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New records of the genus *Crispatotrochus* (Scleractinia; Caryophylliidae) from New Caledonia, with description of a new species

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Abstract

During the expeditions Bathus 4 and Norfolk 2 off New Caledonia, three species pertaining to the genus *Crispatotrochus* were collected: *C. rubescens*, *C. rugosus*, and *C. septumdentatus* sp. nov. This study presents the new records describing and illustrating all species. Also, citation synonyms, type locality, type material, and distribution are provided. A brief revision of the 13 valid Recent species belonging to this genus (plus *C.* sp. cf. *C. cornu* and *C.* sp. A) and an identification key are proposed.

Key words: *Crispatotrochus septumdentatus*, deep–sea, stony coral, Scleractinia, azooxanthellate

Introduction

Belonging to the family Caryophylliidae Dana, 1846, the genus *Crispatotrochus* Tenison–Woods, 1878 was described at the end of the 19th century to accomodate the species *C. inortatus* Tenison–Woods, 1878 collected off Port Stephens, Australia, which, as described by the author, differs from *Ceratotrochus* Milne Edwards and Haime, 1848, in being broadly adherent with very simple costae, having a broad and deep fossa, and having small septa (Tenison–Woods 1878). Known from the Miocene (Wells 1956) and with 12 Recent valid species (Table 1), the genus *Crispatotrochus* is recorded worldwide and is characterized by having a ceratoid to turbinate solitary corallum, which is firmly attached through a robust pedicel; theca costate or porcellaneous; septa symmetry hexameral or decameral; pali absent, and columella fascicular and usually robust, composed of 2–30 twisted laths (Cairns 1991).

Unaware of the resemblance to *Crispatotrochus*, three years later (Moseley 1881) described the genus *Cyathoceras* (junior synonym of *Crispatotrochus*) comprising two species: *Crispatotrochus cornu* (= *Cyathoceras cornu* Moseley, 1881), and *Crispatotrochus rubescens* (= *Cyathoceras rubescens* Moseley, 1881), both collected during the voyage of H.M.S. *Challenger*, in the years 1873–1876. Twenty–one years later, using the specimens collected in the Indian Ocean, Alfred Alcock described *Cyathoceras tydemani* Alcock, 1902, and subsequently, Vaughan described *Cyathoceras diomedeae* Vaughan, 1907 from Hawaii, both species being synonymized as *Crispatotrochus rubescens* by Cairns (1991).

The next description of a species belonging to this genus, *C. niinoi* (Yabe and Eguchi, 1942), was made from a single specimen collected in Japanese waters, off Taitô–zaki, Tiba–ken, followed by the description of the rarely collected species from Aleutian Chain, *Crispatotrochus foxi* (Durham and Barnard, 1952), known from only three specimens. Studies on the ahermatypic corals from Queensland, Australia, done by John

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Wells revealed six specimens of one undescribed species belonging to *Crispatotrochus*, the latter named *C. woodsi* (Wells, 1964), being the first species described in the genus to not have more than 40 septa even in adult coralla.

Producing revisions of azooxanthellate corals in many different regions, Stephen Cairns started the richest period of descriptions of new species belonging to this genus (7 new species). The first one, collected from off Georgia to southern Florida, was named *Cyathoceras squiresi* (Cairns, 1979), being followed by *Cyathoceras irregularis* (Cairns, 1982) and *Cyathoceras* sp A (Cairns, 1982), both collected on the Eltanin fracture zone system, Antarctica. The latter, found deeper than any other species of *Crispatotrochus*, but not named due to the examination of just one specimen. In the revision of the corals from Galápagos and Coco Islands *Crispatotrochus galapagensis* Cairns, 1991 was described, and all species up to the date recognized as *Cyathoceras* were transferred to *Crispatotrochus*, which has nomenclatural priority by three years (Cairns 1991). The last three species described in the genus were: *C. curvatus* Cairns, 1995, *C. rugosus* Cairns, 1995, both collected off New Zealand, and *C. gregarius* Cairns, 2004, collected off Gladstone, Australia and known only from the type locality.

TABLE 1. Species of *Crispatotrochus* (chronological description ordered) with their respective junior synonyms and depth range.

Species	Author	Junior Synonyms	Depth Range (m)
Crispatotrochus inortatus	Tenison–Woods, 1878	–	120–400
Crispatotrochus cornu	(Moseley, 1881)	–	220–1097
Crispatotrochus rubescens	(Moseley, 1881)	*Cyathoceras tydemani* Alcock, 1902 *Cyathoceras diomedeae* Vaughan, 1907	110–634
Crispatotrochus niinoi	(Yabe and Eguchi, 1942)	–	104
Crispatotrochus foxi	(Durham and Barnard, 1952)	–	82–272
Crispatotrochus woodsi	(Wells, 1964)	–	77–87
Crispatotrochus squiresi	(Cairns, 1979)	*Aulocyathus* sp. sensu Squires, 1959	686–822
Crispatotrochus sp. cf. *C. cornu*	sensu (Cairns, 1979)	–	220–241
Crispatotrochus irregularis	(Cairns, 1982)	–	549
Crispatotrochus sp. A	sensu (Cairns, 1982)	–	2305–2329
Crispatotrochus galapagensis	Cairns, 1991	–	84–806
Crispatotrochus curvatus	Cairns, 1995	*Gardineria* sp. sensu Gardiner, 1929	1373–2505
Crispatotrochus rugosus	Cairns, 1995	–	142–1050
Crispatotrochus gregarius	Cairns, 2004	–	460
Crispatotrochus septumdentatus	present study	–	187–400

Using part of the material collected by French Expeditions from New Caledonia waters, four species of *Crispatotrochus* were identified. The present study reports all new records of this genus, providing synonymies, type locality, type material, description, distribution, and pictures for all species examined, including the description of one new species collected during Bathus 4 and Norfolk 2 Expeditions. An identification key for all species pertaining to *Crispatotrochus* is proposed.

Material and methods

This study was based on the examination of 19 unreported specimens collected by French expeditions off New Caledonia and adjacent waters during 1993 to 2003 (Fig. 1). These specimens are deposited primarily at the Muséum National d'Histoire Naturelle, Paris (MNHN) and at National Museum of Natural History, Washington D.C. (USNM). For each species identified in the examined material are provided a complete citation synonym, type locality, type material, new records, description, distribution, and illustrations.

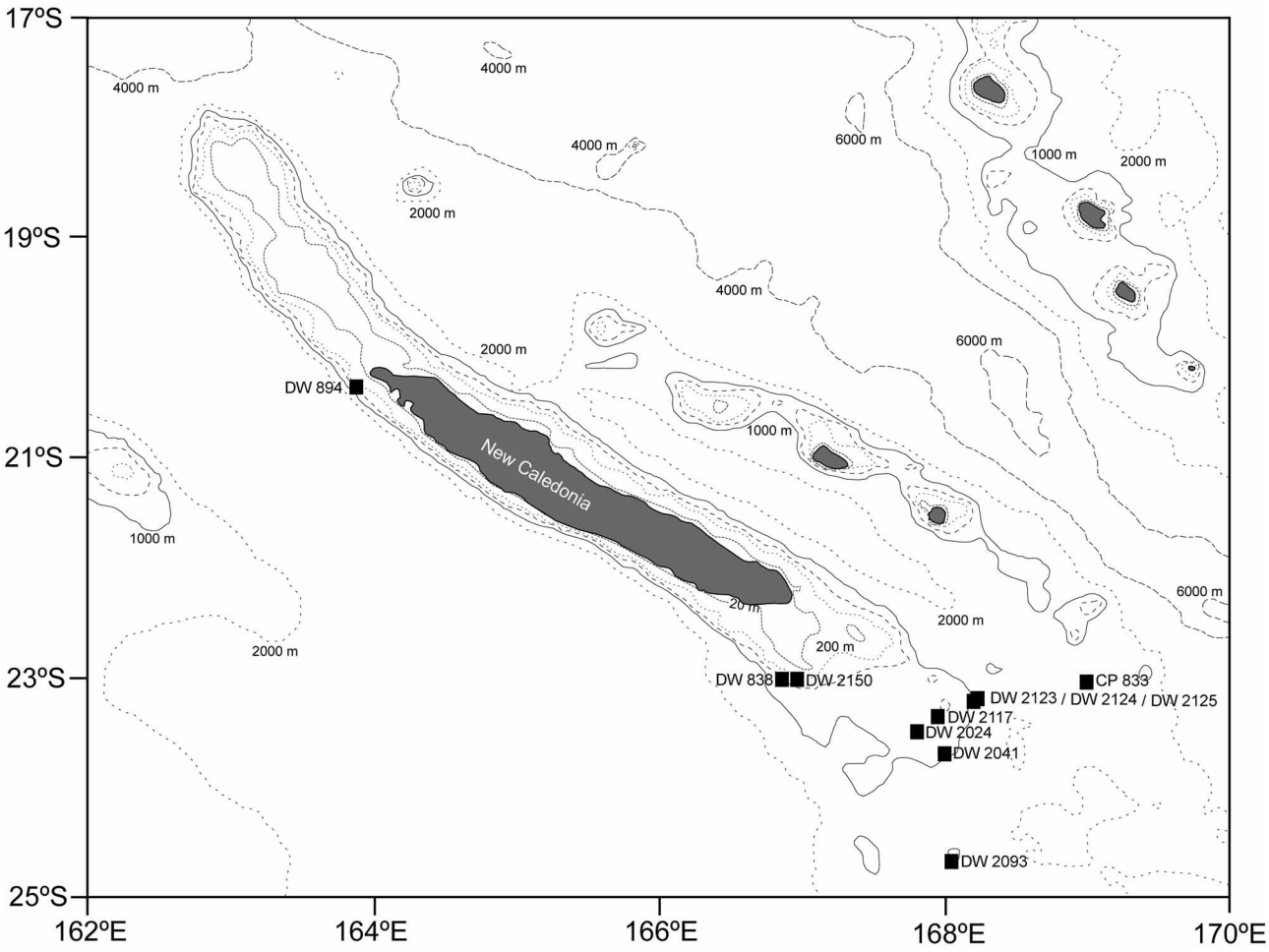

FIGURE 1. Stations with the occurrence of *Crispatotrochus* around New Caledonia (solid squares).

Measurements and counts follow Wells (1956), Zibrowius (1980) and Cairns (1979, 2000). The basic morphological terminology used is explained by Vaughan and Wells (1943), Wells (1956), Alloiteau (1952) and Cairns (1982), and in case of septal formula by Cairns (1989).

Abbreviations: *Morphological*. CD—calicular diameter; GCD—greater calicular diameter; HT—height; LCD—lesser calicular diameter; PD—pedicel diameter; Sx—septa of cycle designated by numerical subscript; Sx>Sy—septa of cycle x wider than those of cycle y; Px—paliform lobes before the septal cycle designated by numerical subscript.

Institutions. USNM—United States National Museum (now National Museum of Natural History); MNHN—Muséum National d'Histoire Naturelle.

Station list:

Expedition	Station	Lat (S)	Long (E)	Depth (m)	Date
Bathus 3	CP 833	23°02.75’	166°58.23'	441–444	30/Nov/1993
Bathus 3	DW 838	23°00.81'	166°55.87'	400–402	30/Nov/1993
Bathus 4	DW 894	20°15.77'	163°52.03'	245–268	03/Aug/1994
Norfolk 2	DW 2024	23°28'	167°51'	370–371	21/Oct/2003
Norfolk 2	DW 2041	23°41'	168°01'	400	23/Oct/2003
Norfolk 2	DW 2093	24°44'	168°09'	230	29/Oct/2003
Norfolk 2	DW 2117	23°24'	168°00'	400	01/Nov/2003
Norfolk 2	DW 2123	23°18'	168°15'	187–197	02/Nov/2003
Norfolk 2	DW 2124	23°18'	168°15'	260–270	02/Nov/2003
Norfolk 2	DW 2125	23°17'	168°14'	275–348	02/Nov/2003
Norfolk 2	DW 2150	23°01,99'	166°57,03'	245–300	05/Nov/2003

Systematics

Order Scleractinia

Family Caryophylliidae Dana, 1846

Genus *Crispatotrochus* Tenison–Woods, 1878

Crispatotrochus Tenison Woods, 1879: 309. —Cairns, 1991: 15. —Cairns & Parker, 1992: 20. —Cairns, 1994: 22. —Cairns, 1995: 56. —Cairns & Zibrowius, 1997: 103. —Cairns, 1998: 378. —Cairns, 1999: 76.
Cyathoceras Moseley, 1881: 156. —Alcock, 1902a, 93. —Alcock, 1902b: 14. —Vaughan, 1907: 77. —Faustino, 1927: 64. –Wells, 1936: 106. —Vaughan & Wells, 1943: 203, 204. —Wells, 1956: F422. —Squires, 1959: 23. —Wells, 1958: 261. —Squires, 1961: 17. —Wells, 1964: 110. —Cairns, 1982: 22. —Cairns, 1984: 15.

Diagnosis: Corallum solitary, ceratoid to turbinate, and usually attached. Septotheca costate or covered with transverse ridges. Pali absent; columella fascicular composed of discrete, twisted elements.

Type species: *Crispatotrochus inortatus* Tenison–Woods, 1878, by monotypy.

Key to the Recent species of *Crispatotrochus*

1 Septa arranged hexamerally 2
- Septa arranged decamerally 11
2 Pedicel unattached; corallum cornute ..... *Crispatotrochus curvatus*
- Pedicel attached; ceratoid to turbinate 3
3 S1 larger than S2 4
- S1 equal in width to S2 5
4 Theca transverse ridged; S1 and S2 sinuous ..... *Crispatotrochus rugosus*
- Theca not transversed ridge; S1 and S2 not sinuous ..... *Crispatotrochus septumdentatus*
5 S1–2 with sinuous inner edges 6
- S1–2 with straight inner edges 9
6 S3 with sinuous inner edges 7

- S3 with straight inner edges ..... *Crispatotrochus cornu*
7 Columella fused, composed of closely united, poorly defined, twisted ribbons *Crispatotrochus irregularis*
- Columella with well defined columellar elements 8
8 Septa arranged in four complete cycles; fossa nonextant ..... *Crispatotrochus galapagensis*
- Septa arranged in five (complete) or six (incomplete) cycles; fossa moderately deep..... .....*Crispatotrochus rubescens*
9 Costae absent ..... *Crispatotrochus niinoi*
- Costae present (ridged or flat) 10
10 Columella composed of 4–7 broad, twisted laths; S5 present; costae slightly ridged near calicular edge.... ..... *Crispatotrochus foxi*
- Columella composed of 28–32 narrow, twisted laths; S5 absent; costae flat..... *Crispatotrochus inortatus*
11 S1 exsert.....12
- S1 nonexsert ..... *Crispatotrochus squiresi*
12 Last septal cycle with serrate to lacerate inner edges 13
- Last septal cycle with entire inner edges 14
13 GCD = 6..... *Crispatotrochus woodsi*
- GCD > 6..... *C.* sp. cf. *C. cornu* sensu Cairns, 1979
14 Adult stage with more than 3 cycles of septa (>40 septa) ..... *Crispatotrochus gregarius*
- Adult stage with three cycles of septa (= 40 septa) ..... *C.* sp. A *sensu* Cairns, 1982

***Crispatotrochus rubescens* (Moseley, 1881)**
Plate 1, Figs. A–D, F–G

Cyathoceras rubescens Mosely, 1881: 157, pl. 2, figs. 8a–c. —Marenzeller, 1888: 21–22. —Yabe and Eguchi, 1942: 117. —Wells, 1964: 112. —Cairns, 1982: 22. —Cairns, 1984: 5, 15.
Cyathoceras tydemani Alcock, 1902a: 93–94; 1902 b: 14, pl. 1, figs. 7, 7a. —Faustino, 1927: 65, pl. 9, figs. 5–6. —Cairns, 1982: 22.
Cyathoceras diomedeae Vaughan, 1907: 77–78, pl. 7, figs. 1–2. —Vaughan, 1919: 1917, pl. XIII, figs. 2, 2a. —Yabe and Eguchi, 1942: 116–117, pl. 9, fig. 8. —Vaughan and Wells, 1943: 333, pl. 41, figs. 14, 14a. —Wells, 1964: 112. —Cairns, 1982: 22.
Crispatotrochus rubescens —Cairns, 1991: 15; —Cairns, 1994: 22, 51, pl. 22, figs. g–h. —Cairns and Zibrowius, 1997: 103–104, figs. 10a–c. —Cairns, 1999: 76–77. —Cairns *et al*. 1999: 21. —Cairns, 2004: 265, 279–280.

Material examined. Bathus 3 station CP 833, 2 (MNHN-Scl.2008-0041 [1], USNM 1115428 [1]).

Description. Corallum ceratoid, elongate, slightly curved, and flared distally. Pedicel robust ranging from 4.2 to 5.5 mm in diameter (PD:GCD = 0.26–0.31), expanding to a thin encrusting base. Largest specimen examined (USNM 1115428) 21 x 16.8 mm in CD and 37.2 mm in height. Costae more prominent (as low ridges) near calicular edge, fading to pedicel. Theca granular. Corallum white.

Septa hexamerally arranged in five complete cycles according to formula S1–2>S3>S4>S5, but largest specimen displays some rudimentary S6. S1–2 highly exsert, with sinuous vertical axial edges that fuse to columella. S3 four fifths width of S1–2 with slightly less sinuous inner edges. S4 three fourths width of S3, with less sinuous axial edges. S5 half width of S4. S6, if present, rudimentary and present only at calicular margin. Fossa of moderate depth, containing an elongate columella consisting of 4–9 slender, twisted elements.

Remarks. Among the species of *Crispatotrochus* that have 5 complete hexamerally arranged septal cycles (*C. rubescens*, *C. foxi*, and *C. niinoi*), all of which occur in temperate Pacific, *C. rubescens* is distinguished by having sinuous axial septal edges for S1 and S2, and costate theca at least near the calicular margin. One new record reported herein of *C. rubescens* (USNM 1115428) has 96 rudmentary S6, present only near calicular edge.

Type locality. Kai Islands, Banda Sea (5º49'15''S, 132º14'15''E), 236 m.

Type specimens. According to Cairns (1984) the holotype is lost.

Distribution. *New Caledonia*: 23º02.85'S, 166º58.23'E, 441–444 m. Elsewhere: *Wallis and Futuna*; *Vanuatu* – Tanna; *Australia* – off Queensland; *Philippines* –Lubang Island, south of Negros (Bohol Sea), Sulu Archipelago (Sulu Sea); *Indonesia* – Kai Islands (Banda Sea), south of Tanimbar Islands (Arafura Sea), Sumba (Savu Sea); *China* – southern Formosa Strait (south China Sea); *Japan* – Sagami Bay and off Kushimoto (Honshu), Shikoku, and off Koshiki (Kyushu); *Hawaii* – Maui, Moloka'i, O'ahu, and Kaua'i, and Nihoa, Blank, and Brooks Banks; *Christmas Islands*; 110–634 m.

Crispatotrochus rugosus Cairns, 1995

Plate 1, figs. E, H–J, M, S

Crispatotrochus rugosus Cairns, 1995: 57, pl. 13, figs. a–b. —Cairns and Zibrowius, 1997: 104. —Cairns, 1998: 363, 368, 378. —Cairns, 1999: 77, figs. 6 a–b. —Cairns *et al*. 1999: 21. —Cairns, 2004: 265.

Material examined. Bathus 3 station DW 838, 1 (MNHN-Scl.2008-0042); Norfolk 2 stations DW 2024, 5 (MNHN-Scl.2008-0043 [4], USNM 1115430 [1]), DW 2117, 2 (MNHN-Scl.2008-0044 [1], USNM 1115429 [1]), DW 2150, 1 (MNHN-Scl.2008-0045).

Description. Corallum ceratoid, elongate, usually curved, and slightly flared distally. Two specimens attached to an older coralla near the calicular margin. Pedicel robust and massive (PD:GCD = 0.32–0.45), expanding to a thin encrusting base. Largest specimen examined 15.1 x 13.3 mm in calicular diameter and 29 mm in height. Calice slightly elliptical (GCD:LCD = 1.05–1.1), and serrated, however, smallest specimen 4.4 x 4 mm in calicular diameter displays a hexagonal calicular margin with each corner corresponding to each S1. Theca covered with thin transverse ridges, which are more prominent near base. Well preserved coralla bear slightly ridged costae (C1–4) separated by very thin shallow striae. One specimen analysed has C4 broader than C3, which in turn is broader than C1–2. Corallum white, but a specimen from Norfolk 2 DW 2150 has C–1 and upper edges of S1–2 pigmented brown.

Septa hexamerally arranged in four complete cycles according to formula: S1>S2>S3>S4. S1 highly exsert (up to 3 mm), thicker than higher septal cycles, with rounded upper margin, and vertical sinuous axial edges almost reaching columella. S2 less exsert, about four fifths width of S1, and have very sinuous axial edges. The sinuosity of secondaries starts above the sinuosity of the primaries. S3 equal to slightly less exsert, but wider and more sinuous than S4. Usually the sinuosity of tertiaries starts above sinuosity of secondaries. Upper outer edges of S4 fuse to the adjacent S1 or S2, becoming more exsert than S3.

Fossa of moderate depth containing a columella composed of 3–5 slender twisted elements.

Remarks. Only reported from the Pacific Ocean, and grouping with the species with septa hexamerally arranged in four complete cycles (*C. cornu*, *C. curvatus*, *C. galapagensis*, *C. inortatus*, *C. irregularis*, and *C. septumdentatus*), *C. rugosus* is easily distinguished by the presence of transverse ridged theca and the absence of septal teeth in the lower axial septal margin of S1. Among the new records presented herein, one lot (DW 2024, composed of 5 specimens collection number) contains a specimen without twisted elements in the columella. Also in the same lot, two specimens are attached near the calicular margin of dead coralla of the same species, being both curved 90º, with the calices staying in the same orientation as the older coralla. Both older coralla encrusted with bryozoans, barnacles, polychaetes, and stylasterids (?).

Another specimen examined (DW 2150 collection number), displays S1–2 and outer edge of S3, and their corresponding costae (only near calicular margin) dark brown pigmented, the costal pigmentation being less dark, similar to two specimens from NZOI Stn C527, examined by Cairns (1995).

Type locality. Lord Howe Seamount Chain (26º59.7'S, 159º18.9'E), 376 m.

Type specimens. The holotype (NZOI H–625), and the paratypes (NZOI P–1014 [1], NZOI P–1015 [2])

are deposited at the New Zealand Oceanographic Institution, Wellington, and the paratypes (USNM 94124 [1] and USNM 94125 [19]) are deposited at the National Museum of Natural History, Washington D.C.

Distribution. *New Caledonia*: from 23º00.81'S, 166º55.87'E to 23º28'S, 167º51'E, 245–402 m. Elsewhere: *Wallis and Futuna* – Combe and Field Banks; *Vanuatu* – Tanna, Efaté, Epi, and Espiritu Santo; *Australia* – off Cape Leveque (western Australia); *Philippines* – Verde Island Passage; *Malaysia* – Sabah (Celebes Sea); *Kermadec Islands*; *Lord Howe Seamount Chain*; 142–616 m.

***Crispatotrochus septumdentatus*, sp. nov.**
Plate 1, figs. K–L, N–R

Holotype. Norfolk 2 station DW 2124 (MNHN-Scl.2008-0046)

Paratypes. Bathus 4 station DW 894, 1 (MNHN-Scl.2008-0047); Norfolk 2 stations DW 2041, 2 (USNM 1115444), DW 2093, 1 (MNHN-Scl.2008-0048), DW 2117, 1 (MNHN-Scl.2008-0049), DW 2123, 1 (MNHN-Scl.2008-0050), and DW 2125, 1 (MNHN-Scl.2008-0051)

Description. Corallum ceratoid, elongate, curved, and usually slightly flared distally. Corallum attached through a robust pedicel (PD:GCD = 0.32–0.47) and a thin encrusting base of approximately 0.2–0.4 mm in width. Largest specimen analysed (USNM 1115444) 9.4 x 9.0 mm in calicular diameter and 21.5 mm in height. Calice circular to slightly elliptical even in small coralla (GCD:LCD = 1.04–1.15), calicular margin jagged, with high lancets corresponding to fusion of each pair of S4 with their adjacent S1 and smaller lancets to fusion of each pair of S4 with their adjacent S2. All costae ridged near calicular edge, slightly convex, and separated by thin intercostal striae. C1–2 more prominent and usually wider than C3–4, sometimes extending to pedicel. Theca uniformly covered by small pointed granules. Almost all specimens analysed bear some very thin, not uniform, continuous transverse ridges (more prominent in worn specimens). Corallum white.
Septa hexamerally arranged in four cycles according to the formula S1>S2>S3>>S4. S1 most exsert septa (up to 2 mm), and much thicker than higher cycle septa, with straight axial edges that reach and fuse to columella deep in fossa. Some specimens bear septal teeth (?) on S1 just above the fusion point with columella. S2 less exsert (about 1 mm) also with straight axial edges that sometimes fuse to columella. If S2 fuse to columella they also bear septal teeth, however, if not fusing, S2 disappear deep in fossa. S3 about one fourth to half width of S2, slightly sinuous, and commonly have lacerate axial edges. S4 rudimentary, composed of a row of granules, and dimorphic in exsertness. A pair of S4 fuse with each S1–2 near calicular edge forming lancets that alternate in height. Those fused with S1 are almost as exsert as S2, and those fused to S2 are the least exsert septa. Septal faces bear sparse, low, pointed granules.
Fossa deep, containing a large elliptical columella composed of closely grouped, slender ribbons, usually fused into a solid mass.

Remarks. Among the 14 Recent species of *Crispatotrochus*, *C. septumdentatus* is most easily distinguished by the unusual presence of septal teeth on the lower axial edges of S1 and S2, the latter only when fused with the columella. The presence of transverse ridges in some specimens is probably related to the expansion of the tissue over the external part of theca (e.g.: the specimen Bathus 4 station DW 894 has lower 3/4 of corallum very encrusted, being separated from the unencrusted higher part by thin transverse ridges).

Etymology. The species name *septumdentatus* (Latin *septum*, fence, edge, wall, partition + *dentatus*, toothed) refers to the small teeth structures present on the primaries' axial septal margins.

Type locality. New Caledonia region (Norfolk 2 station DW 2124–23º18'S, 168º15'E, 260–270 m).

Distribution. Known only in the New Caledonia region, ranging from 20º15.77'S, 163º52.03'E to 24º44'S, 168º09'E, 187–400 m.

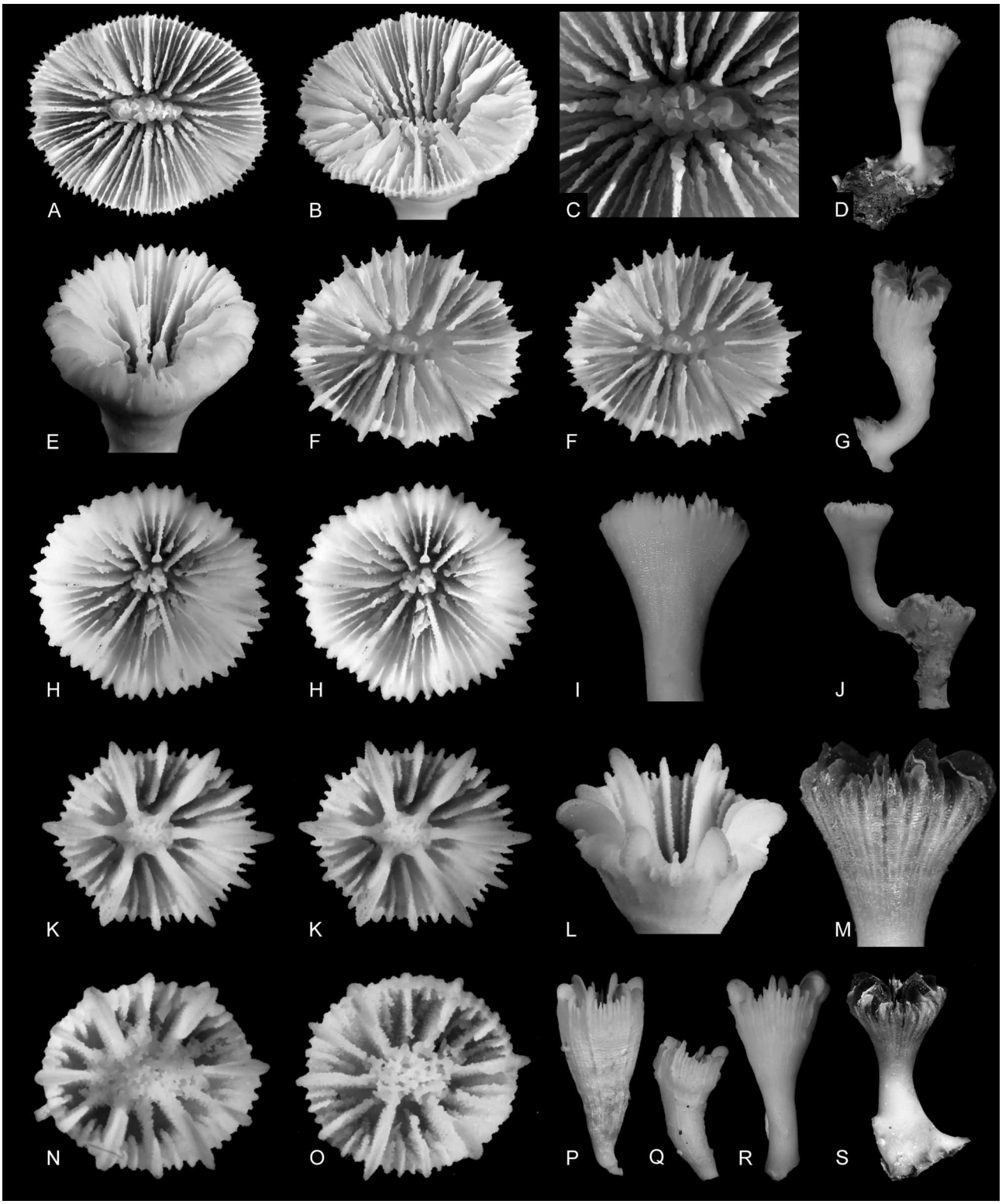

PLATE 1. *Crispatotrochus rubescens* (A–D, F–G): A—calicular view X 1.6, B—oblique calicular view X 1.6, C—detail of columella X 3.5, and D—lateral view X 0.7 of USNM 1115428; F—calicular estereo pair X 2.4, and G—lateral view X 1, of MNHN-Scl.2008-0041. *Crispatotrochus rugosus* (E, H–J, M, S): E—oblique calicular view showing septal exsertnes X 2.8, H—calicular estereo pair X 3.1, I—lateral view X 1.9, and J— lateral view of same specimen showing the attachment near calicular edge of older coralla X 0.9, of USNM 1115430, M—lateral view X 1.9, and S—lateral view showing septal and costal pigmentation X 1.1, of MNHN-Scl.2008-0043. *Crispatotrochus septumdentatus* (K–L, N–R): K—calicular estereo pair of holotype (MNHN-Scl.2008-0046) X 3.7, L—oblique calicular view of holotype X 3.7, N—calicular view of paratype (USNM 1115444) X 3.7, O—calicular view of paratype X 4.6, P, Q, R—lateral views of paratypes (P and Q), and holotype (R), X 1.4, 1.5, 2.1 respectively.

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