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CRYPTOTROCHUS, NEW GENUS AND TWO NEW SPECIES OF DEEP-WATER CORALS (SCLERACTINIA: TURBINOLIINAE)

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Abstract.—A new genus in the Turbinoliinae is described: *Cryptotrochus,* characterized by having an imperforate theca, a papillose columella, and well-developed P2. A partial key to the 21 recognized genera of Turbinoliinae shows it to be similar to *Kionotrochus,* but differing in corallum shape and in having well-developed P2. Two widely geographically separated new species are described in this genus: *C. carolinensis,* known only from 320–338 m off North Carolina, and *C. javanus,* known only from 585 m in the Java Sea.

Species of the subfamily Turbinoliinae have small, solitary, unattached coralla that are completely invested by the polyp. This complete investiture of the corallum by soft tissue allows for deep intercostal furrows from the calice to the base, which is characteristic of the subfamily. They are among the smallest of the Scleractinia; one species, *Oryzotrochus stephensoni* Wells, 1959, has an adult calicular diameter of 1.5 mm, and the genus is so named for its resemblance in size and shape to a grain of rice.

There are approximately 118 species of Turbinoliinae attributed to 21 genera, eight of which are exclusively fossil genera. Species in the subfamily are known from the Upper Cretaceous to the Recent and are worldwide in distribution (including the Antarctic), the Recent species recorded from depths of 9–835 m. Some species of Turbinoliinae are known to be interstitial in habitat. Species of Turbinoliinae are most common in the Australian-New Zealand and Indonesian regions, especially in the Miocene; only five species are described from the Atlantic Ocean.

While studying the deep-water coral collection of the R/V *Gosnold* at the National Museum of Natural History (USNM) in 1977, I discovered a species of Turbinoliinae from off North Carolina (*Gosnold* sta. 1811) that was very different from any yet described from the Atlantic but quite similar to an Indo-West Pacific species (i.e., *Notocyathus conicus* (Alcock, 1902)). Thinking that this single lot of specimens might be improperly labelled, I placed it aside. Several years later I discovered a damaged basal part of the same species from *Gosnold* sta. 1841, not far from *Gosnold* sta. 1811.

More recently, I diagnosed two specimens collected from the Java Sea by the R/V *Galathea* as having the same generic attributes. In reviewing all genera of the Turbinoliinae in preparation for a revision of the deep-water Scleractinia of the Philippine Islands (Cairns, in prep.), I determined that the *Gosnold* and *Galathea* samples are two new species and represent a new genus, described herein as *Cryptotrochus.* A key is provided for the imperforate paliferous genera of Turbinoliinae (9 of 21 genera in the subfamily) to help distinguish the new genus.

Order Scleractinia Bourne, 1900
Suborder Caryophylliina Vaughan and Wells, 1943
Family Caryophylliidae Dana, 1846
Subfamily Turbinoliinae Milne Edwards and Haime, 1848

Cryptotrochus, new genus

Diagnosis.—Solitary, conical, free corallum with pointed base. Imperforate theca.

Well-developed, discrete P2. Columella papillose. Ahermatypic.

Discussion.—Among the 21 genera of Turbinoliinae, nine can be characterized as having pali and an imperforate theca (see Key). Of these nine, only two genera have pali restricted to the second-cycle septa (P2): *Kionotrochus* and *Cryptotrochus*. Although the type species of *Kionotrochus, K. suteri* Dennant, 1906, was originally described as lacking pali, and Wells (1956) also defined the genus as lacking pali, Squires (1960) correctly noted that *K. suteri* does, in fact, have small, rod-like P2 that merge almost indistinguishably with the columella (Fig. 13). This is the basic difference between the two genera: *Kionotrochus* has indistinct rod-like P2, whereas *Cryptotrochus* has discrete lamellar P2. Another important difference is corallum shape: *Cryptotrochus* has a conical corallum with a pointed base; *Kionotrochus* has a bowl-shaped corallum with a rounded base (Fig. 14), often the result of transverse division (Squires 1964). Based on corallum shape, it is unlikely that *Cryptotrochus* reproduces by transverse division. Other less important differences are that species of *Cryptotrochus* have highly exsert S1–2 and four cycles of septa, wheras *K. suteri* has moderately exsert septa and only three cycles of septa. *Kionotrochus* was divided into two subgenera by Squires (1960): the nominal subgenus and *K.* (*Cylindrophyllia*). *Cylindrophyllia* is considered to be a junior synonym of *Peponocyathus* (Cairns, in prep.), resulting in *Kionotrochus* s. str. being monotypic. It is endemic to northeastern New Zealand, 48–241 m (Squires & Keyes 1967).

Although not apparent from the key, *Cryptotrochus* is very similar to *Notocyathus,* being similar in size, corallum shape, septal exsertness, costae, and columella. The only point of difference concerns the pali: *Cryptotrochus* has six P2, whereas *Notocyathus* has 12 P3, arranged in 6 V-shaped pairs, the P1 and P2 of *Notocyathus* usually being suppressed in the adult stage.

Two species are assigned to *Cryptotrochus, C. carolinensis* and *C. javanus*; however, two more undescribed species are known from off New Caledonia and the Chesterfield Islands (H. Zibrowius, pers. comm. and examination of specimens). One differs from *C. javanus* in having a more slender corallum, having only one row of granules per costa, and having less prominent pali. It is known from a similar depth range: 555–680 m. The second undescribed species differs from *C. javanus* in having prominent lateral granules on costal edges, S3 almost as large as S2, and highly granular septa. It is known only from 223–345 m.

Etymology.—*Cryptotrochus* is a combination of "*kryptos*" (Greek: hidden, concealed) and "*trochos*" (Greek: wheel), a common suffix of turbinoliid generic names, together alluding to the inconspicuous presence of these small corals, which are only now being described from the Atlantic. The gender is masculine.

Type species.—*Cryptotrochus carolinensis,* n. sp., here designated.

Distribution.—Currently known only from off North Carolina and Java Sea, 320–585 m. Also New Caldonia and Chesterfield Islands, 223–680 m (H. Zibrowius, pers. comm.).

Partial Key to the Genera of Turbinoliinae with Emphasis on the Imperforate Paliferous Genera
(+ denotes exclusively fossil genera)

1. Corallum perforate .....
   +*Turbinolia* Lamarck, 1816; *Conocyathus* Orbigny, 1849; *Trematotrochus* Tenison-Woods, 1879; +*Bothrophoria* Felix, 1909
1′. Corallum imperforate 2
2. Columella absent .....
   .... +*Dominicotrochus* Wells, 1937
2′. Columella present 3
3. Pali absent .....
   Sphenotrochus Milne Edwards and

Haime, 1848; *Platytrochus* Milne Edwards and Haime, 1848; +*Koilotrochus* Tenison-Woods, 1878; *Holcotrochus* Dennant, 1902; +*Sphenotrochopsis* Alloiteau and Tessier, 1958; *Oryzotrochus* Wells, 1959; *Wellsotrochus* Squires, 1960

3′. Pali present 4
4. Only P2 present 5
4′. P1–2 present 6
4″. Pali before all but last cycle of septa (usually P1–3), but P1–2 suppressed in adult *Notocyathus* ... 8
5. P2 fused to columella, obscure; corallum bowl-shaped with rounded base .... *Kionotrochus* Dennant, 1906
5′. P2 independent and prominent; corallum conical with pointed base ..... *Cryptotrochus,* n. gen.
6. Septa correspond to costae; transverse division lacking .... +*Coronocyathus* Alloiteau and Tessier, 1958
6′. Septa alternate with costae; transverse division present 7
7. Corallum discoidal; pali in one crown of 12 elements; columella spongy ..... *Dunocyathus* Tenison-Woods, 1878
7′. Corallum cuneiform; pali in 2 crowns of 10–12 elements; columella papillose .... *Idiotrochus* Wells, 1936
8. Eighteen primary septa .... +*Monticyathus* Alloiteau and Tessier, 1958
8′. Typical hexameral symmetry (S1≥S2>S3>S4) 9
9. P3 fused to one another in V-shaped pairs; P2 usually suppressed in adult; septa independent; corallum conical, with pointed base ..... *Notocyathus* Tenison-Woods, 1880
9′. P3 fused to intermediate P2; P2 well developed; higher cycle septa fuse with lower cycle septa; corallum of variable shape, but never with a pointed base 10
10. Corallum relatively large (adult calicular diameter over 10 mm), cuneiform; P1 well developed .. *Tropidocyathus* Milne Edwards and Haime, 1848
10′. Corallum small (adult calicular diameter less than 8 mm) and of variable shape (e.g., cylindrical, hemispherical); P1 often poorly developed .... *Peponocyathus* Gravier, 1915 (=*Cylindrophyllia* Yabe and Eguchi, 1937)

Cryptotrochus carolinensis, new species
Figs. 1–9

Types.—Holotype: *Gosnold* sta. 1811, USNM 46914.—Paratypes: *Gosnold* sta. 1811 (8) USNM 46915; *Gosnold* sta. 1841 (1) USNM 81082, 33°38.5′N, 76°29.3′W, 338 m. Type locality: *Gosnold* sta. 1811: 33°00.5′N, 77°16.2′W (off Cape Fear, North Carolina), 320 m.

Description.—Corallum conical, with pointed basal angle of 55°–65°, the corallum becoming cylindrical at height of about 5.5 mm. No evidence of asexual regeneration from basal fragments. Largest specimen (holotype) 6.4 mm in calicular diameter and 7.7 mm tall; calice circular. C1–2 measures 0.16–0.17 mm wide at calicular edge; C3–4 narrower, about 0.10 mm wide. Costae separated by intercostal furrows 0.17–0.21 mm wide and about 0.55 mm deep at calicular edge. Each costa bears a unilinear row of outward projecting triangular teeth, each about 0.14 mm in basal width and height, producing a serrate costal edge. Smaller cylindrical granules, 0.09 mm tall and 0.045 mm in diameter, adorn the lateral edges of costae. Costae arranged in typical turbinoliid fashion (Fig. 2): 12 C1–2 origi-

nate at the base, each C2 bifurcating into 2 C3 very close to the base (0.3 mm from epicenter), and each C3 bifurcating into 2 C4 about 1.5 mm from base epicenter, the original C2–3 continuing beyond points of bifurcation. At level of C3–4 bifurcation, the 12 C1–2 abruptly decrease in width to accommodate the doubled number of costae. Theca about 0.15 mm thick; corallum white.

Septa hexamerally arranged in 4 cycles according to the septal formula: S1>S2≥S3>S4. S1 highly exsert (up to 1.4 mm) and extend about 0.8 distance to columella. S1–3 have straight, vertical inner edges and rounded upper edges. S2 less exsert (about 1.1 mm) and extend slightly over ½ distance to columella. Each S2 bordered internally by a large, flat palus (P2), each about 0.60 mm deep and 0.3 mm thick. S3 slightly less exsert than S2 but extend an equal distance to columella, at which point their lower inner edges create a porous fusion with the P2. S4 slightly less exsert than S3 and extend toward columella only about ⅓ the distance, at which point their entire inner edges create a porous fusion with the adjacent S3. Septal faces covered by low (about 0.07 mm tall) triangular granules aligned in rows perpendicular to septal edges (Figs. 7–9). Granulation of pali coarser, with blunt granules up to 0.15 mm tall.

Fossa very shallow to nonextant, containing the 6 P2 and columella. Rounded upper edges of P2 extend above calicular edge but below the upper edges of the S4; inner edges of pali fused to columella. Columella composed of 7–9 tuberculate papillae, fused among themselves and to surrounding pali. Upper edges of columellar papillae stand above upper edges of pali, equally as high as the S4. Pali and columellar elements morphologically discrete.

Discussion.—*C. carolinensis* is distinguished from *C. javanus,* the only other species in the genus, by three characters: 1) the inner edges of the higher-cycle septa of *C. carolinensis* are fused to the lower-cycle septa or pali (S4 to S3, S3 to P2); septa of *C. javanus* are independent, 2) its costae bear a uniserial row of spines; costae of *C. javanus* bear up to three rows of granules per costa at the calicular margin, and 3) its pali have rounded upper edges that do not rise above the level of the columella; the pali of *C. javanus* have slender, pointed upper edges that rise well above the columella.

Etymology.—This species is named *carolinensis* for North Carolina, its type-locality.

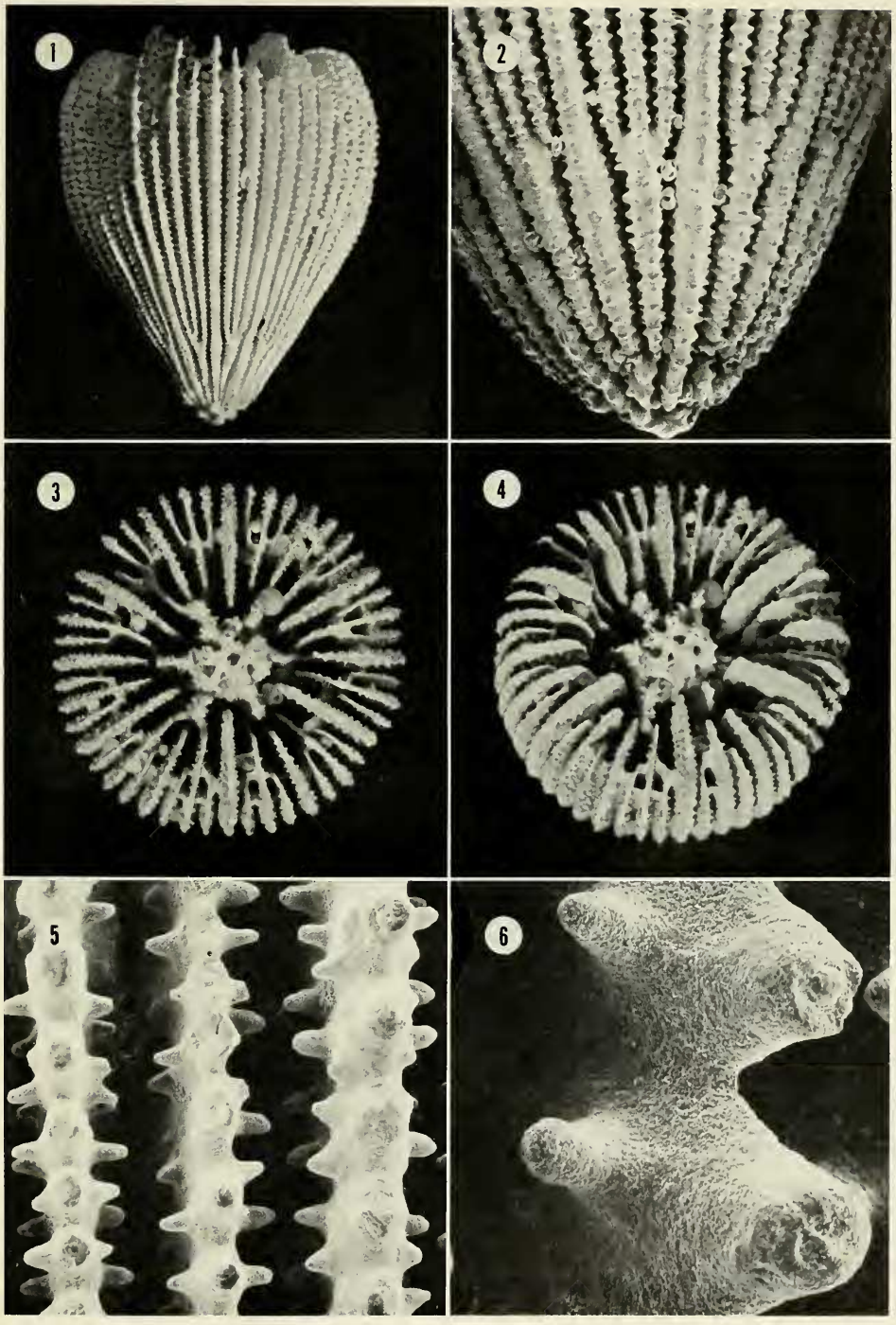
Distribution.—Known only from off Cape Fear, North Carolina, 320–338 m.

Cryptotrochus javanus, new species
Figs. 10–12

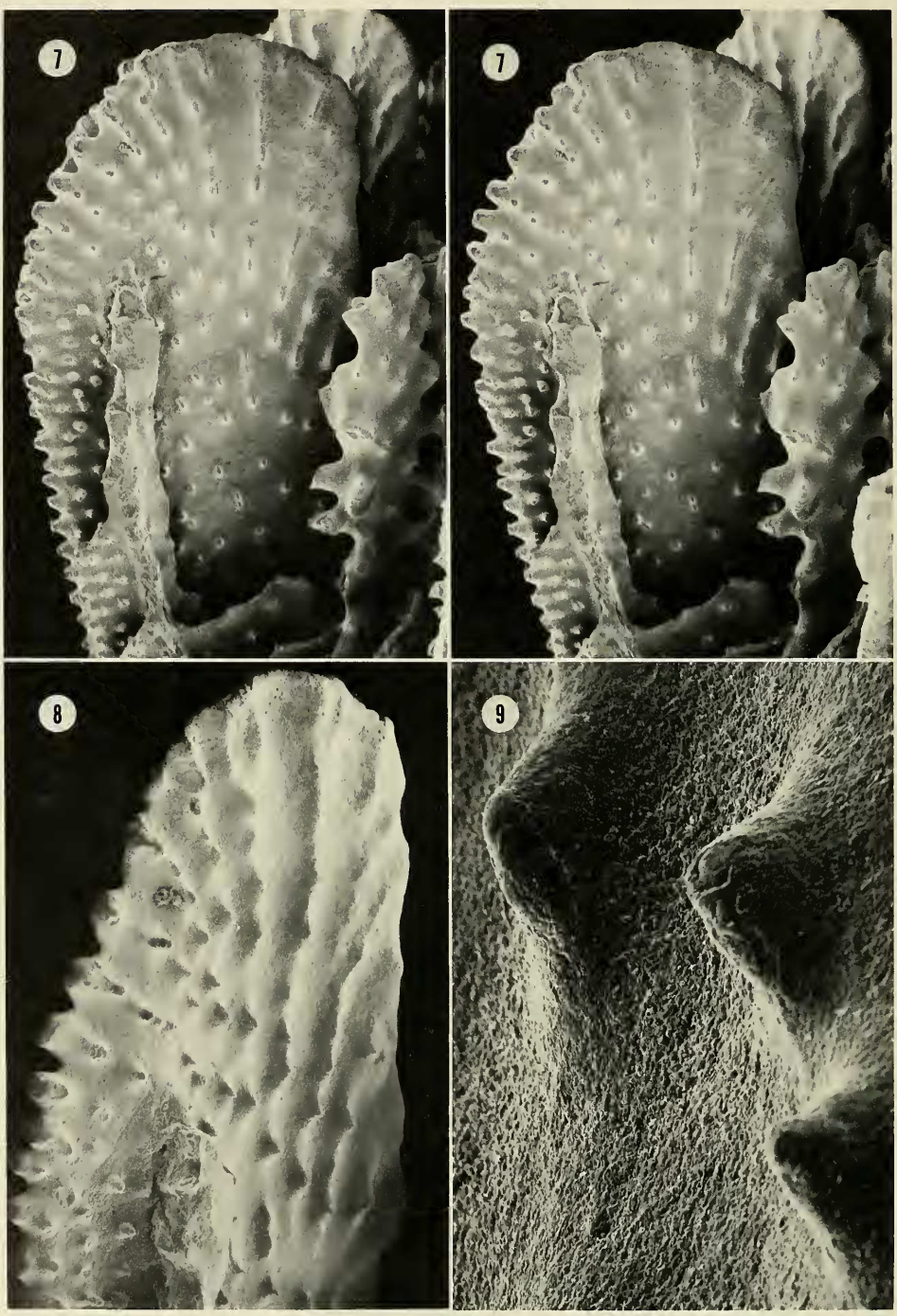
Types.—Holotype: *Galathea* sta. 490, Zoologisk Museum, Copenhagen.—Paratype: *Galathea* sta. 490 (1) Zoologisk Museum, Copenhagen. Type locality: 5°25′S, 117°03′E (eastern Java Sea), 585 m.

Description.—Corallum conical, with a pointed basal angle of 75°, the corallum becoming cylindrical at a height of about 6.0 mm. No evidence of asexual regeneration from basal fragments. Holotype 9.2 mm in calicular diameter and 10.0 mm tall; calice circular. Costae equal in width near calicular edge, about 0.32 mm wide, separated by deep intercostal furrows about 0.18 mm wide and 0.60 mm deep. Basally, each costa bears one row of coarse teeth; several mm from the base epicenter, each costa bears 2 rows of teeth; and near the calicular edge, the C1–2 each bear 3 rows of outward-projecting coarse teeth. Costal arrangement identical to that of *C. carolinensis.* Corallum white.

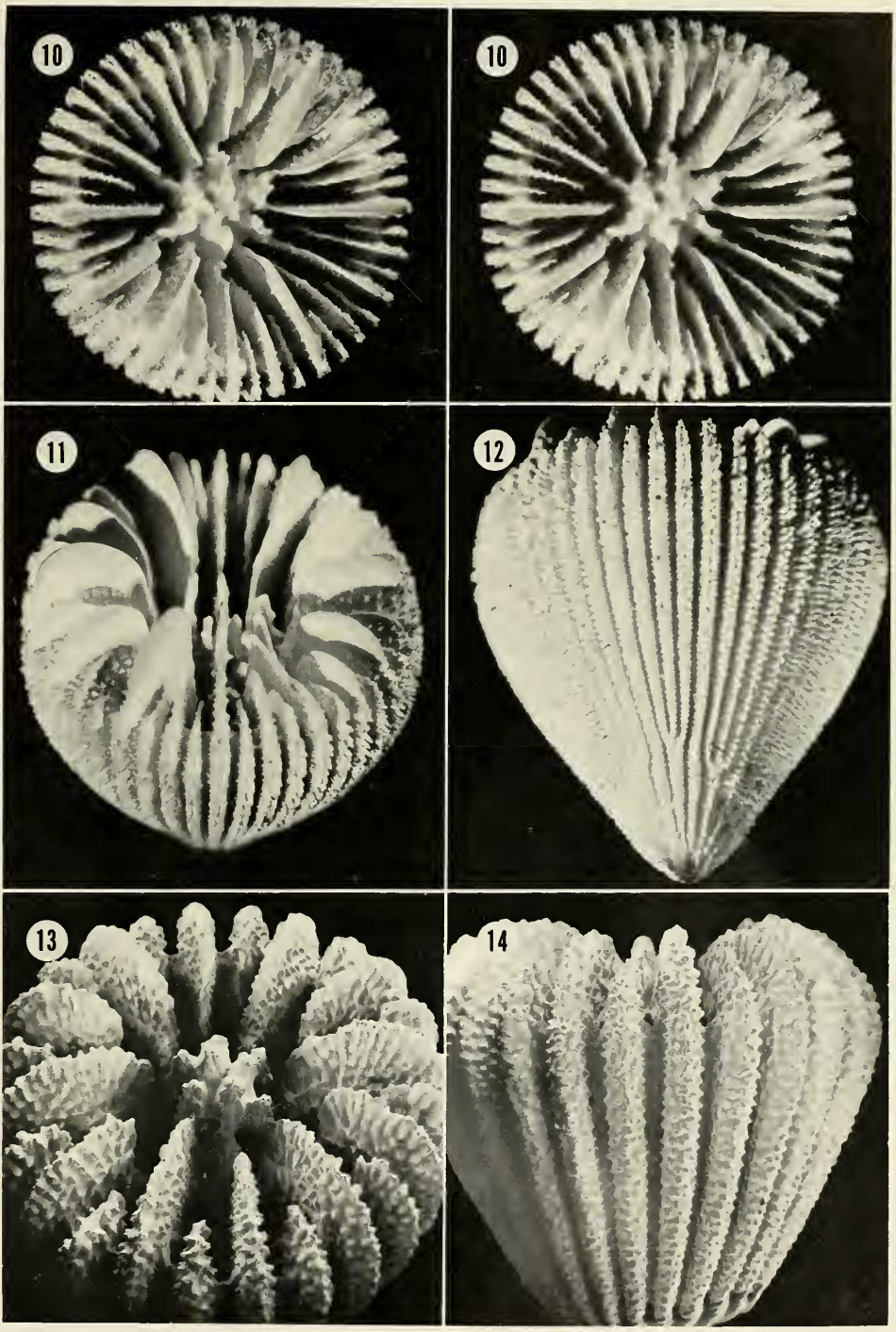
Septa hexamerally arranged in 4 cycles according to the formula: S1>S2>S3>S4. S1 highly exsert (up to 1.5 mm) and extend about 0.8 distance to columella. S1–2 have straight, vertical inner edges and rounded upper edges. S2 slightly less exsert and extend about 0.7 distance to columella. Each S2 bordered internally by a tall, flattened,



Figs. 1–6. *Cryptotrochus carolinensis* (1, 3–4, Holotype, USNM 46914; 2, 5–6, Paratype from *Gosnold* sta. 1811, USNM 46915): 1, Lateral view of holotype, ×7.1; 2, Corallum base showing typical costal bifurcations, ×18; 3–4, Calicular views of holotype, ×7.8; 5–6, Costae, showing large triangular outward projecting teeth and smaller cylindrical lateral granules, ×56, ×202, respectively.



Figs. 7–9. *Cryptotrochus carolinensis,* paratype from *Gosnold* sta. 1811, USNM 46915: 7, Stereo view of broken corallum exposing septocostal face, aligned septal granules, palus, and cross section of theca, ×20; 8, Oblique view of septocostal face, ×34; 9, Enlargement of septal granules, ×260.



Figs. 10–14. (10–12, Holotype of *Cryptotrochus javanus*) 10, Stereo view of calice, ×5.9; 11, oblique view of calice showing relative septal exsertness, ×6.1; 12, Lateral view of corallum showing costal pattern, ×6.6. (13–14, *Kionotrochus suteri,* topotypic specimen from off Cuvier Island, New Zealand, 38 fm (=70 m), USNM 78586) 13–14, Calicular and lateral views, ×12.8, ×14.6, respectively.

sharp palus (P2) having a vertical inner edge. S3 less exsert than S2 and extend about 0.6 distance to columella; their inner edges are slightly sinuous and not fused to any other septa. S4 less exsert than S3 and extend about 0.3 distance to columella; their inner edges also free, not fused to adjacent septa. Upper septal faces smooth, without granulation, but lower septal faces sparsely covered by low pointed granules.

Fossa moderately deep, containing the 6 P2 and columella. Upper edges of pali extend just above calicular edge. Columella composed of 2 papillae, terminating below level of pali.

Discussion.—Comparisons to *C. carolinensis* are made in the account of that species.

Etymology.—This species is named *javanus* for the Java Sea, in reference to its type-locality.

Distribution.—Known only from the type-locality.

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