lateral surfaces of the costae. C_3 and C_4 are similarly granulated but not as prominently. The corallum is usually white but is sometimes uniformly pink.

Septa are arranged in six systems and four complete cycles, only rarely with septa of the fifth cycle. S_1, which are the largest and only independent septa, are only slightly larger than the S_2, which, in turn, are substantially larger than the S_3 and S_4. The S_4 are slightly larger than the S_3. Each S_1 bears a tall, narrow palus separated from its septum by a deep, narrow notch. The two P_1 attached to the principal septa are smaller than the other four. Larger and taller pali usually occur on the inner edges of the S_2; however, they are sometimes reduced in size or absent entirely. P_3 are equal in size to the P_2 and fused to the P_2 by their lower, inner margins, if P_2 are present, forming the characteristic deltas. S_4 do not bear pali; their inner edges are solidly fused to the P_3 at or near the notch separating the S_3 from the P_3. All septa are highly exsert. The septal granulation is prominent but sparse, composed of tall, slender spines (up to two times the septal thickness) or broader, blunter granules. The septal and slightly larger palar granules sometimes form short, vertically oriented carinae.

The fossa is very shallow or nonexistent. The elongate columella, aligned with the principal septa, is composed of numerous slightly twisted, narrow rods, which are solidly fused together.

Discussion. – This species is either closely related or identical to the European fossil species *D. italicus*. The only difference is that the costal granulation of the latter seems to be coarser. *D.* sp. cf. *D. italicus* is easily distinguished from the other Atlantic species by

its strongly conical base and, to a lesser degree by its ridged costae, sometimes pink corallum, and greater depth range.

Material. – P-478 (4) USNM 46201; P-585 (1) USNM 46213; P-607 (5) USNM 46211; P-634 (2) USNM 46217; P-747 (1) USNM 46214; P-754 (1) UMML 8: 373; P-776 (4); P-861 (5) USNM 46207; P-881 (1) USNM 46202; P-891 (1) USNM 46200; P-904 (1) USNM 46210; P-905 (1) USNM 46212; P-919 (2) USNM 46208; P-920 (1) USNM 46204; P-988 (10) USNM 46199; P-1171 (1) UMML 8: 372; P-1177 (2) USNM 46198; P-1181 (2) USNM 46215; P-1238 (3) USNM 46203; P-1255 (2) USNM 46206; P-1256 (1) USNM 46209; P-1261 (1) USNM 46205; P-1435 (15) USNM 46218; G-190 (2) USNM 46185; G-923 (1) USNM 46197; 111 specimens from 18 additional Gerda stations in the Straits of Florida; 322 specimens from 18 Columbus Iselin stations in the Tongue of the Ocean and Exuma Sound, Bahamas; GS-31 (15) USNM 46234; GS-44 (1) USNM 46235; O-2202 (50); O-2775 (1); SB-1182 (6); SB-3515 (1); BL-46 (MCZ); BL-117 (MCZ); BL-129 (1) MCZ; BL-132 (MCZ); BL-161 (MCZ); BL-162 (MCZ); BL-163 (MCZ); BL-173 (MCZ); BL-224 (MCZ); BL-238 (MCZ); BL-244 (MCZ); BL-261 (4) MCZ; Bibb-95 (MCZ); Bibb-141 (MCZ); Bibb-191 (MCZ); Alb-2384 (4) USNM 10372; Alb-2393 (1); Alb-2394 (3) USNM 14004; Alb-2750 (7) USNM 36460A; Alb-2751 (100) USNM 36431; Alb-2754 (17) USNM 36476; Alb-2760 (1) USNM 36454; Alb-2761 (3) USNM 36472; Alb-2763 (2) USNM 36432; Gos-1580 (3); Gos-1595 (2); Caroline-1 (2); Caroline-23 (1); Caroline-84 (3); Caroline-93 (6); WB-322 (6) USNM 46237; WB-391 (1) USNM 46236; Atl-2987A (20) MCZ; Atl-3345 (MCZ); Atl-3355 (MCZ); Atl-3363 (MCZ); Atl-3423 (MCZ); TAMU 65A9–4 (4) TAMU; TAMU 65A9–7D (12) TAMU; TAMU 65A9–11 (10) TAMU; TAMU 65A9–14 (1) TAMU; TAMU 66A5–4 (2) TAMU; TAMU 67A5–4G (1) TAMU; TAMU 67A5–6B (2) TAMU; TAMU 67A5–7E (3) TAMU; TAMU 67A5–8B (1) TAMU; TAMU 67A5–9E (7) TAMU; TAMU 68A7–1A (23) TAMU; TAMU 68A7–2B (16) TAMU; TAMU 68A7–13A (5) TAMU; TAMU 68A7–13D (2) TAMU; TAMU 68A7–15D (3) TAMU; TAMU 68A7–15H (2) TAMU; TAMU 68A7–17B (3) TAMU; TAMU 71A8–47 (6) TAMU; SME-1777 (1) SME. – Moseley's (1881) specimens.

Types. – According to CHEVALIER (1961) the types of *D. italicus* (Michelotti) are lost.
Type-Locality. – Tortona, Italy (Miocene).

Distribution. – Western Atlantic: widespread in the Caribbean and Gulf of Mexico, ranging from off Florida to off Rio de Janeiro, Brazil; Bermuda (Map 23). 403–2634 m. 3°–7°C, based on 10 records. – Eastern Atlantic: area bounded by Gulf of Gascony, the Azores, and Morocco; Gulf of Guinea. 1500–2300 m.

36. **Deltocyathus eccentricus,** new species

Plate XVIII, figures 8–11

Deltocyathus agassizii: POURTALÈS, 1871: 15 (in part: Bibb-141); 1874: 35–36 (in part: off Barbados); 1878: 200 (in part: BL-2, 19, 20, 58). – MOSELEY, 1876: 546 (in part).

Deltocyathus italicus: POURTALÈS, 1880: 101 (in part). – MOSELEY, 1881: 145 (in part: Chall-24, 56). – JOURDAN, 1895: 16 (in part). – GRAVIER, 1920: 34 (in part).

Deltocyathus andamanicus: GRAVIER, 1920: 37, pl. 4, figs. 55–59, pl. 15, fig. 209.

Deltocyathus hexagonus: ZIBROWIUS, 1976: 158–160, pl. 50, figs. A–M, pl. 51, figs. A–N. – CAIRNS, 1978: 11.

Description. – The base of the corallum is flat to slightly conical, with a diameter: height ratio between 2.4–3.2. The wall is very thin except toward the calicular edge, where it forms a thickened outer lip. The calice is irregularly round. The largest specimen examined measures 15.8 mm in calicular diameter. Costae and costal granulation are quite variable. C_1 and C_2 are equal in size and extend to the apex; C_3 are slightly smaller and do not quite reach the apex; and C_4 are the smallest, reaching 0.8–0.9 of the distance to the apex. C_1 and C_2 are usually low and rounded but can be quite high and ridged. Low, rounded granules are usually present on the costae but may become fused toward the calicular edge, forming a series of transverse ridges. There is no scar of attachment at the apex. The coralla are usually white but are sometimes a dark brown or light red.

Septa are arranged in six systems and four complete cycles; however, additional half-systems, composed of four septa (one extra S_2 and S_3 and two extra S_4) are common. S_1 are the largest septa, independent, and connected to the columella through tall, narrow pali. S_2 are slightly smaller and also join the columella via their pali. S_3 unite with the S_2 near the columella by a fusion of the inner edges of their respective pali. S_4 are well developed at the calicular edge but are very small below the upper rim, consisting of only a low ridge or series of spines. They join with the S_3 by four–five narrow processes deep within the fossa near the columella. P_{1-3} are separated from their corresponding septa by deep, wide notches. The two P_1 before the principal septa are smaller than the other pali.

The inner edges of $S1_{-3}$ are slightly to very sinuous. Pointed septal and palar granules can reach as high as twice the septal thickness but are usually shorter and arranged in distinct, widely spaced lines oriented parallel to the septal trabeculae.

The fossa is very shallow but the columella is never higher than the theca. The elongate columella, aligned with the principal septa, is composed of 5-20 small, narrow rods, embedded in a fused basal mass. The columella sometimes expands as a thin, circular membrane fusing with the inner edges of $S1_{-3}$.

Discussion. - *D. eccentricus is* one of four species that both POURTALES and MO5ELEY lumped first as *D. agassizii* and later as *D. italicus.* It is easily distinguished from the other species of *Deltocyathus* by its irregularly round calicular outline, thickened outer lip, reduced $S4$, and rudimentary junction of the S_4 to the S3.

Etymology. - The specific name *eccentricus* (Latin, =deviation from circular shape) refers to the irregular outline of the calice.

Material. - P-340 (45) USNM 46421; P-394 (4) USNM 46423; P-478 (5) USNM 46419; P-585 (4) USNM 46429; P-605 (3) USNM 46426; P-606 (10) USNM 46418; P-607 (31) USNM 46416; P-753 (3) USNM 46431; P-861 (34) USNM 46425; P-881 (2) UMML 8: 247; P-889 (12) USNM 46415; P-891 (13) USNM 46430, (3) UMML 8: 375; P-904 (8) USNM 46420; P-905 (20) USNM 46427; P-944 (1) USNM 46424; P-984 (4); P-1225 (34) UMML 8: 376; P-1256 (7) USNM 46417; P-1261 (1) USNM 46422; P-1356 (1) USNM 46434; 98 specimens from 26 Gerda stations from the Straits of Florida; CI-27 (4) USNM 46435; CI-84 (5) USNM 46436; 0-1986 (1); 0-3252 (2); 0-3560 (3); 0-4226 (1) USNM 46438; SB-3515 (39); BL-2; BL-19; BL-20; BL-58; BL-100; BL-101; BL-130; BL-154; BL-157; BL-176; BL-208; BL-211; BL-230; BL-233; BL-244 - all EL specimens at MCZ; Bibb 141 (MCZ); Hassler, off Barbados, 183 m (MCZ); Alb-2750 (20) USNM 36461; Combat-45 (1); Combat-447 (1); Gos-1632 (4); Gos-1638 (2); Gos-1639 (2); Gos-1723 (1); Gos-1827 (1); Caroline-23 (1); Caroline-25 (8); Caroline-67 (20); Caroline-93 (1); Caroline-94 (1); E-43 (t); Atl-2950; Atl-2990B; Atl-2999; Atl-3370; Atl-3371; Atl-3375; Atl-3459 - all Atl specimens at MCZ; TAMU 71A8-71 (3) TAMU; Explorer 1c (17). - Moseley's (1881) specimens. - Types.

Types. - Holotype: P-881 (USNM 46986). - Paratypes: P-881 (71) USNM 46428.
Type-Locality. - 13°21'N, 61°03'W (off St. Vincent); 576-842m.

Distribution. -Western Atlantic : throughout the Caribbean and Gulf of Mexico, ranging from South Carolina to off the Amazon,

Brazil; Bermuda (Map 24). 183–907 m. – Eastern Atlantic: area bounded by Portugal, the Azores, and Cape Verde Islands. 300–1000 m.

37. **Deltocyathus moseleyi,** new species

Plate XVIII, figures 1–3

Deltocyathus agassizii: POURTALÈS, 1871: 15 (in part). – MOSELEY, 1876: 546 (in part: Chall-56). – LINDSTRÖM, 1877: 10 (in part: eastern Atlantic specimens), pl. 2, figs. 15–17. – POURTALÈS, 1878: 200 (in part: BL-2).
Deltocyathus italicus: MOSELEY, 1881: 145 (in part: Chall-56). – JOURDAN, 1895; 16 (in part). – GRAVIER, 1920: 34 (in part), pl. 3, figs. 45–56.
Deltocyathus sp. B ZIBROWIUS, 1976: 160–162, pl. 52, figs. A–K, pl. 53, figs. A–L.

Description. – The base of the corallum is variable in shape, ranging from flat to almost hemispherical in large specimens. There is usually a slightly indented scar of attachment at the center of the base, but sometimes there is a projecting umbo, or even a short conical pedicel. C_{1-3} are only slightly wider than the C_4. All costae are rounded and extend to the basal scar. At the calicular edge, the costae are separated by very deep furrows, which become progressively shallower toward the scar. The costae bear very fine, pointed granules; those on the lateral surfaces toward the calicular edge are so tall that they often touch those of adjacent costae. The calice is round. The largest specimen measures 16.0 mm in calicular diameter, but 10–11 mm is more typical. The corallum is usually light brown, except for the basal scar and the area surrounding it, which are white. Reddish-brown and pure white coralla are also known.

Septa are arranged in six systems and four cycles in typical *Deltocyathus* fashion. The S_4 are smaller than the S_3 and joined to them very deep in the fossa close to the columella by two–three narrow processes. The inner edges of all septa are straight. The pali that correspond to the S_{1-3} are separated from their corresponding septa by narrow and moderately deep notches. The two P_1 before the principal S_1 are half as large as the other four P_1. P_3 are the most exsert, whereas P_1 are the least exsert pali. Septal and palar granulation consists of high, slender spines; those on the pali are usually

taller (up to three times the thickness of a palus). The septal granules are arranged in radiating lines paralleling the trabeculae.

The columella is usually elliptical, aligned with the principal S_1. It is composed of 10–15 thickened pillars, sometimes slightly clavate, which are fused to one another and to the inner edges of the S_1 and S_2.

Discussion. – This species is unique among the Atlantic species of *Deltocyathus*, being the only one with a basal scar. It is further differentiated by its fine costal granulation and deep intercostal furrows.

Material. – P-610 (2); P-874 (1) UMML 8: 281; P-876 (1) UMML 8: 294; P-931 (1); G-723 (1); GS (G)–40 (1); BL-2 (1) MCZ; Gos-1606 (1); Gos-1641 (1); E-26023 (1) UMML 8: 293. – Lindström's (1877) specimens; Moseley's (1881) specimens. – Types.

Types. – Holotype: P-876 (USNM 46984). – Paratype: P-876 (1) USNM 46985.
Type-Locality. – 13°14'N, 61°05'W (off St. Vincent); 231–258 m.

Distribution. – Western Atlantic: Straits of Florida; off Belize; Windward Group, Lesser Antilles; Bermuda (Map 21). 201–777 m. – Eastern Atlantic: area bounded by Celtic Sea, Azores, and Madeira. 200–1200 m.

38. **Deltocyathus pourtalesi,** new species

Plate XVIII, figures 4–6

Deltocyathus agassizii: POURTALÈS, 1878: 200 (in part: BL-20, 50, 51, 57, 58).
Deltocyathus italicus variety *delta* POURTALÈS, 1880: 103 (in part: BL-101), pl. 1, figs. 6–8.

Description. – The base of the corallum is flat with no scar of attachment, but sometimes a small umbo occurs at the center. The calice is round; the largest specimen measures 14.9 mm in calicular diameter and 6.5 mm tall. C_1 and C_2 are equal in width and only slightly larger than C_3 and C_4, giving the base an equicostate appearance. All but the C_4 reach the center of the base. The costae

have serrated outer edges resulting from large, blunt granules; they also bear smaller, pointed granules laterally. The costae are separated by furrows, which are most deeply incised toward the calicular edge. The upper, outer edges of the septa are usually highly dentate. The corallum is always white.

Septa are arranged in six systems and four complete cycles. S_1 are independent, each septum joining the columella through a tall, wide palus. S_2 are equal in size to the S_1 whereas the S_3 are the smallest septa, joined to the S_2 near the columella by a fusion of their pali. The S_4 are larger and more exsert than the S_3; they fuse solidly with the P_3 above the level of the notch that separates the S_3 from their corresponding pali. All septa are highly exsert because of the very low level of the theca. P_{1-3} are separated from their corresponding septa by deep, narrow notches; usually those notches corresponding to the S_3 are deepest. The two P_1 before the principal S_1 are half as large as the other P_1. The inner edges of all septa are straight to slightly sinuous. The septal and palar granules are widely spaced, randomly arranged, pointed, and about equal to the septal thickness in height.

The columella is elliptical to round and composed of 4–20 irregularly shaped rods fused basally and connected to the inner edges of the S_{1-3}. The level of the columella is higher than the upper thecal edge.

Discussion. – *D. pourtalesi* is distinguished from the other Atlantic species of *Deltocyathus* by its flat base, very low theca, equal costae, and S_4 that are slightly larger than the S_3.

Etymology. – This species is named in honor of L. F. POURTALÈS, who greatly contributed to the knowledge of deep-water corals.

Material. – P-211 (1) USNM 46289, (1) UMML 8: 377; G-56 (1) USNM 46290; G-664 (6) USNM 46291; G-720 (1) USNM 46292; G-721 (1) USNM 46293; BL-20 (25) MCZ; BL-50 (2) MCZ; BL-51 (3) MCZ; BL-57 (11) MCZ; BL-58 (2) MCZ; BL-101 (10) MCZ; Alb-2342 (1) USNM 10235; Gos-1811 (2); Atl-3396 (59) MCZ; Atl-3397 (2) MCZ; Atl-3400 (1) MCZ; Atl-3416 (1) MCZ. – Types.

Types. – Holotype: P-209 (USNM 46883). – Paratypes: P-209 (1) USNM 46884; G-179 (3) USNM 46885, (1) UMML 8: 280; BL, 2 miles (3.2 km) east of Havana, Cuba (5) USNM 19197.
Type-Locality. – 26°59′N, 79°16′W (northern Straits of Florida); 330–450 m.

Distribution. – Off Cuba; Straits of Florida; off South Carolina (Map 25). 311–567 m.

Genus **Stephanocyathus** Seguenza, 1864

Diagnosis. – Solitary, patellate, free. Costae usually present. Paliform lobes usually present on all septa. Columella trabecular, papillose, or fused on surface. Type-species: *Stephanocyathus elegans* Seguenza, 1864, by subsequent designation (WELLS, 1936).

39. **Stephanocyathus (Stephanocyathus) diadema** (Moseley, 1876)

Plate XIX, figures 1–6

Ceratotrochus diadema MOSELEY, 1876: 553–554. – THOMSON, 1878: 113, fig. 30.
? *Ceratotrochus discoides* MOSELEY, 1876: 554.
Flabellum angulare: POURTALÈS, 1878: 203.
Stephanotrochus diadema: POURTALÈS, 1880: 96, 104, pl. 2, fig. 1. – MOSELEY, 1881: 152–153, pl. 3, figs. 1 a–c. – SCLATER, 1886: 130. – AGASSIZ, 1888: 149–150. – TIZARD, *et al.*, 1885; fig. 281.
?*Stephanotrochus discoides*: MOSELEY, 1881: 153–154, pl. 3, figs. 2 a–c.
Not *Stephanotrochus diadema*: JOURDAN, 1895: 18. – ROULE, 1896: 319. – STEPHENS, 1909: 24. – GRAVIER, 1920: 43–51. – THOMPSON, 1931: 9.
Stephanocyathus diadema: GARDINER & WAUGH, 1938: 191. – [BAYER, 1973]: illustrated on Haitian postage stamp, 1.5 gourdes. – ZIBROWIUS, 1976: 165. – CAIRNS, 1977: 87, upper right figure; 1977c: 730–731, figs. 1–2; 1978: 11.
Not *Stephanocyathus diadema*: ZIBROWIUS, SOUTHWARD & DAY, 1975: 100, pl. 3, fig. F (corrected in addendum, p. 100 = *S. moseleyanus*). – SORAUF & PODOFF, 1977: pl. 1, figs. 5–6 (= *S. paliferus*).
Stephanocyathus diadema nobilis: KELLER, 1975: 180, pl. 2, figs. 9 a–b.

Description. – The adult corallum is bowl- or saucer-shaped, free, and rests on a very small, projecting umbo, which is its original point of attachment. Smaller coralla (cd less than than 30 mm) have flat, very thin walls, with a deeply serrated calicular edge. The largest corallum examined measures 64.0 mm in calicular diameter and 33.5 mm in height, making it one of the largest solitary ahermatypic corals in the western Atlantic. About half of the coralla examined are white; the other half are uniformly pink.

C_1 and C_2 are prominent, ridged, and have up to 21 projecting teeth. An average-size specimen (cd = 48 mm) has only 12–14 teeth on each C_1 and C_2, the first tooth occurring about 12 mm from the center of the base. C_3 are sometimes ridged near the calicular edge but rarely have costal teeth. C_4 and C_5 are barely distinguishable. There is no costal granulation.

Septa are arranged in six systems and five cycles. The calicular edge is jagged because the theca forms a point corresponding to every septum, the most projecting points corresponding to the S_1 and S_2. The S_1 are highly exsert and are the only independent septa. The upper margin of each S_1 usually forms a large, exsert lobe, which is reduced in size just below the calicular edge by a wide notch or broad indentation. Toward the columella, the septum enlarges again as a wide paliform lobe. The S_2 are equally as exsert as the S_1 and almost as large; the other cycles are progressively less exsert and smaller. The inner margins of all septa follow the general shape described for the S_1. In each system the inner edges of the two P_3 are united with the P_2 by a spongy extension of the columella. Likewise, the P_4 are connected to the P_3 and the P_5 to the P_4, at distances progressively farther from the columella. The edges of the S_1 are entire; however, those of the higher cycle septa are irregularly dentate. The septa and paliform lobes bear small, blunt granules arranged in lines oriented parallel to the septal trabeculae.

The columella is elliptical in outline, its longer axis aligned with the principal S_1. It is composed of a solidly fused, granular mass, which is usually flat, sometimes concave. Calcareous deposits of the same texture extend outward from the columella into all six systems, serving to unite the inner edges of the higher cycle septa.

Discussion. – Aspects of the synonymy are discussed in CAIRNS (1977c).

Material. – P-337 (9) USNM 46321; P-338 (8) USNM 46325; P-364 (2) USNM 46318; P-374 (1) USNM 46326; P-391 (2) USNM 46319; P-407 (7) USNM 46322; P-413 (5) USNM 46320; P-636 (2) USNM 46307; P-672 (3) USNM 46323; P-682 (2) USNM 46324; P-741 (3) USNM 46308; P-748 (6) USNM 46309; P-754 (1) USNM 46310; P-830 (1) UMML 8: 312; P-850 (2) USNM 46311; P-1177 (2) USNM 46312; P-1178 (2) USNM 46313, (2) UMML 8: 249; P-1197 (2) USNM 46314; P-1224 (9) USNM 46315; P-1262 (10) USNM 46316; P-1304 (2) USNM 46317; P-1435 (64)

USNM 46329; 31 specimens from 10 Gerda stations in the western Straits of Florida; 267 specimens from 35 Columbus Iselin stations in Exuma Sound, Bahamas; GS-31 (71) USNM 46306, (13) UMML 8: 313; O-1302 (2); O-2202 (1); O-2575 (3); O-2813 (3); O-2814 (5) USNM 53397; O-2820 (13) USNM 53371; O-3562 (5); O-3659 (2); O-3663 (1); O-3664 (11); O-3666 (1); O-4430 (4) USNM 53372; O-4570 (5); O-5639 (2); O-10875 (5); O-10876 (4); O-10877 (7); O-10878 (6); O-10897 (2); O-11240 (3); BL-46 (1) MCZ; BL-111 (2) MCZ; BL-173 (1) MCZ; Alb-2117 (24) USNM 7059; Alb-2384 (6) USNM 10369; Alb-2385 (1); Alb-2392 (5) USNM 10408; Alb-2678 (52) USNM 14555; Alb-2751 (6) USNM 36456; Alb-2754 (1) USNM 36480; Alb-2760 (2) USNM 36422; E-30176 (1); Atl-2992A (3) MCZ; WB-322 (8) USNM 46305; TAMU 65A9–11 (2) TAMU; TAMU 67A5–5D (1) TAMU; TAMU 68A7–13B (2) TAMU; TAMU 70A10–41 (10) TAMU; TAMU 70A10–42 (19) TAMU; Anton Bruun-831 (4) MCZ. – Syntypes of *C. diadema*; holotype of *C. discoides*.

Types. – The lectotype (Chall-120) and paralectotype (Chall-78) of *C. diadema* are both deposited at the BM (1880.11.25.55). The paralectotype of *S. diadema* is small, broken, and outside the geographic range for the species. It is probably *S. moseleyanus* or another species of *Stephanocyathus*. The holotype of *C. discoides* (Chall-120) is also at the BM (1880.11.25.56).
Type-Locality. – 8°37′S, 34°28′W (off Recife, Brazil); 1234 m.

Distribution. – Widespread in Caribbean and eastern Gulf of Mexico, ranging from off South Carolina to off Rio de Janeiro, Brazil (Map 26). 795–2133 m. 3°–8°C, based on 12 records.

40. **Stephanocyathus (Stephanocyathus) paliferus** Cairns, 1977

Plate XIX, figures 7–9, 11

Stephanocyathus elegans: POURTALÈS, 1880: 103 (not *C. elegans* Seguenza, 1864).
Stephanocyathus nobilis: ERHARDT, 1976: 59–61, pl. 1, figs. 1–2.
Stephanocyathus diadema: SORAUF & PODOFF, 1977: pl. 1, figs. 5–6.
Stephanocyathus (*S.*) *paliferus* CAIRNS, 1977c: 731–735, figs. 4–7; 1978: 11.

Description. – The corallum is bowl-shaped, free, and usually has a small scar of attachment at the center of the base, which often incorporates a small piece of substrate into the corallum. The largest specimen examined (the holotype) is 42.0 mm in calicular diameter and 21.0 mm in height. The theca, even of small specimens, is moderately thick and always white.

The costae corresponding to the first two cycles of septa bear up to 12 low, blunt spines, which, in larger specimens, occur only on

the lower face of the corallum, being absent from the calicular edge. Costae corresponding to the higher cycle septa are prominent only near the calicular edge, where they are rounded and slightly convex, separated by broad, shallow, grooves; toward the apex they are indistinguishable or represented by faint lines. The calicular edge is entire.

Septa are arranged in six systems and five cycles, but the last cycle is rarely complete. The holotype has 90 septa; however, two other coralla of lesser calicular diameters have 98 septa. The S_1 are the largest septa, most exsert, and independent of the others. The S_2 are only slightly less exsert; the higher cycle septa are progressively smaller. The rudimentary S_5 are very small, thin, and are usually independent. The inner edges of all septa, except the S_5, are straight and entire. The septa and paliform lobes bear numerous low granules, which are often arranged in poorly-defined lines parallel to the trabeculae.

Each septum but those of the last cycle bears a large paliform lobe, which is separated from its septum by a deep, broad notch. The notch is deeper and narrower in the higher cycle septa. P_1 and P_2 extend to the columella; however, P_2 are usually slightly larger. The two P_1 before the principal S_1 are smaller than the other P_1. P_3, about the same size as the P_2, are slightly recessed from the columella. P_4, equal in size to the P_1, are recessed even farther from the columella. Within each system, the P_4 unite with the P_3 and the P_3 with the P_2 by a solid fusion of their lower, inner edges.

The columella is elongated along an axis defined by the principal S_1. It is composed of numerous distinct pillars, which usually remain individualized but sometimes fuse into a more solid structure. The columellar elements are basally fused among themselves and to the adjacent P_1 and P_2. The columella is sometimes absent.

Discussion. – *S. paliferus* is easily distinguished from the other Atlantic *Stephanocyathus* by its distinct paliform lobes and well individualized columellar elements. ERHARDT's (1976) record of *S. nobilis* is undoubtedly a small *S. paliferus*.

Material. – P-340 (2) USNM 46448, (2) UMML 8: 316; P-394 (1) USNM 46447; P-445 (2) USNM 46454; P-607 (1) USNM 46449; P-753 (45) USNM 46443, (7)

UMML 8: 277; P-861 (1) USNM 46444; P-889 (1) USNM 46445; P-984 (1) USNM 46446; P-1171 (3) USNM 46450; P-1255 (2) USNM 46451; G-524 (1) USNM 46439; G-967 (1) USNM 46440; G-1012 (10) USNM 46441, (1) UMML 8: 317; G-1015 (1) USNM 46442; O-450 (3) USNM 53364; O-1555 (1) USNM 53369; O-1869 (1) USNM 53403; O-1981 (75); O-1982 (2) USNM 53373; O-1984 (4) USNM 53401; O-1985 (29); O-1989 (115) USNM 53405; O-2774 (1); O-3584 (4); O-3627 (1); O-4203 (1) USNM 46452; O-4226 (3) USNM 46453; O-4421 (5); O-4423 (4); O-4840 (1); O-4907 (9); O-5028 (1); O-5037 (3); O-5636 (7); O-5740 (7); O-5925 (3); O-5930 (15); O-6708 (1); O-6721 (1); O-11290 (1); SB-2475 (7); SB-2488 (1); SB-3513 (4); SB-3514 (4); SB-3515 (19); BL-274 (1) MCZ; BL-280 (1) MCZ; BL-281 (1) MCZ; Alb-2143 (3) USNM 7145; Combat-45 (4); Combat-449 (1) USNM 53366; E-43 (1) Cornell; Atl-2985 (3) MCZ; Atl-3344 (3) MCZ; Atl-3439 (2) MCZ. – Types of *S. paliferus*.

Types. – The holotype and 19 paratypes of *S. paliferus* are deposited at the USNM (47755–47759).
Type-Locality. – 23°58′N, 79°17′W (Santaren Channel, Bahamas); 555 m.

Distribution. – Common throughout Caribbean and Bahamas, ranging from off Florida to off the Amazon, Brazil; Campeche Bank, Mexico; off Florida west coast (Map 27). 229–715 m. 11°–19°C, based on eight records.

41. **Stephanocyathus (Stephanocyathus) laevifundus** Cairns, 1977

Plate XIX, figure 10; Plate XX, figures 1–4

Stephanocyathus variabilis: Pourtalès, 1880: 104, pl. 2, fig. 2 (not *Ceratocyathus variabilis* Seguenza, 1864).
Stephanocyathus (*S.*) *laevifundus* Cairns, 1977c: 735–736, figs. 8–12.

Description. – The corallum is discoidal, with a flat or slightly concave base. The center of the base is usually blunt, rarely projecting, and never incorporates any of the substrate. The largest corallum examined measures 46.0 mm in calicular diameter and 17.0 mm in height. The corallum is always white. The base is smooth, sometimes glossy, with only faint lines representing costae radiating from the center. Rarely the C_1 and C_2 are slightly ridged near the upturned edge of the base. Very low, rounded granules are barely distinguishable on the base and do not alter the smooth texture. The calicular margin is not serrate.

Septa are arranged in six systems and five cycles; a complete

fifth cycle is often present in specimens measuring only 25 mm in calicular diameter. S_1 and S_2 are equal in size and highly exsert. The higher cycle septa are progressively smaller and much less exsert. The S_1 and S_5 are independent; each S_1 reaches the columella by a large paliform lobe, whereas the S_5 are rudimentary, reaching the columella as very low ridges. The remaining septa are joined to one another within each system by the inner edges of their paliform lobes: the P_4 to the P_3 and the P_3 to the P_2. The inner edges of all septa, except the S_5, are straight and entire. Septal and palar granulation is similar to that of the two previously discussed species, consisting of small, low, rounded granules arranged in close-set radiating lines parallel to the underlying trabeculae, which are most conspicuous near the septal margin.

All but the last cycle of septa bear paliform lobes, each of which is separated from its corresponding septum by a shallow, broad indentation. P_1 are the largest lobes, closest to the columella, and sometimes thickened on their axial margins. Two of the six P_1, those aligned with the principal septa, are smaller than the four lateral P_1. The paliform lobes of the remaining three cycles are progressively smaller, farther away from the columella, and usually more acute.

The columella is elongated in the axis defined by the principal S_1 and is variable in structure. It is often a low, solidly fused mass but it also can be composed of small, individualized pillars united at their bases.

Discussion. – The most distinctive feature of *S. laevifundus* is its smooth, flat base. Comparisons to other species are made by CAIRNS (1977c).

Material. – P-881 (13) USNM 46382, (3) UMML 8: 380; P-1187 (3) USNM 46383; 98 specimens from 17 Gerda stations in the Straits of Florida, USNM 46365–46381; CI-210 (3) USNM 46384; SB-446 (4); BL-214 (1) MCZ; BL-218 (2) MCZ; Alb-2656 (1) USNM 16069; Alb-2657 (2) USNM 14621; Alb-2658 (4) USNM 14553; Atl-2991A (3) MCZ; Anton Bruun-831 (3) MCZ. – Types of *S. laevifundus*.

Types. – The holotype and 47 paratypes are deposited at the USNM (45751–45753). One paratype is at the UMML (8: 278).

Type-Locality. – 25°05′N, 79°21′W (northern Straits of Florida); 840 m.

Distribution. – Antillean distribution; off Panama (Map 28). 300–1158 m. 5°–7°C, based on three records.

Subgenus **Odontocyathus** Moseley, 1881

Diagnosis. – Like the nominal subgenus but with basal part of one or two cycles of costae (C_1 and C_2) bearing stout spines or tubercles. Type-species: *Platytrochus coronatus* Pourtalès, 1867, by monotypy.

42. **Stephanocyathus (Odontocyathus) coronatus** (Pourtalès, 1867)

Plate XX, figures 5–6, 8–9

Platytrochus coronatus Pourtalès, 1867: 114.
Trochocyathus ? coronatus: Pourtalès, 1871: 14–15, pl. 6, fig. 16. – Moseley, 1876; 550–551. – Pourtalès, 1880: 96, 106.
Odontocyathus coronatus: Moseley, 1881: 148–151, pl. 2, figs. 4a–b, 5a–b, text-fig. – Tizard, *et al.*, 1885: fig. 280.
Stephanocyathus (*Odontocyathus*) *coronatus*: Gardiner & Waugh, 1938: 191. – Zibrowius, 1976: 91. – Cairns, 1977c: 736–738, figs. 13–16; 1978: 11.
Stephanocyathus (*Odontocyathus*) sp. Keller, 1975: 179.

Description. – The corallum has a nearly horizontal base, which bears a small, raised scar of attachment at its center. At the basal diameter between 12–18 mm the wall rises almost vertically, forming an angle of 60°–80° with the plane of the base. The largest corallum examined measures 34.5 mm in calicular diameter, 25.0 mm in basal diameter, and 35.0 mm in height. On the base, the C_1 and C_2 each bear three–four spines, which are progressively larger toward the edge. At the edge of the base each of the 12 costae bears a massive tubercle, sometimes very irregular in shape, measuring up to 9 mm in length. These 12 tubercles project outward, usually forming an expanded base of support. Costae and costal granulation are usually inconspicuous; however, on one well-preserved specimen, low, smooth costae separated by very shallow grooves are present. Low,

round granules are closely arranged such that six–seven occur across the width of a costa.

Septa are arranged in six systems and five cycles, but the last cycle is never complete; a corallum rarely has over 72 septa. S_1 and S_2 are the largest septa, equal in size, and highly exsert. The higher cycle septa are progressively smaller and much less exsert. The inner edges of all septa are straight and entire. The septal faces are covered by numerous, very small, low granules arranged in lines parallel to the trabeculae.

Each septum, except the S_5, has a distinct paliform lobe, which is separated from the septum by a deep, broad notch. P_1 and P_2 are closest to the columella, equal in size, and are the smallest, lowest lobes. They are extremely variable in shape: often tall and rounded, standing well above the columella and encircling it, but sometimes elongate and pointed, overhanging the columella. In the extreme case, they are quite long, slender, and pointed, indistinguishable from the columellar elements. Finally, especially in small coralla, the upper edges of the P_1 and P_2 can be horizontal, merging directly with the columella, all at the same level. P_3 are two-three times larger, reach higher in the fossa, and are recessed from the columella. When two S_5 flank an S_4, the S_4 bears a paliform lobe of equal size and height to the P_3, but slightly more recessed from the columella. The P_4 do not reach the columella; instead, their inner edges are loosely joined to the inner edges of the P_3. When an S_4 is not flanked by two S_5, it remains small, rudimentary lower in the fossa, and bears only a slight, sometimes dentate paliform lobe. The P_1 and P_2 form an inner, lower crown of lobes, whereas the P_3 and P_4 form an outer, higher crown.

The columella is small, elongate to round in outline, and quite variable. It may be composed of several poorly individualized, stout rods, which are strongly fused basally or occur as a low, level, spongy mass or as long, slender, contorted rods.

Discussion. – The only other Atlantic *Odontocyathus* is *S. (O.) nobilis* (Moseley, 1873), known from the eastern Atlantic and questionably from the Indian Ocean (Zibrowius, 1976). At the USNM there is a single specimen (Pl. XX 7, 10) that appears to

be *S.* (*O.*) *nobilis* from off Fortaleza, Brazil: 3°22'S, 37°49'W, 763 m (Alb-2756); this would be its first and only record for the western Atlantic. *S.* (*O.*) *coronatus* is distinguished by its more prominent costal tubercles and large paliform lobes.

Material. – P-607 (2) USNM 46476; P-741 (1) USNM 46468; P-754 (1) USNM 46469; P-830 (3) USNM 46470; P-846 (1) USNM 46471; P-892 (2) USNM 46472, (2) UMML 8: 251, 318; P-954 (1) USNM 46473; P-1187 (10) USNM 46474; P-1262 (4) USNM 46475; G-93 (1) USNM 46459, (1) UMML 8: 319; G-131 (2) USNM 46460; G-143 (1) USNM 46461; G-182 (5) USNM 46455, (1) UMML 8: 320; G-187 (1) USNM 46456; G-375 (1) USNM 46462; G-403 (3) USNM 46457; G-448 (1) USNM 46463; G-872 (1) USNM 46464; G-674 (1) USNM 46458; G-1016 (1) USNM 46467; G-1111 (1) USNM 46465; GS-31 (4) USNM 46466; O-3562 (1); O-3573 (1); O-4148 (1); O-4570 (9); O-5639 (7); O-5930 (11); SB-446 (1); BL-141 (1) MCZ; BL-175 (2) MCZ; BL-185 (1) MCZ; Alb-2117 (6) USNM 7062; Alb-2656 (1) USNM 14623; Alb-2750 (5) USNM 36411; Combat-452 (4) USNM 53365; Gos-112/79 (1) Cornell; Gos-112/86 (2) Cornell; E-30176 (3); Atl-2990B (3) MCZ; Atl-2991 (16) MCZ; Atl-2992A (3) MCZ; Atl-2994 (2) MCZ; Atl-2995 (3) MCZ; Atl-3313 (10) MCZ; Atl-3363 (1) MCZ; Atl-3366 (11) MCZ; Atl-3367 (2) MCZ; Atl-3369 (4) MCZ; Atl-3454 (1) MCZ; Atl-3457 (3) MCZ; Atl-3470 (1) MCZ; TAMU 65A9–14 (3) TAMU; TAMU 68A7–13A (1) TAMU; TAMU 70A10–41 (6) TAMU; Anton Bruun-831 (5) MCZ. – Holotype of *P. coronatus*; Moseley's (1881) specimens (BM).

Types. – The small and extremely worn holotype is deposited at the MCZ (2769).
Type-Locality. – 30°41'N, 77°03'W (Blake Plateau, off northern Florida); 841 m.

Distribution. – Throughout the Caribbean and eastern Gulf of Mexico; Bahamas (Map 29). 543–1250 m. 3°–8°C, based on 10 records.

Subfamily Turbinoliinae Milne Edwards & Haime, 1848

Genus **Trematotrochus** T.-Woods, 1879

Diagnosis. – Solitary, ceratoid to cuneiform, perforate, free. Costae prominent with hispid granulation. Three–four cycles of septa, the highest cycle septa often rudimentary but corresponding to well-developed costae. Paliform lobes variable but usually present before S_2. Columella styliform, or fused by union of inner edges of septa and paliform lobes, or slightly compressed. No endotheca or epitheca. Type-species: *Conocyathus fenestratus* T.-Woods, 1878, by monotypy.

Discussion. – When WELLS (1937) established the subgenus *Batotrochus* for *Turbinolia corbicula*, he noted its resemblance to *Trematotrochus* but differentiated *Batotrochus* by its larger columella and lack of paliform lobes. Some of the Atlantis specimens, however, have paliform lobes before the S_2 and the difference in the size of the columella of *T. corbicula* and *T. fenestratus* is not thought to be a generic level character. DENNANT (1899) emended the generic definition to include a wider range of columellar shapes. I have compared *T. corbicula* with 11 topotypic specimens (Pl. XXI 2, 5) and the two syntypes of *T. fenestratus* (Australian Museum, Sydney, Paleontology, F: 1698), all collected from the Balcombian of Muddy Creek, near Hamilton, Victoria, and found the two species to be almost identical. The main difference concerns the costae: the costae of *T. fenestratus* are equal, whereas those of *T. corbicula* alternate in width, the C_3 being twice as broad as the C_1 and C_2. Based on this comparison and the variation found in the Atlantis specimens, *Turbinolia* (*B.*) *corbicula* is transferred to *Trematotrochus*, making *Batotrochus* a junior synonym of *Trematotrochus*.

43. **Trematotrochus corbicula** (Pourtalès, 1878), new comb.

Plate XXI, figures 1, 3–4, 6; Plate XL, figure 10

Turbinolia corbicula POURTALÈS, 1878: 203, pl. 1, figs, 12–13; 1880: 96. – GARDINER & WAUGH, 1938: 171.

Turbinolia (*Batotrochus*) *corbicula*: WELLS, 1937: 239, pl. 1, figs. 3–4. – KELLER, 1975: 176. – CAIRNS, 1978: 11.

Description. – The corallum is free, ceratoid, and very small, rarely exceeding 4 mm in length and 2.4 mm in calicular diameter. The theca is fenestrate (perforate), consisting of 24 hispid costae, which alternate in width, the C_3 being twice as broad as the C_1 and C_2. In each deep intercostal groove, there is a single row of large pores penetrating the theca. Thin, horizontal bars (synapticulae?) between the pores bridge the intercostal space. The C_1 reach the base, whereas the C_2 terminate at about 90% of the distance to the base. Each pair of C_3 unites with a C_2 near the base and extends toward the base for a short distance as one costa. The costae bear

long, narrow, blunt granules on both their outer and lateral edges. The calice is round.

S_1 and S_2 are equal in size, slightly exsert, and extend to the columella. S_3 are rarely developed, but if so, only as small ridges in the upper corallum. The septal faces bear few large, blunt granules.

Some specimens have six small, granulated paliform lobes associated with the inner edges of the S_2. The lobes are closely adjacent to the columella and are separated from the S_2 by deep, wide notches. The fossa is very shallow. The papillose columella is composed of one-five tightly fused elements and is joined by the inner edges of the S_1 and S_2.

Material. – Atl-2987D (10) USNM 46477, (36) MCZ; Atl-2999 (1) MCZ. – Syntypes.

Types. – One syntype from BL-19 (5603) and two from BL-20 (5602) are deposited at the MCZ. An additional syntype from BL-20 is at the BM (1970.1.26.53).
Type-Locality. – Off Bahia Honda, Cuba; 402–567 m.

Distribution. – Known only from off northwestern Cuba (Map 30). 400–576 m.

Genus **Peponocyathus** Gravier, 1915

Diagnosis. – Solitary, free, imperforate. Shape variable, including bowl-shaped, cylindrical, hemispherical, and globose. Presence of pali variable: usually present before S_2 but may be present before all but last cycle. Columella papillose. Type-species: *Peponocyathus variabilis* Gravier, 1915 (= *P. folliculus* (Pourtalès, 1868)), by original designation.

44. **Peponocyathus folliculus** (Pourtalès, 1868)

Plate XXII, figures 1–4

Stephanophyllia folliculus Pourtalès, 1868: 139.
Paracyathus ? folliculus: Pourtalès, 1871: 11–12.
Leptocyathus ? stimpsonii: Lindström, 1877: 9 (in part: 23 out of 26 specimens), specimens), pl. 1, figs. 7–8.

Leptocyathus stimpsonii: POURTALÈS, 1878: 201 (in part: BL-5); 1880: 104 (in part: BL-100).

Peponocyathus variabilis GRAVIER, 1915: 5, figs. 1–2; 1920: 39, pl. 4, figs. 60–73, pl. 13, fig. 202, pl. 14, figs. 203–204.

Trochocyathus (*Peponocyathus*) *variabilis*: VAUGHAN & WELLS, 1943: 205, pl. 41, figs. 9, 9a–b.

Peponocyathus folliculus: ZIBROWIUS, 1976: 178–180, pl. 46, figs. A–L, pl. 47, figs. A–K.

Description. – The corallum is free (only rarely fixed) and is variable in shape. It can be a long or short cylinder, a truncated cone, hemispherical, globose, or even onion-shaped. GRAVIER (1920) illustrated many of its forms under the name of *variabilis*. The calicular diameter is usually exceeded either basally or midway on the corallum. The largest specimen examined measures 7.0 mm in height and 4.5 mm in calicular diameter, but coralla are more typically 3–5 mm high, with a smaller calicular diameter.

In cylindrical specimens there are usually 24 costae, but in more rounded coralla C_4 are often present. The costae are separated by deep, narrow grooves, each costa bearing prominent granules (arranged two–three across a costa), as well as randomly arranged lateral granules that project into the intercostal groove. The costae follow much the same arrangement as in *P. stimpsonii*, differing only in that C_4 are present only in larger coralla and originate laterally, usually halfway between the base and the calice or near the calice.

Septa are arranged in six systems and three cycles; only the largest coralla have distinct S_4. S_1 are the largest and most exsert septa and extend to the columella. S_2 and S_3 are smaller and less exsert than the S_1, but equal in size to each other. Sometimes the inner edges of the S_3 fuse with the S_2. Even though distinct C_4 are sometimes present, S_4 usually are not, or if so, they are developed only in the upper calice as an extension of the costae. The septa and pali are covered with high, blunt granules, which exceed the thickness of a septum in height.

Before each S_2 there is a highly granular palar rod very similar in shape to the columellar elements. The columella is composed of several tuberculated rods, which rest in a very shallow fossa.

Discussion. – *P. folliculus* is similar to *P. stimpsonii* in morphology and geographic and depth ranges. However, it can be differentiated by its highly variable shape (often cylindrical), presence of C_4 without corresponding S_4, lateral origin of C_4 instead of at the base, and the absence of S_4 except in very large individuals. *P. folliculus* is also very similar to *P. orientalis* Yabe & Eguchi, 1932, known from the Pleistocene of Ryukyu. *P. folliculus* differs in being smaller and having less septa.

Material. – BL-2 (2) MCZ; BL-5 (23) MCZ, (3) USNM; BL-100 (6) MCZ; Gos-1590 (6); Hudson-4B (1) NMC. – Holotype of *S. folliculus*; Lindström's (1877) specimens (NRM).

Types. – The holotype of *S. folliculus* is deposited at the MCZ (Bibb-51). Fourteen syntypes of *P. variabilis* are deposited at the MOM (Prince of Monaco station 2214).
Type-Locality. – 24°12'40"N, 81°19'25"W (western Straits of Florida); 433 m.

Distribution. – Western Atlantic: Antillean distribution (Map 30). 284–457 m. – Eastern Atlantic: Azores; the high grounds between Madeira and Portugal. 300–732 m.

45. **Peponocyathus stimpsonii** (Pourtalès, 1871)

Plate XX, figure 11; Plate XXII, figures 5–7

Leptocyathus stimpsonii Pourtalès, 1871: 12, pl. 3, figs. 1–3. – Lindström, 1877: 9 (in part: 3 of 26 specimens), pl. 1, figs. 5–6. – Pourtalès, 1878: 201 (in part: not BL-5); 1880: 104 (in part: not BL-100). – Duncan, 1883: 363.
Deltocyathus italicus: Jourdan, 1895: 16 (in part).
Deltocyathus lens: Gravier, 1920: 36, pl. 3, figs. 47–54, pl. 13, figs. 200–201.
Deltocyathus stimpsoni: Gardiner & Waugh, 1938: 172.
Peponocyathus stimpsonii: Lewis, 1965: 1063. – Zibrowius, 1976: 180–182, pl. 48, figs. A-L. – Cairns, 1977b: 5; 1978: 11.
Notocyathus sp. Lewis, 1965: 1062.
Notocyathus (*Paradeltocyathus*) *orientalis*: Keller, 1975: 178.

Description. – The corallum is hemispherical, rarely exceeds 7 mm in calicular diameter, and is always wider than tall. It is free and sometimes has an irregular, asymmetrical base caused by asexual budding from a parent fragment. Equal costae corresponding to all septa are bordered by very deep, narrow intercostal

grooves. Only the C_1 are independent, reaching the base of the corallum. Each C_3 extends three-fourths of the distance to the center of the base, where it is joined by its two adjacent C_4; this combined costa continues for only a short distance before it joins a C_2 very close to the center of the base. Each costa bears a distinct row of outwardly projecting granules as well as randomly arranged lateral granules, which extend into the intercostal groove.

There is no distinct boundary separating the costae from the septa. The upper costae are so produced and close-set and the septa are so exsert that the upper thecal edge is entirely hidden from view. The septa are arranged in six systems and four cycles. S_1 are the largest, most exsert septa and extend to the columella. The higher cycle septa are progressively smaller and less exsert. The inner edges of the S_4 are usually attached to the P_3 by their lateral septal granules. The septa bear prominent, blunt granules, which are as high as the thickness of a septum. Sometimes the granules fuse into short, vertically oriented carinae at the upper septal edges.

The presence and symmetry of pali are quite variable; usually, however, there are distinct pali at the inner edges of the S_2, appearing as highly tuberculated rods. Less often, there are wider and thinner pali before the S_3. Sometimes, however, pali are missing altogether or they merge indistinguishably with the columella. The columella is composed of six–eight slightly smaller tuberculated rods, which are very similar to the pali in shape. Usually six of the columellar rods are regularly arranged directly before the S_1, resembling pali of the first cycle.

Discussion. – There is confusion about the generic placement of this species and its relative *P. folliculus* (see CAIRNS, 1976) because of overnaming and varying interpretations of the turbinolid genera. A comprehensive generic revision of this subfamily is greatly needed.

P. stimpsonii is extremely similar to the Indo – West Pacific *Notocyathus* (*Paradeltocyathus*) *orientalis* (Duncan, 1876). Further comparisons may show them to be synonymous (Pl. XL 8–9).

DUNCAN (1883) unjustly criticized LINDSTRÖM (1877) in his discussion of *Leptocyathus stimpsonii*. LINDSTRÖM was faulted for not finding pali in front of the S_2 and S_3, as DUNCAN clearly observed

in his specimens. Inasmuch as the variation in distinctness and number of pali in this species is great, I believe that both authors observed correctly.

Material. – G-966 (1) USNM 46478; O-4226 (64); Alb-2665 (4) YPM 8489; Gos-1657 (1); Gos-1735 (1); Gos-1768 (1); BL-20 (2) MCZ; BL-50 (4) MCZ; BL-51 (2) MCZ; BL-253 (1) MCZ; Hassler, off Barbados, 183 m (1) MCZ; MAFLA-2106 (1) FDNR; MAFLA-2957 (1) FDNR; TAMU 65A9–15A (3) TAMU; Hummelinck-1443 (5). – Syntypes of *L. stimpsonii*; Lindström's (1877) specimens (NRM); Lewis's (1965) specimen (USNM 46479).

Types. – Four syntypes (5572) from off Conch Reef, Florida (Bibb-201) are deposited at the MCZ. One syntype from Bibb-201 is at the YPM (4766). The syntype from off Tennessee Reef, Florida (Bibb-181) is missing.
Type-Locality. – Off Florida Keys; 110–293 m.

Distribution. – Western Atlantic: Antillean distribution; Campeche Bank, Mexico; off Florida west coast; off Amazon, Brazil (Map 31). 110–553 m. – Eastern Atlantic: Madeira; Azores. 200–600 m.

Subfamily DESMOPHYLLINAE Vaughan & Wells, 1943

Genus **Desmophyllum** Ehrenberg, 1834

Diagnosis. – Solitary, trochoid, fixed. No pali. Columella absent or very small. Sparse endothecal dissepiments. Type-species: *Desmophyllum dianthus* Ehrenberg, 1834 by subsequent designation (Milne Edwards & Haime, 1850).

46. **Desmophyllum cristagalli** Milne Edwards & Haime, 1848

Plate XXI, figures 7–8; Plate XXII, figure 8

Synonymy incomplete:

Desmophyllum cristagalli MILNE EDWARDS & HAIME, 1848: 253, pl. 7, figs. 10–10a. – DUNCAN, 1873: 321–322, pl. 41, figs. 10–16. – POURTALÈS, 1878: 203 (in part: BL-2); 1880: 96, 106 (in part: BL-288). – VERRILL, 1885: 150. – AGASSIZ, 1888: 151. – JOURDAN, 1895: 22. – ROULE, 1896: 318–319. – MARENZELLER, 1904: 267–268, pl. 15, fig. 2; 1904a: 81. – GOURRET, 1906: 119, pl. 11, fig. 8. – VAUGHAN, 1907: 67–68, pl. 7, figs. 3a–b. – VERRILL, 1908a: 494. – GRAVIER,

1920: 72–76, pl. 8, figs. 130–135. – NOBRE, 1931: 65–66. – HOFFMEISTER, 1933: 8–9, pl. 2, figs. 1–4. – DURHAM, 1949: 158, pl. 10, figs. 2, 4, 7–8. – DURHAM & BARNARD, 1952: 86–87, pl. 11, fig. 48. – SQUIRES, 1958: 91; 1959: 18–20 (in part: Sta. V7–12). – WELLS, 1958: 262. – RALPH & SQUIRES, 1962: 9–10, pl. 3, figs. 1–10. – SQUIRES & KEYES, 1967: 25, pl. 3, figs. 12–14. – BEST, 1969: 310, fig. 11. – SQUIRES, 1969: 16–17, map 1. – LABOREL, 1970: 156. – LIVINGSTON & THOMPSON, 1971: 788. – ZIBROWIUS, 1974a: 758, pl. 3, figs. 1–10. – ZIBROWIUS, SOUTHWARD & DAY, 1975: 98, pl. 4, figs. A–B. – KELLER, 1975: 176. – ZIBROWIUS, 1976: 183–187, pl. 23, figs. A–O, pl. 24, figs. A–M. – SORAUF & JELL, 1977: 2–18, pls. 1–8.

Desmophyllum costatum MILNE EDWARDS & HAIME, 1848: 254.

Desmophyllum cumingii MILNE EDWARDS & HAIME, 1848: 254, pl. 7, fig. 11.

Desmophyllum serpuliforme GRAVIER, 1915: 12, figs. 4–5; 1920: 78, pl. 7, figs. 121–129, pl. 16, fig. 215.

Description. – *D. cristagalli* varies greatly in its corallum shape and diameter of attachment. The corallum is usually greatly flared, with a firm pedicel one-eighth to one-fourth the diameter of the calice, but also can assume a cylindrical shape with a base almost as large as the calice. Some coralla attain a very large size, up to 50 × 80 mm in calicular diameter; elongate, narrower coralla measure up to 20 cm in length. These sizes are exceptional; an average-size specimen containing a full five cycles of septa measures about 45 × 35 mm in calicular diameter and 60–70 mm tall. The shape of the calice is usually round in young specimens, becoming elliptical with greater size. Narrow, ridged costae often correspond to the first three cycles but may be entirely absent. The theca is thick, especially in larger coralla, and covered by low, fine, rounded granules.

Septa are closely arranged in six systems and five cycles. Coralla with calicular diameters ranging from 20–50 mm usually have a complete fifth cycle (96 septa). Coralla larger than 45 mm in calicular diameter often have supplementary S_6. The largest corallum examined (Alb-2781, off Chile) with a calicular diameter of 77.0 × 55.0 mm has 180 septa. S_1 and S_2 are equal in size, exsert, and descend vertically into a very deep fossa. S_3 are smaller and less exsert but are considerably larger than the S_4. The S_4 are equally or less exsert than the S_5 but descend deeper into the fossa. The inner edges of all septa are entire and straight. The septal faces are covered by numerous, very fine granules, which are so low that the face ap-

pears smooth. Occasionally there are large, irregular deposits of stereome on the septal faces.

The fossa is very deep; in those forms that are elongate, sparse endothecal dissepiments are present. A small columella composed of one to several small rods is sometimes present in young specimens. Columellas are rare in larger specimens; none occurred in any of the western Atlantic specimens examined.

Discussion. – Both ALCOCK (1902) and VAUGHAN (1907) suggested that the small specimen described as *Desmophyllum reflexum* Duchassaing & Michelotti, 1860, is synonymous with *D. cristagalli*. The holotype of *D. reflexum* is not present at the MIZS or the MNHNP, and the original description and figures are inadequate to identify the specimen. The brief description of the costal and septal granulation, however, does not agree with that of *D. cristagalli*. I consider *D. reflexum* to be a *species dubia*.

SQUIRES (1959) treated *D. solidum* Pourtalès, 1871, as a junior synonym of *D. cristagalli*. Examination of the holotype shows it to be synonymous with *Thalamophyllia riisei* (Duchassaing & Michelotti) instead.

Material. – G-114 (1) USNM 46480; G-130 (2) USNM 46481; G-311 (1) USNM 46482; G-859 (1) USNM 46483; CI-140 (1) UMML 8: 252; CI-246 (1) USNM 46484; BL-2 (2) MCZ; BL-288 (2) MCZ; Gos-1656 (2); Gos-2150 (2); Gos-2609 (2); E-26017 (1); E-26052 (1); WH-104/68 (1) SME; Atl-260 (1) AMNH; Atl-280–14 (10); Atl-2995 (2) MCZ; Atl-3451 (5) MCZ; TAMU 65A9–4 (1) TAMU; SME-1776 (4) SME. – Holotype of *D. cristagalli*; holotype of *D. serpuliforme*; Marenzeller's (1904a) specimen (USNM 22074); Squires's (1959) specimen (AMNH).

Types. – The holotype of *D. cristagalli* is deposited at the MNHNP. The syntypes of *D. costatum* are probably lost; they cannot be found at the MNHNP or BM. The types of GRAVIER'S *D. serpuliforme* are deposited at the MOM (Prince of Monaco station 1344) (ZIBROWIUS, 1976).
Type-Locality. – Gulf of Gascony; unknown depth.

Distribution. – Western Atlantic: off Nova Scotia; off New Jersey; Muir Seamount; near Kelvin Seamount; Straits of Florida; off Cuba; off Martinique, Lesser Antilles; off southeastern Brazil (Map 32). 155–1939 m. – Elsewhere: widespread in Atlantic, Pacific, Indian, and Antarctic Oceans. 80–2460 m.

47. **Desmophyllum striatum,** new species

Plate XXII, figure 9; Plate XXIII, figures 2–3

Desmophyllum cailetti: LINDSTRÖM, 1877: 12.
Desmophyllum cristagalli: POURTALÈS, 1878: 203 (in part: BL station off Havana, 158 fm = 289 m); 1880: 106 (in part: BL-135).

Description. – The corallum is trochoid with a slightly flared calice. The calice narrows to a thick pedicel with a diameter measuring 40–50% that of the calice. The base may spread out as a thin, translucent layer up to three times the calicular diameter. The largest specimen, the holotype, measures 9.7 × 8.7 mm in calicular diameter and 8.7 mm tall. Low, ridged C_1 and C_2 extend halfway to the base and bear large, blunt granules. Only if S_4 are present in a system are C_3 expressed. There are also very fine (0.2 mm in width), thecal striae oriented perpendicular to the costae. The striae occasionally bifurcate and anastamose; 40–42 parallel striae occur in the holotype. These striae are also found on the base. This thecal ornamentation is identical to that found in three species in the genus *Caryophyllia* (*C. lamellifera*, *C. rugosa*, and *C. corrugata*, n. sp.).

Septa are arranged in six systems and four cycles; the last cycle is never complete. The holotype has 38 septa. S_1 are highly exsert, thick, and meet in the lower fossa. S_2 are almost as large but less exsert and less thick, and also meet at the bottom of the fossa. Often only two of the four S_4 within a system are developed, in which case the S_3 flanked by two S_4 are enlarged to almost the size of an S_2. Both septa, the S_2 and the accelerated S_3, extend closely parallel toward the center of the fossa. The remaining S_3 (unflanked by S_4) and all S_4 are slightly exsert, small, and do not reach the center of the fossa. Small paliform lobes, not separated from the septa by notches, are present on the lower, inner edges of the S_2 and accelerated S_3. If all four S_4 are developed in a system, the higher cycle septa are progressively and regularly smaller. Very close-set, fine, pointed granules cover the septal faces.

The fossa is narrow and deep, usually without a trace of a columella. However, sometimes the lower, inner edges of the S_1 and S_2 fuse to produce a rudimentary columella.