Megataxa 019 (1): 001–113
https://www.mapress.com/mt

Article

ISSN 2703-3082 (print edition)
MEGATAXA
ISSN 2703-3090 (online edition)

https://doi.org/10.11646/megataxa.19.1.1
http://zoobank.org/urn:lsid:zoobank.org:pub:5A6A291C-80D0-4415-B982-1F8BC0CCDF44

New genera, species and occurrences of Goniasteridae (Valvatida, Asteroidea) from New Caledonia

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Abstract

The Goniasteridae is the most diverse family of living asteroids, containing the greatest number of described genera and species. Herein, 28 new species, 3 new genera and 19 new records are described from New Caledonia, almost entirely from deep-sea settings (>200 m). An accounting of the goniasterid fauna shows a total of over 70 species, in 38 genera from 3 subfamilies. If this is considered relative to the total known number of goniasterid species, this accounts for nearly 20% of total species and 46% of genera are represented from this region suggesting that the goniasterid diversity in this area is relatively high.

Key words: New Caledonia, deep-sea, mesophotic, New Zealand, taxonomy

Introduction

Comprehensive accounts of marine diversity have estimated up to two thirds of a total 1.0 million marine species remain to be described (Appeltans *et al.*, 2012). Accounts such as those of Bouchet *et al.* (2002) have reported extraordinary molluscan species richness, 2738 species, from New Caledonia. Their estimates for deep-sea mollusks from this region, including New Caledonia and adjacent islands) suggest correspondingly high numbers, 15–20,000 of deep-sea (100–1500 m depth) mollusc species yet to be discovered from New Caledonia and 20–30,000 species for the South Pacific region as a whole (Bouchet *et al.* 2008). Roux (1994) reported on *in situ* observations from the CALSUB cruise on the bathyal slopes off New Caledonia, describing many benthic communities including many suspension feeding echinoderms such as ophiuroids and brisingids.

Echinoderms comprise an ecologically important component of marine ecoystems in shallow and deep-water habitats. Sea star predators such as the Crown of Thorns (*Acanthaster* spp.) occupy important roles affecting coral reefs (e.g. Birkeland & Lucas 1990). Accounts of echinoderms from New Caledonia (e.g. Améziane 2007), especially from shallow-water faunas (e.g., Guille *et al.* 1986) suggest considerable diversity. Stalked crinoids were the earliest of New Caledonian deep-sea echinoderms to be studied (Améziane-Cominardi *et al.* 1987; Bourseau *et al.* 1991). Deep-sea ophiuroids are currently among the most heavily studied (Vadon 1991; O'Hara & Stöhr 2006; Stohr 2011). Ameziane (2007) provided an accounting of echinoderm diversity from New Caledonia.

Jangoux (1984, 1986) summarized and provided an identification key for shallow-water asteroids from New Caledonia, including descriptions of three new species. Jangoux (1981b) was the first to describe a deep-water taxon, 390–395 m, from this region, *Dissogenes petersi.* Mah (1999) redescribed the stemward brisingid *Brisingaster robillardi* as a member of these suspension feeding communities further solidifying the importance of these species in these settings and has described asteroid species shared between New Caledonia and the Eastern Tropical Pacific (Mah 2021) in addition to many new taxa in the Valvatida.

Goniasteridae of New Caledonia

Among the most diverse and most recognizable of asteroid faunas from 200 to 1000 m are members of the Goniasteridae. The Goniasteridae is the most diverse (367 species, 81 genera) of asteroid groups (Mah 2025, Mah & Blake 2012), with many new taxa having been described in only the latter half of the 20th Century, especially from deep-water habitats (e.g. H.E.S. Clark & McKnight 2001, Mah 2017, 2018, 2020, McKnight 2006).

Deeper-water sampling led to additional discoveries. New goniasterid taxa, including 12 new species in 5 new genera and one new subfamily from the New Caledonia region has been based largely on deep-sea collections, including *Iconaster uchelbeluuensis, Glyphodiscus magnificus*, *Glyphodiscus pentagonalis, Eknomiaster beccae,* and *Akelbaster novaecaledoniae* (Mah 2006, 2007). The Ferdininae, established by Mah (2018) included four genera and six newly described species from New Caledonia, including *Kanakaster*, named for the Kanak, New Caledonia's indigenous inhabitants. A new hippasterine, *Hippasteria muscipula* was described by Mah *et al.* (2014). One new genus and three new species of Ophidiasteridae have also been described (Mah 2021).

Submitted: 6 May 2025; accepted by T. Saucède: 7 Dec. 2025; published: 6 Jan. 2026

Material described herein is reported from the collections of Muséum National d'Histoire Naturelle in Paris (MNHN) based on ongoing studies by the author since 1999. O'Hara and Stöhr (2006) presented an historical overview of collections relevant to the echinoderm fauna of New Caledonia. They noted the enormous collection of primarily benthic invertebrates collected by the French Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) and its successor, the l'Institut de Recherche pour le Développement (IRD). This report was motivated by recent New Caledonia material collected during KANADEEP and KANADEEP 2, but also includes material from prior collections.

Materials & Methods

Specimens are deposited in the collections of the Muséum national d'Histoire naturelle (MNHN) in Paris, France. Other specimens referenced are from the National Museum of Natural History (USNM) in Washington, D.C., the California Academy of Sciences in San Francisco, CA (CASIZ), and the Bernice P. Bishop Museum (BPBM) in Honolulu, Hawaii. Taxonomy follows molecular work by Mah & Foltz (2011). Taxonomic composition is summarized by Mah (2024a). Material was studied from MNHN expeditions to New Caledonia including AZTEQUE, BATHUS 1, BATHUS 2, BERYX II, BIOCAL, CHALCAL 2, EXBODI, HALIPRO 1, KANADEEP, KANADEEP 2, KANACONO, LITHIST, MUSORSTOM 4, MUSORSTOM 6, NORFOLK 2, SMIB 3, SMIB 4, SMIB 5, SPANBIOS, TERRASSES, VAUBAN, and ZONECO 6. Specimen preservative status (i.e., dry, wet preserved) is indicated with each lot. Wet specimens are preserved in 80 to 95% ethanol. Based on the scope of material examined, DNA extraction and analysis was beyond the scope of the manuscript herein, but is part of ongoing phylogenetic efforts (Mah, in prep.).

Diagnoses are presented under the family heading. Measurements throughout the manuscript text are in cm. **Boldface** in the Diagnoses follow a format in Marsh & Fromont (2020) emphasizing characters that most readily identify the respective taxon.

GONIASTERIDAE Forbes 1841

Diagnosis

Modified from Mah (2023). Body shape pentagonal to strongly stellate (R/r=1.0 to 4.0), body variably soft to stout, thickness ranging from strongly arched to relatively flat, interradial arcs variably angular to straight. Surface covering ranges from bare and smooth to thick dermis embedded with granulation. Abactinal surface with widely variable range of plate morphologies ranging from discrete polygonal abutted plates, to shaft-like tabulae or paxillae to imbricate or irregularly arranged plates embedded in thick dermis. Plate surface ranges from smooth and bare to a highly variable range of primary ornamentation, such as large spines as well as smaller accessory structures, primarily granules, but also including spinelets, surficial plates and pedicellariae. Pedicellariae present or absent, ranging from bivalve, paddle-like, forceps-shaped and etc. When large pedicellariae present, these tend to be more consistent in location.

Marginal plates, generally blocky, but variably forming well-defined periphery with either lateral or abactinal-facing in two distinct series, superomarginals and inferomarginals, present from terminal to interradius. Marginal plates with variable accessories, such as granules, spineless, or pedicellariae. Some groups with large primary structures such as spines. Marginal plate surface variably covered by dermis or bare. Several genera with abutted superomarginals over midline on arm, variably along whole length or near arm tip. Actinal plates, abutted, quadrate to polygonal or irregular in shape in chevron-like formation with full series adjacent to the adambulacral plate series becoming more irregular distally adjacent to the contact with

the inferomarginal plate series. Actinal plate surface with variable cover of granules, spinelets or pedicellariae. Primary structures such as spines or large pedicellariae present in some taxa. Adambulacral plates with furrow spines, variably narrow to thick, with blunt or pointed tips. Further spination on adambulacrals variably granular to more spine or spinelet like.

Comments

Subfamily groupings within the Goniasteridae has been an ongoing process with multiple attempts to provide structure within this large group. Some subgroupings, such as the Mediasterinae, have fallen out of disuse owing to lack of definition and taxonomic uncertainty. The Pentagonasterinae Perrier was restricted and supported by morphological characters (Mah 2007) which provided a rigorous basis for a previously historical concept. Molecular efforts added several taxa to the traditional composition of the Goniasteridae. Mah & Foltz (2011) surveyed the Valvatacea with molecular phylogenetic data and found that *Fromia* and *Neoferdina*, traditionally members of the Ophidiasteridae, were better placed within the Goniasteridae. Based on those results, Mah (2017) described *Kanakaster* in the subfamily Ferdininae, whose members had historically been thought of as "goniasterid-like" within the Ophidiasteridae before being shown to be otherwise. *Pseudarchaster* and allies were found to be members of the Paxillosida (Mah & Foltz 2011) and will be dealt with elsewhere. Mah (2014) provided support from molecular and morphological data for the Hippasterinae, a group known primarily for cold-water and deep-sea corallivory (e.g. Mah 2022; 2024). Mah (2024) recently separated *Circeaster* and related genera into the Circeasterinae.

The Goniasteridae in New Caledonia

A full listing of goniasterids is summarized in Table 1, including representatives from four recognized

subgroupings within the Goniasteridae, the Circeasterinae, the Hippasterinae, the Ferdininae, and the Pentagonasterinae with the remaining Goniasteridae listed under "Goniasterinae", which herein is considered a term, of convenience as ongoing work on not just the Goniasteridae but affiliated Valvatida, such as the Asterodiscididae (e.g., Mah, 2021) will affect composition and thus, nomenclature. Likely historical subgroupings are considered in the Discussion.

CIRCEASTERINAE Mah 2024 & "Corallivorous Goniasteridae" Clade

Diagnosis for "Circeasterinae"

From Mah (2024). **Body strongly stellate (R/r=3.0–4.0), arms elongate, slender to broad based. Abactinal plates variably flat to weakly convex, covered by large, coarse granules. Abactinal plate surfaces mostly smooth but with large granules, scattered to absent, but notably convex or lacking granules on arms.** Distinctly coarse granules mark periphery. **Arm plates in *Circeaster* and *Atheraster* 2–3x the size of those on the disk but more consistent in size in *Lydiaster* and *Armaster*. Marginal plates blocky, wide, forming prominent border variably bare or with pronounced large conical spine and/or spinelets; granules on plate surfaces, scattered, surfaces otherwise smooth. Actinal surface covered by spinelets or granules.** Adambulacral spination with enlarged, thickened subambulacral spine(s), alveolar pedicellariae with variable morphology but valves spoon to flattened with teeth or prongs. **Furrow spine number, ranging from 6 to 20, mostly 7 to 15.**

Comments on the Circeasterinae and the "Corallivorous Clade" within the Goniasteridae

The Circeasterinae, a subfamily of goniasterids, including *Circeaster* was designated by Mah (2024) including *Armaster, Atheraster*, and *Lydiaster*. All sharing a well-developed stellate body, smooth abactinal plates with marginal and actinal plates bearing spines or projections in many taxa, as well as the presence of alveolar and bivalve pedicellariae and numerous furrow spines (mostly 7 to 15). *Circeaster* and *Atheraster* display enlarged abactinal arm plates relative to those on the disk.

Circeaster and *Atheraster* have been observed *in situ* feeding on deep-sea octocorals, but it has been argued that the shared characters, such as the marginal and actinal spination and prominent pedicellariae, when present, are associated with predation on colonial octocorals (Mah, 2024, 2025) suggesting that all members of the group are corallivorous.

More broadly, all corallivorous Goniasteridae show support for grouping based on molecular phylogenetic analysis of the Valvatacea (Mah & Foltz, 2011), including the Hippasterinae on the same clade as *Calliaster* and *Cladaster*. Other molecular work (Mah *et al.* in prep.) further supports *Circeaster* and related taxa to be closely related, but additional work to clearly establish taxonomic boundaries is ongoing. Further work is in progress to assess the boundaries, if any, between the Circeasterinae the Hippasterinae and other goniasterids that cluster within this lineage.

Many of the taxa within this grouping are identified by the presence of prominent conical spines on the abactinal, marginal and actinal plate surfaces as well as the presence of paddle-shaped or bivalve pedicellariae.

Atheraster Mah, 2022

Mah 2022:25; 2024: 5.

Diagnosis

Body strongly stellate (R/r=3.8–4.0) with arms, elongate and tapering. Abactinal arm plate size 2–3 times those on disk. **Sharp, thorn-like spines, well developed to incipient, on all superomarginal and inferomarginal plates, forming regular series.** Granules with pointed tips. Pedicellariae paddle-like. Furrow spines number 5–15 in known species.

Comments

Atheraster was described by Mah (2022) to accommodate those species of *Circeaster*-like Goniasteridae with spines or weakly expressed spines or a tumescence, as described in Mah (2024). Although not every species has been observed *in situ*, species of *Atheraster*, such as *A. symphonia* have been observed predating on deep-sea octocorals (Mah, 2022).

Atheraster umbo Mah, 2024b

FIGURE 1A–D

Mah 2024b: 10.

Diagnosis

Body stout, strongly stellate (R/r=3.2), arms elongate, triangular, interradial arcs weakly curved to straight (Fig. 1A). Abactinal plates irregular, bare, extending to arm tip. Arm plates variably flat to strongly convex, acutely large relative to adjacent disk plates (Fig. 1B). Pedicellariae abundant, 4–12, along depression in each interradius. Five plates across proximally on arms decreasing to a single series to terminus. **Marginal plates, 40–44 per interradius, 20–22 per arm side, interradially with 2–10 small granules/tubercles, but otherwise smooth and bare** (Fig. 1A)**.** Marginal plates along the arms with single distinct tumescence. Granules coarse, nearly tubercular, most abundant (1–15) interradially on marginal plates, decreasing then absent along arm surface. **Actinal plates with distinct alveolar pedicellariae flanked on either side by bisected hemispherical granules (**Fig. 1D**). Furrow spines 5–15, but mostly seven or eight, with a prominent single tong-like pedicellaria with quadrate valves on each adambulacral plate.** Subambulacral spine, large thick, 2–3 times the thickness of the furrow

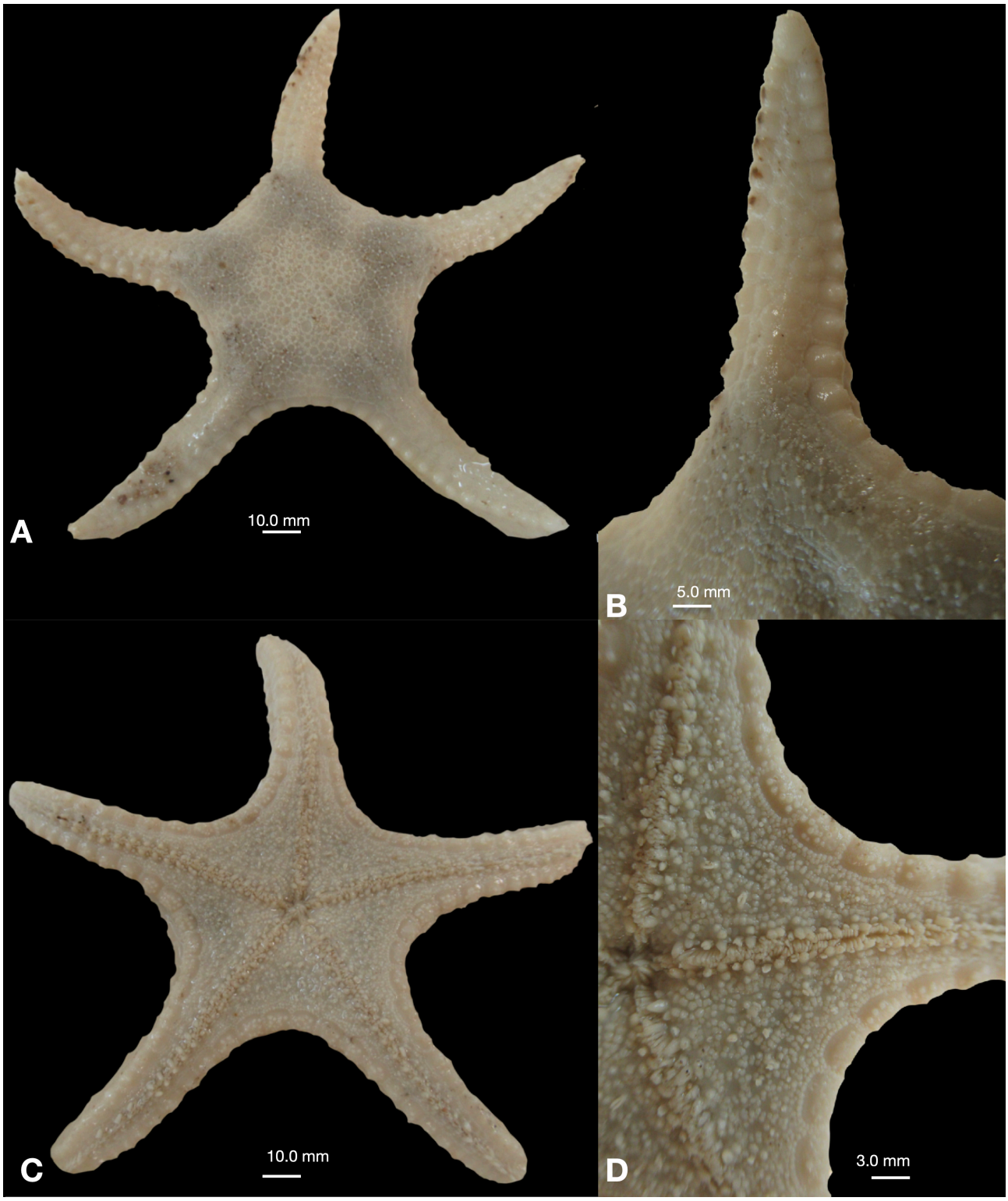

FIGURE 1. ***Atheraster umbo*** Mah, 2024 MNHN IE-2013-7118. A. Abactinal. B. Arm closeup. C. Actinal. D. Actinal surface detail.

spines, identical in length to the longest of the furrow spines, present at oblique angle to pedicellariae. Oral plates, each with large, paddle-shaped pedicellaria per plate, thus two per interradius, but not symmetrically positioned.

Comments

A species that is widely distributed throughout the South Pacific and the Indian Ocean. Marginal plates on this species consistently display only pronounced tumescences (Fig. 1B) rather than fully formed spines suggesting an intermediate form between *Circeaster* and other *Atheraster* species with well-developed marginal

spination. This is the first occurrence of this species from New Caledonia, which is most likely related to its presence at greater depths than have been historically surveyed, 1589–1896 m.

Occurrence/Distribution
New Caledonia, Tasmania, Southeast Cape, Lord Howe Rise, to Cocos (Keeling) Islands Territory, Indian Ocean, Australia. 1896–1589 m.

Material Examined
MNHN IE-2013-7118, New Caledonia, 23º 1.7'S, 168º 9.3'E, 1373– 1407 m. Coll. KANADEEP 2, CP 5108. 1 wet spec, R=5.3, r=1.6.

Circeaster Koehler 1909

Circeaster Koehler, 1909: 83. Halpern 1970a: 265. Downey 1973: 47, 55, pl. 21A, B. Clark & Downey 1992: 237. Clark 1993: 250; Mah 2006: 927; 2024b: 13.

Diagnosis
Body weakly stellate to stellate, R/r > 2.5. Disk strongly arched, large. Arms elongate, tapering. Tips upturned. Interradial arcs linear to curved. **Abactinal arm plates two to three times larger than disk plates, variably changing between gradually to abruptly from disk to arm. Abactinal arm and disk plates bare.** Superomarginal plates abutted over midline in several species. Marginal plates bare, but variably with spinelets or granules present along dorsolateral/ventrolateral edges and surfaces of marginal plates. Spines absent from marginal plates. Greater density of spinelets/granules on inferomarginals than on superomarginals. Adambulacral furrow spines 6–15. Enlarged subambulacral spine or spines present. Prominent, paddle-like, bivalve, or sunken pedicellariae with jagged teeth present on adambulacral plates.

Comments
Circeaster currently includes 10 species, which occur across the Atlantic, Indian and Pacific Oceans in deep-sea settings (320–2160 m). Although not all species have been observed *in situ*, when they have, they are known primarily as predators on colonial octocorals (e.g. Mah 2015, 2020), including members of the Isididae and the Paragorgiidae.

Two species of *Circeaster* are known from the South Pacific, *C. sandrae* and *C. pullus*, both have been collected from New Caledonia (Mah 2006).

Circeaster mandibulum sp. nov.
FIGURE 2A–F

Etymology
The species epithet *mandibulum* is Latin for "jaw" alluding to the pedicellariae present on the adambulacral plates.

Diagnosis
Body stellate, R/r=2.8–3.3, arms elongate. Abactinal plates flat mostly bare with round granules, 10–15, widely distributed on surface. Abactinal plates becoming gradually larger on arms relative to those on disk. The larger specimen with distinctly larger arm plates than on the disk.

Superomarginal plates, 36 to 38, inferomarginal plates 38 to 40 (at R=4.0 to 5.0), abutted along arm, approximately 10–15 plates from arm terminus. Superomarginals forming prominent border, comprising 13–17% of total "r". Surface of marginal plates mostly bare, covered by 20–30 coarse, round granules, widely distributed. Inferomarginal plates covered by similar to identical granules. Nearly every actinal intermediate plate with a single pedicellariae, palm-like shape with wide valves bearing 3 to 5 serrations on each valve. **Pedicellariae especially prominent on actinal plates adjacent to the adambulacral plate series but less abundant in the intermediate region adjacent to the inferomarginal plates.** Distinct, granules, round, 1 to 10 present on each plate surface, widely spaced. Furrow spines 8–15, flattened, blade-like in shape in straight to palmate arrangement. Subambulacral spine absent, but pedicellariae present, each with palmate to clam-shaped valves, 1 or 2 per plate.

Comments
Circeaster mandibulum **sp. nov.** is comparable with *Circeaster loisetteae,* which also has spiny-tipped actinal granules and paddle-shaped pedicellariae with valves bearing serrated edges ('teeth') on the actinal and adambulacral plate surfaces (Fig. 2E, F). However *C. mandibulum* **sp. nov.** is distinguished by the more numerous furrow spines, 8 to 15, which are flattened and blade-like in shape in a palmate arrangement versus the latter *C. loisetteae* with 7 to 8 spines which are quadrate in cross-section. *C. mandibulum* is further distinguished by a prominent single row of enlarged abactinal plates extending along the majority of the arm with abutted superomarginals only at the distalmost tip. *C. loisetteae* has abutted superomarginals beginning at arm base adjacent to the disk.

Circeaster pullus is distinct from *C. mandibulum* **sp. nov.** by the presence of bivalve pedicellariae with nearly smooth valves on the actinal and adambulacral plate surface, which are absent in known specimens of *C. mandibulum*. Furrow spines in *C. pullus* are also smooth and blunt, whereas those in *C. mandibulum* are roughened with a nearly bristle-like texture on the tips of the adambulacral spination (furrow and subambulacral spines). Actinal granules in *C. pullus* are less abundant and more widely spaced relative to *C. mandibulum*, which are crowded and more abundant on each plate. Abactinal plates on *C. mandibulum* show a distinctly larger series of abactinal plates along the arm relative to the disk plates than *C. pullus*, which show a more gradual transition.

Circeaster sandrae shows closer morphological resemblance to *C. mandibulum* in lacking bivalve pedicellariae and in having paddle-shaped pedicellariae

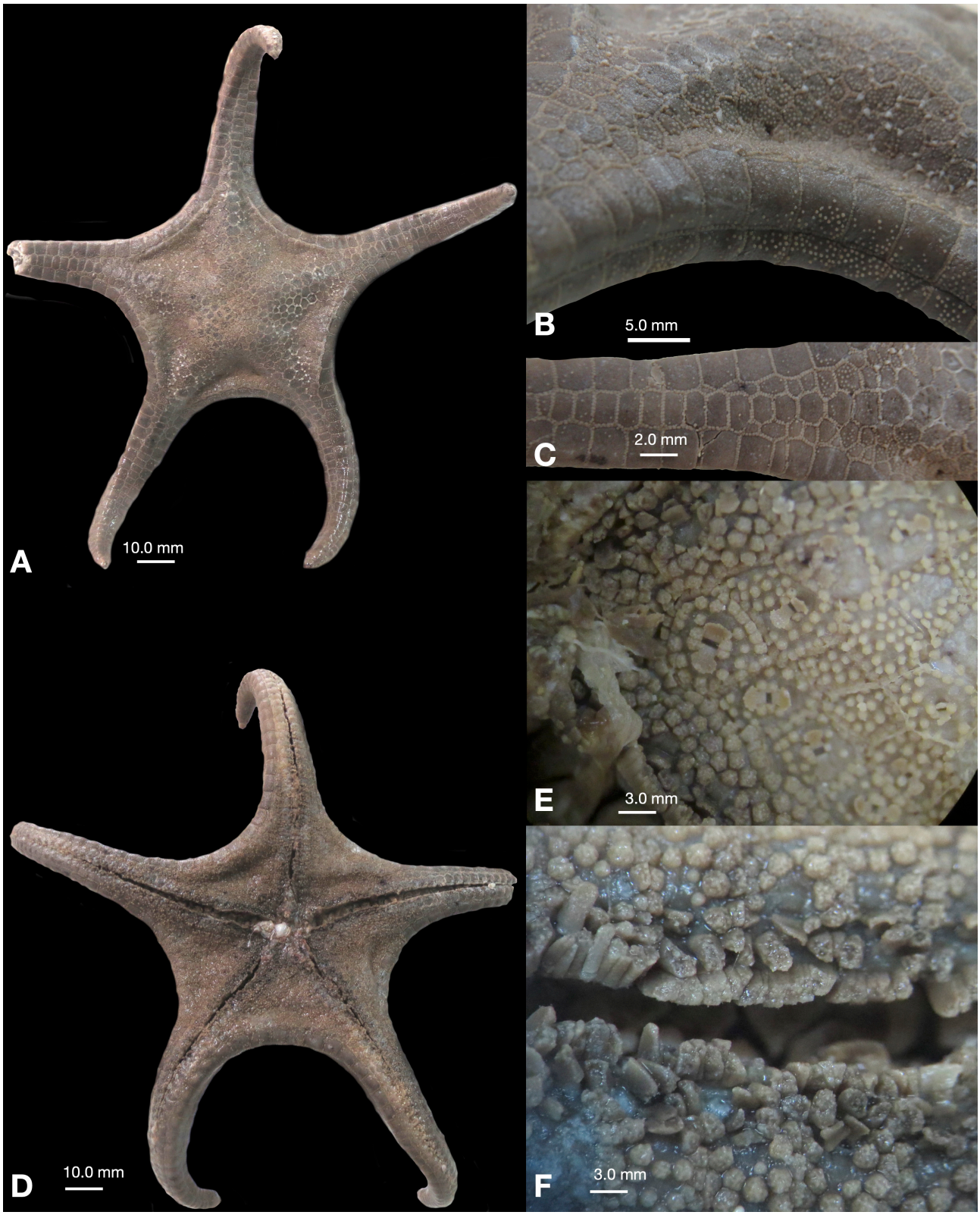

FIGURE 2. ***Circeaster mandibulum*** **sp. nov.** MNHN IE-2013-9786. A. Abactinal. B. Abactinal-lateral view. C. Abactinal-superomarginal arm detail, enlarged plates. D. Actinal. E. Actinal closeup. F. Adambulacral furrow.

with “teeth” or serrations on each valve, but in contrast, *C. mandibulum* shows actinal and adambulacral spination, with roughened to bristle-like tips versus *C. sandrae* with blunt and smooth furrow spines. Circeaster sandrae haș 4 to 8 flattened furrow spines versus 8 to 15 triangular to quadrate furrow spines.

Occurrence/Distribution
New Caledonia, 320–470 m.

Description
Body stout, stellate (R/r=2.8–3.3), arms elongate, distinct, triangular in shape, arms tip rounded (Fig. 2A, D).

Abactinal surface polygonal to irregularly round in shape. Plate surface flat with granules, round, 10–15, widely distributed on each plate, surface is otherwise smooth. Granules absent from arm plates, these areas are bare (Fig. 2C). Abactinal arm plates gradually becoming larger than those on disk (Fig. 2C) with the R=9.7 specimen showing distinctly larger plates than those on the smaller specimen. Papular regions present proximally on arms, absent distally. Madreporite rhombic in shape, flanked by four plates. No pedicellariae.

Superomarginal plates 36 to 38, inferomarginal plates 38 to 40 (at R=4.0 to 5.0) both series offset, forming zig-zag contact. Superomarginal plates wide, quadrate in shape with round angle at abactinal-lateral edge. Superomarginal plates are prominent abactinally, comprising approximately 13 to 17% of disk radius (0.4 to 0.5/2.9). Superomarginal plates abutted over midline, 10–15 distalmost on arm. Individual superomarginal plate surfaces bare on abactinal surface, with round, deciduous granules, 20–30 on lateral side (Fig. 2B). Inferomarginal plate covered with granules, 20 to 60, widely spaced on lateral and actinal surface becoming more abundant adjacent to actinal intermediate plates.

Actinal surface composed of quadrate to polygonal plates in chevron like arrangement with plates adjacent to inferomarginals most irregular in size (Fig. 2D). Nearly every actinal intermediate plate with a single pedicellariae, palm-like shape with wide valves bearing 3 to 5 serrations on each valve. Pedicellariae especially prominent on actinal plates adjacent to the adambulacral plate series but less abundant in the intermediate region adjacent to the inferomarginal plates. Distinct, granules, round, 1 to 10 present on each plate surface, widely spaced. Where pedicellariae absent, granules cover the complete surface.

Furrow spines 8–15, flattened, blade-like in shape in straight to palmate arrangement (Fig. 2F). In the larger specimen (R=9.7, MNHN IE-2013-9786) the spines are much thicker and display a quadrate like cross-section. Subambulacral pedicellariae present with palmate to clam-shaped valves, 1 or 2 per plate, approximately similar to 4 or 5 furrow spines in width. Valves with 4 to 5 teeth on edge. Alveolar depression adjacent to pedicellariae on adambulacral plate in addition small, angular granules, 12–13 similar to those on actinal surface. No subambulacral spines. Oral plate with 15 to 18 furrow spines identical to those on adambulacral plates, i.e. compressed and blade shaped with jagged tips.Two prominent flattened angular spines projecting into mouth presenting a sharply angular appearance projecting into the mouth. Oral plate surface covered by granules, angular in shape with pointed tips, approximately 20–25 per side (40 to 50 total), widely distributed. Diastema between halves weakly developed, irregularly separated by roughened, spiny granules, 10–12 per side.

Material Examined
Holotype. MNHN IE-2013-9786, New Caledonia, 21º30'S 159º24'E, 330–320 m Coll. KANADEEP DW 5001, 18 March 2017 1 wet spec. R=9.7 r=2.9.

Paratype. MNHN IE-2007-7579, New Caledonia, 21º31'S 162º27'E, 747.0 m. Coll. EBISCO CP 2646, 23 Oct 2005, 1 wet spec. R=6.5 r=2.3.

Calliaster Gray 1840

Calliaster Gray 1840: 280; Döderlein 1922: 47; A.M. Clark & Courtman-Stock 1976: 60; A.M. Clark 1993: 246; Gates & Rowe 1995: 64; Mah 2018: 17, Mah, *et al.* 2024: 3.
Astrothauma Fisher 1913: 645; 1919: 320; A.M. Clark 1993: 246; Liao & Clark 1995: 91; Kogure *et al*. 2011: 83.
Mabahissaster Macan 1938: 391; A.M. Clark 1993: 261; Rowe & Gates 1995: 64.

Diagnosis. Arms five, distinct, triangular, elongate in some species. **Conical pointed spines present on abactinal, marginal and actinal plates. Abactinal, marginal and actinal plate surfaces bare and smooth.** Marginal plates abutted in several species, forming a prominent abactinal border in most genera but this varies among species. **Subambulacral spines enlarged, present in transverse series.**

Comments
Calliaster currently includes 17 species distributed across the Indo-Pacific region, occurring primarily at mesophotic to deep-sea depths (approximately 20–600 m). No Atlantic members are known. Aziz & Jangoux (1985) argued for close affinities between *Calliaster, Astrothauma, Mabahissaster* and *Milteliphaster* based on the presence of enlarged transverse, subambulacral spines and enlarged spination present among species in these genera. Unpublished morphology-based phylogenetic analysis of *Calliaster* and these related genera (Mah 2005b) supported these proposed affinities.

A 3 gene-molecular overview of the Valvatacea (Mah & Foltz 2011) showed *Calliaster elegans* and *Milteliphaster* (now *Calliaster*) *wanganellensis* as sister taxa to the Antarctic *Pergamaster* and more broadly to the Hippasterinae, within the Goniasteridae. Although further sampling is necessary, this lends further support to the notion that these species are members of a group. Ecological data for most *Calliaster* species is poorly understood, but nearly all members of the Hippasterinae prey on cnidarians (e.g. Mah 2020) and it is possible *Calliaster* does as well.

Mah (2018) synonymized *Astrothauma* and *Mabahissaster* upon discovering that diagnostic characters were variable and distinctions from *Calliaster* could not be discerned. *Milteliphaster* was argued as distinct but only for the type species, *Milteliphaster woodmasoni*. A further species, *Milteliphaster monstrosus*, compatible with the type species, *M. woodmasoni*, was described by Mah (2022).

H.E.S. Clark & McKnight (2001) described 3 *Calliaster* species, including *Calliaster thompsonae*, *Calliaster erucaradiatus* (=*C. hystrix* herein), and *Milteliphaster* (=*Calliaster*) *wanganellensis* from New Zealand waters.

Key to *Calliaster* in the New Caledonia region

(0) Bivalve pedicellariae present in abundance on actinal and in some, marginal surface (e.g. Fig. 4F). Actinal plates lacking large conical spines. Distalmost 4 to 6 superomarginal plates abutted .....(1)

(0') Pedicellariae paddle-shaped, present or absent. Actinal plates with single, conical spines. Distalmost 8 to 12 superomarginal plates abutted .....(2)

(1) Arms elongate, narrow, R/r=3.33. Superomarginals, forming ~15% of distance "r". Abactinal spination abundant covers entirety of abactinal field, (Fig. 6A, B) proximal region of arm along carinal series up to contact with superomarginal plates. Inferomarginal plates with multiple short spines, 3 to 10 (Fig. 6C, D) ..... ***Calliaster kyros* sp. nov.**

(1') Arms thick, R/r=2.5–3.0. Superomarginals, forming 20–30% of distance "r". Abactinal spines present but only along radial series and primary circlet. Proximal superomarginals with 2 spines, 1 directed dorsally, 1 laterally (Fig. 11A, C, D). Abactinal plates adjacent to superomarginals mostly unarmed. Inferomarginal plates with multiple spines, larger, 3 to 5 ..... ***Calliaster hystrix* sp. nov.**

(2) Actinal plates bare with spines absent (Fig. 4A, B). Abactinal surface largely devoid of spines, save for 1 to 3 present on primary circlet and proximal carinal plates. Marginal plates dorsal surface flat, flush with abactinal plates, broadly quadrate in cross-section..... ..... ***Calliaster nazaninae* sp. nov.**

(2") Actinal plates each with a prominent actinal spine. Disk surface with weakly convex abactinal plates, spines present proximally and interradially with variable abundance. Marginal plates round to swollen in cross-section, tumid to strongly convex surface. Abactinal plates weakly convex, not flush with superomarginal surface.....(3)

(3) Spines present on every abactinal plate (Fig. 5A, C). Superomarginal, inferomarginal plates round, in cross-section (Fig. 5C, D). Proximal superomarginal plates, 3 to 7, not abutted, on disk in contact with abactinal plates at R=2.0 to 6.0 ..... ***Calliaster kanak* sp. nov.**

(3') Spines present on proximal disk plates and in each interradii (Fig. 3A, C, D), but absent from distal plates adjacent to superomarginal contact. Proximal superomarginal plates 10–20, not abutted, on disk in contact with abactinal plates at R=2.0 to 6.0 ..... ***Calliaster aquamontis* sp. nov.**

Calliaster aquamontis sp. nov.

FIGURE 3A–F

Milteliphaster wanganellensis Mah & Foltz 2011: 771

Etymology

The species epithet *aquamontis* is derived from Latin for "water mountain" alluding to this species' collection localities primarily from seamounts.

Diagnosis

Body stellate, R/r=2.4 to 3.2, arms relatively short, triangular. **Spines present on proximal disk plates and in each interradii, but absent from distal plates adjacent to superomarginal contact.** Superomarginals, 19–30 per interradius (arm tip to arm tip, largest at R=7.2, forming approximately 14–15% of diameter "r" (0.5/3.5). Superomarginals with two series of prominent spines, conical, pointed, one series present on the lateral surface in series from arm tip to arm tip. **Each actinal plate with large prominent single spines on each plate with surface otherwise bare and smooth. Approximately 25% of these plates with a paddle-shaped pedicellaria present adjacent to the spine one the plate surface. Pedicellariae, paddle-shaped, but not abundant, present in minority of interradii (2/5).** Furrow spines 6 to 7, subambulacral spines two, variably with conical blunt or flattened, chisel-like tips.

Comments

Calliaster aquamontis **sp. nov.** invited immediate comparison with the New Zealand *Calliaster wanganellensis* (H. L. Clark & McKnight 2001) in sharing similar numbers of furrow spines (5 to 8, mostly 5 to 7 versus 6 to 7 in *Calliaster aquamontis* **sp. nov.**), similar dorsal facing superomarginal plates, subambulacral spines with flattened or leaf-like, tips, and based on the description "1, to 3 or even 5 large tapering spines" on the superomarginal plates. Both *C. aquamontis* **sp. nov.** and *C. wanganellensis* also share paddle-shaped pedicellariae. Specimens of *Calliaster aquamontis* **sp. nov.** were misidentified in Mah & Foltz (2011) as *Milteliphaster wanganellensis*.

However, numerous character differentiate between the two species, including significantly fewer superomarginal and inferomarginal spines, 1 or 2 from a single point (Fig. 3C, D) versus 2 different series in *C. wanganellensis*, significantly fewer abactinal spines on the disk and the arms (Fig. 10B), an indistinct carinal plate series and distalmost abutting superomarginal plates (absent in *C. wanganellensis*).

Calliaster aquamontis **sp. nov.** also shares some character similarities with *Calliaster spinosus* H.L. Clark 1916 from Bass Strait in southern Australian waters with which it shares similar numbers of furrow spines (7 to 8) and relatively few spines on the abactinal surface. However,

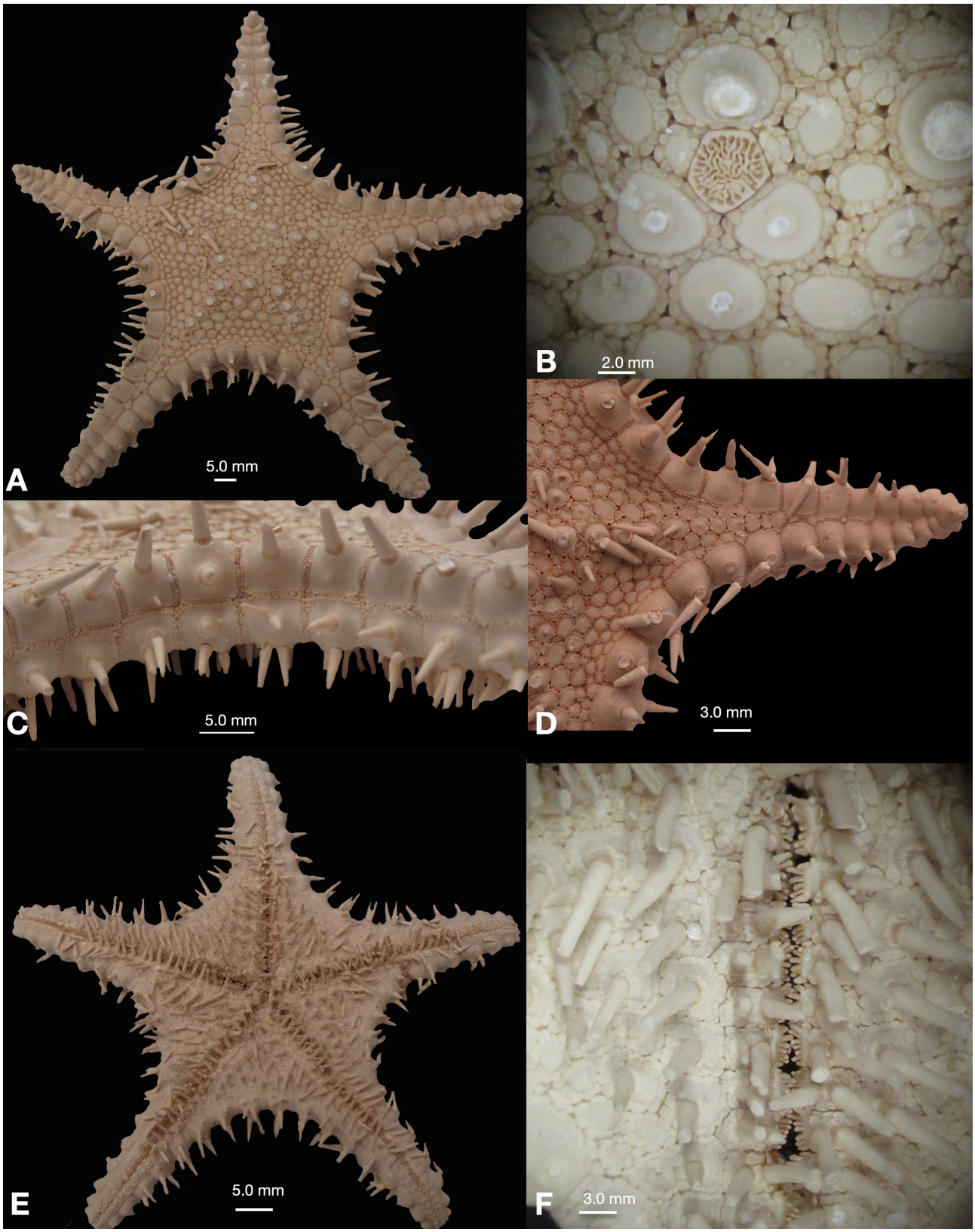

FIGURE 3. ***Calliaster aquamontis*** **sp. nov.** MNHN IE-2018-3803. A. Abactinal. B. Abactinal plate closeup. C. Lateral view. D. Arm plates. E. View. F. Adambulacral furrow spines.

C. spinosus displays enlarged, discrete proximal carinal plates and spines with abactinal plates that extend to the arm tip and has 25–26 marginal plates per arm (50–52 per interradius) at R=14.0 cm versus indiscrete carinal plates (similar in size to other abactinal plates), superomarginal plates abutted approximately 2 to 5 paired plates to the arm tip, and much larger marginal plates with 11–15 per arm, (19–30 per interradius) at R=7.8 cm.

Calliaster aquamontis n sp. also shows resemblance to *Calliaster chaos* Mah 2018 in the Indian Ocean in sharing the overall presence of abactinal spines predominantly on the disk but with spines absent from the arms. It also shares the presence of abutted superomarginal plates distally on the arms and a similar number and type of spine on the superomarginal and inferomarginal plates. *Calliaster chaos* differs in displaying a greater number of furrow spines, 9 to 10 versus 6 to 7 in *Calliaster aquamontis* **sp. nov.** and displays substantially greater numbers of abactinal spines in more irregular arrangement on its disk than *Calliaster aquamontis* **sp. nov.**

Most of the surveyed specimens of this species were collected from seamounts.

Description

Body stellate, R/r=2.4 to 3.2, arms triangular, interradial arcs curved (Fig. 3A, E).

Abactinal plates round to irregularly polygonal (Fig. 10B). Spines, large, cone-shaped, present on primary circulate and along proximal carinal series, absent at arm base (Fig. 3B). Most abactinal plates lacking spines, bare, smooth. Abactinal plates extending onto proximal arm region up to contact with distal superomarginals, 5 to 6, abutted over midline. Granules 5 to 25, mostly 10 to 15, evenly spaced, large, comprising approximately 20% of total diameter (plate+granules) (0.5/2.0 mm). Pedicellariae, paddle-shaped, but not abundant, present in minority of 2/5 interradii on holotype, Madreporite round to polygonal, convex with well-developed sulci, flanked by approximately 4 abactinal plates.

Superomarginals, 19–30 per interradius (arm tip to arm tip, largest at R=7.2, forming approximately 14–15% of diameter "r" (0.5/3.5) (Fig. 3A, D). Superomarginals with two series of prominent spines, conical, pointed, one series present on the lateral surface in series from arm tip to arm tip (Fig. 3A, C, D). One or more distalmost superomarginals adjacent to the terminal, lacking a spine. Second spine series on proximalmost superomarginal plates (i.e. in contact with disk plates) facing dorsally. Superomarginal plates otherwise tumid with smooth surface. Inferomarginal plates similarly with one spine series present in each interradius (arm tip to arm tip) which display an actinolateral facing and a second series adjacent to actinal intermediate region on disk, this latter series with 1 to 4 spines with an actinal facing. One or more pointed tubercles present or absent on these proximal inferomarginal plates. Large granules, evenly spaced, present between superomarginal and inferomarginal plates.

Actinal intermediate regions composed of three full series, and a partial series distally in contact with inferomarginal plates. Actinal plates limited to disk, not extending onto arms. Each plate with large prominent single spines on each plate with surface otherwise bare and smooth. Approximately 25% of these plates with a paddle-shaped pedicellaria present adjacent to the spine one the plate surface (Fig. 3E, F). Actinal plates with peripheral granules, 10–25, large, quadrate to irregularly polygonal in shape, occupying approximately 20% of total distance between peripheral edge and plate center.

Furrow spines 6 to 7, subambulacral spines two, variably with conical blunt or flattened, chisel-like tips (Fig. 3F). Furrow spines set off from subambulacral spines by distinct space. Oral plates with blunt, furrow spines, 5 per side with an elongate blunt spine from each plate projecting into the mouth. Oral plate covered by large granules, block, angular in shape, 4 to 6, closely but not completely covering oral plate surface. Paired granules on either side of the diastema between oral plates on each side of the interradius. Granular surface flat and smooth.

Color of specimens on deck is grey-brown with a dark white actinal surface.

Occurrence/Distribution

New Caledonia, 425–540 m

Material Examined

Holotype. MNHN IE-2019-3803, Banc Antigonia, New Caledonia, 23°16'22.7424"S; 168°0'37.2996"E, 540 m, Coll. Lozouet, Boisselier & Richer-IRD, NORFOLK 1, DW1722, 26 June 2001, 1 dry spec. R=6.4 r=2.4.

Paratypes. MNHN IE-2019-3804, Banc *Stylaster*, New Caledonia, 23°38'1.5576"S; 167°41'56.5836"E, 463–470 m. Coll. Lozouet, Boisselier & Richer-IRD, NORFOLK 1, CP 1660, 2 dry specs, R=7.3 r=2.5, R=7.8 r=2.5.

MNHN IE-2019-3805, Norfolk Ridge, SW Banc *Stylaster*, New Caledonia, 23°40'24.0024"S; 167°45'24.0048"E, 425–470 m. Coll. N/O *Alis*, AZTEQUE, 14 Feb 1990, 2 dry specs. R=7.1 r=2.7, R=7.8 r=2.2.

MNHN IE-2019-3881, Banc *Stylaster*, South New Caledonia, 23º37.4'S 167º42.1'E, 440 m. Coll. Richer de Forges, Campagne LITHIST, N/O *Alis*, st. DW01, 3 dry specs. R=5.6 r=2.4 R=7.2 r=2.5 R=5.1 r=2.3.

***Calliaster hystrix* sp. nov.**

FIGURE 4A–F

Etymology

The species epithet is derived from the Greek *hystrix* for porcupine, alluding to the many marginal spines present on this species.

Diagnosis

Body strongly thick, stellate (R/r=2.54–3.0), arms elongate. **Abactinal plates smooth, bare no surficial accessories (i.e. no granules). Distinct carinal spines present, but interradial areas on disk spineless. Superomarginals, 10–15 abutted along arm, 5 to 8 free on disk. Large**

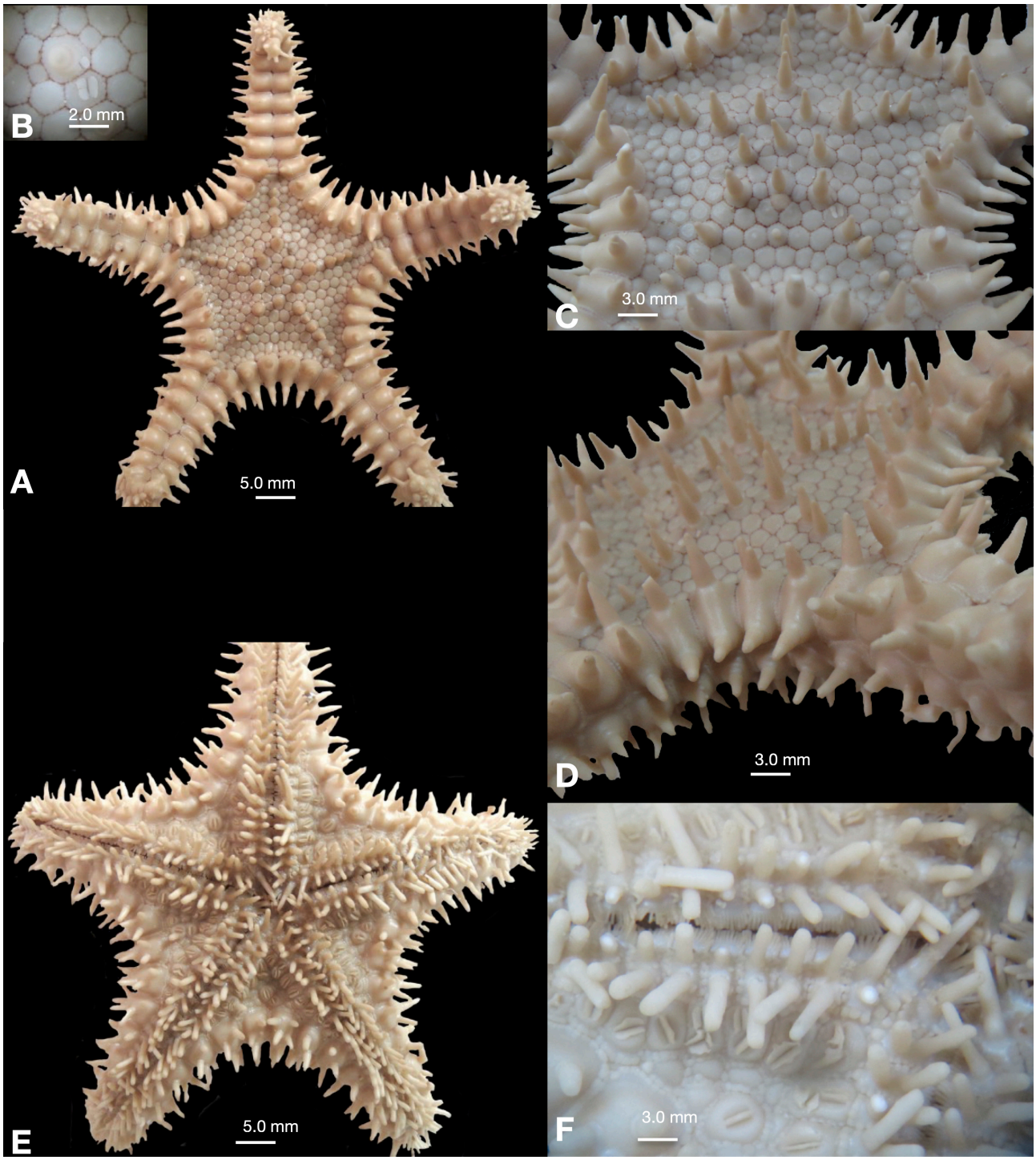

FIGURE 4. ***Calliaster hystrix*** **sp. nov.** MNHN IE-2013-7078. A. Abactinal.B. Abactinal plate close. C. Abactinal spination detail. D. Abactinal-lateral view. E. Actinal. F. Adambulacral-furrow detail showing pedicellariae.

conical spines present on all superomarginal plates, with two series present on disk. Bivalve pedicellariae present on nearly all actinal plates. Furrow spines 8 to 11, mostly ten

Comments

This species invites immediate comparison with the Australian *Calliaster erucaradiatus* as described by Livingstone (1935) due to the presence of the wide, abutted superomarginal plates along the arms each with a single prominent spines occurring serially along the dorsolateral edge of each plate. *Calliaster hystrix* **sp. nov.** shows several character differences, notably the presence of multiple bivalve pedicellariae on nearly every actinal plate (Fig. 4F), significantly fewer spines on the interradial abactinal regions (Fig. 4C), and 8 to 11 furrow spines (6 to 7 in *C. erucaradiatus*).

Calliaster hystrix **sp. nov.** is similar to *Calliaster kanak* **sp. nov.** as described herein, in sharing numerous abutted superomarginal plates and prominent spines but,

differs in displaying numerous bivalve pedicellariae, which appears to be absent among in *Callaster* species. Spination on the superomarginal and inferomarginal plates also appears to be more serial in *C. hystrix* than in *Calliaster kanak* **sp. nov.**

Description

Body strongly thick, stellate (R/r=2.54–3.0), arms elongate, upturned, interradial arcs weakly curved (Fig. 4A, E).

Abactinal surface composed of flat, abutted polygonal, primarily hexagonal, plates (Fig. 4B), forming a discrete pentagonal outline on the abactinal surface. Individual plates in very discrete series. Plates flat, bare and smooth with no surficial accessories. Primary circlet plates, each polygonal, approximately twice the size of adjacent abactinal plates. Most other disk plates largely homogeneous in size, becoming smaller, more irregular in shape distally adjacent to superomarginal contact. Abactinal plates with prominent, sharp, conical spines, approximately 0.5 cm each, present on each primary circlet plate and along carinal series but absent elsewhere on the disk surface (Fig. 4A, C, D). Carinal spines absent from distalmost abactinal plates adjacent to abutted superomarginal plates and variably absent from irregular plates along carinal series. Spine bearing plates with a distinct convexity which conforms with spine base. Each plate with 15 to 30, mostly 16 to 24, quadrate granules forming close, almost flush, peripheral series around each plate. Shallow fasciolar groove and small papulae present at angular points on each plate. One wide shaped, clam shaped pedicellariae with smooth valves present. Anus surrounded by five or six offset irregularly sized granules. Madreporite triangular, weakly convex, shallow sulci, flanked by five plates, two with button-like tubercles present at center.

Superomarginal plates 22, inferomarginals 26 per interradius (Fig. 4A), plates offset along lateral contact. Surfaces of both superomarginal and inferomarginals are bare and smooth with no accessories, except for the primary spines. Superomarginals wide, seven or eight pairs, abutted along mid radius of each arm, completely encompassing abactinal arm surface and forming distinct boundary around periphery of body, forming 22% (0.5/2.2) of "r" value on disk. Superomarginal plates each with one to three, mostly two or three, large, conical pointed spines on each plate in ordered series. Two or three spines present on interradial superomarginals in transverse series along the arm, decreasing to only a single spine present along the dorsolateral edge of each arm plate. Interradial spines directed abactinally, along edge of superomarginal at contact with abactinal plate but also laterally, in series along lateral surface (Fig. 4D). Superomarginal plates strongly convex in cross section with pronounced tumid spine base where spine is present (Fig. 4C, D). Superomarginals along arm variably 1:1 or offset but forming a distinct abutted surface along arm surface. In some smaller individuals (R=4.0), the contact between the abutted superomarginals is nearly flat, forming a flattened surface along the arm tip. Inferomarginal plates also with two or three prominent spines in transverse series, decreasing to a single spine on distal plates. Small, paddle-shaped pedicellariae (~0.2 cm in length) present on minority (on one or two) inferomarginal plate surfaces. Terminal plate triangular, smooth with two short spines on tip.

Actinal plate surface with one complete series and approximately two irregular, incomplete series. Plates quadrate to rectangular in shape, becoming more irregular adjacent to inferomarginal contact. Each plate with one to three prominent, wide, bivalved pedicellariae (Fig. 4F) with smooth valves, each nearly bisecting the plate, some are curved or irregularly shaped. Smaller individuals (R=4.0 cm) with single pedicellariae, larger specimens with up to three. One row of actinals between the adambulacrals and the irregular actinal plates lacking pedicellariae, each plates small and irregular in shape. Most actinal plates otherwise smooth and flat, spines absent from actinal plate surface. Each actinal plate with five to 20, mostly seven to 15, large coarse granules present around each plate.

Furrow spines 8 to 11, mostly ten with ten spines present proximally decreasing to eight distally (Fig. 4F). Furrow spines elongate with round tips, quadrate in cross-section, in straight series. Subambulacral spines, 2, in transverse series along each plate (Fig. 4E, F). Furrow spines separated from subambulacral spines by discrete, smooth space. Adambulacral plates each with coarse, quadrate granules, fifteen, approximately five per side, with plate surface otherwise bare.

Oral plate furrow spines, eight or nine, similar in appearance to furrow spines but with one enlarged spine per plate projecting into mouth. Each enlarged spine triangular in cross-section, blunt-tipped, approximately twice the thickness, 25% longer than adjacent furrow spine in length. Oral plate surface with five enlarged, flattened quadrate granules paired on either side of fossae formed between two halves of oral plate interradii. Flattened oral plate surface smooth with only one or two granules at most.

Occurrence/Distribution

New Caledonia, 140–428 m.

Coral Sea, depth unknown.

Material Examined

Holotype. MNHN IE-2013-7078, East Jumeau Bank, Norfolk Ridge New Caledonia, 23º45'S 168º17'E, 961 m 426–386 m. Coll. N/O "*Alis*" campagne NORFOLK 1, Coll. Lozouet, *et al.* IRD 25 June 2001. 1 wet spec. R=5.6 r=2.2.

Paratypes. MNHN IE-2013-7629, New Caledonia, Banc Jumeau east, 386–426 m, Coll. NORFOLK 1 DW 1710, Lozouet *et al.* 2 wet spec. R=4.2 r=1.4, R=1.2 r=0.4.

MNHN IE-2016-1547, New Caledonia, 22º47 S 167º22 E, 390 m, Coll. MUSORSTOM 4, DW 226, Coll. C. Vadon, 30 Sept. 1985. 1 wet spec. R=2.4 r=0.9.

Coral Sea. MNHN IE-2016-1548, Coral Sea. MUSORSTOM 5 DW 329, 1 wet spec. R=2.8 r=0.9.

***Calliaster kanak* sp. nov.**
FIGURE 5A–G

Calliaster erucaradiatus H.E.S. Clark in Clark & McKnight 2001: 29 (non *C. erucaradiatus* Livingstone 1936).
Calliaster elegans Mah & Foltz 2011: 771

Etymology
The species epithet honors the Kanak, the native people of New Caledonia. Noun held in apposition.

Diagnosis
Abactinal plates on disk, carinal series and on most to all interradial regions with distinctly produced bases and spines, ranging from short, nubbin-like to blunt and elongate, especially on primary circlet. **Abactinal plates limited to disk, none, where superomarginals are abutted.** Distalmost abactinal plates adjacent to superomarginal plate contact, flat with spines absent. **Superomarginal plates, approximately 8 to 10 along arm side, 16 to 20 per interradius, arm tip to arm tip, 4 to 6 pairs, abutted across most of arm, plate surfaces tumid, variably weak to strongly so, smooth with no surficial granules. Elongate spines, 1, exceptionally 0 on arm to 2 interradially.** Abactinal plate surface smooth, no other surficial accessories. Actinal surface relatively small with approximately 2 to 3 plate series, primarily isolated to disk. **All actinal plates with a single spine, plates smooth, surface weak convex. no other accessories.** Furrow spines 5 to 6, blunt tipped in straight series. Subambulacral spines 2, thick, elongate and blunt, arranged in transverse series to ambulacral furrow. **Paddle-shaped pedicellariae present, especially adjacent to the oral region.**

Comments
A species that is recognized based on the multiple abutted, strongly tumid/convex marginal plates (Fig. 5A, C, D) and irregularly distributed elongate single spines present on the superomarginal and inferomarginal plates as well as the numerous spines on the primary circlet and radial regions present on the abactinal surface. This species is by far the most abundant species of *Calliaster* collected from New Caledonia and was misidentified in H.E.S. Clark in Clark & McKnight (2001) as *Calliaster erucaradiatus* Livingstone 1935 from New Zealand. This species was used in Mah & Foltz (2011) but misidentified as *Calliaster elegans*.

Comparison of this species with the description of *Calliaster erucaradiatus* shows the marginal spines of this species in serial arrangement along the superomarginal plates, two spines on the proximalmost paired superomarginal plates, as well as more flattened abutted superomarginal plates along the arm as well as 6 to 7 furrow spines versus *Calliaster kanak* **sp. nov.** which shows marginal spines in irregular arrangement, only one spine on all superomarginal plates (none paired), strongly convex superomarginal plates and 5 to 6 furrow spines. Livingstone (1935) noted that *C. erucaradiatus* displayed papular pores on the actinal surface. Although the type specimen was not examined, most members of the Goniasteridae are not known to show papular pores on the actinal surface, with perhaps the exception of the shallow to mesophotic, *Fromia*.

This species invites further comparison with several other similar species, notably *Calliaster elegans* Döderlein 1922, which is distinguished primarily by the presence of 3 to 4 pointed spines on the inferomarginal plates as well as the presence of relatively short conical spines on the superomarginal plate surface, both of which in series, in contrast to the single, irregularly arranged and prominent, pointed spine on both superomarginal and inferomarginal series. Spines on *C. elegans* are also shorter and less pronounced than those in *C. erucaradiatus* and in *C. kanak* **sp. nov.**

There is a close resemblance between *Calliaster kanak* **sp. nov.**, *Calliaster elegans, Calliaster erucaradiatus*, and *Calliaster mammilatus* which may suggest that they form part of a wide-ranging complex across the tropical Indo-Pacific. However, spination appears to vary, perhaps suggesting some type of ecological or defensive differentiation.

A eulimid snail was observed on the holotype (Fig. 12E).

Occurrence/Distribution
New Caledonia, 180–470 m and New Zealand (Taupo Seamount), 90–153 m.

Description
Body stellate to strongly stellate, R/r=2.8 to 3.4, arms pointed, elongate. Interradial arcs weakly curved (Fig. 5A).

Abactinal plates round to polygonal in shape. Plates on disk, carinal series and on most to all interradial regions with distinctly pronounced bases each bearing conical spines (Fig. 5C, D), ranging from short, bullet-shaped to blunt and elongate, especially on primary circlet. Abactinal plates limited to disk; none on arms where superomarginals are abutted. Distalmost abactinal plates adjacent to superomarginal plate contact, flat with spines absent. where spines or other accessories are absent, plates are flat to weakly convex, smooth with no surface accessories. Plates each with coarse peripheral granules, 5 to 40, mostly 20 to 30, quadrate to polygonal in shape, occupying approximately 20 to 30% of total diameter of each plate. Alveolar pedicellariae present, each with paddle-shaped valves (Fig. 5B, B.1). Madreporite asymmetrically pentagonal, flanked by five plates. Sulci well-developed.

Marginal plates, approximately 8 to 12 along arm side (Fig. 5A), 16 to 24 per interradius, arm tip to arm tip, 4 to 8 pairs, mostly 6 to 7, abutted across most of arm (Fig. 5D), plate surfaces smooth, highly tumid with strongly convex surface which is smooth with no surficial granules. Superomarginal plates compose a prominent periphery around the body edge, occupying ~40–50% of distance "r" (disk diameter). Distalmost superomarginals more acutely convex than those proximally. Elongate spines, 1, exceptionally 0 on arm to 2 interradially. Spines

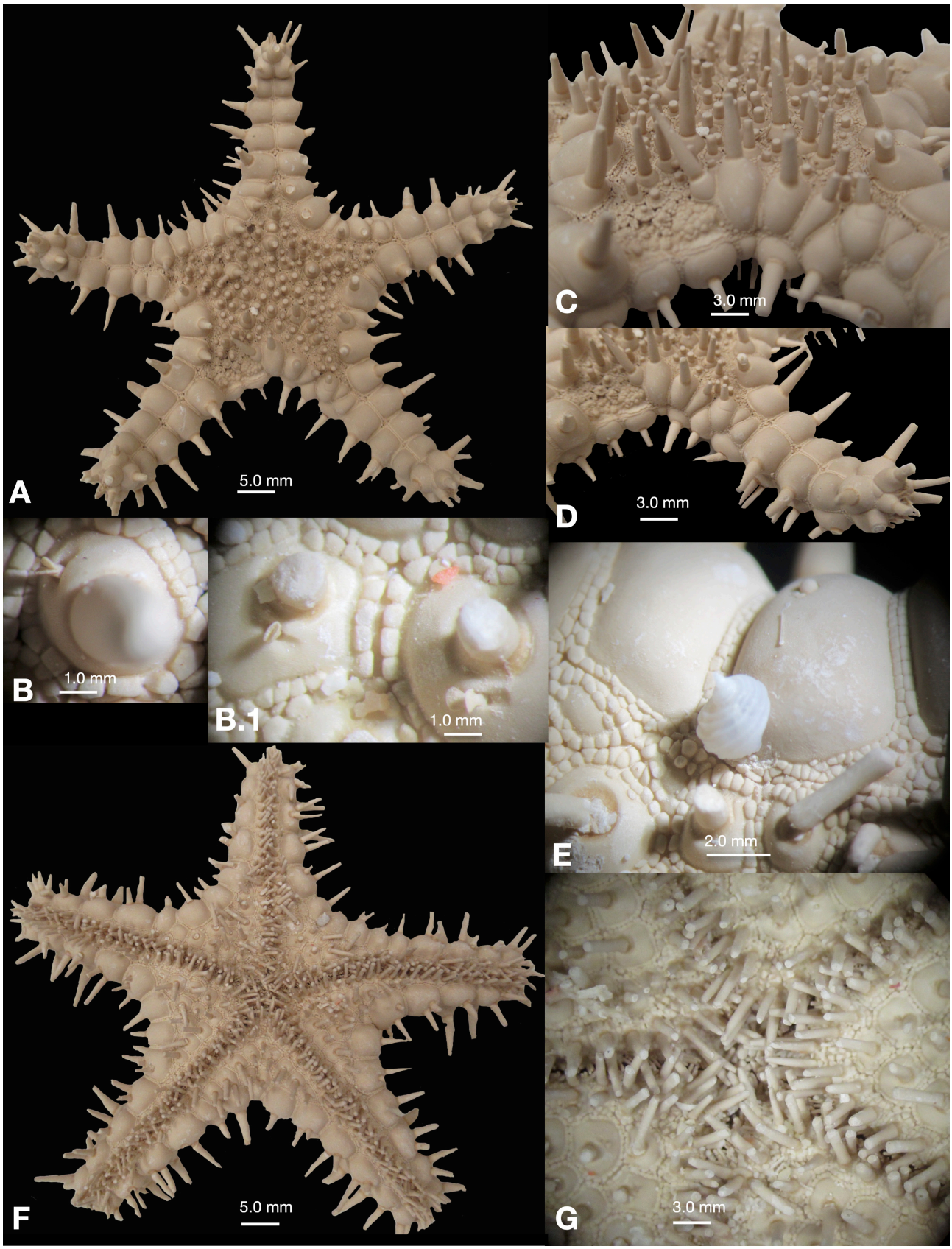

FIGURE 5. ***Calliaster kanak*** **sp. nov.** MNHN IE-2013-6923. A. Abactinal. B. Closeup of spines and pedicellariae. C. Abactinal-lateral view. D. Abactinal-lateral detail arm. E. Superomarginal plate with eulimid snail parasite present. F. Actinal G. Closeup oral-furrow region.

directed irregularly (Fig. 5C, D), not in serial order with some directed obliquely and others directed laterally with a minority of plates lacking spines. Abactinal plate surface smooth, no other surficial accessories. Marginal plates with peripheral granules, approximately 10 to 15 per side, total approximately 40 to 70, identical to those on abactinal plates, quadrate to polygonal in shape. Specimens irregularly with damaged or heterogeneously sized marginal plates. No pedicellariae observed on marginal plates. Terminal plate triangular with enlarged, and prominent conical spine.

Actinal surface relatively small with approximately 1 to 3 plate series (Fig. 5F), primarily isolated to disk. All actinal plates with a single spine present or absent, surface flat to weakly convex (Fig. 5G). single alveolar pedicellariae with paddle-shaped valves present on a minority of actinal plates, especially proximal to the oral region. When present, pedicellariae are in association with actinal spines, adjacent to the base. Peripheral granules identical to those on abactinal and marginal surface, with shallow fasciolar groove present between actinal plates.

Furrow spines 5 to 6, blunt tipped in straight series (Fig. 5G). Subambulacral spines 2, thick, elongate and blunt, arranged in transverse series to ambulacral furrow. Paddle-shaped pedicellariae present, especially adjacent to the oral region. Oral plates approximately 7 to 10 per side with one enlarged spine in series projecting into mouth. Oral plate surface with 2 enlarged spines the size of the transverse subambulacrals directed into mouth.

Color in life, orange.

Material Examined

Holotype. MNHN IE-2013-6923, Norfolk Ridge, Banc Antgonia, New Caledonia, 23°423'S, 168°02'E, 180–250 m, Coll. Lozouet, Boissellier, Richer *et al.* IRD, NORFOK 1, 26 June 2001. 1 dry spec. R=6.6 r=2.3.

Paratypes. MNHN IE-2013-6913, New Caledonia, 23°53'0"S, 167°11'6 E, 375–402 m, Coll. Richer de Forges, VAUBAN, 18 Sept 1986. 2 dry specs. R=2.2 r=0.7; R=4.5 r=1.3.

MNHN IE-2013-6921, Southern New Caledonia, 23°41'S, 168°1 E, 240–300 m, coll. B. Richer, ORSTOM, N/O *Alis*, BERYX 11. 1 dry spec. R=4.9 r=1.4.

MNHN IE-2013-7452, Northern New Caledonia, 18º9'S 163º5.3'E, 239–249 m Coll. SPANBIOS DW 5207, 17 July 2021, 5 wet specs. R=3.7 r=1.3 R=3.6 r=1.3 R=3.3 r=1.1 R=2.9 r=0.9 R=3.3 r=1.1 R=1.8 r=0.7.

MNHN IE-2019-3755, South New Caledonia, 24°46'S, 168°08'E, 245–260 m. Coll. SMIB 4, DW 46 1 dry spec. R=4.8 r=1.7.

MNHN IE-2019-3759, New Caledonia, 22°19'41.9988"S, 168°42'18.0072"E, 240–260 m Coll. SMIB 5, DW 85, 2 dry specs. R=5.1 r=1.6 R=3.4 r=1.1.

MNHN IE-2019-3760, New Caledonia, 23°21'S, 168°04'E 210–260 m. Coll. SMIB 4 DW 57, 1 dry spec. R=5.1 r=1.6.

MNHN IE-2019-3765, New Caledonia, 23°41'S, 167°59'E 338 m. Coll. SMIB 3 DW 18 1 dry spec. R=1.9 r=0.7.

MNHN IE-2019-3766, New Caledonia, 23°18'35.9964"S, 168°4'42.0204"E 290–305 m. Coll. SMIB 5 1 dry spec., R=2.8 r=0.9.

MNHN IE-2019-3769, Southeast New Caledonia, *Stylaster* Bank, 23°38'S, 167°42'E to 23°40'S, 167°45'E, 425–470 m. Coll. AZTEQUE Ch 06 1 dry spec. R=4.6 r=1.6.

***Calliaster kyros* sp. nov.**

FIGURE 6A–F

Etymology

The species epithet *kyros* is derived from the Greek for lord or master, alluding to the striking appearance of this species.

Diagnosis

Body stellate, R/r=2.2 to 4.0, mostly around 3.0–3.3, arms five, triangular, elongate, tapering with pointed tips. **Abactinal surface with distinct spines, conical, pointed on primary circlet and along carinal series, more variably in interradial regions. Superomarginal plates abutted over midline, 10–15 along arm, abactinal plates present only on disk and triangular region onto arm prior to abutted superomarginal plates. Superomarginal plates with two spine series, both widely spaced from one another, one series present only on plates in contact with disk, 5 to 8 plates, directed dorsally, present on upper surface of superomarginal plates in contact with disk.** Second spine series extending along most of arm, short 5 to 8 superomarginals, to that of next arm, directed laterally or abactinal-laterally. Inferomarginals similar in arrangement with one series of mostly one spine present on nearly all plates, directed at an actinolateral angle, with a second series, including 1 to 5 directed ventrally. This latter series shorter, smaller. **Actinal surface, especially adjacent to adambulacral series and approximately 50% of actinal intermediate plates, with large bivalve pedicellariae, bivalved with large round valves bearing rough to teethed edge.** Furrow spines 8 or 9, subambulacral spines 2 to 4, large, thick.

Comments

Similar to *Calliaster hystrix* **sp. nov.** in sharing numerous bivalved pedicellariae on the actinal surface (Fig. 6F). However, this species is distinguished by the very striking armament present on the abactinal and marginal plates (Fig. 6A–D) as well as the abutted superomarginal plates that include over half of the distal paired plates along the arm.

Description

Body stellate, strongly so, R/r=2.2–4.0, arms five, triangular elongate, tapering with pointed tips. Interradial arcs weakly curved to straight (Fig. 6A, E).

Abactinal plates polygonal to round becoming more elongate on arms, mostly flat but many weakly tumid, with no granules or other surficial accessories, plates primarily occur on disk but with triangular region

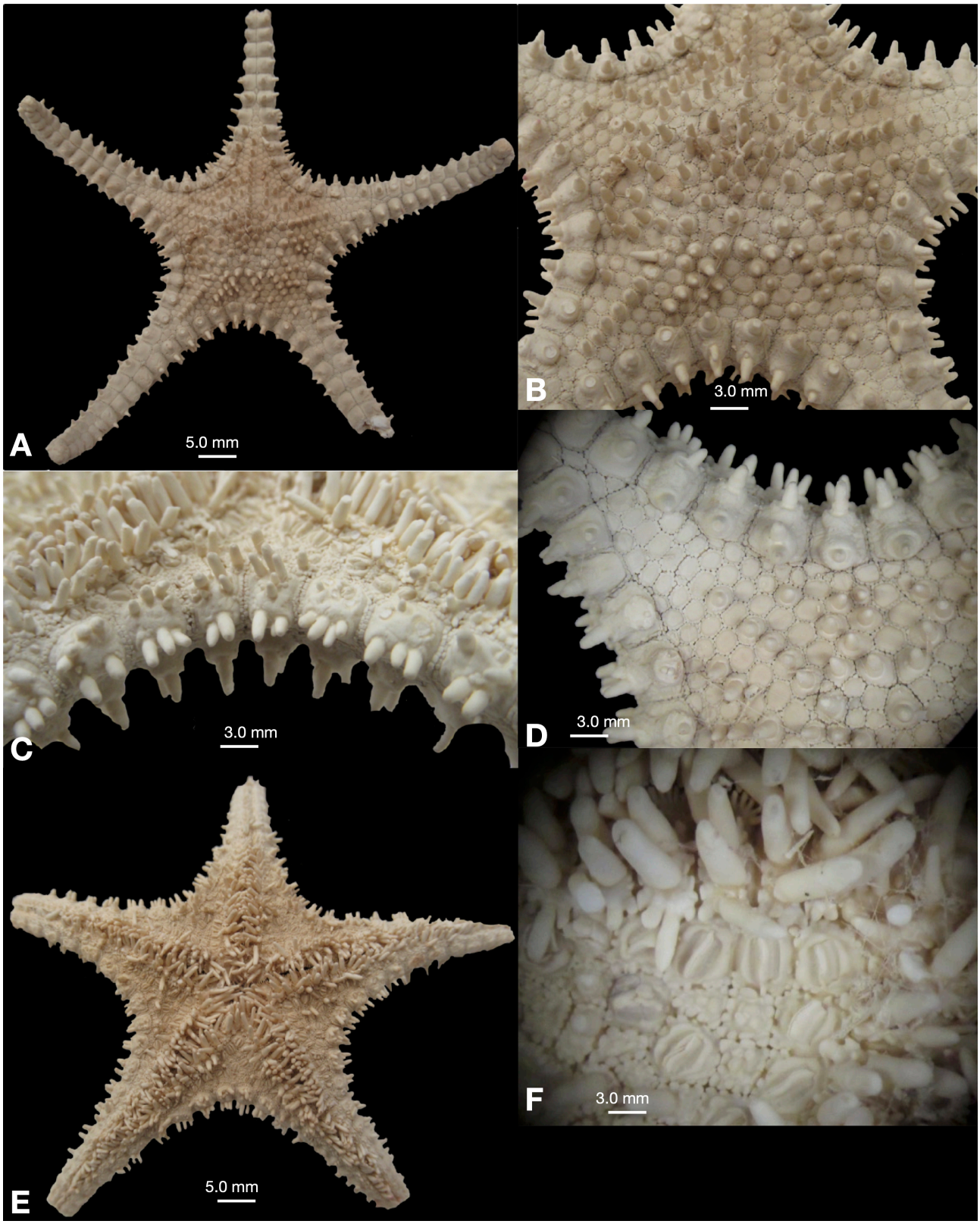

FIGURE 6. ***Calliaster kyros*** **sp. nov.** MNHN IE-2013-6918. A. Abactinal. B. Disk detail. C. Lateral view. D. Abactinal arm spination. E. Actinal. F. Adambulacral furrow, pedicellariae detail.

encroaching from disk onto arm, ending where abutted superomarginals begin. Large primary spines, 1 per plate, prominent, conical extending up to 5.0 mm length, well above disk surface (Fig. 6B, D). Spines present on primary circlet on disk, present on interradial plates variably proximal to disk center to distally on plates in contact with superomarginal boundary. Carinal spines 5 to 7, mostly uninterrupted, but some with absent spines in sequence (Fig. 6B). Peripheral granules, 3 to 25, mostly 12 to 15, irregular to round in shape, evenly spaced from one another, large, occupying approximately 20% of total diameter of disk+peripheral granules. Shallow fasciolar groove present. Madreporite round to quadrate in shape, strongly convex, sulci well-developed, flanked by 3 to 4 adjacent plates. No pedicellariae observed.

Both marginal plates tumid, lacking surficial accessories, i.e. no granules on central plate surface. Marginal plates with quadrate to irregularly polygonal granules, approximately 30–40, close but evenly spaced around plate periphery. Shallow fasciolar groove present between plates.

Superomarginal plates 18 (at R=3.3), 28 (R=6.7) to 34 (R=8.2) per interradius (arm tip to arm tip), abutted along midline of arm, approximately 10 to 12 paired plates from arm terminus to where disk plates taper out. Superomarginal plates form approximately 17–18% of distance "r" along abactinal surface (4.0 mm/23.0 mm). Approximately 10–15 superomarginals on disk in contact with abactinal plates. Superomarginals on disk with a second prominent single, in a minority of cases, two, spine(s) directed dorsally. Marginal spination pronounced with spines on each proximal superomarginal plate, one at a lateral-oblique angle and a second facing dorsally, but both on a strongly tumid superomarginal plate surface extending over the spine base, the combination of these forming a spinose periphery around the interradial regions along the disk.

Inferomarginals approximately 32 (R=6.7) with 1:1 association proximally becoming offset distally along arms. Superomarginal plates all with a single prominent conical spine present along the abactinal-lateral edge, serially along the entire interradius extending in nearly all specimens to at least 50 to 80% of arm distance, distalmost superomarginals variably 2 to 7 paired plates lacking spines. Inferomarginal plates with numerous spines (Fig. 6C), totaling up to 8 on the disk decreasing to 2 distally along the arm. Inferomarginal spines in two different clusters, 2 to 3 pointing laterally adjacent to the contact with the superomarginal plates and a second series of approximately 4 or 5 on the ventral surface of the inferomarginal plate surface.

Bivalve pedicellariae present variably on 1 to 6, mostly 2 to 4 proximally on inferomarginal plates, but absent on others.

Actinal intermediate areas with only 2 to 3 full series, limited to disk with no actinal plates extending onto arms. Actinal plates irregularly shaped, quadrate to polygonal. Actinal series next to adambulacral plates and about 50% of other actinal plates each with a large bivalve pedicellariae (Fig. 6F), wide, approximately 1.0 mm in length bisecting plate on which it sits, bearing large wide, flat valves with roughened to smooth edges. Approximately half of the other actinal plates bare, smooth, tumid. exceptionally a single blunt spine present centrally on a single plate surface. Actinal plates with quadrate to irregularly shaped granules, 8 to 12. Fasciolar grooves weakly present among actinal plates.

Furrow spines 8 to 9, slender blunt spines, weakly palmate. Subambulacrals 2 (at R=7.1) to 4 (at R=6.8), blunt, enlarged, thick, remainder of adambulacral plate with 3 to 6 granules, quadrate to irregular in shape. Oral plate with furrow spines, 12, one spine directed into mouth, thus two per interradius. Large quadrate, smooth granules, 4 or 5 on either side of diastema between oral plates.

Occurrence/Distribution

New Caledonia, 274–460 m.

Material Examined

Holotype. MNHN IE-2013-6918, Vauban, New Caledonia, 22º56'2"S 167º15'9"E, 442–460 m.
Coll. Richer de Forges, 17 Sept. 1986. 1 dry spec. R=6.8 r=2.0.

Paratypes. MNHN IE-2020-475, New Caledonia, 18º6.5'S 163º3.4'E, 274–254 m. Coll. SPANBIOS DW 5238, 22.7.21 1 wet spec. R=7.9 r=2.5.

MNHN IE-2007-6645, New Caledonia 22º15'S 167º13'E, 406–442 m, Coll. EXBODI CP 3786, 2.9.11. 1 wet spec. R=7.3 r=1.8.

MNHN IE-2007-9714, SW Ile des Pins, New Caledonia, 22°50'39.6024"S, 167°14'58.7904"E, 440–482 m. Coll. KANACONO CP 4663, 11 Aug 2016, 1 wet spec. R=7.0 r=2.0.

MNHN IE-2013-9960, New Caledonia 19º42'S 158º37'E, 315–295 m, Coll. KANADEEP DW 4979, 9 Sept. 2017, 1 wet spec. R=2.5 r=0.9.

MNHN IE-2013-9471, S Ile des Pins, New Caledonia, 22°52'59.4012"S; 167°34'44.9868"E, 376–390 m. Coll. KANADEEP DW 4677, 13, Aug., 2016, 1 wet spec. R=3.9 r=1.3.

MNHN IE-2013-9910, Betw. Chesterfield & Bellona Plateau, New Caledonia 20º23'S 158º43'E, 370–380 m, Coll. KANADEEP DW 5022, 21.09.17. 1 wet spec. R=3.2 r=1.4.

MNHN IE-2013-9915, Plateau des Chesterfield, New Caledonia 19º51'S 158º34'E, 310–320 m, Coll. KANADEEP DW 5036, 22.09.17. 1 wet spec. R=3.7 r=1.3.

MNHN IE-2013-9976, Plateau des Chesterfield, New Caledonia 19º57'S 158º43'E, 350 m, Coll. KANADEEP DW 5040, 22.01.17 1 wet spec. R=3.2 r=1.3.

MNHN IE-2013-7001, New Caledonia 22º54'S 167º14'E, 425–440 m. Coll.C. Vadon, MUSORSTOM 4. 4 dry specs. R=1.7 r=0.8; R=3.1 r=0.9; R=6.1 r=2.0; R=7.1 r=2.2.

MNHN IE-2016-1546, New Caledonia 22º52'4"S 167º11'9"E, 405–435 m. Coll. VAUBAN dr. 19, 20 Sept. 1986, 1 dry spec. R=5.6 r=1.5.

MNHN IE-2007-7598, Plateau des Chesterfield, New

Caledonia, 19º35'S 158º41'E, 392 m. Coll. EBISCO DW 2612, 1 wet spec.

MNHN IE-2013-9960, Plateau des Chesterfield, New Caledonia, 19º42'S 158º37'E, 315–295 m. Coll. KANADEEP DW 4979, 9.9.17, 1 wet spec. R=7.3 r=2.3.

MNHN IE-2013-7647, New Caledonia, 23º00'S 167º16'E, 400–420 m TERRASSES DW 3127, 30.10.08 1 wet spec.

MNHN IE-2023-167, Banc Azteque, Southeast New Caledonia, 23º13'S 168º5"E, 290–460 m. Coll. ORSTOM, N.O. Alis, campagne AZTEQUE, 12 Feb 1990. 2 dry specs.

Calliaster nazaninae sp. nov.

FIGURE 7A–F

Etymology

This species is named for my colleague Sara Nazanin Alexander of the Integrated Taxonomic Information System (ITIS).

Diagnosis

Abactinal plates flattened with abactinal spines present only on proximalmost radial plates and primary circlet. Distinguished by the flattened body, abutted superomarginal plates, quadrate in shape, dark to black outline present around periphery for abactinal and marginal plates. Two spines on interradial superomarginal plates with spines projecting upward and laterally. Remainder of spines on plates directed around the dorsal-lateral edge.

Comments

This species shows a marked contrast to *Calliaster hystrix* **sp. nov.** and/or *Calliaster kyros* **sp. nov.** in that spines are observably few on this species with the disk armament especially minimized (Fig. 7A, B). This species shows some resemblance to the Pacific *Calliaster childreni* and the typological *Calliaster elegans*, in showing a relatively flattened disk with few disk spines.

Occurrence/Distribution

New Caledonia, 150–282 m.

Description

Body stellate, but flat, R/r=2.65–2.7, arms broad based, triangular in shape with pointed tip, interradial arcs weakly curved. Black ring present around periphery of abactinal, and marginal plates (Fig. 7A).

Abactinal plates polygonal, variably shaped, mostly homogeneous in size but with some smaller plates 20% of the size of other adjacent plates, restricted to arm base (Fig. 7B). Plate surfaces mostly flat, but completely smooth bearing no surficial accessories (Fig. 7B). Spines present only on proximalmost carinal plate, 1 to 3, with spine-bearing plates displaying pronounced base. Spines absent from all other plates. Peripheral granules, 15 to 40, approximately 5 per side very narrow, rectangular, indistinct. Arm composed of approximately 3 to 6 fully or partially abutted superomarginal plates beginning at approximately halfway along arm's length. Madreporite triangular, flanked by 3 adjacent plates. No pedicellariae observed.

Superomarginal plates 14 per arm side, 28 per interradius (arm tip to arm tip) (Fig. 7A). Dorsal edge and surface of superomarginal plates flattened, flush with the abactinal disk surface. Both marginal plates wide with surfaces smooth with no surficial accessories. Peripheral granules, approximately 20 to 60, mostly 40 to 50, evenly spaced present between superomarginal and inferomarginal series, Superomarginal plates forming approximately 25% of the total distance "r" on disk. Superomarginal plates strongly quadrate in shape, especially proximally becoming slight more irregular distally along arm. Conical pointed spines, 2 to 4, on proximalmost superomarginal plates with identical spines present in series along dorsolateral angle along superomarginal plate series (Fig. 7C). Inferomarginal plates with 1:1 association. Surfaces smooth with proximalmost plates displaying a single, exceptionally two spines, which are absent on distalmost plate surfaces. No pedicellariae. Terminal plates triangular with a prominent pointed spine.

Actinal area composed of 1 or 2 incomplete series, limited to the disk region with no actinal plates extending along the arm, quadrate in shape. Proximalmost plates quadrate in shape, those closer to the inferomarginal plates more polygonal to irregular in shape. Prominent spines present on fewer than 50% of the actinal plates, most bare and smooth (Fig. 7E). Approximately two alveolar pedicellariae present with elongate paddle-shaped vales (Fig. 7F).

Furrow spines, 7 to 10, slender, pointed in stellate arrangement. Subambulacral spines, 2, then 1 distally, prominent, thick with blunt but pointed tips (Fig. 7E). Oral spines 10, identical to proximal furrow spines with 2 to 3 large, thick spine from each side projecting into mouth. Oral plate surface with 10 quadrate shaped granules on either side of central diastema, 3 prominent spines, similar to those on the subambulacral spines on the oral plate with a single 4th nubbin-like spine present distally on the oral plates.

Material Examined

Holotype. MNHN IE-2013-6917 New Caledonia, 20°43'S, 167°01'E, 150–210 m. Coll. A. Guille & Meou, N.O. *Jean-Charcot*, BIOCAL, 6 Sept. 1985. 1 dry spec. R=5.3 r=2.0.

Paratype. MNHN IE-2013-6922 Ride des Loyaute, New Caledonia. 20°42'S, 167°00'E, 282 m. Coll. N.O. Alis, MUSORSTOM 6, 14 Feb 1989. 1 dry spec. R=3.6 r=1.3.

Cladaster Verrill, 1899

Verrill 1899: 175; Fisher 1911: 221; Bernasconi 1964: 13; 1964: 255; Halpern 1970: 179; Clark & Downey 1992: 238; A.M. Clark 1993: 251; Mah 2011: 19; Mah 2018: 29; Mah 2024: 482

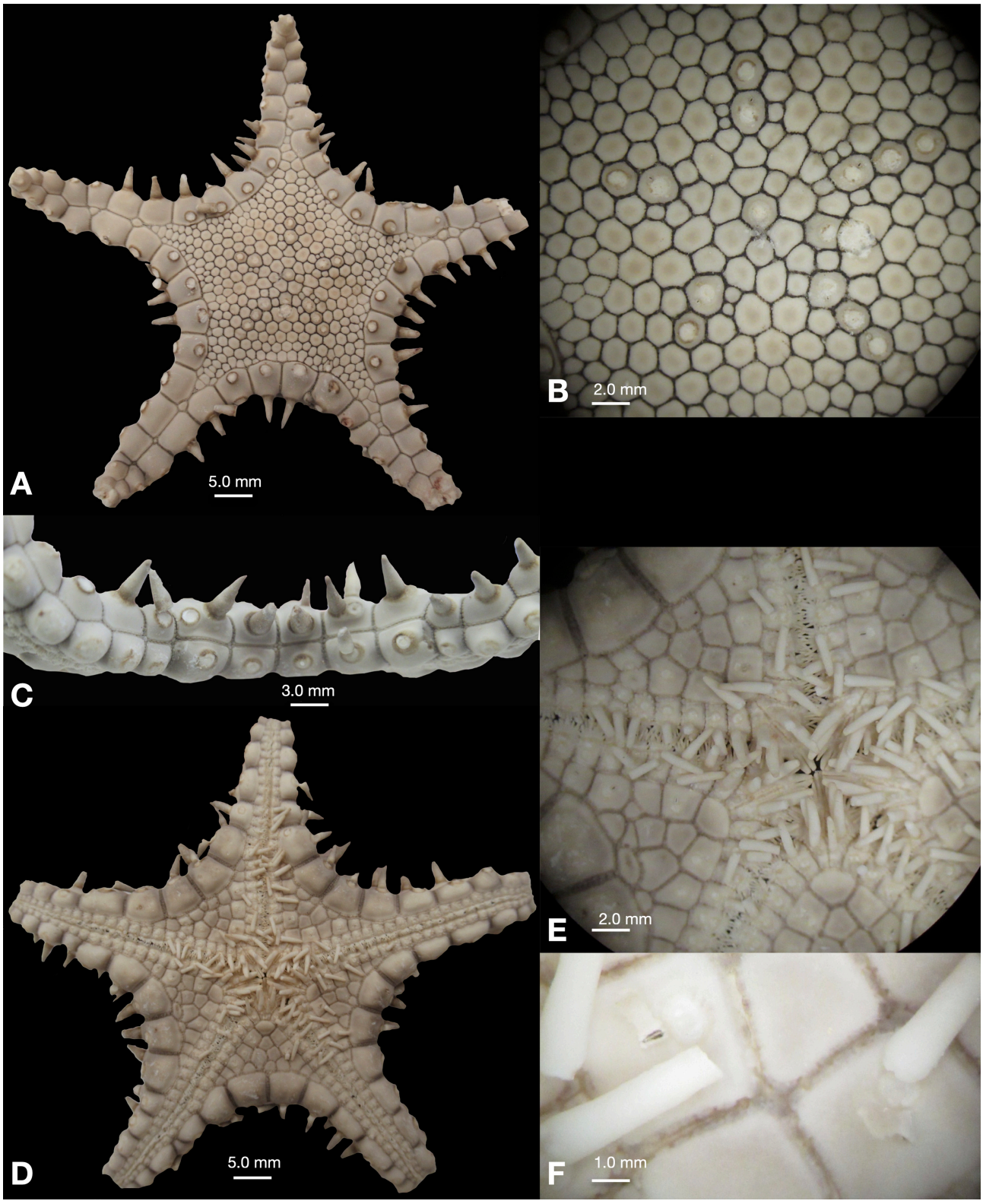

FIGURE 7. ***Calliaster nazaninae*** **sp. nov.** MNHN IE-2013-6917. A. Abactinal. B. Abactinal plate closeup. C. Lateral view. D. Actinal. E. Actinal oral region. F. Actinal surface pedicellariae.

Diagnosis. Body weakly stellate. Abactinal plates low tabulate with weakly to strongly expressed fasciolar channels. Hemispherical, coarse grained granules present on abactinal, marginal, and actinal plate surface which are easily removed on preserved specimens. **Superomarginal plates abutted along arm on all but one species. Large, spatulate type actinal pedicellariae. Furrow spines, blunt to spatulate, oval in cross-section. Large, thick subambulacral spine present in addition to furrow spine.** Similar sized narrow, but thick subambulacral pedicellariae present on some species.

Comments
Cladaster presently includes six species, including the recently described Pacific *C. kiko* Mah 2024 and *C. katafractariu*s Mah 2018 from New Caledonia and the Indian Ocean, respectively. All known species are reported from deep-sea habitats, 145 to 2044 m. Individuals of *Cladaster* are not commonly encountered, and *in situ* observations are infrequent. However, the Atlantic *C. rudis* Verrill, 1899 was perched on a dead *Lophelia* coral skeleton, suggesting predatory habits (Mah 2024)

***Cladaster salebra* sp. nov.**
FIGURE 8A–E

Etymology
The species *salebra* is Latin for a rough road, alluding to the plates present along the arms extending to the terminus.

Diagnosis
Body stellate. Abactinal plates abutted, individually polygonal to round in shape, larger on disk, smaller distally, adjacent to superomarginal contact and along arm to terminus. Granules, 1 to 10, mostly 3 to 6, very widely spaced on each plate. **Abactinal plates extend entirely to arm terminus, none abutted.** Superomarginal plates 16, inferomarginal plates 20 per interradius (arm tip to arm tip). Periphery is wide, but individual plates elongate interradially becoming more equally sized distally along arm. Abactinal-lateral and actinal-lateral edges rounded. Superomarginal and inferomarginal plate surface with granules, 20–40, mostly 30, widely spaced and when removed leaving a weak convexity where granule has been removed. **Furrow spines 6. Single large subambulacral spine adjacent to a similarly sized (large) pedicellariae, forceps like.**

Comments
This species is differentiated based on the presence of 6 furrow spines (Fig. 8D) as well as the presence of abactinal plates extending to the arm terminus (Figs 8A, B). Other *Cladaster* species possess 2 to 4 furrow spines and are all known to possess abutted superomarginals across the arm radius. *Cladaster salebra* **sp. nov.** displays subambulacral pedicellariae, which are absent on the Indian Ocean *C. katafractarius* Mah, 2018 and the high-latitude *C. analogus* Fisher, 1940.

The holotype was collected from a sandy, sedimented bottom.

Occurrence/Distribution
New Caledonia, 1054 m.

Description
Body stout, stellate (R/r=2.0), arms triangular, arm tips pointed (Fig. 8A, C).

Abactinal plates abutted, individually polygonal to round in shape, larger on disk, smaller distally, adjacent to superomarginal contact and along arm to terminus (Fig. 8A). Granules, 1 to 10, mostly 3 to 6, very widely spaced on each plate. Highest granule abundance distally on plates adjacent to superomarginals, arm plates lacking granules. Primary disk plates weakly concave. Central disk region arched. Papulae present around arm base. Madreporite irregularly round with well developed sulci. No pedicellariae

Marginal plates with prominent abactinal facing, forming 27% of the distance "r" (0.3/1.1) becoming wider distally along the arm, but without complete contact (Fig. 8A). Superomarginal plates 16, inferomarginal plates 20 per interradius (arm tip to arm tip). Periphery is wide, but individual plates elongate interradially becoming more equally sized distally along arm. Abactinal-lateral and actinal-lateral edges rounded. Superomarginal and inferomarginal plate surface with granules, 20–40, mostly 30, widely spaced and when removed leaving a weak convexity where granule has been removed (Fig. 8B). Granule abundance highest interracially, absent distally. Terminal plate bulbous, round with two short spines.

Actinal region relatively small with only two complete series in chevron formation. Plate surface with granules,10–16, round, similar to the type present on abactinal, marginal surfaces. Pedicellariae paddle-like, approximately 1 to 3 per interradius, with wide valves present.

Furrow spines 6, 4 central and tallest, 2 at end of each series (Fig. 8E), approximately 50% of the height of central spines. Each spine flattened, pointed, interlaces with opposite furrow spine series when groove closes. A large single subambulacral spine, flattened, pointed and blade-shaped adjacent to a single large pedicellariae, paddle-like, each valve thick with approximately 3 interlocking teeth (Fig. 8D, E). Remainder of adambulacral plate with 3 to 7 angular to pointed granules, irregularly arranged and similar to those on actinal intermediate plate surface. Oral plate with furrow spines, 10 per side, similar to those present on adambulacral plates. Oral plate surface with 6 large spines, followed by successively smaller 4 spines down to the oral surface where the smallest spine/granule is comparable in size those granules on the actinal surface.

Color in life was orange.

Material Examined
MNHN IE-2019-2979 New Caledonia, 23°36'S, 169°36'E, 1054 m. Coll ROV Victor 6000, 9 Aug 2019, KANADEEP 2, PL741-PBT-M-06 PL741-PBT-P-04. 1 wet spec. R=2.3 r=1.1

FERDININAE Mah, 2017

Diagnosis
Body form stellate or weakly stellate with broad disk. Adults not larger than R=7.0 cm, most in the R=3.0 to 5.0 cm range. Body with abactinal surface framed by dorsal–facing superomarginal plates, usually in larger specimens. However, in *Ferdina* only smaller individuals show this form developing into larger individuals with cylindrical

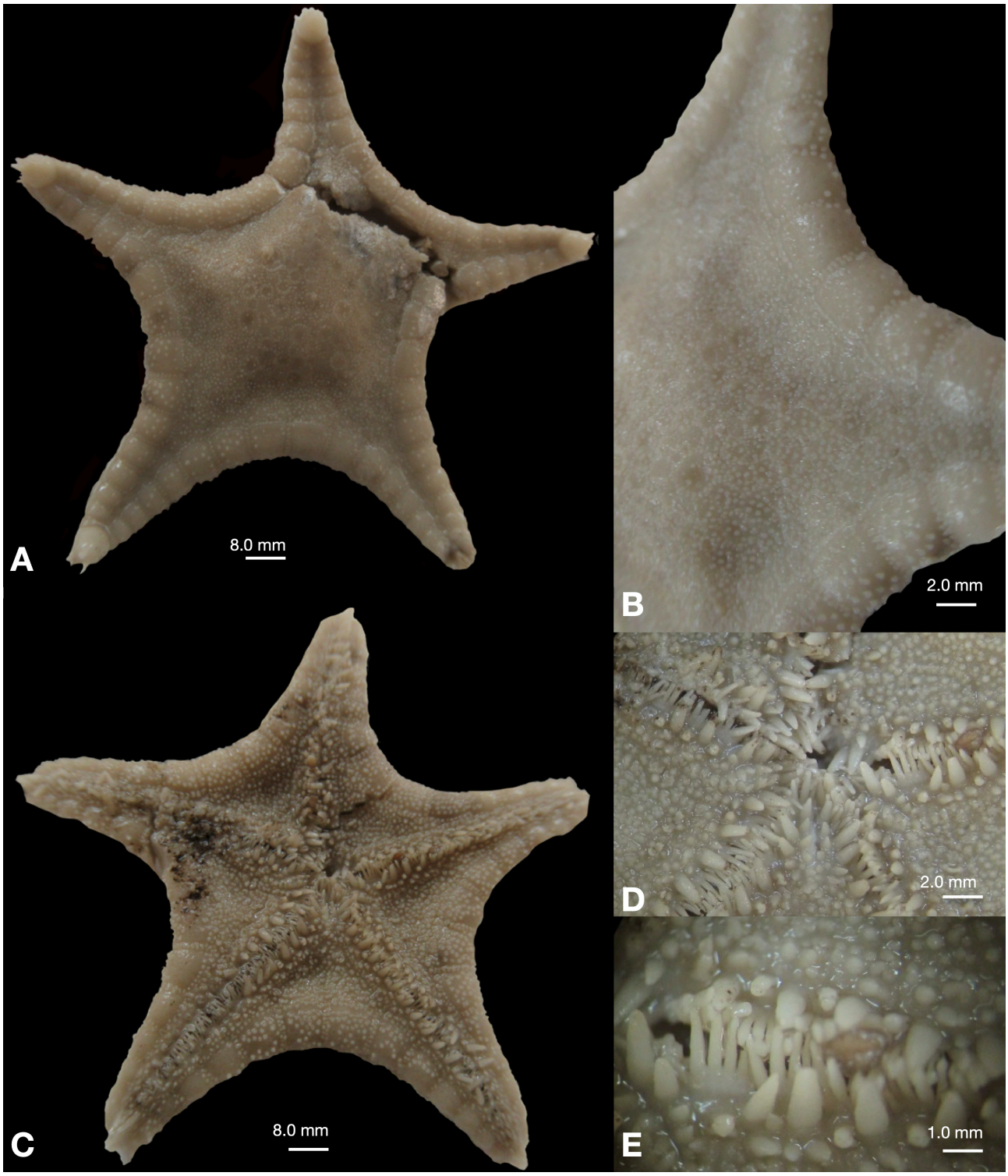

FIGURE 8. ***Cladaster salebra*** **sp. nov.** MNHN IE-2019-2979. A. Abactinal. B. Abactinal close. C. Actinal. D. Oral-adambulacral detail. E. Adambulacral furrow.

arms. Body surface, including abactinal, marginal and actinal surfaces covered by granular tegument. Bare regions on abactinal and marginal plates present on several taxa as outlined below, especially on strongly convex surfaces. Arms flat and angular or cylindrical in cross section. Furrow spines one to three, in single continuous series with no other adambulacral accessories. Adambulacral surface covered by granular tegument, continuous with actinal surface extending up base of furrow spines. Note that *K. solidus* Mah, 2017 with enlarged granules as part of the adambulacral granular tegument which superficially appear like subambulacral spines.

Kanakaster Mah 2017

Mah 2017: 24.

Diagnosis. Characterized by the presence of crystalline or glassy nodules on the surface of the abactinal plates and on both marginal series below a coarse granular tegument covering the body surface. Weakly expressed to irregularly shaped bare patches present or absent on superomarginal plate surface. **Furrow spines in a serial row, no other adambulacral spines or accessories.**

Comments
A genus of Goniasteridae described as a member of the Ferdininae by Mah (2017), which includes 6 mesophotic to deep-sea species present throughout the tropical Pacific and in South Africa. Three of the six species are known only from New Caledonia. Biology of *Kanakaster* species is unknown.

Kanakaster longibrachium sp. nov.
FIGURE 9A–E

Etymology
The species "*longibrachium* is derived from the Latin *longus* and *brachium* for "long arm" alluding to the elongate arms present in this species.

Diagnosis
Body stellate (R/r=2.7), arms triangular, elongate. Interradial arcs curved. Dermis present over abactinal surface, weakly obscuring plate boundaries. **Abactinal plates round to irregularly polygonal, primary circlet elevated. Superomarginals abutted along arm, 6 to 7 pairs completely; 1 or 2, partially so, constraining plates to disk, creating wide dorsal abactinal periphery, forming 28% of total "r" (0.2/0.7).** Superomarginal, inferomarginal plates 17 to 18 per interradius (arm tip to arm tip). Superomarginal plate surfaces with roughened texture, but no apparent surficial accessories (i.e. no granules, etc.). Actinal intermediate region composed of two series, with one extending to arm base before tapering off. Actinal and adambulacral plates covered by dense granular cover. Furrow spines two per plate, blunt tipped, quadrate to rectangular in shape, larger proximally, arranged serially along the adambulacral edge. No subambulacral or other adambulacral accessories. **Disk region with sharply dark coloration relative to central primary circlet and superomarginal plates which are light to white.**

Comments
This species shows the single serial row of furrow spines and the absence of subambulacral spination that identify members of the Ferdininae. The surface of the body is covered by a granulated dermis along with the abactinal plate and marginal plate further place this in the genus *Kanakaster* Mah 2017.

This species is distinguished primarily based on the elongate arms and the presence of numerous abutted superomarginal plates abutted over the arm radius (Fig. 9A, C). A distinct dark coloration is also present on the disk of specimen MNHN IE-2019-2955 that is not clearly evident on the holotype.

Kanakaster longibrachium **sp. nov.** joins the other three species of *Kanakaster* known from New Caledonia. In terms of total number of marginal plates, this species displays 17–18 per interradius (Fig. 9A), which compares with *K. convexus* Mah, 2017*, K. solidus* Mah, 2017*,* and the Philippine *K. balutensis* Mah, 2017. However, none of these species shows the large number of abutted superomarginal plates or the elongate arm shape. The abactinal disk plates are more similar to *K. solidus*, but the furrow spines between *K. longibrachium* **sp. nov.** and *K. solidus* differ with those in the former. Paddle-shaped pedicellariae are present in the holotype of *K. longibrachium*, but not seen in other species.

Occurrence/Distribution
New Caledonia, 310–380 m.

Description
Body stellate (R/r=2.7), arms triangular, elongate. Interradial arcs curved. Dermis present over abactinal surface, weakly obscuring plate boundaries (Fig. 9A). Abactinal surface sunken relative to superomarginal periphery. Individual plates round to irregularly polygonal, forming boundary around primary circlet which is elevated, this boundary composed of two to four plates between primary circlet and superomarginal plate contact. Glassine tubercles embedded in abactinal plate surface (Fig. 9B). Primary circlet and associated secondary plates distinct from plates on disk, forming raised mound centrally. Madreporite round to polygonal, flanked by three plates, including one plate from primary circlet. No pedicellariae.

Superomarginals abutted along arm, 6 to 7 pairs completely (Fig. 9A, C); 1 or 2, partially so, constraining plates to disk, creating wide dorsal abactinal periphery, forming 28% of total "r" (0.2/0.7). Superomarginal, inferomarginal plates 17 to 18 per interradius (arm tip to arm tip), widest interradially becoming more quadrate distally. Superomarginal plate surfaces with roughened texture (Fig. 9B, C), but no apparent surficial accessories (i.e. no granules, etc.). Terminal plate broadly triangular, bare surface. No pedicellariae.

Actinal intermediate region composed of two series, with one extending to arm base before tapering off. Shorter series incomplete, adjacent to inferomarginal contact. Individual plates quadrate in shape, weakly convex, covered by a continuous granular layer present over the plate surface. Pedicellariae, paddle-shaped two to four, present in each actinal interradius (Fig. 25E).

Adambulacral plates rectangular, covered by granular layer as present on actinal surface (Fig. 9D). Furrow spines two per plate, blunt tipped, quadrate to rectangular in shape, larger proximally, arranged serially along the adambulacral edge (Fig. 9E). No subambulacral or other adambulacral accessories. Oral plates with larger,

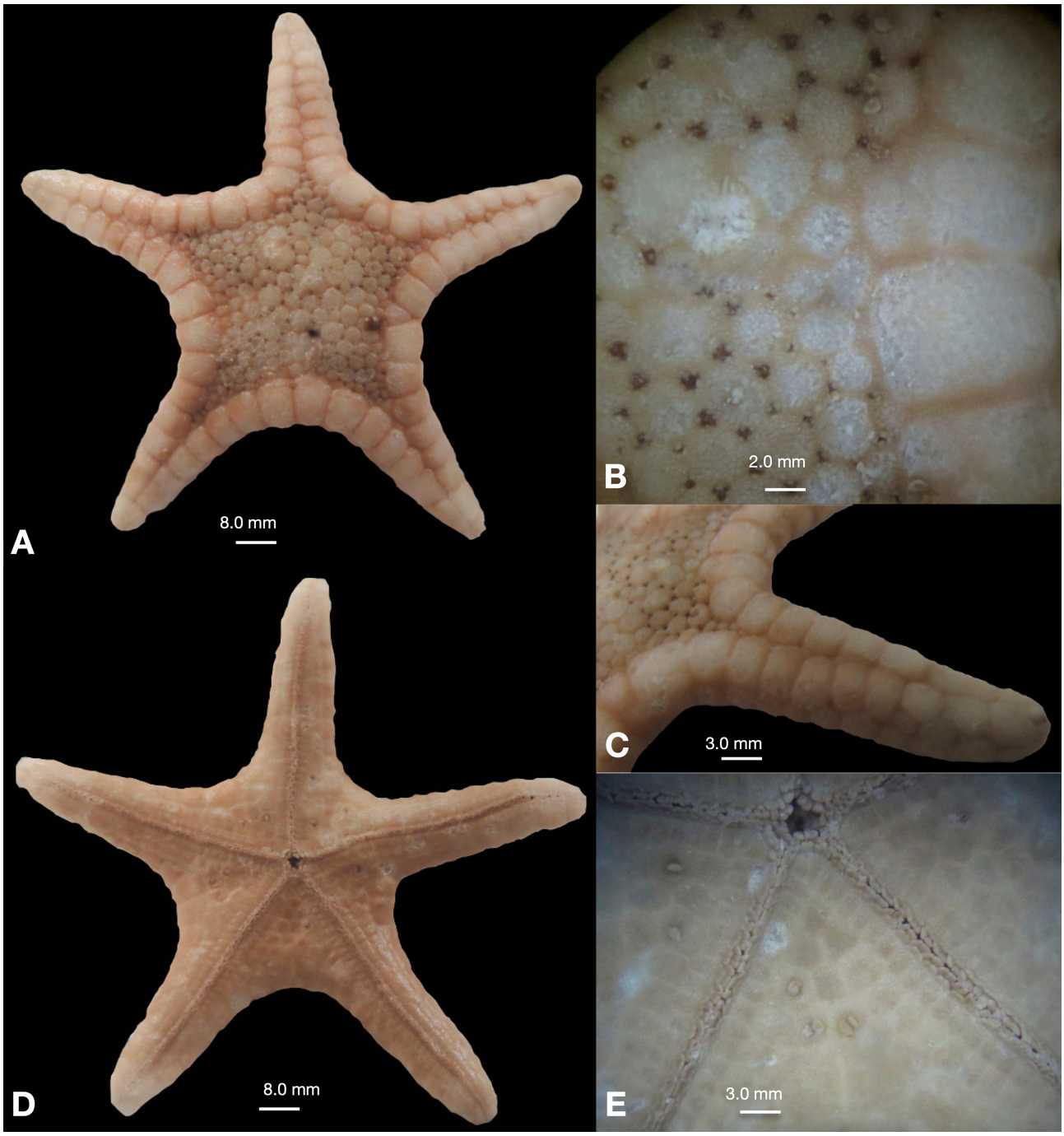

FIGURE 9. ***Kanakaster longibrachium*** **sp. nov.** MNHN IE-2016-1516. A. Abactinal. B. Abactinal-superomarginal close. C. Abutted superomarginal plates along arm. D. Actinal. E. Actinal and adambulacral.

triangular to polygonal furrow spines, larger spines projecting into mouth.

Disk region with sharply dark coloration relative to central primary circlet and superomarginal plates which are light to white.

Material Examined

Holotype. MNHN IE-2016-1516, New Caledonia 19º44'S 158º32'E, 380–360 m, Coll. KANADEEP, DW 4976, 9.9.17 1 wet spec. R=3.8 r=1.5.

Paratypes. MNHN IE-2013-9946, New Caledonia 19º44'S 158º32'E, 380–360 m, Coll. KANADEEP, DW 4976, 9.9.17 1 wet spec. R=2.4 r=1.0.

MNHN IE-2019-2955, New Caledonia, 23º04'S 168º14.4'E, 362 m, Coll. ROV Victor 6000, PBT-M-9 PL-766-3, 14/09/2019, KANADEEP 2, 1 wet spec. R=1.9 r=0.7.

MNHN IE-2016-1517, New Caledonia 25º29'S 159º49'E, 320–310 m, Coll. KANADEEP, DW 4940, 4.9.2017. 4 wet specs. R=1.6 r=0.8, R=1.8 r=0.7, R=1.4 r=0.6, R=1.6 r=0.7.

Neoferdina Livingstone 1931

Ferdina (in part) Gray 1840: 282; 1866: 12; Perrier 1875: 447; Sladen 1889: 397; Fisher 1911: 241; H.L. Clark 1921: 37.

Scytaster. Müller & Troschel 1842: 34; Grube 1860: 9; Dujardin et Hupé 1862: 365; Lütken 1865: 163.

Neoferdina. Livingstone 1931: 307; H.L. Clark 1946: 112; Clark & Rowe 1971: 64 (in key); Jangoux 1973: 776; Clark 1993: 344 (checklist); Rowe & Gates 1995: 89; Liao & Clark 1995: 119; H.E.S. Clark & McKnight 2001: 175.

Diagnosis. Body strongly stellate (R/r=~2.0–5.7, mostly between 3.0–4.0 cm), body flattened (i.e. quadrate in cross–section) **in most species but variably pentagonal in larger individuals), body surface almost completely covered by granular tegument, save for bald patches or spots on abactinal and marginal plates.** Crystalline nodules absent from abactinal, marginal plates. **Abactinal plates variably flat to strongly convex, forming distinctive bumpy surfaces in many species. These plates also present in transverse series across the arm in several but not all species.** Marginal plates variably equal dimensions to elongate to elliptical in shape. Most superomarginals convex, variably weak to strong but all with distinct bald region. *N. annae* **sp. nov.** with bare regions on penultimate superomarginals, but otherwise covered by granular tegument. Inferomarginals variably granule–covered or with bald patch present. **Actinal intermediate regions small (with fewer than four full actinal series) with single furrow spine series,** subambulacral accessories absent. Most species display a bright to striking color pattern with a wide range, generally with dark colored superomarginal plates and lighter colored disk plates.

Comments

Neoferdina currently includes 12 species distributed throughout the Indo-Pacific in shallow, mesophotic and deep-sea depths (0–250 m). Mah (2017) reviewed *Neoferdina,* adding 4 species. *Neoferdina* was placed within the Goniasteridae by molecular data and grouped with five other genera in the subfamily Ferdininae (Mah 2017). The shallow-water species, *Neoferdina cumingi* (Gray 1840) and *Neoferdina offreti* (Koehler 1910) are widely occurring and can show considerable variation. Unpublished data suggests that species such as *Neoferdina cumingi* comprises a wide-ranging species complex across its range (G. Paulay pers. comm). The widespread nature of the mesophotic *Neoferdina antigorum* suggests it could also comprise genetically distinct populations. Further sampling is desirable.

Neoferdina akala sp. nov.

FIGURE 10A–F

Etymology

The species epithet *akala* is derived from the Hawaiian word for “pink” alluding to this species’ striking color.

Diagnosis

Body stout, stellate (R//r=3.0), arms triangular, elongate, interradial arcs acute, curved. Body surface covered by a granule-infused dermis extending over marginal and actinal surface.

Abactinal plates convex, with flat surface, abutted forming a bumpy but relatively homogeneous surface, especially across the disk. Abactinal plates extending along arms to distalmost point where superomarginal plates, 3 to 4, are irregularly abutted. **Superomarginal plates with abactinal facing, forming approximately 18% (0.2/1.1) of distance “r” becoming more prominent distally on arm tips. Both marginal plate series covered by continuous layer of granule-invested dermis save for a bald patch, quadrate on superomarginals, circular on inferomarginals present centrally on every plate. Actinal surface covered by continuous, granule-infused dermis obscuring plate boundaries, covering the actinal intermediate surface.** Single furrow spine per adambulacral plate, present in a linear series along adambulacral groove. No other adambulacral accessories, i.e. spines, discrete granules, etc.

Color of specimen, disk pink with dark pink to purple convex plates distally on arms. Superomarginal plates with dark red quadrate patch, inferomarginals with circular bald patch demonstrating light pink bald patch. Color lighter, fading distally on inferomarginals distally.

Comments

Neoferdina akala **sp. nov.** invites immediate comparison with *Bathyferdina aireyae,* with which it shares the numerous quadrate-shaped bald spots on each of the superomarginal plates (Fig. 10B,C), but *N. akala* **sp. nov.** displays bald convex plates on the abactinal surface (Fig. 10C) and lacks the glassine embedded granules present in *Bathyferdina*.

Neoferdina akala **sp. nov.** displays the bald plates that diagnose *Neoferdina*, and shows several convex plates separating it from *Neoferdina insolita*, which displays only flat abactinal plates. *Neoferdina akala* **sp. nov.** is post similar to *Neoferdina antigorum* with which it shares the presence of distinct bald patches on most superomarginal and inferomarginal plates, but differs in that *N. akala* shows a full series of bald patches on both superomarginal and inferomarginal series, especially on interradial plates where they are absent in *N. antigorum*. *Neoferdina akala* n.s p. also shows fewer convex bare plates than *N. antigorum,* differing in color, and is much less stellate, with R=3.0 versus R=3.5 to 3.9 in the latter. *Neoferdina longibrachia* which is very similar to *N. antigorum* also differs in much more stellate but also lacks the proximal bare patches on the marginal plates.

Neoferdina akala **sp. nov.** is the third species known from New Caledonia and the deepest known. At a depth of 230–249 m, this is to date, the deepest known *Neoferdina* species. Other known species have been collected from mesophotic and continental shelf depths, 30 to 200 m (Mah 2017). Two other *Neoferdina* species, *N. offreti* and *N. cumingi* are known from shallow-reef settings.

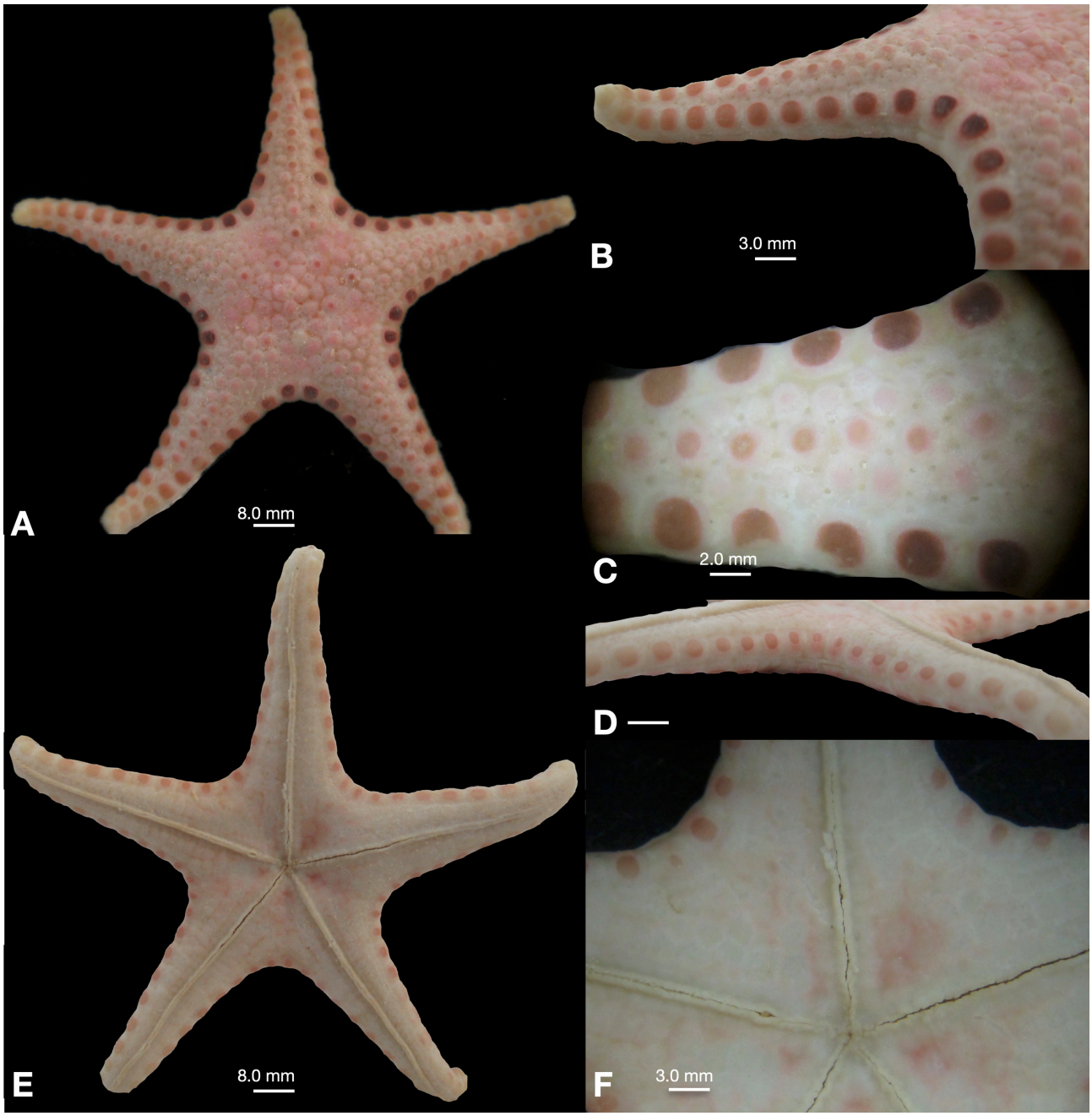

FIGURE 10. ***Neoferdina akala*** **sp. nov.** MNHN IE-2013-7449. A. Abactinal. B. Abactinal-lateral C. Abactinal close. D. Lateral. E. Actinal. F. Oral-adambulacral.

Occurrence/Distribution
New Caledonia, 230–249 m.

Description
Body stout, stellate (R//r=3.0), arms triangular, elongate, interradial arcs acute, curved. Body surface covered by a granule-infused dermis extending over marginal and actinal surface (Fig. 10A, E).

Abactinal plates convex, with flat surface, abutted forming a bumpy but relatively homogeneous surface, especially across the disk. Abactinal plates extending along arms to distalmost point where superomarginal plates, 3 to 4, are irregularly abutted. Surface is covered by continuous granule cover save for approximately 6 to 8 plates distally along arms which have distinct centrally located bald spots (darkly colored with granules absent) as well as multiple convex plates on disk, 12 to 18 where granulation is absent (Fig. 10A, B, C). Papular pores single, present primarily on arms, absent from disk. Madreporite not clearly observed, surface possibly damaged, flanked by three adjacent plates. No pedicellariae.

Marginal plates wide, quadrate in shape, interradially becoming more equidistant (L=W) distally. Superomarginal plates 25 per interradius, inferomarginal plates 26 to 28 per interradius. Superomarginal plates with abactinal facing, forming approximately 18% (0.2/1.1) of distance "r" becoming more prominent distally on arm tips. Both marginal plate series covered by continuous

layer of granule-invested dermis save for a bald patch, quadrate on superomarginals, circular on inferomarginals present centrally on every plate. Terminal plate triangular, bare surface. No pedicellariae.

Actinal surface with quadrate to polygonal intermediate plates in chevron-like formation, but covered by continuous, granule-infused dermis obscuring plate boundaries, covering the actinal intermediate surface with a relatively smooth, granular surface (Fig. 10F).

Single furrow spine per adambulacral plate, present in a linear series along adambulacral groove (Fig. 10F). No other adambulacral accessories, i.e. spines, discrete granules, etc. absent. No pedicellariae.

Color of specimen (Fig. 10A, B), disk pink with dark pink to purple convex plates distally on arms. Superomarginal plates with dark red quadrate patch, inferomarginals with circular bald patch demonstrating light pink bald patch. Color lighter, fading distally on inferomarginals distally.

Material Examined

MNHN IE-2013-7449 New Caledonia, 18º9'S 163º5.3'E, 239–249 m SPANBIOS DW 5207 17.7.21, 1 wet spec. R=3.3 r=1.1.

GONIASTERINAE

Alloceramaster Mah 2025

Diagnosis

Overall body forms pentagonal or weakly stellate (R/r = 1.1–1.9) with few known adults greater in size than R = 2.0 to 5.0 cm. Arm tips blunt. Interradial arcs weakly curved to straight. **Fasciolar grooves present around radial papular regions, but shallow to absent around other abactinal plate regions. Two distinct types of abactinal accessories, the more rectangular to rhombic shaped granules forming a periphery around papular radially positioned, abactinal plates versus those forming round to polygonal granules forming periphery around the remainder of the plates.** Marginal plates per interradius (arm tip to arm tip), 6–18, with elevated bald or with large bald region on plate surface which could be bare or covered with widely spaced granules. Actinal plates quadrate to polygonal, covered by granules. Furrow spines 2 to 9, blunt, subambulacral spines 3 to 4.

Comments

Alloceramaster was described by Mah (2025) to include *Ceramaster*-like taxa which were characterized by the presence of heteromorphic granules around the radial regions, specifically those with elongate to angular peripheral granules and more rounded to polygonal central granules on triangular or polygonal shaped plates as well as a bare spot on the superomarginal plate surface. *Sphaeriodiscus irritatus* and *S. maui* both possess the diagnostic radial plates and peripheral plates along with abactinal and marginal plate types, but have a mostly bare superomarginal plate surface with a small number of widely spaced granules, which are argued as species level-variation.

Fisher's (1910) definition of *Sphaeriodiscus* indicates enlarged penultimate or antipenultimate superomarginal plates as one of the distinctive diagnostic characters in addition to several others which are more widespread among similar taxa, e.g. granular cover on abactinal plates. neither of these two species displays enlarged enlarged penultimate superomarginals, at least not relative to the adjacent proximal superomarginal plates. Thus, it is argued that these species are better placed within *Alloceramaster* rather than *Sphaeriodiscus*. Other character conflicts, include that of the fewer marginal plates per interradius and the bald superomarginal surface versus the granular covered surface in *Sphaeriodiscus*. However, the widely spaced granules sit on an elevated bald space similar to those in *Alloceramaster* and *Ceramaster* and is argued as character variation across species.

Alloceramaster irritatus (H.E.S. Clark in H.E.S. Clark & McKnight 2001)

FIGURE 11A–E

Sphaeriodiscus maui McKnight 1993: 169, 185 (non *S. maui* McKnight, 1973)

Spheriodiscus irritatus H.E.S. Clark in H.E.S. Clark & McKnight 2001: 133.

Diagnosis

Body pentagonal. Abactinal plates covered by granular cover but forming discrete cover over individual plates. **Radial plates wide with round to polygonal radial plates, displaying peripheral rectangular granules** (Fig. 11B). **Marginal plates 6, inferomarginal plates 8 to 9 (distalmost small, upturned and adjacent to terminal plate)** (Fig. 11A, C)**.** Superomarginals covered by widely spaced granules, 20–40 on raised surface, otherwise covered by closely spaced round granules. Inferomarginal plates numerous and dense, covered by polygonal to round granules. Furrow spines 7 to 9, distally 5 or 6, subambulacrals in 3 to 4 irregular series decreasing in size from those adjacent to furrow to those adjacent to actinal plates (Fig. 11D).

Comments

Comparisons between the type material and specimens from New Caledonia suggest they resemble one another closely. Further occurrence of this species in the New Caledonian region extend this species' distribution north from Norfolk Island. Based on MNHN collections, this is a relatively abundant species in this region.

Occurrence/Distribution

Southeast of Norfolk Island, Norfolk Basin (New Zealand), 530 m.

New Caledonia, 428–470 m.

Material Examined

MNHN IE-2013-6971 Vauban, New Caledonia, 22º55'1"S

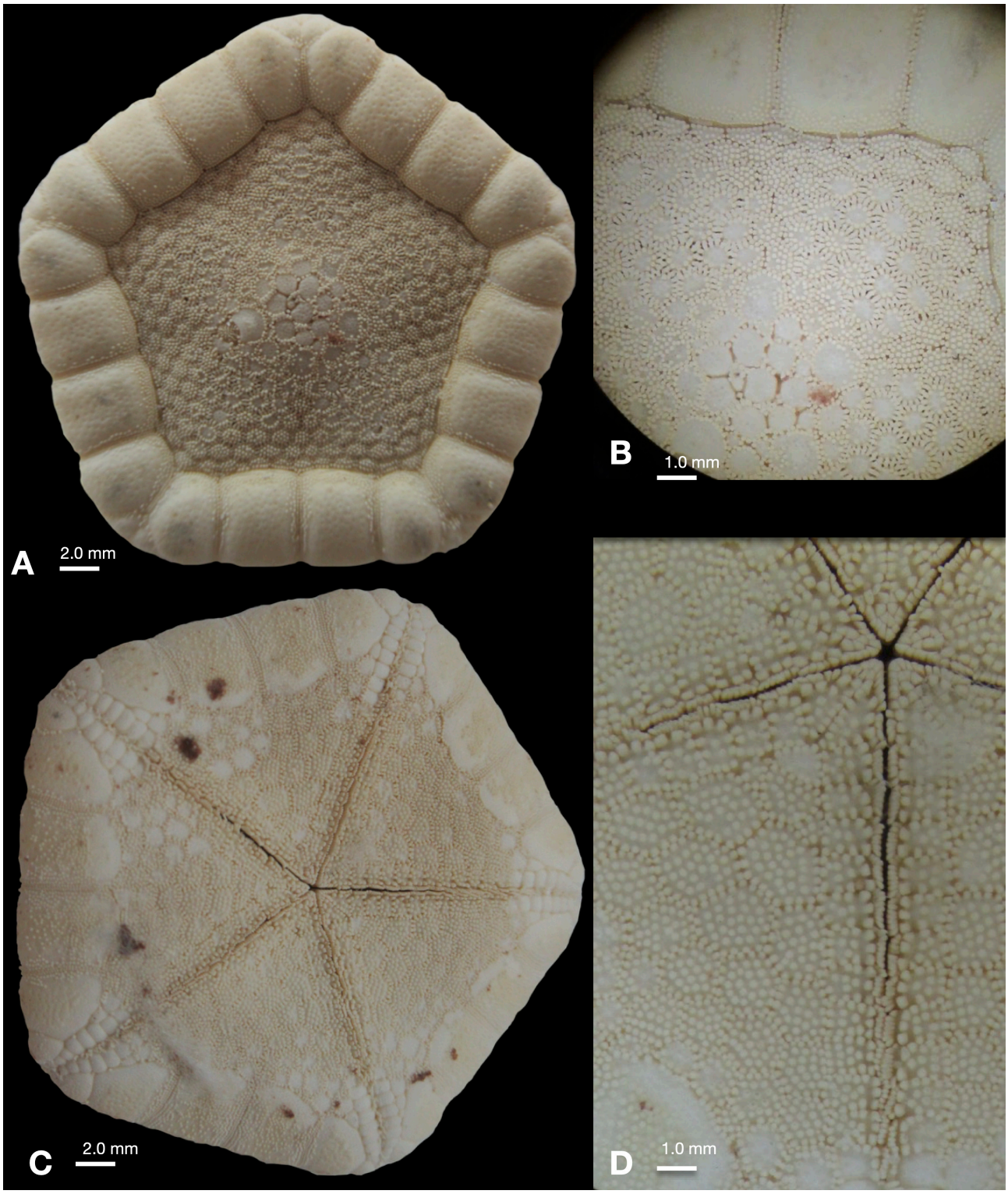

FIGURE 11. ***Alloceramaster irritatus*** (H.E.S. Clark & McKnight 2001) MNHN IE-2013-3869. A. Abactinal. B. Abactinal-lateral. C. Actinal. D. Actinal-adambulacral.

167º14'5"E, 428–448 m. Coll. Richer de Forges Sept.19 1986. 2 dry specs. R=2.5 r=1.9 R=2.3 r=1.9.

MNHN IE-2013-6972 South New Caledonia, 23º37'S 167º41"E, 460–470 m, Coll. Richer, N/O *Alis*, ORSTOM, campagne BERYX 11, 18 Oct 1992, 3 dry specs. R=1.4 r=1.3 R=0.8 r=0.7; R=0.6 r=0.5.

MNHN IE-2013-6958 S*tylaster* Bank, South New Caledonia, 23º 37.4'S 167º42.1"E, 440 m. Coll. Richer-IRD, N/O *Alis*, campagne LITHIST, DW 01, 10 Aug 1999, 7 dry specs. R=2.2 r=1.9, R=2.1 r=1.8 R=1.8 r=1.5 R=1.8 r=1.7 R=2.0 r=1.7 R=1.8 r=1.4 R=1.8 r=1.6.

MNHN IE-2013-6975 New Caledonia, 22º 53'6 S

167º 12'5"E, 435–447 m, Coll. Richer de Forges, N/O Alis, campagne VAUBAN dr. 8, 17 Sept. 1986, 1 dry spec. R=3.2 r=2.3.

MNHN-2023-178, New Caledonia, 23°37'S, 167°41'E to 23°38'S, 167°42'E, 460–470 m, Coll. Richer, N/O *Alis*, ORSTOM, campagne BERYX 11 DW 27, 18 Oct 1992. 1 dry spec. R=1.9 r=1.7.

Alloceramaster maui (McKnight 1973)

FIGURE 12A–E

Sphaeriodiscus maui McKnight 1973: 187, fig. 8; A.M. Clark 1993: 284 (checklist).

Diagnosis

Body pentagonal. Abactinal surface with relatively dense granular cover, obscuring boundaries between plates. **Radial plates triangular to "kite shaped" in shape with narrow angular peripheral granules, central granules round** (Fig. 12B)**.** Superomarginal plates 6 to 10 per interradius at R=3.5 (Fig. 12A, D). Furrow spines 8 or 9, subambulacral spines in 2 to 4 rows, each with 4 or 5 granules (Fig. 12E).

Comments

Specimens herein differ from those described from New Zealand in showing 6 to 8 superomarginals (Fig. 12A, D) per interradius rather than 10, but with a consistent

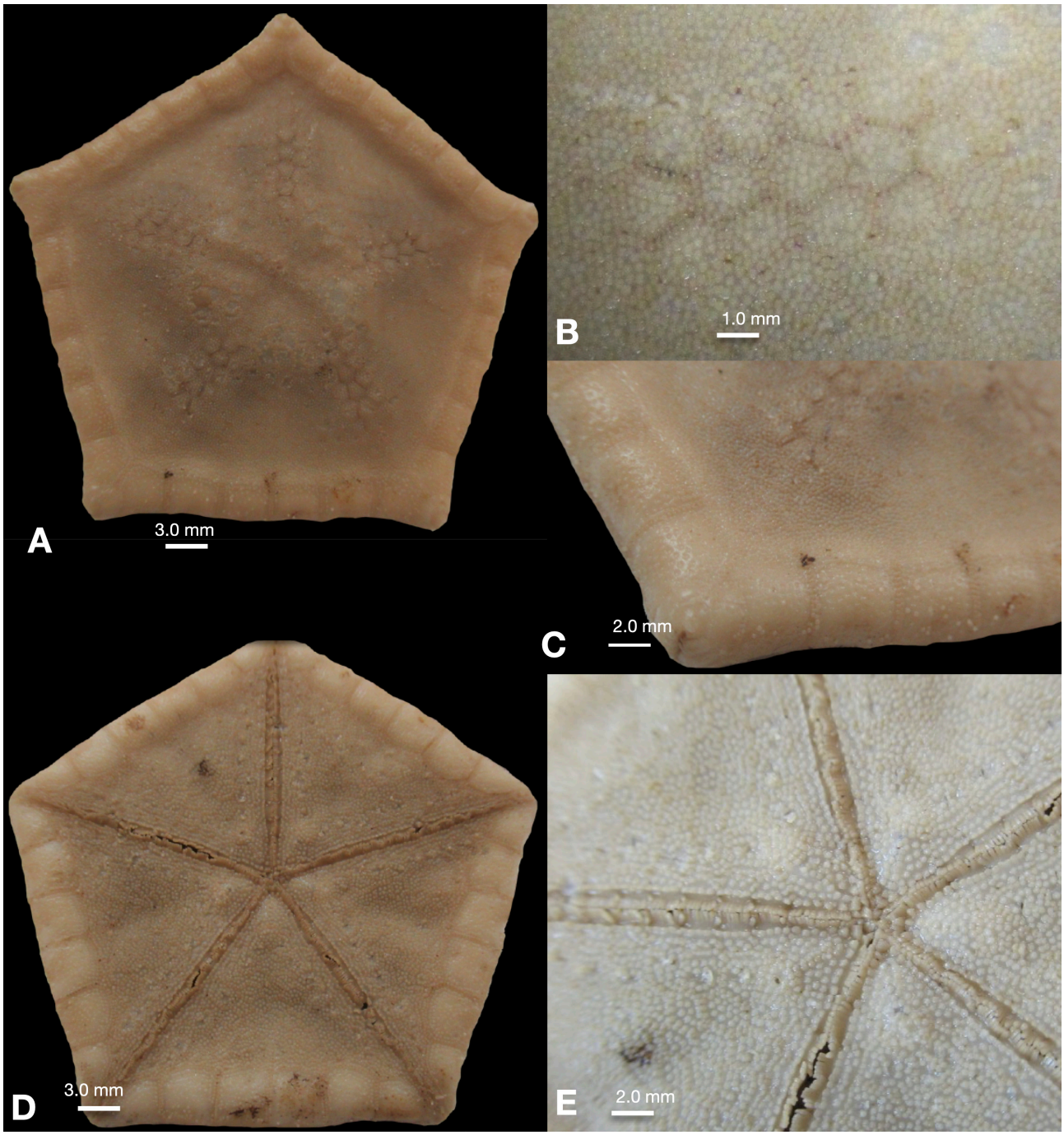

FIGURE 12. ***Alloceramaster maui*** (McKnight 1973) MNHN IE-2013-5082. A. Abactinal. B. Radial plates with angular peripheral granules. C. Abactinal-marginal arm tip. D. Actinal. E. Actinal adambulacral.

number of furrow spines, 8 to 10 and a similar abactinal granular core (Fig. 12E).

This represents a range extension from their New Zealand occurrence as outlined by H.E.S. Clark & McKnight (2001).

Occurrence/Distribution

New Caledonia, 758–780 m.

Aotea Seamount, west of Auckland, New Zealand and Macauley Island, Kermadec Group. 926–1180 m.

Material Examined

MNHN IE-2013-6968 Fairway Ridge, New Caledonia, 161º31'E 21º4.3'S, 758 m. Coll. IRD, N/O *Alis*, campagne ZONECO 6, st. CC12, 10 Dec 1998. 2 dry specs. R=2.7 r=2.0 R=2.5 r=1.8.

MNHN IE-2013-5082 New Caledonia, 18°52'S, 168°55'E, 775 m. Coll. MUSORSTOM 8 CP 992, 24 Sept 1994.1 wet spec.

MNHN IE-2013-5098 New Caledonia, 17°56'S, 168°44'E, 765–780 m. Coll. MUSORSTOM 8, CP 1035, 29 Sept. 1994. 3 wet specs.

Anthenoides Perrier 1881

Anthenoides Perrier, 1881: 23; 1884: 246–247; Verrill, 1915: 113; Fisher, 1906: 1070; Fisher, 1919: 328; Bernasconi 1964: 20; 1964: 254–255; Clark and Downey, 1992: 228; A.M.Clark, 1993: 241; Mah 2018: 6; 2021: 416.

Leptogonaster Sladen, 1889: 326; Fisher, 1906: 1070; Fisher, 1911: 169, 173

Antheniaster Verrill, 1899: 173; Fisher, 1906: 1067; 1911: 169,173

Diagnosis

Goniasteridae with stellate body form, pointed, triangular arms, broad interradial arcs, abactinal plates abutted, papulae present over radial regions on disk and arms, absent interradially. Continuous granule-invested tegument covers abactinal, marginal, actinal surface. Marginal plates quadrate forming distinct abactinal-actinal facing border with granules or short spinelets. Pedicellariae present or absent. Furrow spines, fine slender, subambulacral spination variable but some species with both bivalve and forceps-like pedicellariae.

Comments

Anthenoides is a genus of Goniasteridae with widely ranging species, including *Anthenoides pericei* in the Atlantic (Mah 2024; Clark & Downey 1992), *A. marleyi* in the Indian Ocean (Mah 2018), two Indo-Pacific species, *A. cristatus* and *A. granulosus,* and the Pacific *A. epixanthus* (Mah 2021). *Anthenoides rugulosus* Fisher 1913 was synonymized with *A. granulosus* by H.E.S. Clark & McKnight (2001) followed by synonymy of *A. sarissa* with *A. cristatus* (Mah 2021).

Character variation among *Anthenoides* species has become increasingly better understood as additional specimens have been collected. H.E.S. Clark (2001) remarked on several species which are likely synonyms, but a review of species is desirable.

Although the biology of most species is poorly understood, *in situ* observations of the Atlantic *A. peircei* show it appressed into the sediment with the actinal surface flush or pressed below the sediment surface (Mah 2024). Other species of *Anthenoides* are similar in appearance and possibly show a similar life mode.

Key to *Anthenoides* species in New Caledonia

(0) Inferomarginal plates with blunt, bullet-shaped spines..... ..... *Anthenoides cristatus* (Sladen, 1889)

(0') nferomarginal plates without spines.....(1)

(1) Pedicellariae present on abactinal, actinal surface ....*Anthenoides granulosus* Fisher 1913

(1') Pedicellariae absent from all but the adambulacral plates... .....*Anthenoides epixanthus* (Fisher, 1906)

Anthenoides cristatus (Sladen 1889)

FIGURE 13A–F

*Leptogonaster cristatus S*laden 1889: 327, pl. 54: 1–7

Anthenoides sarissa Alcock 1893: Macan, 1938: 405;A.M. Clark 1993: 242 (checklist); Mah 2018: 7 (referred to synonymy)

Anthenoides cristatus Fisher 1919: 329, pl. 78, figs. 1–2, pl. 88, fig.1; pl. 89, fig. 1; Macan 1938: 403, pl. 3, fig. 5; pl. 5, Fig. 1; McKnight 1973: 192; Jangoux 1981: 459; Liao & A.M. Clark 1989: 41; A.M. Clark 1993: 241; H.E.S. Clark & McKnight 2001: 14; Mah 2018: 7.

Anthenoides tenuis Liao & Clark 1989: 39, pl. 2, figs 1–4; Liao & Clark 1995: 90, pl. 7 figs 3,4.

Diagnosis

Body stellate, R/r=2.3 to 3.0, arms triangular, interradial arcs weakly curved. **Abactinal surface composed of polygonal plates covered by dermis, granules, round to irregular in shape covering surface, especially distally adjacent to superomarginal plates. Abactinal forceps like pedicellariae present.** Superomarginal plates covered by dermis, but otherwise smooth, abutted distally approximately 4 to 6 plates from terminus. **Inferomarginal spines present, especially on proximal plates.** Actinal regions covered by dermis, granules present, but sparsely so. Furrow spines 4 to 7, widely spaced, blunt with pointed tips. Subambulacral spines, 2 to 3, short, approximately half the height of furrow spines. Pedicellariae, tong-like present adjacent to subambulacral spines, especially proximally.

Synonymy of *Anthenoides tenuis*

Anthenoides tenuis Liao & Clark, 1989 is a junior synonym of *Anthenoides cristatus* (Sladen 1889). Both species share the presence of short, conical spines on the inferomarginal plates and refinement of character observations shows *A. cristatus* with 4 to 7 furrow spines, where *A. tenuis* is diagnosed as having 6 to 7 furrow spines. A further distinguishing character, the presence of bivalve pedicellariae on the abactinal surface was noted among the variation

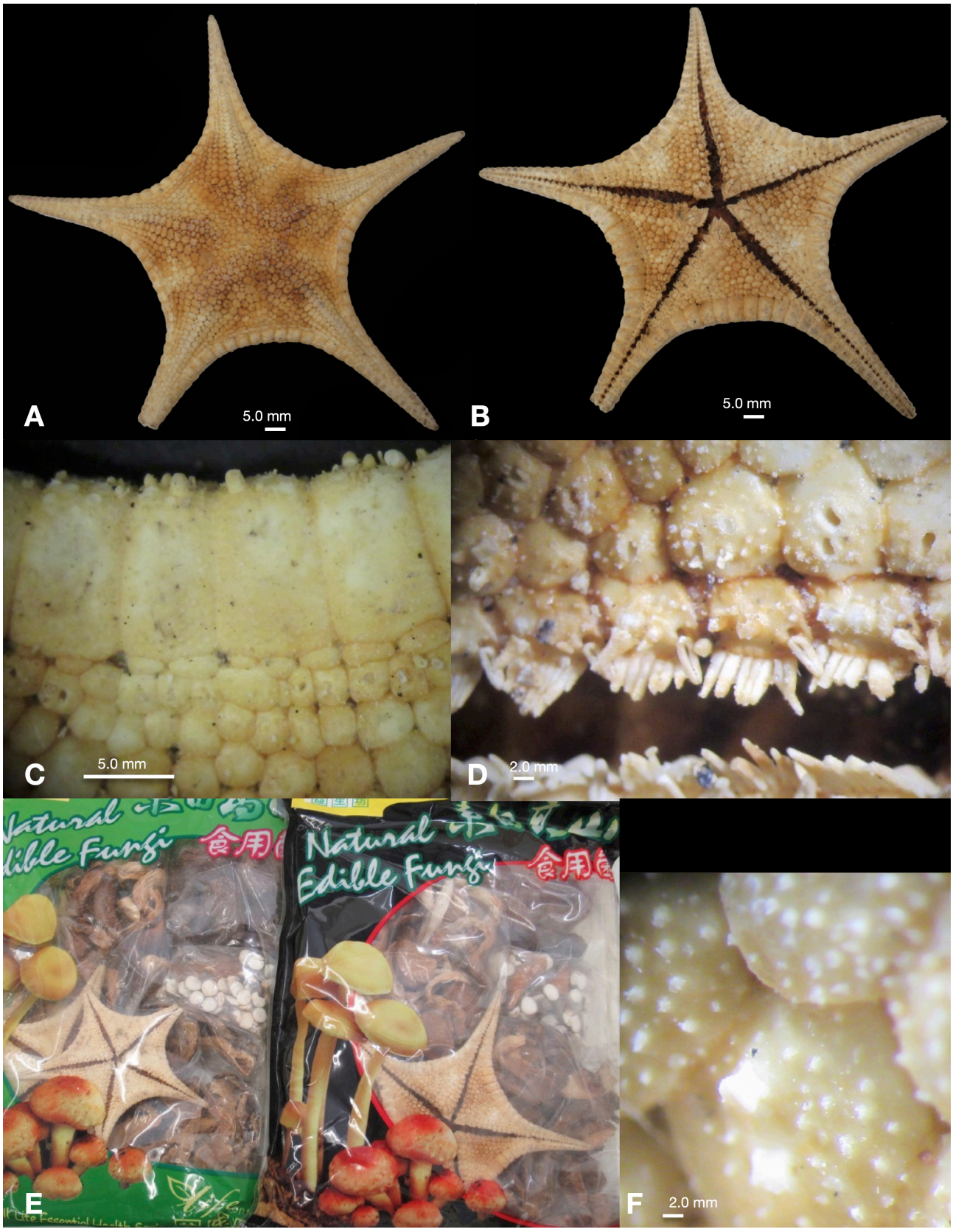

FIGURE 13. ***Anthenoides cristatus*** (Sladen, 1889) soup mix specimen. A. Abactinal. B. Actinal surface. C. Inferomarginal plates, actinal view showing spines. D. Furrow spines and pedicellariae. E. Packaging of specimens. E. Abactinal closeup showing pedicellariae.

of characters documented by Fisher (1919) for Philippine specimens. Liao and Clark (1989) list other characters, such as size differences of abactinal plates, abundance of secondary plates, and presence/absence of "true" granules (versus "fine" calcarious bodies) which all fall within the limits of morphological variation of *A. cristatus*.

Comments

With the determination of *A. tenuis* as a synonym of *A. cristatus*, this permits positive ID of observations of this species used in an ingredient of Asian commercial soup mixes (Fig. 13E). Specimens figured herein were consistent with trawled specimens from the South China Sea (MNHN IE-2013-7412). Liao & Clark (1989) noted this as a commonly dredged species off the coast of Hainan Island and found in fish markets from Guangdong. Those figured here were purchased from a market in San Francisco, California in 2006, sold by "New Horizon Enterprises Ltd." a company in China. Specimens included dried, but apparently not bleached, accompanied by dried fungus for inclusion in hot water to form a soup.

These specimens (Fig. 13A–F) had short spination on the inferomarginal plates (Fig. 13C), fine "calcareous bodies" on the body surface, paddle-like pedicellariae on the abactinal and superomarginal plate surface, slender "tweezer" like or forcipiform pedicellariae (Fig. 13D) on the adambulacral plates, and 4 to 8 furrow spines, characters consistent with *Anthenoides tenuis* and thus *A. cristatus*.

Occurrence/Distribution

Gulf of Aden (Indian Ocean), Philippines, Indonesia, Papua New Guinea, Solomon Sea, Marquises Islands, South China Sea, New Zealand, 134–1350 m.

New Caledonia, 289–510 m.

Material Referenced

New Caledonia. MNHN IE-2009-2195, Norfolk Ridge, Kaimon Maru seamount, New Caledonia, 24°45'0"S; 168°6'41.9904"E, 490–510 m. Coll. Richer de Forges, N/O *Alis*, campagne BERYX 11, CP 22, 17 Oct 1992, 1 dry spec.

MNHN IE-2009-2196, Norfolk Ridge, Kaimon Maru seamount, New Caledonia. 24°45'1.8"S; 168°6'47.9772"E, 430–450 m. Coll. Richer de Forges, N/O *Alis*, campagne BERYX 11, CP 21, 17 Oct 1992, 1 dry spec.

MNHN IE-2009-2197, SW I'lle es Pins, New Caledonia, 23°4'18.9012"S; 167°1'18.3864"E, 420–430 m. Coll. Richer de Forges IRD, campagne HALIPRO 1, CH878, 31 March 1994. 1 dry spec.

MNHN IE-2009-2198, Bassin des Loyaute, New Caledonia, 21°43'57.5976"S; 166°43'25.7376"E, 314–364 m. Coll. Richer de Forges, N/O Alis, campagne HALIPRO 1, CP 851, 19 March 1994. 1 dry spec.

MNHN IE-2013-7445, Off the coast of Touho, New Caledonia, 20°43'31.5588"S; 165°18'57.8412"E,

441–452 m. Coll. N/O *Alis*, campagne SPANBIOS, CP 5190, July 11, 2021. 7 wet specs.

MNHN IE-2013-7519, Off the coast of Touho, New Caledonia, 20°43'13.62"S; 165°19'57.1412"E, 335–364 m. Coll. N/O *Alis*, campagne SPANBIOS, CP 5189, July 11, 2021. 5 wet specs.

MNHN IE-2013-7636, Off the coast of Hienghene, New Caledonia, 20°33'59.6412"S; 164°58'43.9212"E., 354–368. Coll. Coll. N/O *Alis*, campagne SPANBIOS, CP 5131, July 1, 2021. 16 wet specs.

MNHN IE-2019-3843, SW Ille des Pins, New Caledonia, 23°3'29.16"S; 166°58'45.8436"E, 450–491 m. Coll. N/O. *Alis*, campagne HALIPRO 1, CH880, 2 dry specs.

MNHN IE-2019-3930, Norfolk Ridge, New Caledonia, 24°45'1.8"S; 168°6'47.9772"E, 430–450 m. Coll. N/O *Alis*, campagne BERYX 11, 17 Oct 1992, 1 dry spec.

MNHN IE-2019-3931, Norfolk Ridge, Kaimon Maru seamount, New Caledonia, 24°45'0"S; 168°6'41.9904"E, 490–510 m. Coll. N/O *Alis*, campagne BERYX 11, 17 Oct 1992, 1 dry spec.

MNHN IE-2020-485, Off the coast of Touho, New Caledonia, 20°43'13.62"S;165°18'19.1412"E, 335–364 m. Coll. N/O *Alis*, campagne SPANBIOS, CP5189, 1 wet spec.

MNHN IE-2020-496, Off the coast of Hienghene, New Caledonia, 20°33'45.2412"S; 164°58'24.7188"E, 398–431 m. Coll. N/O *Alis*, campagne SPANBIOS, CP5132, 1 wet spec.

MNHN IE-2020-499, Off the coast of Hienghene, New Caledonia, 20°34'10.2612"S; 164°58'57.4212"E, 289–312 m. Coll. N/O *Alis*, campagne SPANBIOS, CP5135, 1 wet spec.

New Zealand. USNM E11319 Between Mayor and the Alderman Islands, New Zealand, South Pacific. 37°33'N 172°02'E, 293–402 m. Coll. NZ Prawn Survey, University of Victoria. 1 Jan 1969. 1 dry spec. R=4.7 r=3.0.

Indonesia MNHN IE-2013-8300, Makassar Strait, Sulawasi, Indonesia, 1°56'35.9988"S; 119°16'42.0096"E, 134–186 m. coll. Guille *et al.* N/O *Coriolis*, campagne CORINDON 2, 7 Nov 1980. 1 dry spec.

Papua New Guinea. MNHN IE-2007-3174, South of Lae, Huon Gulf, Papua New Guinea, 6°53'41.5212"S; 147°2'43.2564"E, 305–307 m. Coll. Samadi & Cobari, N/O *Alis*, campagne BIOPAPUA, CP3630, 22 Aug 2010, 1 wet spec.

MNHN IE-2007-3244, South of Lae, Huon Gulf, Papua New Guinea, 7°28'30.6012"S; 147°30'47.2428"E, 279–290 m. Coll. Samadi & Cobari, N/O *Alis*, campagne BIOPAPUA, CP3634, 23 Aug 2010, 3 wet spec.

Marqueses Islands. MNHN IE-2013-5188, Marquises Archipelago. Coll. Bouchet *et al.*, N/O *Alis*, MUSORSTOM 9, Aug 1 1997. 1 wet spec.

MNHN IE-2013-5193, Nuku Hiva Island, Marquises Archipelago, 8°44'48.0012"S; 140°14'30.0084"E, 260 m. Coll. Bouchet *et al.*, N/O *Alis*, campagne MUSORSTOM 9, CP1176, 265 Aug 1997,1 wet spec.

Solomon Islands. MNHN IE-2013-7129 SE New Britain, Ainto Bay, Solomon Sea, 6°7'18.0012"S; 149°9'47.988"E, 220–440 m. Coll. N/O *Alis*, campagne MADEEP, CP 4333, 6 may 2014, 1 wet spec.

MNHN IE-2013-2188, West of San Cristobal, Solomon Islands, 10°25'48.5976"S; 161°24'16.7868"E,

190–232 m. Coll. Richer & Boisellier, N/O *Alis*, campagne SALOMONBOA 3. 12 wet specs.

South China Sea. MNHN IE-2013-7412. Continental slope of the South China Sea, 19°56'30.0048"N; 114°33'52.8012"E, 249–250 m. Coll. R/V *Ocean Researcher 1,* campagne ZhongSha2015, CP 4136, 23 July 2015. 1 wet spec.

MNHN IE-2013-7424, Seamount, W of Macclesfield, South China Sea, 16°2'16.8"N; 113°53'48.0012"E, 360–403 m. Coll. R/V *Ocean Researcher 1,* campagne ZhongSha2015, DW 4143, 23 July 2015. 1 wet spec.

MNHN IE-2013-7427, N. Macclesfield Bank, South China Sea,16°8'9.0024"N; 114°17'58.2"E, 259–353 m. Coll. Coll. R/V *Ocean Researcher 1,* campagne ZhongSha2015, DW 4143, 23 July 2015. 4 wet specs.

Anthenoides epixanthus (Fisher 1906)

Antheniaster epixanthus Fisher 1906: 1067, pl. 20, fig. 3, pl. 24, figs. 1–2, pl. 49, fig. 1; Hayashi 1952: 152; Liao & Clark 1989: 39; 1995: 90; H.E.S. Clark & McKnight 2001: 18.

Anthenoides epixanthus Hayashi, 1952: 152, pl. 8, figs. 10–11; A.M. Clark, 1993: (part of checklist); Chave and Malahoff, 1998: Table 1; Mah, 1998: 67 (part of checklist); H.E.S. Clark 2001: 18; pl. 2.

Diagnosis

Body stellate, R/r=2.3, arm tips pointed, interradial arcs rounded. **Abactinal surface covered by bosses to granules, weakly developed.** Dermis covers body surface, **Marginal spines absent.**

Pedicellariae, absent from all but the adambulacral plate surface.

Comments and Synonymy of *A. laevigatus*

Anthenoides laevigatus Liao & Clark 1989 is a synonym of *Anthenoides epixanthus* (Fisher 1906). Diagnostic characters of *A. laevigatus* were its relatively stellate body form, R/r=2.2–2.6, rudimentary abactinal granules, as well as its relatively large abactinal plates and madreporite, fewer secondary plates and absent pedicellariae. These characters all fall well within the range of character variation of *A. epixanthus*, which occurs widely throughout the Indo-Pacifc and demonstrates a considerable range of morphological variation, of which *A. laevigatus* demonstrates a partial example.

Occurrence/Distribution

Rapa Nui, Hawaiian Islands, Japan, New South Wales Australia, Papua New Guinea, Bismarck Sea, New Zealand. 100–591 m.

New Caledonia, 398–463 m

Material Referenced

New Caledonia. MNHN IE-2013-7617 Off Hienghene, New Caledonia, 20°33'45.2412"S; 164°58'24.7188"E, 398–431 m. Coll. N/O *Alis*, campagne SPANBIOS, 1 July 2021, CP 5132, 1 wet spec.

MNHN IE-2016-1530 Offshore of Yate's Pass, New Caledonia, 22°4'48"S; 167°9'18"E, 400–437 m. Coll. N/O *Alis*, EXBODI, 8 Sept. 2011, CP 3830, 2 wet specs.

MNHN IE-2023-3668 NW of Lifou, New Caledonia, 20°42'8.9964"S; 166°59'35.9952"E, 343 m. Coll. Bouchet *et al.*, N/O *Alis,* campagne MUSORSTOM 6, DW 416, 12 Feb 1989, DW416, 1 dry spec.

MNHN IE-2020-478 Off Poindimie, New Caledonia, 20°48'44.9388"S; 165°26'6.4788"E, 306–452 m. Coll. N/O *Alis*, campagne SPANBIOS, CP 5200, 15 July 2021, 1 wet spec.

MNHN IE-2023-3666 NW Lifou, New Caledonia, 20°40'9.0012"S; 167°3'56.9736"E, 463 m. Coll. Bouchet *et al.* N/O *Alis*, campagne MUSORSTOM 6, DW413, Feb 2 1989, 1 dry spec.

Bismarck Sea. MNHN IE-2013-7126, Gazelle Channel, NE New Ireland, Bismarck Sea, 2°53'39.0012"S; 151°4'34.824"E, 350–847 m. coll. N/O *Alis,* campagne MADEEP, CP4260, 25 April 2014. 3 wet specs.

MNHN IE-2013-7130, Gazelle Channel, NE New Ireland, Bismarck Sea, 2°52'38.3988"S; 151°5'47.9904"E, 370–429 m. Coll. N/O *Alis*, campagne MADEEP, CP4259, 25 April 2014. 9 wet specs.

Papua New Guinea. MNHN IE-2007-6370, Canal de l'Savannah, New Caledonia, 22°13'48"S; 167°11'6"E, 378–414 m. Coll. N/O *Alis*, campagne EXBODI, CP3790, 3 Sept 2011, 1 wet spec.

Asia. Specimens with no data. Teaching Collection-Mah, purchased 2004 from Clement street asian market, San Francisco, California. 2 packages, each with 3 dry specs.

Anthenoides granulosus Fisher 1913

FIGURE 14A–E

Anthenoides granulosus Fisher, 1913: 647; Fisher, 1919: 333, Pl. 88, fig. 2,3, pl. 94, figs. 4,4a–b.; Döderlein, 1924: 65; Fell, 1958a: 12, pl. 1, fig. B; Fell, 1958b: 135 (included in key); Clark, H.E.S. 1970: 3; Baker and H.E.S. Clark, 1970: 4; Rowe 1989: 289; A.M. Clark, 1993: 242; Rowe & Gates 1995: 63; H.E.S. Clark & McKnight 2001: 20; Mah 2018: 8, Fig. 1A–F.

Anthenoides rugulosus Fisher 1913: 648; 1919: 338, pls 85(4), 88(4), 90(1), 94(5a,5b); Rowe 1989: 289; Rowe & Gates 1996: 63; A.M. Clark 1993: 242.

Diagnosis

Body stellate, arms triangular, tapering, interradial arcs curved. **Spines absent from the inferomarginal plates** (Fig. 14B). Presence of variably fine to coarse/small to large granulation on superomarginals. Furrow spines, thick six to eight. **A duck- bill or straight pedicellariae present abactinally and on the adambulacral plates on the proximal side of the adambulacral plate.**

Comments

A variable species present throughout the South and Central Pacific, extending to Madagascar. H.E.S. Clark (2001) assessed the granules, ray length and pedicellariae characters that differentiated *A. rugulosus* from *A.*

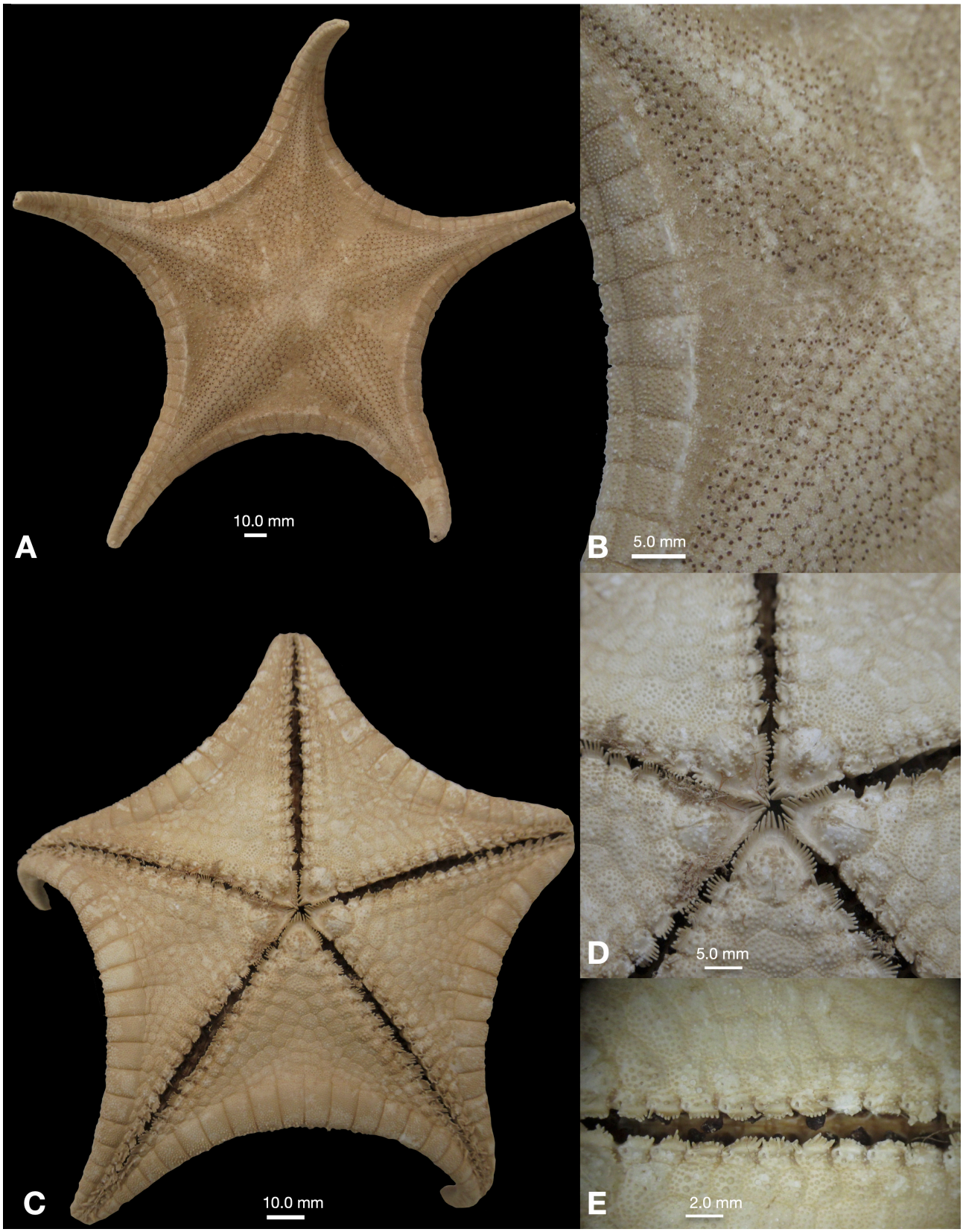

FIGURE 14. ***Anthenoides granulosus*** Fisher, 1913. MNHN IE-2023-166. A. Abactinal. B. Abactinal-superomarginal view. C. Actinal. D. Actinal closeup, oral and adambulacral furrow, E. Adambulacral furrow spination.

granulosus and concluded that they were synonyms. Mah (2018) agreed with this conclusion.

Occurrence/Distribution

Philippine Islands, Moluccas, Papua New Guinea, Solomon Islands, Vanuatu, New South Wales, Australia, Norfolk Island (near Raoul Island, Kermadec Islands and New Zealand, Madagascar. 143–731 m.

New Caledonia 192–580 m

Material Examined

New Caledonia. MNHN IE-2023-166, East coast of New Caledonia, 21º13.45'S 165º 55.1'E, 515–580 m. Coll. Bouchet & Richer, ORSTOM, N/O *Alis*, campagne BATHUS 1, 12 March 1993, 4 dry specs. R=7.8 r=3.4 R=6.8 r=2.7 R=7.5 r=3.3 R=7.3 r=3.3.

MNHN IE-2007-6376, Ellet Bank, New Caledonia, 22°53'17.9988"S; 169°24'47.9988"E, 580–780 m. coll. N/O *Alis*, campagne EXBODI, 16 Sept 2011 CP 3871, 1 wet spec.

MNHN IE-2009-2191 East coast, New Caledonia, 21°14'26.9988"S; 165°54'55.7892"E, 490–530 m. Coll. Bouchet & Richer de Forges IRD, N/O *Alis*, campagne BATHUS 1, CP657, 12 March 1993, 3 specs.

MNHN IE-2013-9503 *Crypthelia* seamount, New Caledonia, 23°17'12.0012"S; 168°14'30.0084"E, 192–260 m. Coll. MNHN, N/O *Alis*, campagne KANACONO, DW 4763, 27 Aug 2016. 1 wet spec.

MNHN IE-2019-3835 Off the coast of Havannah Canal, New Caledonia, 22°11'18.0024"S; 167°15'0"E, 495–550 m. Coll. Richer de Forges, IRD, N/O *Vauban*, campagne MUSORSTOM 4, CP 236, 2 Oct 1985, 2 dry specs.

MNHN IE-2019-3934, East coast, New Caledonia, 20°34'10.7976"S; 164°57'19.2168"E, 491–533 m. coll. Bouchet & Richer de Forges, IRD, N/O *Alis,* campagne BATHUS 1, CP 698, 17 March 1993, 1 dry spec.

Tonga. MNHN IE-2019-3937 NW Tongatapu, Tonga Islands, 21°2'4.2"S; 175°18'37.1988"E, 431 m. Coll. Bouchet *et al.* IRD, N/O *Alis*, campagne BORDAU 2, CP 1568, 10 June 2000, 1 dry spec.

MNHN IE-2019-3938, Tongatapu Island, Tonga Islands, 21°4'38.9964"S; 175°22'31.2096"E, 461–497 m. Coll. Bouchet *et al.* IRD, N/O *Alis*, campagne BORDAU 2, CP1510, 31 May 2000. 2 dry specs.

Vanuatu. MNHN IE-2019-3772, E. Santo, Vanuatu, 15°10'10.7976"S; 167°14'4.1892"E, 394–421 m. Coll. Bouchet & Richer de Forges-IRD, N/O *Alis*, campagne MUSORSTOM 8, 6 Oct 1994, CP1087. 1 dry spec.

Solomon Islands. MNHN IE-2019-2877, N. Guadalcanal, Solomon Islands, 9°22'0.0012"S; 160°30'59.9868"E, 620 m. coll. Bouchet *et al.* N/O *Alis*, campagne SALOMON 1, CP 1860, 7 Oct 2001. 2 dry specs.

Papua New Guinea MNHN IE-2007-2774, Pointe Sud-Est Manus Island, Papua New Guinea, 2°9'40.3812"S; 147°18'47.8008"E, 408–448 m. Coll. Samadi & Cobari, N/O *Alis*, campagne BIOPAPUA, 29 Sept 2010, CP 3692, 3 wet specs.

Astroceramus Fisher 1906

Astroceramus Fisher 1906: 1056; 1911: 172 (in key); 1919: 309; Döderlein 1924: 60; Macan 1938: 388; H.L. Clark 1941: 45; Halpern 1970: 140; Clark & Downey 1992: 230; A.M. Clark 1993: 243; McKnight 2006: 88; Kogure & Tachikawa 2009:77.

Diagnosis. Abactinal plates polygonal in outline, abutted, no surficial granules, surface smooth, bare. Glassy tubercles (aka crystalline nodules) embedded in surface of abactinal plates (e.g. Fig. 4B) of all known species. Marginal plates large, blocky, quadrate in outline, surface with coarse, surficial granules. Superomarginal plates abutted over midline variably from base of arm to paired distal penultimate plates. Actinal surface variably covered by coarse granules to bare. One to many large, thick subambulacral spines present in most species. Pedicellariae present or absent.

Comments

As outlined in Mah (2018), *Astroceramus* currently includes 11 species distributed throughout the Indian, Pacific and Atlantic Oceans. *Astroceramus* diversity in the tropical Pacific began with Fisher's (1906) description of *Astroceramus callimorphus* from the Hawaiian Islands followed by *A. sphaeriostictus* and *A. lionotus* from the Philippine Islands (Fisher 1913). *Astroceramus denticulatus* has been described by McKnight (2006) from the Kermadec Ridge (New Zealand), *Astroceramus boninensis* from southern Japan (Kogure & Tachikawa, 2009), and *Astroceramus eldredgei* was described from the Hawaiian region (Mah 2015). Mah (2018) reviewed and described new *Astroceramus* from the Indian Ocean. A single species, *A. brachyactis* H.L. Clark 1941 is known from the Atlantic.

The body morphologies of *Astroceramus* in New Caledonia is acutely diverse, ranging from species showing discoid or thick, compact forms with R/r=1.0 while other show strongly stellate forms with elongate arms, R/r>3.0. Abactinal and marginal plate arrangements, e.g. with abutted superomarginal plates along the arms are surprisingly consistent, but with variable adambulacral spines, tubercles, and pedicellariae.

Discovery of further undescribed diversity of *Astroceramus* from samples throughout the tropical Pacific, especially in the South Pacific, is ongoing, with further specimens and additional undescribed species present in collections (Mah unpublished data).

Key to the *Astroceramus* species of New Caledonia

(0) Body nearly discoid, R/r=1.0. (Fig. 17A). 4 superomarginals per side. Abactinal tubercles absent. No pedicellariae .... ***Astroceramus cyclus* sp. nov.**

(0) Body weakly to strongly stellate. Arms variably short, thick to elongate, slender. 10–40 superomarginals per side (arm tip to arm tip). Tubercles on abactinal plates present or absent. Pedicellariae-spoon shaped present.....(1)

(1) 3 to 5 superomarginals abutted along entire length of arm (Fig. 15A). Arms shut, body thick, 3 to 5 free superomarginals on disk. No abactinal tubercles ....***Astroceramus astrikos*** **sp. nov.**

(1') >8 superomarginals, mostly 10–12, abutted long entire length of arm. Body weak stellate to stellate, >5 superomarginals free on disk. Abactinal tubercles present or absent .....(2)

(2) Subambulacral spine single, enlarged and mace-shaped with denticulate, flanged surface. A tong-like pedicellariae present on the adambulacral plate adjacent to the subambulacral spine. Superomarginal plates wide, 8 to 12 abutted, 10–15 free superomarginal plates on disk. No abactinal tubercles ..... ***Astroceramus pernachus*** **sp. nov.**

(2') Subambulacral spine one or more, enlarged with smooth surface.....(3)

(3) Abactinal plates with a single nipple-like tubercle. Arms more triangular, broad at base, 12–15 free superomarginals on disk, approximately 3 subambulacral spines, one central enlarged with 2 shorter ones on either side. Furrow spines thick, round in cross-section..... ..... ***Astroceramus titthos*** **sp. nov.**

(3') Abactinal plates with no tubercle. Arms elongate, slender. 4 to 5 free superomarginals on disk, 2 to 3 subambulacral spines similar in height and gauge. Furrow spines compressed, thin..... ..... *Astroceramus callimorphus* Fisher, 1906

Astroceramus astrikos **sp. nov.**
FIGURE 15A–F

Etymology
The species epithet, *astrikos*, is Greek referring to "of the stars" alluding to this species distinctly stellate shape.

Diagnosis
Body stout, weakly stellate to pentagonal in shape, R/r=1.2–1.9, short arms, interradial arcs straight. Abactinal plates polygonal to round, with 40–200 crystalline bosses embedded in plate surface. **Superomarginal plates abutted over midline, entirety of arm, composed of 2 to 3 superomarginal plates, approximately 2 free superomarginals (no sides in contact with other marginals). 6 (at R=2.1), 8, or 10 (at R=3,5) marginal plates present in each interradius (arm tip to arm tip).** Individual marginal plates covered by granules, 40–250, evenly distributed over marginal plate surface, with each lost granule vacating a tiny, crater-like hole. Inferomarginals with small paddle-shaped pedicellariae, valves with four to six interclasping teeth. Actinal plates covered by coarse, round granules, three to 20 per plate surface, distributed unevenly. Pedicellariae paddle-like, one or two per plate, each with interclasping teeth, 6–12 per valve. Furrow spines five to six (primarily six) strongly flattened with blade like, round-wide tips. **Subambulacral spines immediately adjacent to furrow spines three or four, with one prominent elongate pedicellariae present median to the others.** One subambulacral spine in this series becomes prominent and enlarged approximately 15–20 adambulacrals from arm tip. Remaining subambulacral granules, 8–12, angular to polygonal in cross-section in irregular arrangement on plate surface, similar in size but not shape to those on other actinal plates.

Comments
Asteroceramus astrikos **sp. nov.** displays an immediate resemblance with the Hawaiian *Astroceramus eldredgei* Mah 2015 in that it displays relatively short arms with wide superomarginals abutted over the arm radii and a relatively low R/r, 1.2–1.9, versus 1.6 to 2.0 in *A. eldredgei*. However, *A. astrikos* **sp. nov.** displays consistently fewer superomarginals with 2 to 3 abutted superomarginal plates per arm (Fig. 15A) versus 4 to 6 in *A. eldredgei*. There are 12 to 16 marginal plates per interradius in *A. eldredgei*, versus 6 to 8 in *A. astrikos* **sp. nov.** (Fig. 15A, E). Actinal granulation is coarser in *A. eldredgei,* and furrow and subambulacral spines are larger and 2 to 3X as thick in *A. eldredgei* than in *A. astrikos* **sp. nov.**

Superomarginal plates on the holotype showed extensive etching on several interradial surfaces which was similar to the damage on Cretaceous goniasterid marginals as described by Neumann (2000).

Occurrence/Distribution
New Caledonia, 370–621 m.

Description
Body stout, weakly stellate to pentagonal in shape, R/r=1.2–1.9, short arms, interradial arcs straight (Fig. 15A, E).

Abactinal surface flat, forming distinct pentagonal region bordered by superomarginal plates (Fig. 15A, B). Plates flat, pentagonal to polygonal and circular in outline with distinct borders. Fasciolar channels shallow. Plate size overall homogenous proximal to distally. Plates show half-shapes adjacent to contact with superomarginal plates. All abactinal plates bare with no surficial accessories (i.e., no granules, etc.). but with 40–200 embossed crystalline bosses embedded in each plate surface distributed evenly across the surface (Fig. 15B). Some distalmost plates adjacent to superomarginals with bare surface devoid of crystal bosses. Each plate with surrounded by 25–50 round, evenly-spaced granules. Madreporite triangular with well-developed sulci, flanked on three sides by single abactinal plates (Fig. 15B). Pedicellariae not observed on abactinal surface.

Marginal plates form distinct, thick border around perimeter, composing ~26% of distance "r" from anus to edge of superomarginals. Marginal plates 6 to 8 per interradius, arm tip to arm tip. Superomarginal to inferomarginals with 1:1 correspondence. 6 (at R=2.1), 8, or 10 (at R=3,5) marginal plates present in each interradius (arm tip to arm tip). Individual superomarginal plates variable in length. First superomarginal on arm, longer, more triangular in shape. Superomarginal plates abutting along midline. Two to four superomarginals joined on arm on smallest (R=2.1) to largest (R=3.5) sized animals with variable

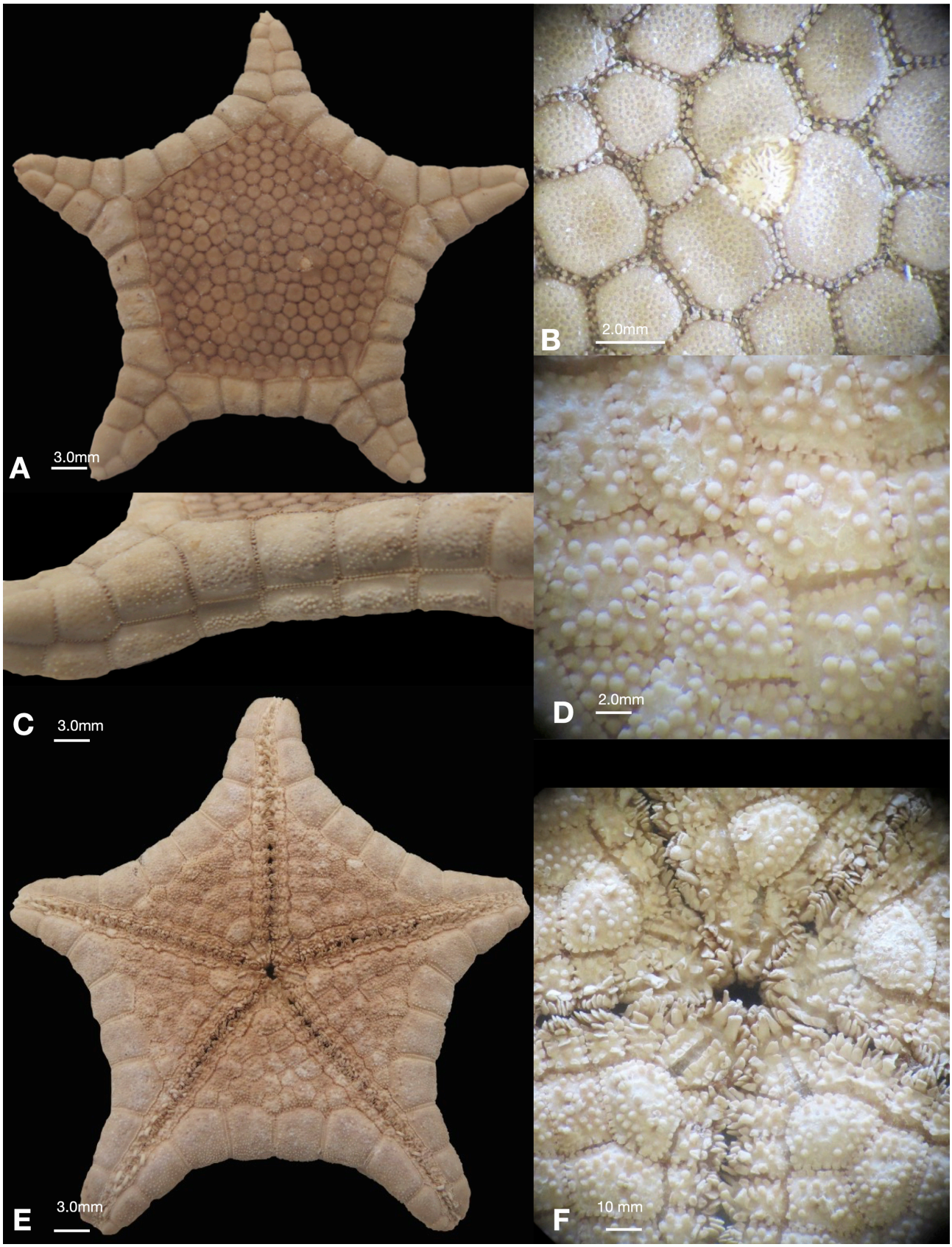

FIGURE 15. ***Astroceramus astrikos*** **sp. nov.** MNHN IE-2013-7008. A. Abactinal. B. Abactinal plates closeup. C. Lateral view. D. Actinal closeup. E. Actinal. F. Actinal oral view, adambulacral furrows.

numbers at intermediate sizes. Four superomarginals on abactinal surface in contact with abactinal disk region (Fig. 15A). Marginal plates blocky, swollen, convex in cross-section. Individual marginal plates covered by granules, 40–250, evenly distributed over marginal plate surface, with each lost granule vacating a tiny, crater-like hole (Fig 15C). Granules most abundant on central superomarginal and inferomarginal plates but absent from peripheral plate surface, especially on lateral surface contact between superomarginal and inferomarginals. Granules slightly more abundant on inferomarginal actinal-facing surface. Each superomarginal/ inferomarginal with a periphery of approximately 20–30 small granules along each side. Some superomarginals twice as large than corresponding inferomarginal plate, these plates more triangular in shape. Terminal plates triangular in shape, surface bare with no granules present. Inferomarginals with small paddle-shaped pedicellariae, valves with four to six interclasping teeth. Pedicellariae most abundant on inferomarginal adjacent to actinal-inferomarginal contact.

Actinal chevron with only a single complete series with two incomplete series adjacent to the inferomarginal contact. Individual actinal plates distinctly quadrate to polygonal. Actinal plates covered by coarse, round granules, three to 20 per plate surface, distributed unevenly (Fig. 15D). Some plates with crowded granules whereas others are more widely spaced. Peripheral actinal plate granules, more quadrate than the more spherical granules on actinal plate surface. Pedicellariae paddle-like, one or two per plate, each with interclasping teeth, 6–12 per valve (Fig. 15D). Fasciolar grooves shallow.

Adambulacral plates distinct, becoming narrower more distally. Adambulacral plates covered by angular granules, which are similar in size to those on actinal surface. Furrow spines 5 to 6 (primarily six) strongly flattened with blade like, round-wide tips (Fig. 15F). First ambulacral with eight furrow spines, two spines at distal ends are 25% of the length of the other middle spines. Subambulacral spines immediately adjacent to furrow spines three or four, with one prominent elongate pedicellariae present median to the others. Other spines in this series strongly notched with angular tips, approximately half the length of the pedicellariae. One subambulacral spine in this series becomes prominent and enlarged approximately 15–20 adambulacrals from arm tip. Remaining subambulacral granules, eight to 12, angular to polygonal in cross-section in irregular arrangement on plate surface, similar in size but not shape to those on other actinal plates.

Oral plates with eight furrow spines, proximal most spines triangular in cross-section, more distal spines flattened similar to other furrow spines (Fig. 15F). Two larger, thicker spines on oral plate edge projecting into mouth. Oral plate surface with paired (one on each half of the oral plate), prominent triangular oral spines, at least twice as thick as those spines projecting into mouth. These spines sometimes with notched tips. Oral plate surface covered with angular to spiny tipped granules. Distinct series of granules, six to seven, quadrate to triangular in cross-section on each paired side of the oral plate. Each side of the oral plate with five to six angular granules with notched tips. A single, large elongate pedicellariae is sometimes present adjacent to the furrow spine series but oral plate surface is otherwise bare.

Material Examined

Holotype. IE-2013-7008. *Stylaster* Seamount, New Caledonia, 23°37.81'S, 167.°38.78'E, 571–610 m. Coll. T. Schlager, NORFOLK 2 DW 2036, 22 Oct 2003, 1 dry spec. R=3.5, R=2.1.

Paratypes. IE-2013-7009, *Stylaster* Seamount, New Caledonia, 23°37.81'S, 167.°38.78'E, 571–610 m. Coll. T. Schlager, NORFOLK 2 DW 2036, 22 Oct 2003, 1 dry R=2.5, r=1.3.

IE-2013-7010, Banc 1 (Brachiopode), New Caledonia, 23.°27.92'S, 167.°50.90'E, 370–371 m NORFOLK 2, DW 2024,1 dry spec. R=2.7, r=1.4.

IE-2013-7011 *Stylaster* Seamount, New Caledonia, 23°40.64'S 167°41.36'E, 485–505 m. NORFOLK 2, DW 2034, 1 dry spec. R=2.1, r=1.7.

IE-2013-7012 "Jumeau Est" (North sector), New Caledonia, 23°42.88'S, 168.°15.43'E 470–621 m, NORFOLK 2 DW 2049, 3 dry specs. R=2.3, r=0.9; R=2.1, r=1.3: R=2.6, r=1.4.

IE-2013-9999 Nova Bank, New Caledonia 22°6'30.6"S; 159°19'20.3772"E, 330–920 m. Coll. KANADEEP, DW 5012 19.09.17, 1wet spec, R=2.0, r=1.1

IE-2013-7022 New Caledonia, 460 m. Coll. CHALCAL 2, 30 Oct. 1986. 2 wet specs. R=3.3 r=2.0, R=3.6 r=2

Astroceramus callimorphus Fisher, 1906

FIGURE 16A–F

Fisher 1906: 1056; Macan 1938: 390 (in key); Kogure & Tachikawa 2009: 80, 81 (in key).

Diagnosis

Body stellate to strongly stellate, 2.2–3.35, arms elongate, interradii straight to weakly curved. **Abactinal plates restricted to disk, abutted superomarginals, approximately 8 at R=2.0 to 12 at R>5.0, approximately 4 to 6 free superomarginals on disk.** Glassy nodules forming stellate patterns on each plate. Superomarginal plates covered by widely distributed granules, 10–70. Actinal plates covered by round to bullet-shaped granules. **Furrow spines 6 to 7, subambulacral spines, 2 to 3 consistently enlarged with all three subambulacral spines variably enlarged in larger individuals (R> 6.0 cm). Pedicellariae, spoon-shaped, variably present on actinal and adambulacral plates ranging from absent to present on over 50% of plates observed.**

Comments

Astroceramus callimorphus known previously from Hawaii (Fisher, 1906) is present in New Caledonia, represented by an abundance of specimens across a wide size range. Specimens from New Caledonia are essentially consistent with the holotype from the Hawaiian Islands.

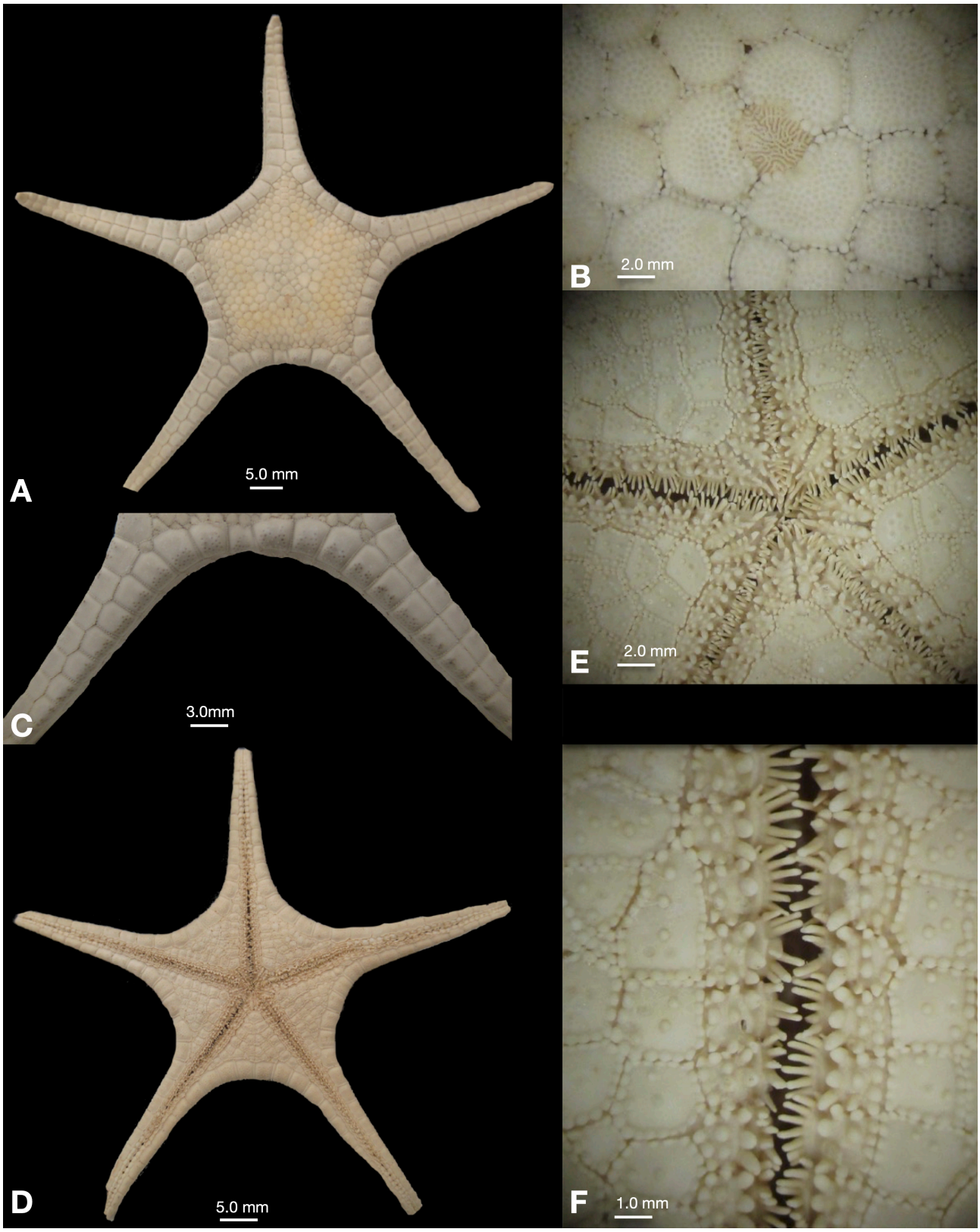

FIGURE 16. ***Astroceramus callimorphus*** Fisher, 1906. MNHN IE-2013-6924. A. Abactinal. B. Abactinal close. C. Lateral and abactinal arm surface. D. Actinal. E. Actinal oral view. F Adambulacral region-furrow spines.

Astroceramus denticulatus, described by McKnight (2006) is nearly identical to *A. callimorphus* save for a large, conspicuous bivalve pedicellariae sitting on each adambulacral plate. Comparable species include *Astroceramus boninensis*, which displays similar superomarginal arrangement and although furrow spines are fewer, the holotype of that species is smaller and subambulacral spination is similar.

Many species of *Astroceramus* are known from relatively few specimens and given that there is an abundance of unpublished material (Mah, pers. obs.) understanding of further variation is desirable.

In situ observations of *A. callimorphus* in the Hawaiian region shows this species on coarse, sandy sedimented bottoms (Mah, pers. obs.).

Occurrence/Distribution

Hawaii, 233 m.

New Caledonia, 317–1000 m.

Description

Body stout, stellate (R/r=2.20–3.35), arms elongate, interradial arcs straight to weakly curved (Fig. 16A, D).

Abactinal surface, flat to weakly convex. Individual plates polygonal, many hexagonal to irregularly round (Fig. 16B). Plates limited to disk surface only, none on arms where superomarginals are abutted over the midline of the arm surface. Each plate with smooth surface, largely lacking any surficial accessories, but exceptionally a single or small number of small granules are present on one or two plates. Embossed glassy granules, 5 to 300 embedded in and level with plate surface arrayed in a starburst-like pattern with linear projections emanating from the center of the plate (Fig. 16B). Abactinal plates with peripheral granules 40–80, weakly quadrate or bean-shaped, approximately 10–20 per side, each widely spaced around each plate. Pedicellariae, paddle-like in shape, if present, small in size (<l.0 mm length) and present on a minority of plates. Madreporite triangular or shield-shaped (Fig. 16B), flanked by three abactinal plates. Anus surrounded by four, blunt spines.

Marginal plates 26–30 per interradius (arm tip to arm tip) in larger (R=4.0 to 6.0), both marginal series with identical numbers, 26 to 28 (Fig. 16A). Some superomarginals with distal plates fused creating odd numbers per interradius. Superomarginals elongate (L>W) quadrate in shape with a rounded dorsolateral edge but a distinct but small lateral edge. Superomarginal plates 8–10 abutted along midline (Fig. 16C) along arm with proximal most superomarginals abutted at arm base with one or two abactinal plates present between them. Abutted superomarginals mostly with 1:1 association but some are offset with plates forming offset contact between them. Superomarginal plate with round, deciduous granules, 10–70 completely covering surface. Peripheral edge between abactinal surface and superomarginal contact adjacent to granule covered areas on superomarginal plate surface with 10–30, mostly 15–20 small embossed granules on the surface in one to two irregular series. Other peripheral edges without embossed granule series. One or two superomarginal plates per superomarginal plate series with a single small, paddle-like pedicellariae. Inferomarginal plate covered with deciduous granules, 30–300 round, deciduous granules, leaving well-defined convex pitting. A narrow granule-free band is present on the upper lateral surface adjacent to the contact with superomarginal plates. Both superomarginal and inferomarginal plates with 100–150 peripheral granules, each bean-shaped to weakly quadrate in shape, approximately 25–35 granules per side. Granules on actinal inferomarginal surface in weakly linear to irregular patterns.

Actinal surface weakly arched. Actinal plate surface in three to four series full series with one or two irregular plates adjacent to inferomarginal contact, each plate quadrate to irregularly round in shape becoming smaller and more irregular distally adjacent to inferomarginal plates. Actinal surface with coarse, round granules 5–10 per surface, widely spaced. Peripheral granules 6 to 30, some pointed in shape, almost spine like, widely spaced. Shallow fasciolar grooves present between plates. Proximal plates on series adjacent to the adambulacral plates each with a single narrow paddle-shaped pedicellariae.

Furrow spines 6 to 7, individual spines with blunt points, variably compressed to more oval-like in cross-section in straight to weakly palmate arrangement (Fig. 16E, F). Three subambulacral spines, two are consistently enlarged with all three subambulacral spines variably enlarged in larger individuals (R> 6.0 cm). When subambulacrals are enlarged they are 3 to 5X the thickness of each furrow spine and approximately 25% longer than the furrow spines. The smallest of these subambulacrals approximately 40% of the height of the others, present proximally on the spine series. Two to three additional series of spine-like granules, 3 to 4, present on the remainder of the adambulacral plate, all widely spaced from one another. A narrow paddle-shaped pedicellariae variably present adjacent to the subambulacral spines.

Oral plates with 6 to 8, mostly 7 angular furrow spines, round to crescentic in cross-section (Fig. 16E). Two paired spines, flattened, directed into mouth, triangular in cross-section. Oral plate surface with 5 to 7 spines in paired series on either side of fossae between halves of the oral plates. Spines decreasing in size with largest, most elongate proximally and shortest, distally adjacent to oral plate-actinal plate contact. Oral plate spines quadrate to triangular in cross-section, all widely spaced.

Material Examined

IE-2013-6925, New Caledonia, 18˚56'S 163˚23'E. 415 m. Coll. C. Vadon, 19 Sept. 1985, N/O *Vauban*, MUSORSTOM 4, CP 193, 1 dry specs. R=5.3 r=2.4; R=5.7 R=1.8.

IE-2013-6924, Southern New Caledonia, 23˚10'S 166˚49'E. 870–1000 m. Coll. Richer, ORSTOM, 31 March 1994, N/O *Alis*, HALIPRO 1. 2 dry specs. R=5.4 r=1.3, R=,5.7 r=2.0.

IE-2013-6926, Southern New Caledonia, 23˚2.6'S 166˚58.3'E, 397–400 m. coll. Bouchet & defogs, ORSTOM 12 May 1993. 1 dry spec. R=2.5 r=0.9.

IE-2013-6930 Noumea, New Caledonia, 22˚46'S 167˚12'E, 405 m. Coll. R. de Forges, VAUBAN, ORSTOM st. 423. 1 dry spec. R=3.4 r=1.1.

IE-2013-7041, New Caledonia, 23°17'S, 168°14'E, 405 m, Coll. NORFOLK 2, DW 2132

3 dry specs. R=5.2 r=1.6, R=5.6 r=1.5 R=4.0 r=1.5 (arms broken)

IE-2013-7042, New Caledonia, 22°50'S, 167°17'E, 518 m. Coll. NORFOLK 2, 4 Nov 2003, CP 2146. 1 dry spec. R=4.1 r=1.6

IE-2013-7043 Banc I, New Caledonia, 23°28'S, 167°51'E, 370–371 m. Coll. NORFOLK2 DW2024 20 Oct 2003, 1 dry spec. R=4.0 r=1.7

IE-2013-7044 New Caledonia, 23°47'S, 168°17'E, 403–440 m, Coll. NORFOLK 2, CW 2108, 31 Oct 2003, 1 dry spec,. R=4.4 r=1.6

IE-2013-9513 N. Mount Antigonia, New Caledonia, 23°11'35.4012"S; 168°2'31.776"E, 317–343 m. Coll. KANACONO, DW 4759, 26.8.16. 1 wet spec. R=4.7 r=1.4.

IE-2013-9641 SW Ille des Pins, New Caledonia, 22°45'12.0024"S; 167°12'36.0252"E, 400–405 m. Coll. KANACONO, DW 4660, 11.8.16. 3 wet specs. R=5.8 r=2.0, R=2.5 r=1.0, R=3.6 r=1.3.

IE-2013-9472 S Ile des Pins, New Caledonia, 22°52'59.4012"S; 167°34'44.9868"E, 376–390 m. Coll. KANACONO, DW 4677, 13.8.16. 6 wet specs. R=3.6 r=1.2, R=3.6 r=1.2, R=2.9 r=0.9, R=2.9 r=0.9, R=1.6 r=0.6 (this specimen with coral fragment in mouth?), R=1.6 r=0.5

Astroceramus cyclus **sp. nov.**

FIGURE 17A–F

Etymology

The species epithet *cyclus* is derived from the Greek for circle alluding to this species round shape.

Diagnosis

Body shape pentagonal, nearly round with R/r=1.2 to 1.3. Primary circlet composed of enlarged plates. Superomarginal plates 4 per interradius, pre terminal superomarginals abutted, each plate strongly tumid, enlarged relative to adjacent superomarginals. Furrow spines 5 to 6 (mostly 6) in linear series, each blunt, quadrate in cross-section, sunken relative to first series of subambulacral spines. Subambulacral spines blunt, 3 to 4, approximately twice as thick as furrow spines.

Taxonomic Comments

Compared to other known *Astroceramus* species, which show a stellate to strongly stellate body shape with slender arms (e.g. *Astroceramus callimorphus*), *Astroceramus cyclus* **sp. nov.** is a significant departure demonstrating a pentagonal body shape similar to other pentagonal goniasterids such as *Plinthaster*. *Astroceramus cyclus* **sp. nov.** is superficially similar to *Plinthaster*, not only in that it displays a similar shape but also displays abactinal plates with glassy, embossed granules and marginal plates with widely spaced granules. *Plinthaster* however, displays many more marginal plates per interradius which are more tumid and shows much wider marginal plates. *Astroceramus* also forms a higher superomarginal border around the abactinal surface.

Other pentagonal Goniasteridae with comparable body forms present in this region include *Glyphodiscus pentagonalis, Kanakaster* and *Discoplintha reganae* **gen. nov. sp. nov.** as described here. Embossed granules on the abactinal plates and granules on the superomarginal plates are absent in *Glyphodiscus* and *Discoplintha.* In contrast, *Kanakaster* has embossed granules on the abactinal and marginal plate surfaces, granules embedded in a dermis covering the surface and other than a linear series of furrow spines, lacks adambulacral spination (i.e. no subambulacral spines, granules).

Occurrence

New Caledonia 409–439 m.

Description

Body shape pentagonal, nearly round. R/r= 1.2–1.3 (Fig. 17A).

Abactinal surface flat, disk surface sunken, lower than superomarginal plate margin. Granules, fine, widely dispersed on abactinal plates surface but easily abraded and often absent. Abactinal plates, distinct with sharp angles, hexagonal to polygonal in outline. Fine glassy granules/bosses 70–300, embedded in abactinal plates in linear arrangement, radiating from plate center (Fig. 17B). Peripheral granules, 20–70, fine indistinct. Primary plates largest in size on size with smaller plates present distally adjacent to contact with superomarginal plates (Fig. 17D). Madreporite triangular, flanked by three plates; sulci relatively shallow. Pedicellariae not observed.

Marginal plates 4 per interradius. Interradial plates qudrate in shape, superomarginals adjacent to the terminal triangular in shape, larger than interradial plates (Fig. 17A, C). Marginal plates swollen, strongly convex. Plate surfaces covered by fine, easily abraded granules, with fine granular pitting widely distributed. Surface is easily abraded with central abactinal region sometimes appearing smooth. Superomarginals correspond 1:1 with inferomarginals. Granules, small, fine, 20–50 per side of each marginal plate. Contact between superomarginals and inferomarginals with dense cluster of granules. Very small, reduced inferomarginal plates present between terminal, superomarginal, and larger inferomarginal plate. Terminal plate triangular.

Actinal region flattened, approximately two chevrons of plates present in each region (Fig. 17E). Plates, hexagonal, polygonal to rounded, largest proximally becoming smaller distally, adjacent to inferomarginals. Adambulacral plates quadrate in shape. Actinal plates covered by coarse, angular, well-spaced granules. Underlying surface on actinal plates with embossed crystalline granules. Granules, larger with 20–70 around plate edge, approximately 10 per side.

Furrow spines 5 to 6 (mostly 6) in linear series (Fig. 17F), each blunt, quadrate in cross-section, sunken relative

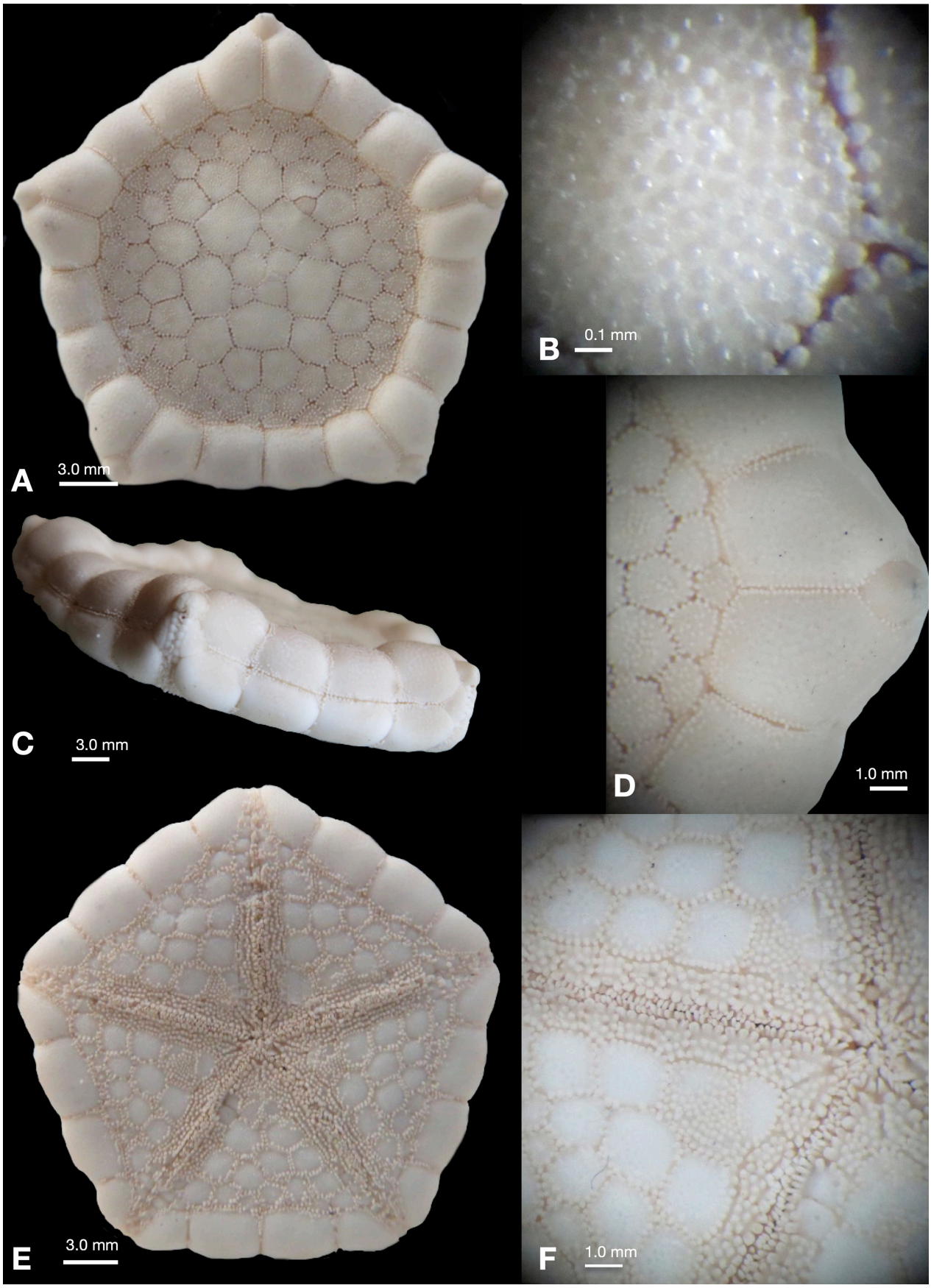

FIGURE 17. ***Astroceramus cyclus*** **sp. nov.** MNHN IE-2013-7006. A. Abactinal. B. Abactinal plate detail, glassy bosses. C. Lateral view D. Superomarginal plates penultimates. E. Actinal. F. Adambulacral furrow

to first series of subambulacral spines. First subambulacral spines behind furrow spines, three to four, approximately twice as thick as furrow spines, blunt. Adambulacral spination crowded. Second and third subambulacral granules, three to four per series, approximately 50% of height of first subambulacral spines with pointed or blunt tips. Accessory granules consistent with those on other actinal plates present on adambulacral contact with actinal plates. Oral plates triangular in shape. Oral plate furrow spines quadrate in cross-section, seven Proximalmost furrow spine projecting into mouth, triangular in cross-section. Paired angular granules bisecting oral plate surface. Other shorter angular granules, four to six present on oral plate surface.

Material Examined

Holotype. MNHN IE-2013-7006. Norfolk Ridge, east Banc Jumeau, New Caledonia. 23º46'S 168º17'E, 409–439 m. Coll. Lozouet, Boisselier, Richer, IRD, campagne NORFOLK 1, N/O *Alis*. 1 dry spec. R= 1.2, r=1.0.

Paratypes. MNHN IE-2013-7007. Norfolk Ridge, east Banc Jumeau, New Caledonia. 23º46'S 168º17'E, 409–439 m. Coll. Lozouet, Boisselier, Richer, IRD, campagne NORFOLK 1, N/O *Alis*. 3 wet spec. R=1.2, r=0.9; R=1.0, r=0.8, R=0.9, r=0.7.

MNHN IE-2013-9891 Chesterfield Plateau, New Caledonia 19°44'35.3976"S, 158°34'35.976"E, 386–428 m. Coll. KANADEEP DW 4975, 1 wet spec. R=1.2 r=0.9.

***Astroceramus pernachus* sp. nov.**

FIGURE 18A–F

Etymology

This species is named for a *pernach*, a type of flanged mace alluding to the distinctive shape of the subambulacral tubercle.

Diagnosis

Body stellate (R/r=2.27–2.52), arms elongate and triangular, interradial arcs straight to weakly curved. Abactinal plates largely limited to disk with short single series extending proximally onto arms. **Superomarginals, 5–7 abutted, superomarginal plates 12–13 free on disk.** covered on abactinal-lateral surface with 30–50 widely spaced granules. Actinal plates covered by granules, coarse, round. **Furrow spines, 7–8, distinct single subambulacral tubercle with denticulate surface.**

Comments

Astroceramus pernachus **sp. nov.** is distinguished by the single denticulate subambulacral spine (Fig. 18F), but also its relatively short, triangular arms and stellate shape (Fig. 18A). Other New Caledonian species are either much more stellate, such as *A. callimorphus* which displays elongate, slender arms and 2 to 3 thick subambulacrals or much more compact, such as *A. cyclus* **sp. nov.** or *A. astrikos* **sp. nov.** which display short or no distinct arms. *Astroceramus eldredgei* shares a similar type of single, enlarged subambulacral tubercle but displays much fewer, thicker furrow spines and larger, thicker superomarginal plates and shorter arms.

Occurrence/Distribution

Known only from New Caledonia, 600–691 m.

Description

Body stellate (R/r=2,.27–2.52), arms elongate and triangular, interradial arcs straight to weakly curved (Fig. 18A, E). Abactinal surface sunken relative to superomarginal frame.

Abactinal plates distinct in shape, hexagonal to round in outline, present only on disk, ending where superomarginals abut on arms (Fig. 18A, C). Plate surface smooth, bare with no surficial accessories (i.e., no granules, etc.). Glassy granules, 15–35, mostly 20–25, embedded in abactinal plate surface. Highest glassy granule abundance centrally on disk, with plates in contact with interradial superomarginals devoid of glassy granules (Fig. 18A, C, D). Abactinal plates homogeneous in size, even at distal contact with superomarginal plates with only a few plates smaller and more irregular in size, shape. Each abactinal plate with 10–18 widely distributed bead-shaped granules evenly spaced on each side, (3 granules on each side in most). Madreporite, convex, trapezoid in shape, flanked by four abactinal plates (Fig. 18B). Anus flanked by approximately 12 granules, six of which are approximately twice the size of the granules observed around the other plates. Four of the five inter radii with one or two strongly convex, plates devoid of glassy granules, irregularly located on the contact between the superomarginals and the abactinal surface. No pedicellariae.

Superomarginal and inferomarginal plates, 27 to 29 per interradius, with 11–12 superomarginals abutted over mid-radius and encompassing total arm distance (Fig. 18A, E). Superomarginal plates wide, forming distinct peripheral border when viewed on abactinal surface. Individual plates strongly arched in cross-section. Superomarginals along arm forming flattened surface on abactinal surface on three of the five rays. Two distal arm tips show irregular correspondence and could be damaged (Fig. 18C). Surface of all marginal plates, especially those proximally with rugose texture, with regular, almost molar-like patterns but then becoming more flattened distally. Superomarginals with no granules on abactinal surface but with 20 to 60 (mostly 30 to 50) deciduous, round granules present along abactinal-lateral edge in a roughly rounded quadrate patch on each plate (Fig. 18D). Surface around this patch is smooth and devoid of granules or other accessories. Marginal plates each surrounded by approximately 30 to 120 round granules. Inferomarginals further covered by abundant round granules, approximately 30 to 200 (mostly 50 to 160) in close-set dense arrangement especially along ventrolateral edge of inferomarginal plates. Inferomarginal actinal surface with irregularly shaped but prominent bald patch. Terminal plate, round, smooth approximately the size of four adjacent superomarginal plates. No pedicellariae.

Actinal surface large with three full series in chevron-like series with one irregular series adjacent

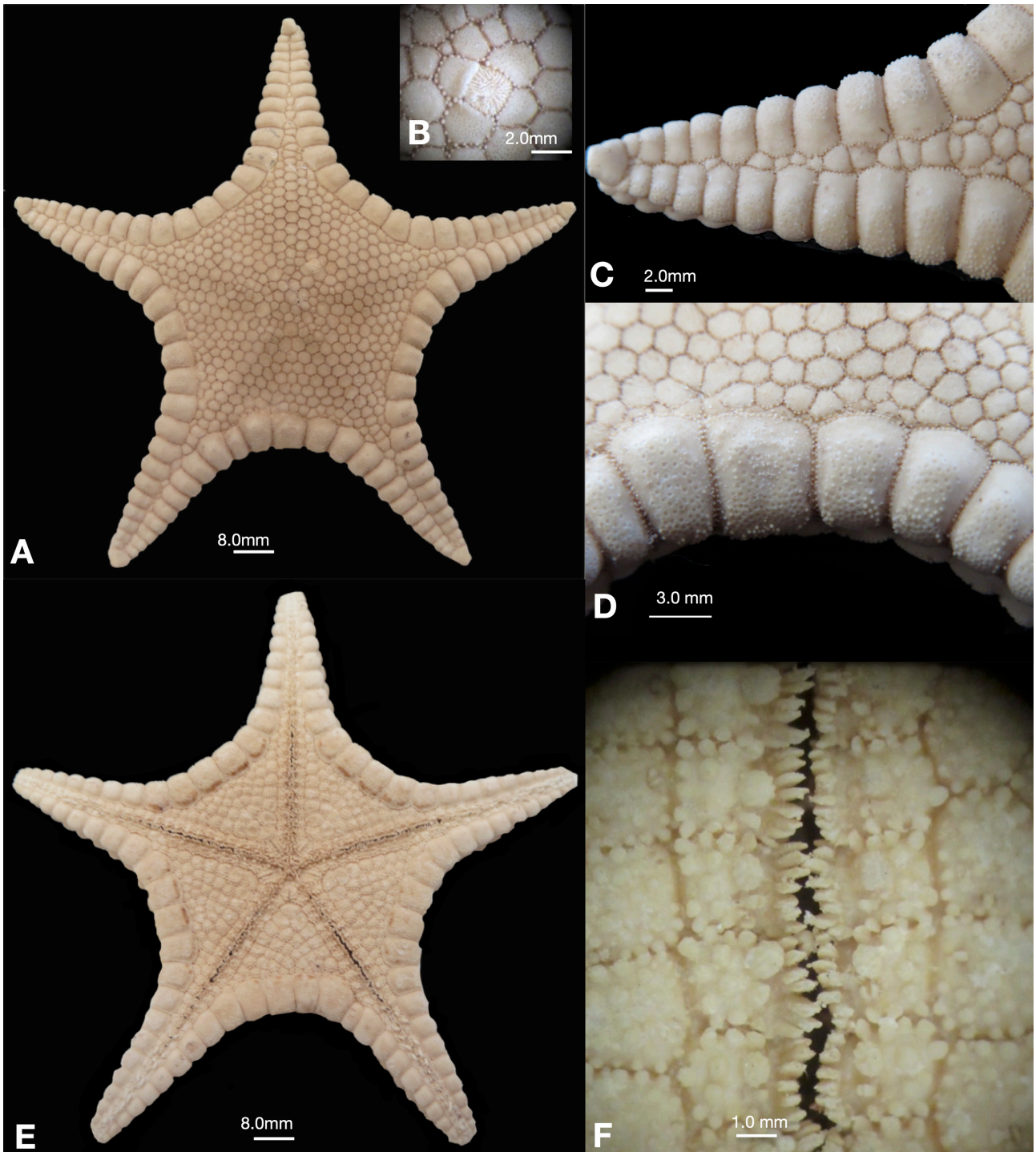

FIGURE 18. ***Astroceramus pernach*** **sp. nov.** MNHN IE-2013-7013. A. Abactinal. B. Abactinal plate detail. C. Arm tip, abactinal surface. D. Abactinal-lateral view, superomarginals. E. Actinal. F. Adambulacral furrow spines.

to the inferomarginals interradially (Fig. 18E). Actinal plates flat, covered by abundant, coarse, round granules, approximately three counted along a 1.0 mm line, and 15 to 25 widely spaced on the surface of each plate. Actinal plates mostly quadrate becoming more irregular in shape distally, adjacent to inferomarginals. Five small, approximately 1.0 mm in length, paddle-shaped pedicellariae with valves displaying rough edges on each tip.

Furrow spines, 7 or 8, flattened, with round tips, paddle-shaped, in a straight to weakly curved array. Spines thicker proximally, becoming thinner distally. Proximalmost furrow spines approximately 25% of the height of the other spines. Furrow spines set off from subambulacral spine by discrete bald space. Subambulacral accessories composed of a pedicellariae with elongate, round-tipped forceps like valves showing smooth edges and one very enlarged and thick blunt spine or tubercle, approximately 3 to 5 times the thickness of the furrow spines and approximately twice the length (Fig. 18F). Remaining accessories on adambulacral plates composed of 6 to 10 large tubercle-

like granules, similar to but slightly larger than granules on actinal plate surface.

Oral plate with eight to ten thick furrow spines along edge of plate with one prominent oral spine directed into mouth (two total) from each oral plate half. Each spine quadrate in cross-section with round tipped edge. Oral plate with one prominent spine identical to subambulacrals present on other plates, and three thick spines on each plate, paired with a corresponding spine on the other half, making six total. Remainder of oral plate surface with coarse, widely spaced blunt granules. Approximately 8 on each paired side of the oral plate.

Material Examined

Holotype. MNHN IE-2013-7013, New Caledonia, 24°40'S, 168°38'E, 600 m, Coll. NORFOLK 2, DW 2060, 25 Oct 2003. 1 dry spec. R=4.6 r=2.1.

Paratype. MNHN IE-2013-4710, Banc Athos, New Caledonia, 25°16'35.4036"S, 168°55'38.4168"E, 609–691 m. Coll. NORFOLK 2, DW 2064, 26.10.03. 1 wet spec. R=5.8 r=2.3.

MNHN IE-2013-7040 New Caledonia, 23°37.81'S, 167°38.78 E, 571–610 m. Coll. NORFOLK 2, DW 2036. 1 dry spec. R=7.5 r=3.3.

Astroceramus titthos sp. nov.

FIGURE 19A–F

Etymology

The species epithet is derived from the Greek *titthos* alluding to the nipple-like shape of the abactinal tubercles.

Diagnosis

Body stellate in shape (R/r=2.2–2.31), arms elongate and triangular, interradial arcs curved to straight. **Abactinal tubercles present centrally on some to most abactinal plates. Abutted superomarginal plates 8–12, with approximately 9–11 superomarginal plates free in each interradius.** Superomarginal plate surface covered by widely spaced coarse granules that almost completely covers the superomarginal plate surface. Actinal plates covered by coarse, round granules, 10–25, furrow spines 4 to 8, **subambulacral spines 3, one large central flanked by two smaller (<50% height).** All adambulacral spination thick, round to polygonal in cross-section. Pedicellariae small, spoon-shaped variably present on abactinal (holotype, paratype) and actinal surface (paratype)

Comments

A stellate species with a broad disk that is characterized by tubercles on the abactinal plates (Fig. 19C) and 3 subambulacral spines, the central of which is thick and enlarged relative to the other two (Fig. 19F), which are shorter and smaller. The presence of the abactinal tubercle invites comparison with the Philippine *Astroceramus sphaeriostictus* Fisher 1913 which also displays tubercles centrally on the abactinal plate. However, the adambulacral spination in *A. sphaeriostictus* is distinctly different from *A. titthos* **sp. nov.** in that the furrow spines are compressed and nearly leaf-like in thickness with only a single large subambulacral spine displaying a distinct sulcus whereas in the latter species herein, furrow spines are thick and round to polygonal in cross section with more numerous subambulacral spines which are thicker, larger with no sulcus or compressed shapes.

Occurrence/Distribution

New Caledonia, 600 m.
Marquesas islands, 416–440 m.

Description

Body stellate in shape (R/r=2.2–2.31), arms elongate and triangular, interradial arcs curved to straight (Fig. 19A, E).

Abactinal surface flat, planar. Individual abactinal plates hexagonal to irregularly polygonal. Most plates larger proximally becoming smaller and more irregular in shape distally adjacent to superomarginal contact. Abactinal plates limited to disk with triangular plates in contact with superomarginals on proximal arm region. No plates on arm. Individual plates each with embossed, glassy granules on plate surface, 10–160, mostly about 100–120, widely spaced variably arranged in irregularly to stellate pattern. Single small tubercle, similar in size, shape to peripheral granules present on a minority of abactinal plates, approximately 5 or 6 per interradial region (Fig. 19B, C). Abactinal plate surface otherwise free from surficial accessories (i.e. no surficial granules, etc.). Each plate with peripheral granules, 10–80, bean-shaped, mostly 30–60, approximately 5 to 6 per side, each widely and evenly spaced (Fig. 19B). Fasciolar grooves shallow to weakly developed. A minority of plates, approximately 5 or 6 per radial region with a paddle-shaped pedicellariae with smooth valves. Madreporite triangular to shield-shaped, shallow surface with well-developed sulci, flanked by three abactinal plates.

Marginal plates 23–28, approximately 23–26 superomarginals, 25–28 inferomarginals. Superomarginal and inferomarginal plates with 1:1 correspondence interradially, with 1:1 correspondence on two of the five arms, becoming more offset distally on some three of the five arms. Fasciolar grooves between marginal plates shallow, weakly developed. Marginal plates with peripheral granules, 30–200, mostly 20–120, with variably 20–40 per side, bean-shaped. Widely and evenly spaced. Superomarginal plates blocky, wide, framing the disk, occupying approximately 18% (width/r=0.4/2.2) of radius. Superomarginals abutted over midline along arm, 8–12 arm plates in full contact, with approximately eight either partially or completely free from contact on disk surface. Dorsolateral angle of superomarginal plates rounded, plate rounded in cross-section. Dorsolateral surface of each superomarginal with 20–60 round, coarse deciduous granules (Fig. 19D), widely spaced sitting on raised superomarginal plate surface with individual granules sitting away from the most abundant cluster. Approximately 2 to 4 superomarginal plates in

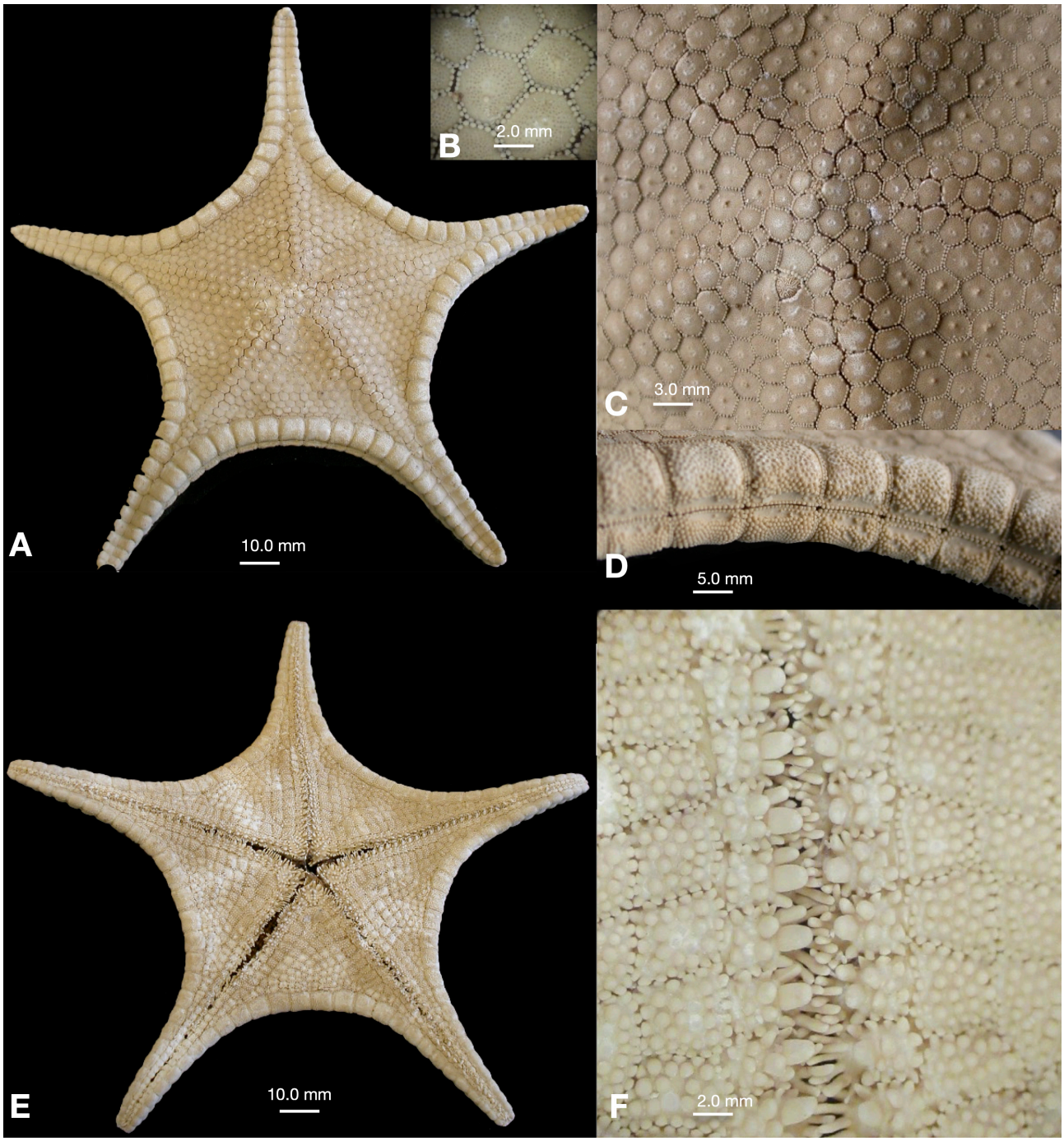

FIGURE 19. ***Astroceramus titthos*** **sp. nov.** MNHN IE-2013-6933. A. Abactinal. B. Abactinal plate detail C. Abactinal-lateral surface. D. Lateral plate surface. E. Actinal. F. Adambulacral-furrow spines.

each interradius with a single wing-shaped paddle-like pedicellariae sitting adjacent to the contact with the disk, sitting in depressions on the abactinal plate surface. Superomarginal plate contact with abactinal plate surface straight to weakly curved. Lateral surface bare and smooth on the superomarginal plate below the granule cluster raised plate surface. Inferomarginal plate bare and smooth on lateral surface above the granule cluster on ventrolateral surface of the inferomarginal plate. Granules, 10–50 round, deciduous, widely spaced with convex pitting on inferomarginal plate surface. Granules present most densely occurring on ventrolateral surface, forming meandering lineation on actinal inferomarginal plate surface. Otherwise, inferomarginal plate surface smooth and bare. Most inferomarginals without pedicellariae but one paddle-shaped pedicellariae present on a single plate at arm base of a single interradius. Terminal plate broadly triangular with smooth surface.

Actinal intermediate region composed of three full series, with an irregular cluster of plates distally adjacent to the inferomarginal plate contact. Individual plates irregularly polygonal in shape. Actinal plates with only a single row on proximal arm region, otherwise absent. Individual actinal plates with 10–60 round, coarse

granules. approximately 20–40 in single, even widely spaced series (Fig. 19F). Granule density, number per area of each plate, greatest on plates adjacent to contact with inferomarginal plates. Actinal plate surface with identical granules to those on plate periphery but fewer in number, 6 to 20, clustered with large bare space on each plate. Actinal plate series adjacent to adambulacral plate series each with a single paddle-like pedicellariae on each plate. Proximalmost actinal plate in contact with the oral plate with two paddle-like pedicellariae. Exceptionally one or two paddle-like pedicellariae with three valves with wing-like depressions on plate surface. Identical pedicellariae present on 3 to 5 actinal plates per interradius. Fasciolar grooves present, shallow to weakly developed.

Furrow spines, 4 to 8, (Fig. 19F) mostly 4 to 6 with higher spines present proximally decreasing distally. Furrow spines blunt, finger-like in shape, round in cross-section in straight to weakly fan-like series, interlacing with furrow spine array on opposite side of tube foot furrow where adambulacral plates are in proximity to one another. A single large subambulacral spine with smooth surface (Fig. 19F), approximately twice the width and 15% longer than the furrow spine length present on each adambulacral plate. The enlarged subambulacral flanked by two shorter subambulacral spines similar in thickness, appearance to furrow spines but only approximately 10% of furrow spine height. Remainder of adambulacral plate with two series of granular spines, 3 to 5 per series, decreasing in size with the smallest granules adjacent to those on the actinal intermediate plates. Middle subambulacral granules 3 to 5, intermediate in height between granules on actinal plates and adjacent subambulacral granules.

Oral plates with six furrow spines, triangular to quadrate in cross-section, identical in length to other furrow spines. Two elongate spines on oral plate projecting into mouth, triangular to rectangular in cross-section. Remainder of oral plates with 6 to 8 spines, blunt-tipped, with largest enlarged, comparable to the enlarged subambulacral spine. Oral plate surface mostly bare with 7 pairs of granules on either side of fossae between oral plate halves with the proximal most of these granules enlarged and adjacent to the spines projecting into the mouth.

Material Examined

Holotype MNHN IE-2013-6933, North New Caledonia, 18º50'S 163º14'E, 600 m, Coll. N.O. *Vauban*, MUSORSTOM 4, CP 199, 20 Sept. 1985 1 dry spec. R=7.5 r=3.3

Paratype. MNHN IE-2013-6928, Archipel des Marquises, Haunt-fond Dumont d'Urville. 416–440 m. 9'38'S 139'48'W. Coll. Bouchet, Dayrat, Richer coll. MUSORSTOM 9, 2 Sept 1977. 1 dry specs. R=5.1 r=2.2.

Ceramaster Verrill, 1899

Tosia(Ceramaster) Verrill, 1899: 161

Ceramaster Fisher, 1906: 1054; 1911: 162, 204; Verrill, 1914: 289; Koehler, 1924: 173; Mortensen, 1927: 80; Djakonov, 1950: 38; Tortonese & A.M. Clark, 1956: 347; Halpern, 1970a: 212; Downey, 1973: 49; McKnight, 1973: 178; Downey, 1973: 49; A.M. Clark & Courtman-Stock, 1976: 61; Clark & Downey, 1992: 231; Downey in Clark & Downey, 1992: 231; Mah 2025: 69.

Philonaster Koehler, 1909: 78 [type species *Pentagonaster (Philonaster) mortenseni* Koehler, 1909]

Tosiaster Verrill, 1914: 292.

Diagnosis

Body outline pentagonal in most (i.e., R/r=1.1–1.5) with some becoming more stellate. Abactinal plates tabulate, granules present on abactinal plates, marginals, actinal plates. **Fasciolar grooves present among abactinal, marginal plates. Bare "patch" on dorsal facing of superomarginal plates on most species**

Comments

Ceramaster herein disagrees with the treatment outlined in Clark & Downey (1992) who argued that the widespread *Ceramaster patagonicus* was a subspecies of *Ceramaster grenadensis*. *Ceramaster grenadensis* was separated into a separate genus, *Alloceramaster* (Mah 2025), whereas *C. patagonicus* and *C. granularis* are argued as more closely related with species similar to "*C. patagonicus*" argued as sharing more characters with the typological *Ceramaster granularis.* This includes the more well-developed fasciolar grooves as well as larger, coarser granules present on the tabulate plates (e.g., Fig. 15B). Changes to the taxonomy of *Ceramaster* were outlined by Mah (2025).

Species included herein are morphologically consistent with considered members of the *Ceramaster patagonicus* "group."

Ceramaster australis H.E.S. Clark & McKnight 2001

FIGURE 20A–F

Ceramaster patagonicus australis H.E.S. Clark & McKnight 2001: 36, Pl. 7.

Ceramaster australis Mah, 2011: 6, Fig. 1A–E;

Diagnosis

Modified from H.E.S. Clark & McKnight (2001). Body stout, pentagonal to weakly stellate, R/r = 1.3–1.4, interradii weakly curved. Abactinal plates tabulate with well developed fasciolar grooves on radial regions. **Plates hexagonal to irregularly polygonal, strongly angular with 12–15 peripheral granules, quadrate to polygonal, strongly angular. Central granules, 12 to 25, polygonal to round in shape. Superomarginal plates, 10–19 per interradius, strongly tumid, eating rectangular in shape, forming approximately 20% (0.5 cm/2.5) of total distance "r."** Superomarginal dorsal surface covered by polygonal, close-set granules, but with irregular bald region interrupted by irregular granule clusters. Inferomarginal plate surface, completely covered

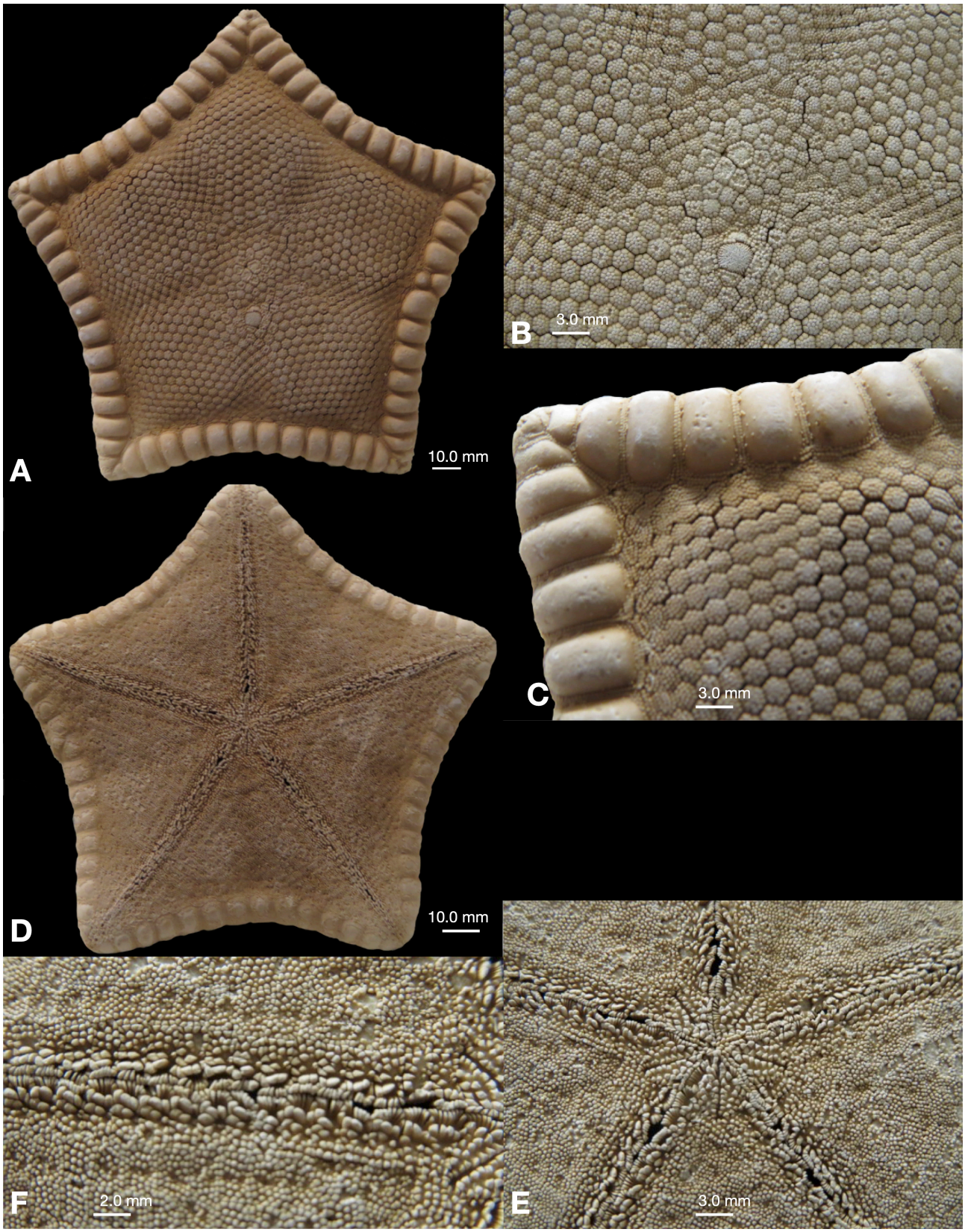

FIGURE 20. ***Ceramaster australis*** H.E.S. Clark & McKnight, 2001. MNHN IE-2013-6963. A. Abactinal. B. Abactinal plate closeup. C. Abactinal-superomarginal arm tip detail. D. Actinal. E. Oral adambulacral region F. Adambulacral furrow detail.

by identical, polygonal close-set granules. Actinal region occupied by 7 to 10 full series in chevron-like formation. Individual plates quadrate, each covered by widely spaced polygonal-shaped granules with roughened tips. Furrow spines 6 to 7 (4 to 6 in Clark & McKnight), blunt, triangular in cross-section. Subambulacral spines 2 to 5, mostly 3 to 4, approximately two to three times the thickness of the furrow spines, with blunt tips, with smooth to rough surfaces, both subambulacral spines in 2 to 3 irregular series.

Comments

Ceramaster australis H.E.S. Clark & McKnight 2001 is recognizable by the distinctly tumid superomarginal plates, and distinctly tabulate plates with coarse abactinal granules. This species was described as a subspecies of *Ceramaster patagonicus* and as such, characters, such as the large bald region on the dorsal surface of each superomarginal (Fig. 20A, C) and the well-developed fasciolar grooves (Fig. 20B) place show affinities with the "*C. patagonicus*" group within *Ceramaster* species.

A species resembling *Ceramaster australis* from the Rapa Nui area has been reported by Mecho *et al.* (2019) and Mah (2021) based on video imagery. If specimen collections can permit verification of this species, it would show this species as widely distributed throughout the South Pacific from Rapa Nui to New Caledonia and Macquarie Ridge.

Occurrence/Distribution

Papua New Guinea, Macquarie Ridge (New Zealand), 148–415 m.

New Caledonia, 460–967 m.

Material Examined

New Caledonia. MNHN IE-2009-2124. Mont *Stylaster*, Norfolk Ridge, New Caledonia, 23°37'31.2024"S; 167°41'33.018"E, 460–470 m. coll. Richer de Forges aboard N/O *Alis*, campagne BERYX II, Oct 18, 1992.

MNHN IE-2009-2125. Mont *Stylaster*, Norfolk Ridge, New Caledonia, 23°37'14.9952"S; 167°38'57.6168"E, 550–690 m. coll. Richer de Forges aboard N/O *Alis*, campagne BERYX II, Oct 19, 1992.

MNHN IE-2009-2134. Mont Antigonia, Norfolk Ridge, New Caledonia, 23°19'48"S; 168°0'22.194"E, 580–600 m. coll. Richer de Forges aboard N/O *Alis*, campagne BERYX II, Oct 20, 1992.

MNHN IE-2013-4677. Athos Bank, New Caledonia, 25°16'35.4036"S; 168°55'38.4168"E, 609–691 m. Coll. Lozouet, Samadi & Richer, N/O *Alis*, campagne, NORFOLK 2, 26 Oct 2003. 1 wet spec.

MNHN IE-2013-4679, Banc Zorro, New Caledonia, 25°23'7.2024"S; 168°20'4.2108"E, 650–1000 m. Coll. Lozouet, Samadi & Richer, N/O *Alis*, campagne, NORFOLK 2, 27 Oct 2003. 1 wet spec.

MNHN IE-2013-4681. Athos Bank, New Caledonia, 25°16'53.9976"S; 168°55'6.6108"E, 834–870 m. Coll. Lozouet, Samadi & Richer, N/O *Alis*, campagne, NORFOLK 2, 26 Oct 2003. 1 wet spec.

MNHN IE-2013-5754, Banc Brachiopode, New Caledonia, 25°26'20.3964"S; 167°51'22.8204"E, 465–650 m. Coll. Lozouet, Samadi & Richer, N/O *Alis*, campagne, NORFOLK 2, 21 Oct 2003. 1 wet spec.

MNHN IE-2013-6961, Southern New Caledonia, 23°37'S; 167°41'E, 460–470 m. Coll. B. Richer, ORSTOM, 18 Oct 1992, N/O *Alis* campagne BERYX 11. 1 dry spec. R=3.3 r=2.5.

MNHN IE-2013-6963, Norfolk Ridge, Banc Eponge, New Caledonia, 24°56'S; 168°21'E, 507–967 m. Coll. Lozouet, Boissellier, Richer de Forges, IRD. 23 June 2001, N/O *Alis*, campagne NORFOLK 1. 1 dry spec. R=5.8 r=4.0.

MNHN IE-2013-6964, Southern New Caledonia, 24°56'S; 168°22'E, 525–560 m. Coll. N/O *Alis*, campagne SMIB 4. 1 dry spec. R=5.3 r=3.8.

MNHN IE-2013-7387, Seamount north of Mount J. Ride des Loyautés, New Caledonia, 23°34'36.012"S; 169°36'47.988"E, 660 m. Coll. S. Samadi, Lozouet & Castilian, aboard N/O *Alis,* champagne TERRASSES, 18 Oct 2008. 1 wet spec.

MNHN IE-2013-7643, Ile des Pins, New Caledonia, 23°0'11.412"S; 167°16'3E+1"E, 400–420 m. Coll. S. Samadi, Lozouet & Castilian, aboard N/O *Alis,* champagne TERRASSES, 30 Oct 2008. 1 wet spec.

MNHN IE-2013-9394, S Ile des Pins, New Caledonia, 23°2'5.4204"S; 167°43'40.7892"E, 550–590 m. Coll. Lozouet, Samadi & Richer, N/O *Alis*, campagne, NORFOLK 2, 23 Oct 2003. 1 wet spec.

MNHN IE-2013-12081, Passe de Hienghène, New Caledonia, 20°31'55.6788"S; 164°56'6.3744"E, 705–750 m. Coll. Métivier & Richer de Forges-IRD coll. N/O *Alis*, campagne, BATHUS 4, 10 Aug, 1994. 1 wet spec.

MNHN IE-2013-12110, Grand Passage, New Caledonia, 15°54'43.0164"S; 163°23'43.7748"E, 420–452 m. Coll. Métivier & Richer de Forges-IRD coll. N/O *Alis*, campagne, BATHUS 4, 7 Aug, 1994. 1 wet spec.

MNHN IE-2013-12116, Grand Passage, New Caledonia, 18°55'36.48"S; 163°7'40.8216"E, 690–702 m. Coll. Métivier & Richer de Forges-IRD coll. N/O *Alis*, campagne, BATHUS 4, 5 Aug, 1994. 1 wet spec.

MNHN IE-2019-2895, Mont D, New Caledonia, 23°32'56.5764"S; 169°37'0.6672"E, Coll. MNHN N/O L'*Atalante*, KANADEEP 2, 6 Sept. 2019. 1 wet spec.

Papua New Guinea. MNHN IE-2013-8417, Bougainville seamounts, Papua New Guinea, 5°32'57.6024"S 154°0'18.6768"E, 369–377 m. Coll. S. Samadi, L. Cobari, aboard N/O *Alis*, BIOPAPUA, 12 Oct 2010. 1 wet spec.

Ceramaster fortis Mah 2025

FIGURE 21A–E

Mah 2025: 69, Figs. 10A–F

Diagnosis

Body stout, thick, weakly stellate (R/r=1.66), arms upturned, broadly triangular in shape. Disk large, interradial arcs weakly curved to straight. Abactinal plates tabulate. **Each plate covered with polygonal, well-developed,**

coarse granules, 4–18 around periphery, angular, 3–20 present in central surface. Fasciolar grooves well developed. Superomarginal plates, 13–14 per side, 26–28 per interradius, surface covered with coarse, round granules, close-set approximately 3 count along a 1.0 mm line. Superomarginal surface completely covered with no bare region (Fig. 21A, C). Actinal region large, with up to 15 full series in chevron-like arrangement. Plate surface covered by large, coarse, round to polygonal granules. Furrow spines, 5 to 9. Subambulacral spines and granules in two to three irregularly arranged series. Subambulacral spines closely arranged, 3 to 5, two to three times as thick as the furrow spines,

Comments

Described from the Gascoyne region, Western Australia in the Indian Ocean (Mah 2025), this represents the first occurrence of this species from the South Pacific. This species shares multiple characters with *Ceramaster patagonicus*, including a well-developed abactinal fasciolar groove, coarse, angular tabular plates, and granules covering its superomarginal and inferomarginal plates.

Description/Occurrence

Gascoyne Marine Park, Western Australia 794 m.

New Caledonia, 1000–1019 m

Description

Body stout, weakly stellate (R/r=1.57), arms short, broad at base, triangular, weakly upturned. Interradial arcs weakly curved (Fig. 21A, D).

Abactinal plates tabulate, weakly tabulate, with surface plates ranging from polygonal and round proximally and radially to quadrate interradially (Fig. 21B). Plate granular surface relatively smooth forming even-surface. Tabulae relatively low and plate bases round to polygonal with no radiating plates. Plates larger in size, proximally becoming smaller distally adjacent to superomarginal contact, outline shape very homogeneous overall across disk. Fasciolar grooves well developed proximally and radially, shallower interradially (Fig. 21B). Plates with larger, angular shaped granules, six to 40 (mostly eight to 15) around periphery and round granules, one to eight, mostly one or two, present on central surface. Most abactinal plates show six to eight trapezoid-shaped granules with primarily one round granules centrally, especially distally. Abactinal plates in ordered series along disk forming approximately six to eight chevrons in each interradius. Granules becoming more irregular and crowded adjacent to superomarginal plate contact. Madreporite pentagonal in shape, weakly convex surface, flanked by seven abactinal plates. No pedicellariae.

Marginal plates 28 superomarginals, 28–20 inferomarginals (Fig. 21A, D), plates offset with zigzag contact between superomarginal and inferomarginal series. Superomarginal plates wide consistently wide along the entire arm length. Penultimate superomarginals about 25% of the size of the adjacent superomarginal. Superomarginal plates completely covered by evenly spaced, round to polygonal granules (Fig. 21C), numbering approximately three along a 1.0 mm line.Inferomarginal plates also wide, also covered by identically spaced and sized granules. Granules on marginal plates flattened forming discrete layer. Granules, 40 to 70, quadrate to polygonal forming evenly spaced peripheral series around plate edge, plate center with identical granules, approximately 200–400 granules evenly but closely covering central surface. Terminal plate triangular, flattened relative to penultimate superomarginals. No pedicellariae.

Actinal plate surface large, approximately five or six complete series in chevron-like formation, each plate quadrate in shape with angular edges (Fig. 21D, E). Granules, coarse, approximately two or three per 1.0 mm line, forming dense crowded covering on actinal plate surface, such that boundaries among the actinal plates are obscured by the actinal plates, especially distally adjacent to the inferomarginal contact where they become most irregular and most crowded. No pedicellariae. Actinal granulation forms a nearly flush surface with granules on the adambulacral plates, which are more widely spread apart.

Furrow spines four or five, each thick and triangular in cross-section, each closely arranged and crowded in straight or weakly curved series along furrow. Subambulacrals three or four, triangular to quadrate in cross-section, approximately 10% shorter than furrow spines, immediately adjacent to furrow and closely present with no gap between furrow spine or other subambulacral spines, approximately twice the thickness of one furrow spine (Fig. 21E). Third subambulacral spine series, shortest of the adambulacral spine series, also quadrate to triangular in cross-section, most similar to actinal granules but more widely spaced. All adambulacral armature very close-set forming nearly flush arrangement with actinal accessories.

Oral plates each with eight furrow spines, triangular in cross-section, identical to those on other adambulacral plates, each plate with an enlarged spine projecting into the oral region, triangular in cross-section with rounded edge. Oral plate surface covered four or five thick subambulacral spines, with flattened tips, quadrate or triangular in cross-section. Six or seven thick, quadrate to triangular granules present along oral plate midline with paired granule on opposing side of oral plate fossae.

Material Examined

MNHN IE-2013-9266, New Caledonia, 23°20'S, 167°54'E 23°22'S, 167°54'E, 1009–1019 m. Coll. KANACONO, CP 4754, 8.25.2016. 1 wet spec. R=5.2 r=3.3.

Chimeraster gen. nov. sp. nov.

Etymology

The genus name is derived from the Greek monster, the Chimera, alluding to the many bizarre characters present in this taxon, seemingly taken from different goniasterid genera.

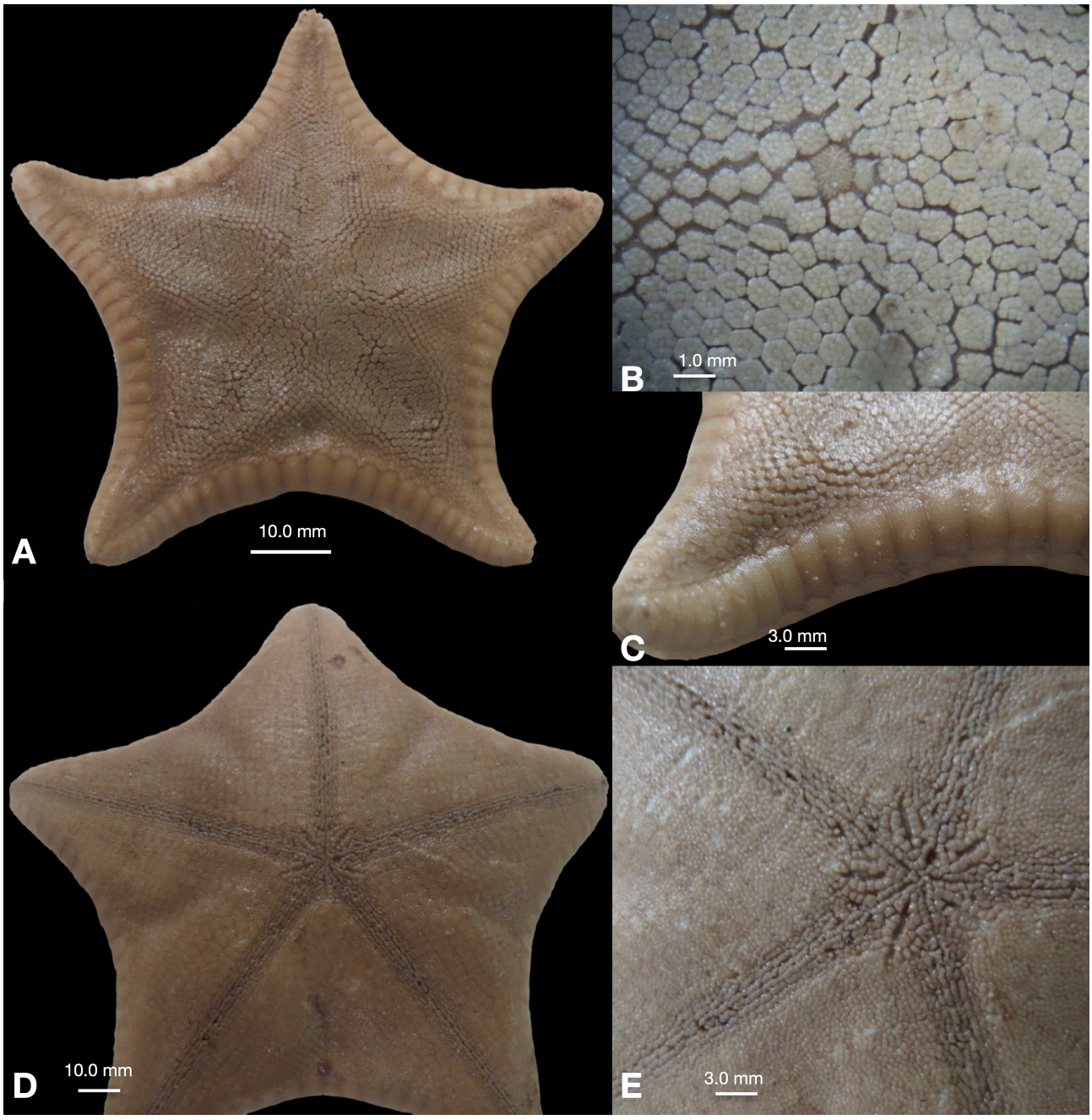

FIGURE 21. ***Ceramaster fortis*** Mah, 2025. MNHN IE-2013-9266. A. Abactinal. B. Abactinal plates closeup. C. Abactinal-lateral arm view. D. Actinal E. Actinal-oral, adambulacral region.

Diagnosis & Comments
Monotypic. As for species.

Chimeraster acutus **sp. nov.**
FIGURE 22A–E

Etymology
The species name *acutus* is derived from Latin for "point" alluding to the numerous small, blunt spinelets that cover the body surface.

Diagnosis
Body stellate, R/r=1.95 with arms, triangular short and wide at base. Abactinal plates abutted, with carinal plates in approximately 3 series, each plate hexagonal, wide becoming rectangular distally**. Disk surface covered by spinelets, 10 to 80, short, blunt, homogeneous in size and shape, widely spaced from one another. Marginal plates wide, a**pproximately 32 in each interradius from arm tip to arm tip, separated by disk plates to terminus. **Surface covered by short, blunt spinelets, 60–300 similar in stature, shape, on abactinal plates, peripherally numbering approximately 50 x 15 per side, widely spaced.** Actinal surface covered by short spines, 10 to 50, variably blunt to pointed, widely spaced. **Adambulacral plates, furrow spines 16, compressed, quadrate in cross-section in concave arrangement. First**

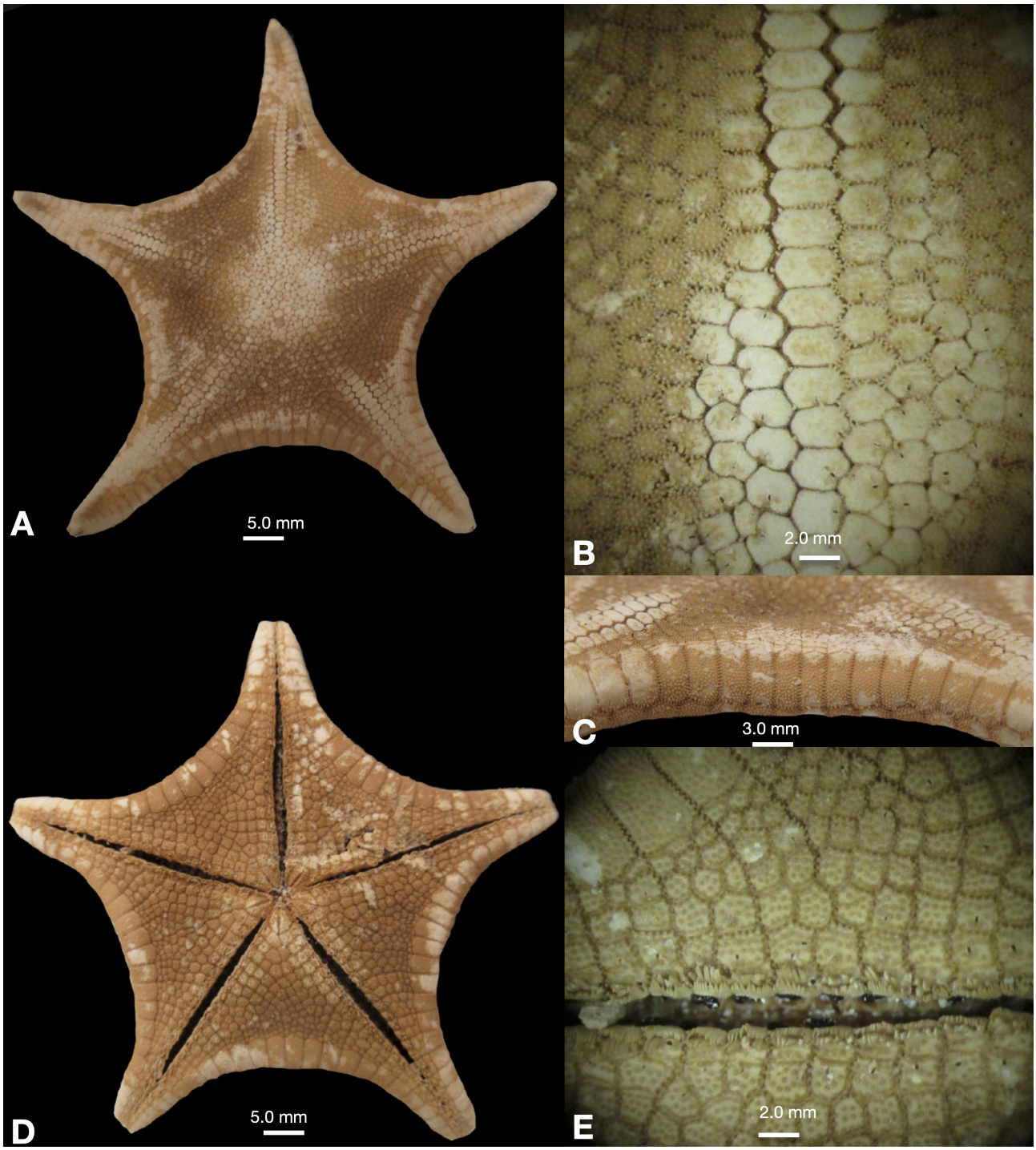

FIGURE 22. ***Chimeraster acutus*** **sp. nov.** MNHN IE-2023-168. A. Abactinal. B. Abactinal plate detail. C. Abactinal-lateral view. D. Actinal. E. Adambulacral furrow.

series of subambulacral spines, 4 to 5, widely spaced, with jagged tips in irregular series. Pedicellariae, on abactinal, marginal, and actinal plates, with elongate paddle-like valves, each bearing teeth.

Comments

Chimeraster acutus **gen. nov. sp. nov.** displays an unusual mix of characters, having very wide marginal plates (Fig. 22A, C), which are similar to those in *Mediaster* and pseudarchasterid taxa such as *Pseudarchaster*, but lacks tabulate or paxillate plates and instead displays abutted plates which are polygonal, especially along the radial series (Fig. 22B) but then becoming rectangular along the arm at its distal tip, which is reminiscent of *Paragonaster*. There is also an overall body shape very similar to *Anthenoides* in having short, triangular arms, broad interradial arcs with a relatively large disk. A surprising abundance of paddle or tong-like pedicellariae were observed on all of its body surfaces. The presence of abutted plates as observed on these specimens is surprisingly uncommon and is similar

to *Pseudoceramaster regularis* Jangoux 1981b and *Kermitaster pacificus* H.E.S. Clark 2001. *Chimeraster* is distinguished based on the presence of the spinelets covering the abactinal, marginal and especially the actinal plates (Fig. 22C, E), whereas *Pseudoceramaster* and *Kermitaster* are covered by round to polygonal granules.

The marginal plate morphology suggests a shared character with *Mediaster* and may represent a related taxon, in spite of its lack of tabulate abactinal plates and/or the radial plates on the underlying basal plate.

Occurrence/Distribution
New Caledonia, 570 m.

Description
Body stellate, R/r=1.95, arms triangular, short, broad based. Interradial arcs weakly curved to straight (Fig. 22A, D).

Abactinal plates plates abutted, polygonal to irregular in shape, extending to arm tip. Carinal plates hexagonal (Fig. 22B), wide along 3 series along arm, becoming more rectangular distalmost at arm tip. Disk and interradial plates more polygonal to quadrate in shape but more irregular adradially and proximally on disk. No secondary plates. Disk surface covered by spinelets, 10 to 80, short, blunt, homogeneous in size and shape, widely spaced from one another. Peripheral spinelets consistent in size, shape, but not morphologically differentiated from those centrally on plate surface. Pedicellariae, alveolar, paddle-shaped, mostly slender, bivalve with 3 to 5 teeth per valve, twice the size of the adjacent short spinelets, approximately 2 per plate, numbering about 10 count along a 5.0 mm line, most abundant along radial regions with relatively few present interradially. Papulae present over proximal radial areas, absent interradially and distalmost arm regions. Madreporite polygonal to round, sunken below disk surface, sulci well-developed.

Marginal plates wide along full series, approximately 32 in each interradius from arm tip to arm tip, separated by disk plates to terminus (Fig. 22A). Surface covered by short, blunt spinelets (Fig. 22C), 60–300 similar in stature, shape, on abactinal plates, peripherally numbering approximately 50 x 15 per side, widely spaced. Absent spinelets leave shallow convexities when removed. Single paddle-shaped pedicellariae present on dorso-lateral surface for every 6 plates. None observed on inferomarginal plates. Distalmost superomarginal plates, 4 to 5, tumid showing glassy tubercles. Shallow fasciolar grooves present between marginal plates. Terminal plate enlarged, diamond shaped with rounded surface.

Actinal plates in 4 to 5 complete series, individual plates quadrate to irregular in shape with rounded edges. Complete series present proximally becoming more irregular distally adjacent to inferomarginal contact. Surface covered by short spines, 10 to 50, variably blunt to pointed, widely spaced (Fig. 22E). Fasciolar grooves present. Pedicellariae present, alveolar with paddle-shaped, narrow valves, each with 3 to 6 teeth interlacing, one present on every plate on series adjacent to adambulacral series. Further pedicellariae of this type present on plates present adjacent to the oral region.

Adambulacral plates with furrow spines 16, compressed, quadrate in cross-section in concave arrangement. First series of subambulacral spines, 4 to 5, widely spaced, with jagged tips in irregular series. Further spination more similar in size to those on actinal plates (Fig. 22E). Distinct space separates furrow and subambulacral armament from spinelets on remainder of plate. Oral plates with similar compressed furrow spines, 18 to 20 per side. Suboral spines 20 to 25 per interradius, covering each half of oral plate with a parallel series along central diastema.

Material Examined
Holotype. MNHN IE-2023-168, Ride des Loyaute (Loyalty Ridge) 20º49'S 167º09'E, 570 m. Coll. MUSORSTOM 6, N/O Alis DW 394. 1 dry spec. R=4.5 r=2.3. **Paratypes**. MNHN IE-2023-169, Ride des Loyaute (Loyalty Ridge) 20º49'S 167º09'E, 570 m. Coll. MUSORSTOM 6, N/O *Alis* DW 394. 1 dry spec (1 arm with sublethal damage) R=4.3 r=2.2.

MNHN IE-2023-170, Loyalty Ridge, 23º54'S 169º50'E, 652–750 m.Coll. Bouchet/richer/Waren, N/O Alis, campagne BATHUS 3, CP 788, 25 Nov 1993. 1 dry spec. R=6.3 r=2.7.

MNHN IE-2023-171, New Caledonia, no other data, 3–600 m, Coll. Richer de Forges VAUBAN, 9 dry specs. R=4.0 r=2.0, R=3.6 r=1.8 R=3.3 r=1.8, R=4.0 r=2.0, R=3.9 r=1.8 R=3.8 r=2.0 R=4.5 r=2.3, R=3.6 r=1.8 R=3.7 r=1.8.

Discoplintha gen. nov.

Etymology. The genus refers to the Greek *diskos* for flat and circular and the Greek *plinthos* for brick or tile alluding to the round plate like shape of this taxon.

Diagnosis & Comments. As for species.

Discoplintha reganae gen. nov. sp. nov.
FIGURE 23A–E

Etymology
This species is named for Ms. Regan Miller whose distinctive fashion has inspired the name for this species.

Diagnosis
Body weakly stellate (R/r=1.4 to 1.8), arms short, triangular. **Abactinal plates smooth, bare, devoid of surficial accessories but with embossed, glassy granules. Superomarginals 14 per interradius (arm tip to arm tip),** distalmost two superomarginals abutted. **Most of superomarginal dorsal surface bare with no surficial granules with exception of circular area on lateral area in contact with inferomarginal surface**. Abundant granular cover save for a discrete bare quadrate shaped region centrally on inferomarginal surface. Pedicellariae small paddle-shaped present on marginal plates. Actinal plate surface covered by granules. Furrow

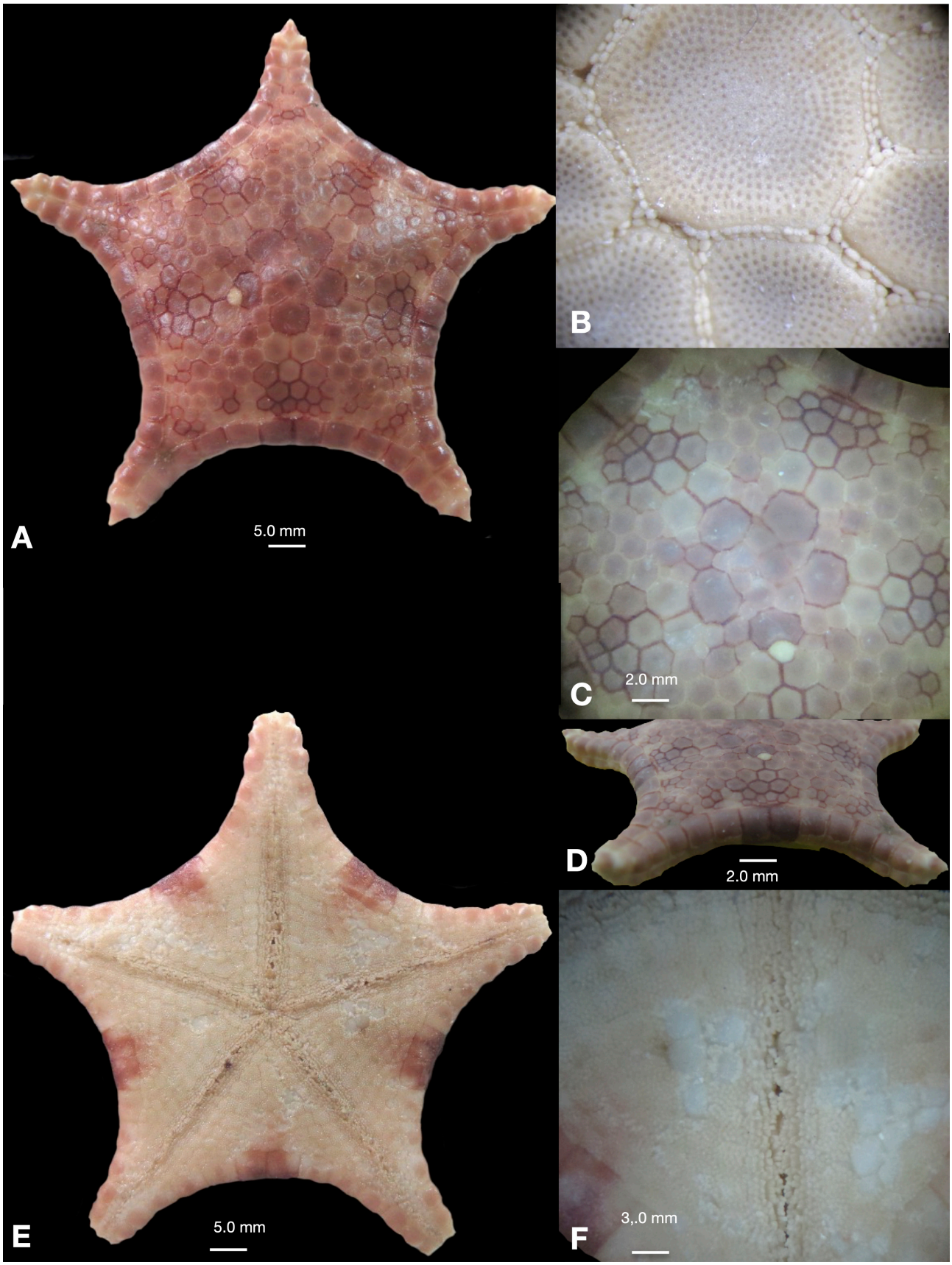

FIGURE 23. ***Discoplintha reganae*** **gen. nov. sp. nov.** MNHN IE-2013-9914. A. Abactinal. B. Embossed Granules on abactinal plate surface (from dried paratype). C. Abactinal plate detail. D. Disk-lateral view. E. Actinal E. Actinal-adambulacral furrow.

spines 6 to 8, mostly 6 proximally, increasing in number distally, weakly palmate to straight in arrangement. Spines blunt, quadrate in cross-section. Subambulacral spines in 3 to 4 distinct series, each with 3 to 5 spines.

Comments

Discoplintha reganae **gen. nov. sp. nov.** invites immediate comparison with *Plinthaster* and *Astroceramus,* which both displays polygonal, bare smooth abactinal plates (Fig. 23A, B) with embossed glassy tubercles and similar pentagonal body shape. However, superomarginal plates in *Discoplintha* **gen. nov.** have a tumid, smooth surface and lack the granules present on the superomarginal surface as observed in *Plinthaster* or *Astroceramus,* which have a largely flat surface with widely spaced, coarse granules on the superomarginal plates. Larger specimens of *Discoplintha*, R=2.6 display greater numbers of marginal plates per interradius than *Plinthaster*, although some smaller specimens (e.g. MNHN IE-2007-1877, R=2.1) do overlap in number. *Astroceramus* is also differentiated based on the much wider superomarginal frame around the periphery of the body, which occupies approximately 20–25% of the total "r" versus superomarginal plates in *Discoplintha* which only occupies approximately 10% of the total "r". The color patterns present from known *Discoplintha* are retained in preserved specimens, and are absent from *Plinthaster* and *Asteroceramus*.

Discoplintha **gen. nov.** is similar to *Glyphodiscus* in having completely bare abactinal and superomarginal plate surfaces with no surficial granules. The most comparable species, *Glyphodiscus perierctus* lacks embossed, glassy tubercles on the abactinal plates and marginal plates which are more quadrate in shape and cross-section. Patterns are absent from known *Glyphodiscus* species.

Other goniasterids with similar glassy tubercles on the plate surface include *Ogmaster, Lithosoma*, and *Iconaster. Ogmaster* is immediately discounted based on the possession of distinct dermis on the body surface, obscuring the glassy tubercles and much of the actinal surface. *Discoplintha* differs from *Iconaster* and *Lithosoma* in the possession of a distinct covering of surficial granules on the actinal plates, which are smooth and bare in the latter two taxa.

Occurrence/Distribution

New Caledonia, Philippines. 150–320 m.

Description

Body stout, but flattened, pentagonal to weakly stellate (R/r=1.4 to 1.8), arms short, triangular in outline, interradial arcs weakly curved to straight. Arm tips weakly upturned (Fig. 23A, D)

Abactinal surface weakly convex, plates abutted, surface flat, smooth, polygonal to round in shape. Abactinal plates flush with superomarginal plates. Distalmost superomarginals abutted over midline, with abactinal plates extending along arm base to this point. All plates with tiny, embossed translucent granules embedded in plate surface in a starburst type pattern (Fig. 23B). Each "ray", approximately 40 to 200 per plate, composed of granules, 4 to 7 in a linear pattern radiating from broad central region lacking granules. Plate surfaces are otherwise devoid of any surficial accessories, no granules, etc. Peripheral granules, approximately 15 to 150, round to quadrate, widely spaced. Primary circlet plates irregularly hexagonal, largest of abactinal plates approximately 4 to 6 times the size of adjacent plates (Fig. 23B). Radial plates in approximately three series, each round in shape extending to arm base. Interradial abactinal plates in a loosely pyramid like arrangement with the primary plate at apex (i.e. the primary circlet) with other plates more distinctly polygonal to hexagonal becoming smaller and more irregular in shape adjacent to superomarginal plates. Abactinal plates at arm base becoming more rhombus-like in shape. Madreporite oval to polygonal in shape, flanked by three plates, one of the primary circlet and two others. No pedicellariae.

Superomarginal plates 14, inferomarginal plates 16 (Fig. 23A, C). Distalmost two superomarginals abutted over midline, with third mostly or partially so. Abactinal surface of superomarginal plates smooth, bare with no surficial structures, i.e. no granules, etc. Both marginal series with rounded abactinal/actinal-lateral edge. Lower lateral surface of superomarginal plates covered with granules, round, deciduous, approximately 40–60. Inferomarginal surface with a complete, tightly arranged covering of granules, approximately 70 to 200 with distinct bald patches, quadrate to irregular in shape 1 to 2 per plate, one facing laterally and the other facing actinally. Actinal facing bald spot (Fig. 23E) increasing in size distally until it completely occupies lateral surface of distalmost inferomarginal plate. Penultimate inferomarginal plates with pointed spinelet-like granules 2 to 3. Terminal plates triangular with pointed tip, surface bare. Pedicellariae small, approximately 1 to 2 mm in length, one or two per interradius, paddle shaped on lateral surface inferomarginal plates.

Actinal surface in three complete series and approximately two incomplete, irregular series adjacent to the inferomarginals. Actinal plates flat, abutted, in polygonal to quadrate in outline, each completely covered by by coarse, round granules, 10–100, but mostly 20–60 widely spaced in ordered series on each plate (Fig. 23D, E), approximately five or six counted along a 1.0 mm line. Central and peripheral granules identical in size, shape, approximately eight to 10 granules per side. Granules approximately twice as large as those on adjacent inferomarginal surface Pedicellariae one to three per interradius, similar to the one present on interradial surface, small, approximately 1 to 2.0 mm, paddle-shaped.

Furrow spines 6 to 8, mostly 6 proximally, increasing in number distally, weakly palmate to straight in arrangement. Spines blunt, quadrate in cross-section. Subambulacral spines in 3 to 4 distinct series, each with 3 to 5 spines (Fig. 23E). Immediately adjacent to the furrow spines, first subambulacral series composed of three or four thick spines, each twice as thick as one of the furrow spines with a blunt tip but approximately 20% shorter than the furrow spines. Subsequent second to fourth subambulacrals smaller in size as subambulacrals

approach contact with actinal granulation, each widely spaced.The second subambulacral series is approximately 50% the length of the adjacent subambulacral series, four or five with pointed or blunt tips. Remaining accessories on adambulacral plates covered by pointed granules in two, widely spaced series. These granules slightly elongate but overall similar to those granules on the adjacent actinal plate surface.

Oral plates with furrow spines, 10 with 2 projecting into mouth, one each per plate, Oral spines projecting into mouth triangular in cross-section with each forming a half-triangle. Subambulacral spines behind the oral furrow spines, each triangular in cross-section, many with pointed or fluted tips. Remainder of oral plate covered by thick, short spines, 6–10 quadrate in cross-section, each flanking the fossae created by the pairing of the oral plates.

Darker coloration present over primary circlet and interradial plates, especially around periphery, these darker colors extending as a band to the actinal surface interradially over two central marginal plates (Fig. 23A, D). Actinal surface white.

Material Examined

Holotype. MNHN IE-2013-9914, New Caledonia, 19º51'S 158º34'E, 310–320 m Coll. KANADEEP DW 5036, Sept. 22, 2017. 1 wet spec. R=2.6 r=1.4.

Paratype. USNM 1754312. Balut Island 150–250 m. 1 dry spec. R=3.8 r=2.1.

Dissogenes Fisher 1913

Fisher 1913: 212; 1919: 367; Jangoux 1981: 712; H.E.S. Clark & McKnight 2001: 169

Diagnosis

Body stellate to strongly stellate (R/r=3.94–4.0), disk and arms thick, arms elongate, triangular in shape, interradial arcs curved. **Surface covered by granular cover, variably dermis present or absent** (Fig. 21B, C)**. Abactinal plates abutted variably with single or more papular pores present, plates extending from disk to arm terminus. Marginal plates quadrate and blocky, forming lateral boundary around periphery** (Fig. 21B). Actinal surface covered by continuous granular cover, variably covered by dermis or not. Proximal actinal plates with conical spines present or absent, similar in overall gauge with subambulacral spines. Furrow spines 2–7, blunt in known species in straight series. Subambulacral spines similar in size to furrow spines but each twice as thick, approximately 3 to 6 (Figs 24 F, G).

Comments

Dissogenes styracia was described from the Philippines and assigned to the Ophidiasteridae by Fisher (1913, 1919) with a second species, *Dissogenes petersi*, described by Jangoux 1981 from New Caledonia. Molecular data has more recently shown that the Ophidiasteridae is paraphyletic, with several genera, including *Fromia* and *Neoferdina*, found to be members of the Goniasteridae (Mah & Foltz, 2011; Mah 2017). Fisher (1919) commented on *Dissogenes*' goniasterid affinities remarking that it could easily be assigned to the Goniasteridae based on its similarity with *Narcissia* and *Ferdina*. In addition to further molecular data in preparation, the abutted abactinal plates, blocky and quadrate marginal plates (Fig. 24B, C) show stronger affinity with the Goniasteridae than the Ophidiasteridae, indicating that this genus shows membership with the former rather than the latter.

Dissogenes petersi Jangoux 1981

FIGURE 24A–G

Jangoux 1981: 709, Fig. 1; H.E.S. Clark & McKnight 2001: 169, pl. 70.

Diagnosis

Body strongly stellate, R/r=3.94–4.0, arms elongate, arm tips upturned, interradial arcs curved. **Abactinal plates abutted, completely unarmed abactinal and marginal plates uniformly covered with a very dense fine granulation.** Papulae, single, isolated, limited to abactinal surface, absent from interradius on disk, lateral surfaces and distal arm regions. **Interradial actinal plates covered with large granules and bearing one to five short spines. Actinal surface with spines, 1–5 per plate, low and similar in elevation to subambulacrals.** Furrow spines six, blunt, quadrate in cross section. Subambulacrals 3, 2X to 3X the thickness of the furrow spines. Small pedicellariae present on the actinal surface.

Comments

Dissogenes petersi is distinguished from *D. styracia* primarily by the complete absence of spines on the abactinal surface (Fig. 24A) and in possessing the presence of clustered rather than single actinal spines in the latter. Additional specimens of *D. petersi* shows that it displays more varied morphology than is observed in the holotype, primarily on the arrangement and number of spination on the actinal surface. Actinal spines on the holotype number 1 to 4, with blunt tips with granules that are relatively small and level with the actinal surface. Those on MNHN IE-2013-6830 at R=10.3 cm are much thicker, approximately 2 to 3X the thickness of the furrow spines, similar in size and stature with the subambulacral spines sitting on plates with a ring of spinose granules present around the periphery rising above the granules present on the actinal surface. Actinal spines are positioned in an irregular outward projecting arrangements rather than in close, ordered clusters. Furrow and subambulacral spine number are identical and the presence of straight, beak-like pedicellariae are present adjacent to the adambulacral plates (Fig. 24E). A smaller specimen, MNHN IE-2013-6831 with R=6.7 shows a similar array of actinal spines and enlarged peripheral granules.

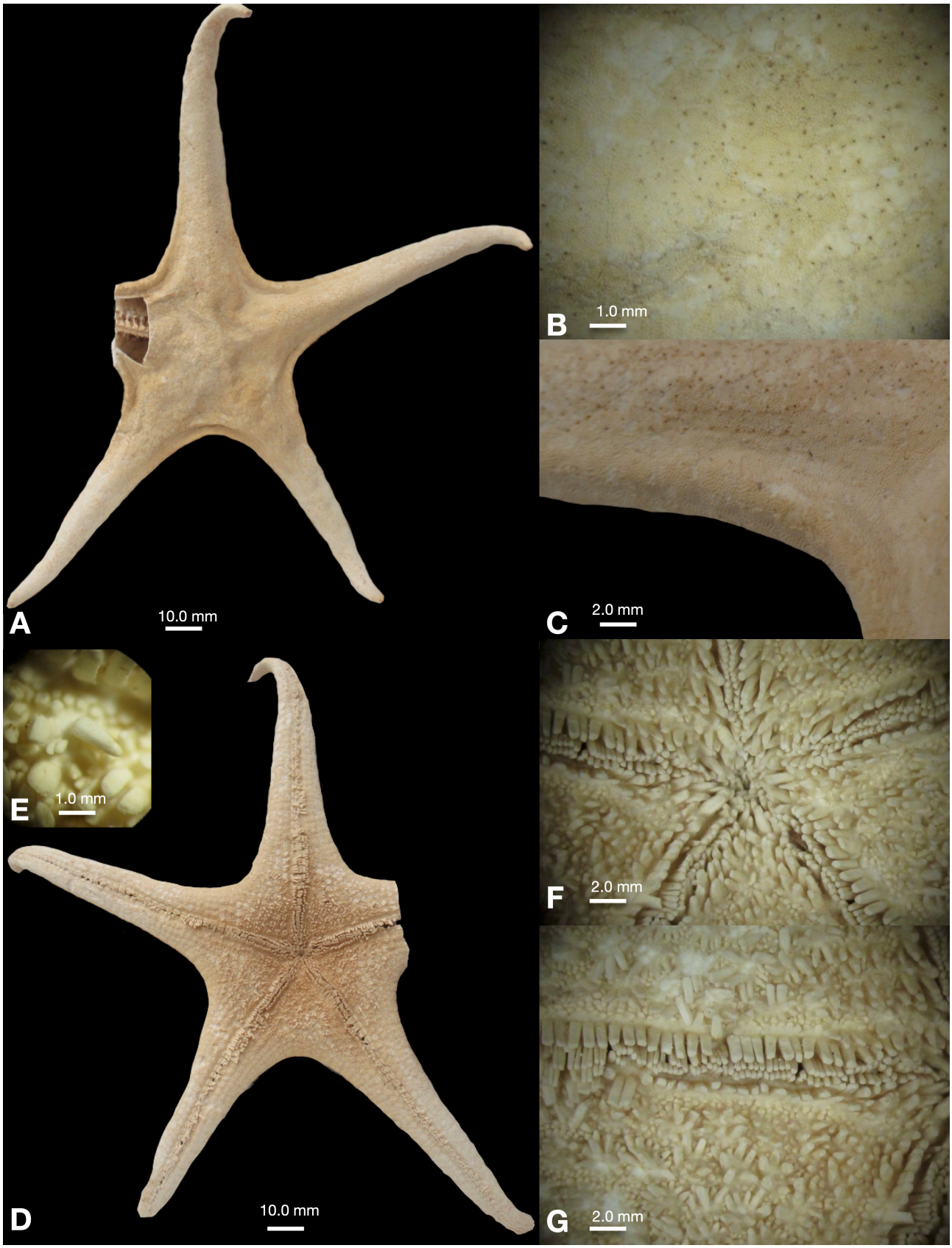

FIGURE 24. ***Dissogenes petersi*** Jangoux, 1981. MNHN IE-2013-6830. A. Abactinal B. Abactinal plate detail. C. Abactinal-lateral. D. Actinal. E. Actinal pedicellariae. F. Actinal-oral view. G. Actinal-adambulacral view.

Occurrence/Distribution
New Caledonia, New Zealand (Three Kings Rise), 195–500 m.

Material Examined
MNHN IE-2013-6830 Southern New Caledonia, 22º55'S 167º16'E, 500 m. Coll. Bargibant & Tirard, aboard N/O *Vauban*, campagne SMIB 1, DW07, 6 Feb 1986. 1 dry spec. R=10.3 r=2.6.

MNHN IE-2013-6831 Southern New Caledonia, 22º53'S 167º12'E, 403–429 m. Coll. Louzouet, Boisseller, Richer de Forges, IRD, DW 1734, 28 June 2001. 1 dry spec. R=6.7 r=1.7.

MNHN IE-2013-9824 East of I'Ile des Pins, New Caledonia, 22°39'37.7424"S; 167°39'33.5952"E, 195–233 m. Coll. MNHN, N/O KANACONO, DW 4735, 22 Aug 2016, 1 wet spec.

Fromia Gray 1840

Fromia Gray 1840: 286; Fisher 1919: 373; H.L. Clark 1921: 38; Rowe & Gates 1995: 81; Mah & Foltz 2011: 771, 779, 782
Celerina A.M. Clark 1967: 193; Rowe & Gates 1995: 80
Austrofromia H.L. Clark 1921: 48; Rowe 1989: 291; Rowe & Gates 1995: 81

Diagnosis. Body strongly stellate (R/r=3.5–5.0), arms elongate, strap-like to triangular in shape. Interradial arcs acute. Arm rectangular in cross-section. Abactinal plates abutted, ranging ranging from flat to convex, covered with a distinct continuous cover of granules. **Marginal plates broadly quadrate in outline forming discrete frame around abactinal-lateral outline of body.** Marginal plate surface covered by continuous cover of granules Actinal region small, covered by granules. **Papulae present between marginal and actinal plate contact.** Furrow spines blunt, relatively few, with variable subambulacral armature. Pedicellariae absent in most species.

Comments
Fromia presently includes 16 species, which are present throughout the Indo-Pacific ranging from shallow, reef to mesophotic settings, 0 to 149 m (Mah *et al.* 2024). No Atlantic species are known. *Fromia* has been historically assigned to the Ophidiasteridae, but was moved to the Goniasteridae as molecular phylogenetic evidence clarified its relationship among the Valvatida (Mah & Foltz 2011).

Fromia bathybia sp. nov.
FIGURE 25A–G

Etymology
The species epithet *bathybia* is derived from the Greek for "deep" alluding to this species unusually deep occurrence. Gender is feminine.

Diagnosis
Abactinal plates **flat, large, polygonal in shape**, surface covered by granules, but discretely present on each plate. **Abactinal plates in 2 to 3 series proximally, narrowing to a single series distally adjacent to arm tip. Glassy tubercles present on abactinal surface.** Granular cover discontinuous. **Papulae absent from inferomarginal-actinal surface.** Furrow spines three or four, pointed to pointed, quadrate in cross-section in straight arrangement. Subambulacrals composed of three series, immediately adjacent subambulacral spines composed of three pointed spines

Comments
This species is differentiated from other *Fromia* spp. based on the large polygonal abactinal plates, approximately 2 to 3 at arm base, decreasing to a single series distally. Also, granular cover on the abactinal, marginal and actinal surface is discontinuous, with plates showing discrete association with surficial granules. With the exception of *Fromia indica*, most other *Fromia* species show a continuous granular cover that obscures the boundaries between plates. This species is differentiated from *F. indica* based on the significantly larger abactinal and marginal plates. Abactinal plates in *F. indica* shows two differently sized, large and small abactinal plates. Papulae, which are present at the contact between the inferomarginal and actinal plates on other species are here absent. It shares a more more homogeneous series of superomarginal plates with species such as *F. pacifica*.

Fromia bathybia **sp. nov.** is the deepest known species of *Fromia*, which had previously been known only from 0 to 150 m depths.

Description
Body strongly stellate (R/r=2.8–3.6), abactinal surface flat, arms elongate, triangular in shape, interradial arcs acutely curved (Fig. 25A, E).

Abactinal plates angular, ranging from triangular, quadrate to irregularly polygonal (Fig. 25D). Each plate discretely separated from one another and slightly raised forming shallow fasciolar grooves between plates with plates extending along arms to terminus. Each plate with coarse, round to polygonal granules, approximately three granules counted along a 1.0 mm line, each plate with 1 to 30 granules, each with 10 to 20 per plate surface. Embossed weakly convex glassy granules present on the surface of each plate (Fig. 25D). Abactinal plates, three or four counted across the base of each arm (Fig. 25B). Carinal plates, each with approximately 20 granules, variably angular in shape decreasing to single series along distalmost half along arm with small triangular to diamond shaped adradial secondary plates present on arm proximally. Interradial abactinal plates corresponds to central interradial superomarginal plates. Papular pores single, large, present on disk and along arms up to arm tips but absent interradially (Fig. 25B). Madreporite triangular, weakly convex with shallow sulci, flanked by three abactinal plates.

Superomarginals and inferomarginals 40–42 per

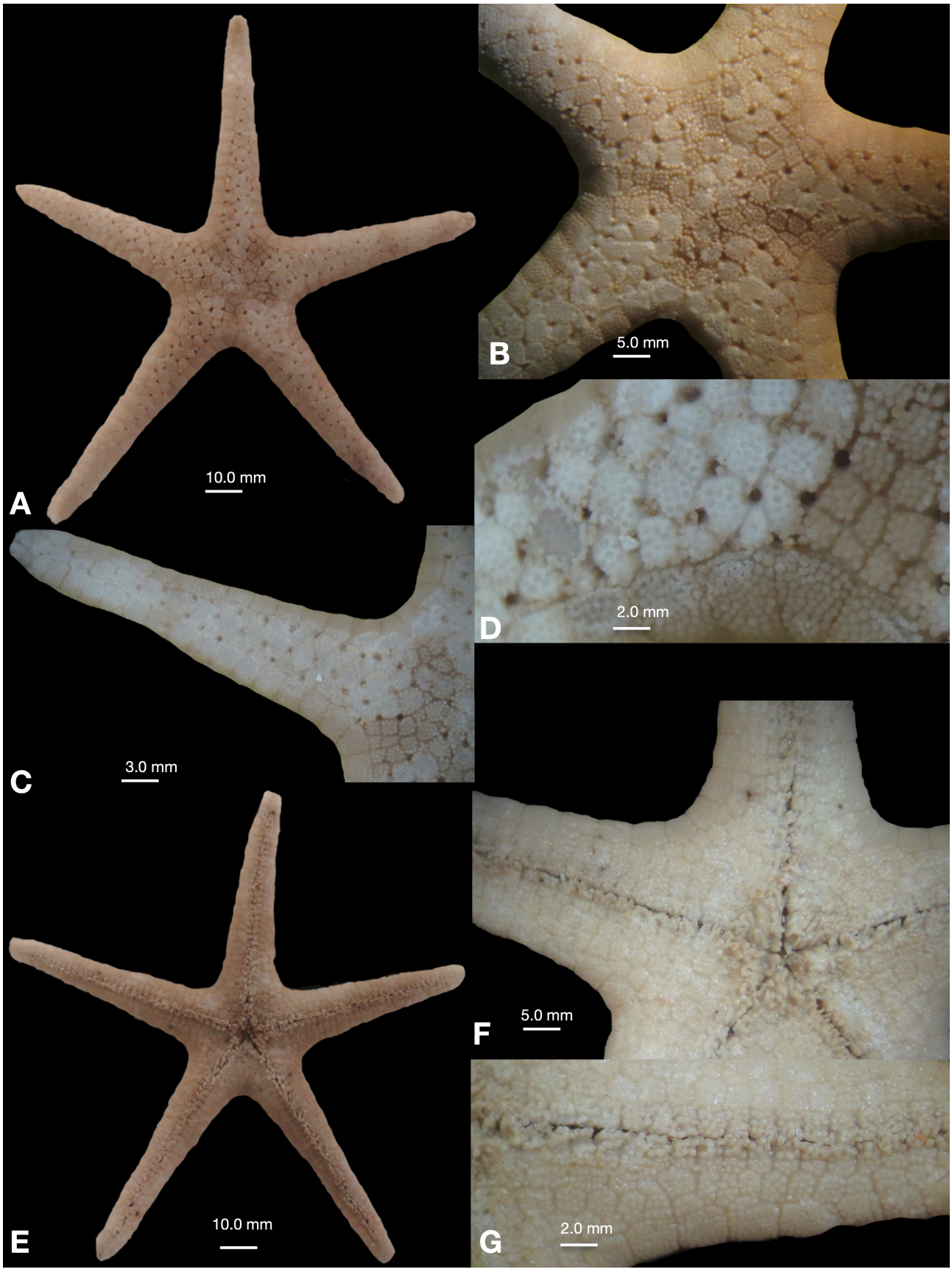

FIGURE 25. ***Fromia bathybia*** **sp. nov.** MNHN IE-2013-9398. A. Abactinal. B. Abactinal plate detail. C. Arm plate detail D. Abactinal arm plate detail. E. Actinal. F. Actinal-oral region. G. Adambulacral furrow.

interradius (arm tip to arm tip), wide interradially, forming rounded abactinal-lateral edge around body surface. Interradial plates largest decreasing in size distally. Each plate covered by coarse, round to polygonal granules, approximately 40 to 100 per plate surface, all widely spaced (Fig. 25D). Peripheral granules, widely spaced 12 to 40, each side with approximately four to 10 granules per side. Granules identical in size to those on abactinal surface. Superomarginals with underlying embossed crystal granules on underlying surface. These crystal granules identical to those on abactinal plates. Shallow fasciolar grooves present between superomarginal and inferomarginal plates. Inferomarginal plates quadrate in shape, approximately 40 to 120 granules, round to polygonal, all evenly spaced. Embossed crystal granules also present on inferomarginal plate surfaces.

Actinal interradial region with plates in two full series, each quadrate to polygonal in outline but actinal plate series extend only approximately halfway along arm (Fig. 25F). Actinal plates with polygonal to round granules, 4 to 30, mostly 10 to 20, evenly spaced. Actinal fasciolar grooves present, shallow. No papulae. Pedicellariae absent.

Furrow spines three or four, pointed to pointed, quadrate in cross-section in straight arrangement (Fig. 25F, G). Subambulacrals composed of three series, immediately adjacent subambulacral spines composed of three pointed spines, round to quadrate in cross-section. Remaining subambulacrals composed of two series of widely spaced, angular granules, approximately 25% of the height of the adjacent subambulacral spines.

Oral plates with four furrow spines, one enlarged pointed spine projecting into mouth, each paired per interradii (Fig. 25F). Oral plate surface with two large, pointed spines, triangular to quadrate in cross-section sitting adjacent to furrow spines. Remaining oral plate with spines similar to the subambulacrals but approximately 50% in height.

Occurrence/Distribution
New Caledonia, 290–590 m.

Material Examined
Holotype. MNHN IE-2013-9398, New Caledonia, 22º02'S 167º44'E, 550–590 m. Coll. KANACONO DW 4747, Aug 23 2016,. 1 wet spec. R=3.6 r=1.0.

Paratype. MNHN IE-2013-9417, New Caledonia, 22º53'S 167º37'E. 290–345 m. Coll. KANACONO DW 4742, Aug 23 2016, 2 wet specs. R=2.3, r=0.8; R=1.3 r=0.3.

Fromia nodosa A.M. Clark 1967
FIGURE 26A–D

Ferdina offreti (pt) Koehler 1910: 143, pl. 15, figs. 4, 5.
Fromia nodosa A.M. Clark 1967: 189–191, pl. 6, figs. 1–3; A.M. Clark & Rowe 1971: pl. 8, fig. 8; Oguro & Sasayama 1984: 101–106; Lee & Shin 2013: 5–6; Hui *et al.* 2014: 413.

Diagnosis
A single series of strongly convex carinal plates present, such that they nearly occupy the entire distance along the abactinal plates along the arm (Fig. 26A, B)**.** Superomarginal plates displaying abrupt convex shape and separated by approximately 1/3 the distance by the abactinal series (Fig. 26B).

Comments
Fromia nodosa is a widely distributed species throughout the Indo-Pacific, with occurrence recorded from the South Pacific, the Philippines, to the Indian Ocean and east African coast. MNHN IE-2013-9920 appears largely consistent with the description, showing the strongly convex, relatively large superomarginals and carinal series.

This species shows a strong resemblance with the commonly encountered *Fromia monilis*

and based on *in situ* observations demonstrates similar coloration, a deep-red disk with distinct white plates along its arms. Some individuals of *Fromia heffernani* also shows distinctly convex plates along the arms, which are generally smaller, more numerous and more irregular. *Fromia nodosa* is superficially similar to *Paraferdina plakos*, from Thailand and Madagascar (Mah 2017) but differs in that the latter species shows no adambulacral spination save for a single series of furrow spines.

This occurrence is the first for New Caledonia and the deepest for this species, 53–54 m, indicating its lower depth limit extends to the mesophotic zone.

Occurrence/Distribution
New Caledonia, 53–54 m.

Marshall Islands, Micronesia, Kosrae, Yap, Philippines, Sri Lanka, Ceylon, Western Indian Ocean, Amirante Island, Maldives, Christmas Island, Indian Ocean Territory-Australia, eastern Africa Aldabra, Seychelles. 10–54 m.

Material Examined
MNHN IE-2013-9920, New Caledonia, 23°24.1'S, 168°4.1'E to 23°25.2'S, 168°4.5'E, 53–54 m Coll. KANACONO, 27 Aug 2016. 1 wet spec.

Glyphodiscus Fisher, 1917

Iconaster Fisher (1913): 642 (in part)
Iconaster (Glyphodiscus) Fisher 1917: 173; 1919: 306; H.E.S. Clark & McKnight 2003: 52
Glyphodiscus Rowe 1989: 273; Rowe & Gates 1995: 65; H.E.S. Clark & McKnight 2001: 52.

Diagnosis
Body pentagonal to stellate. Disk sunken. **Abactinal, superomarginal actinal plates smooth, bare devoid of surficial accessories.** Abactinal plates with complete ring of peripheral accessories. Primary circlet plates enlarged. Marginal plates relatively few. Superomarginals along arm abutted in most species.

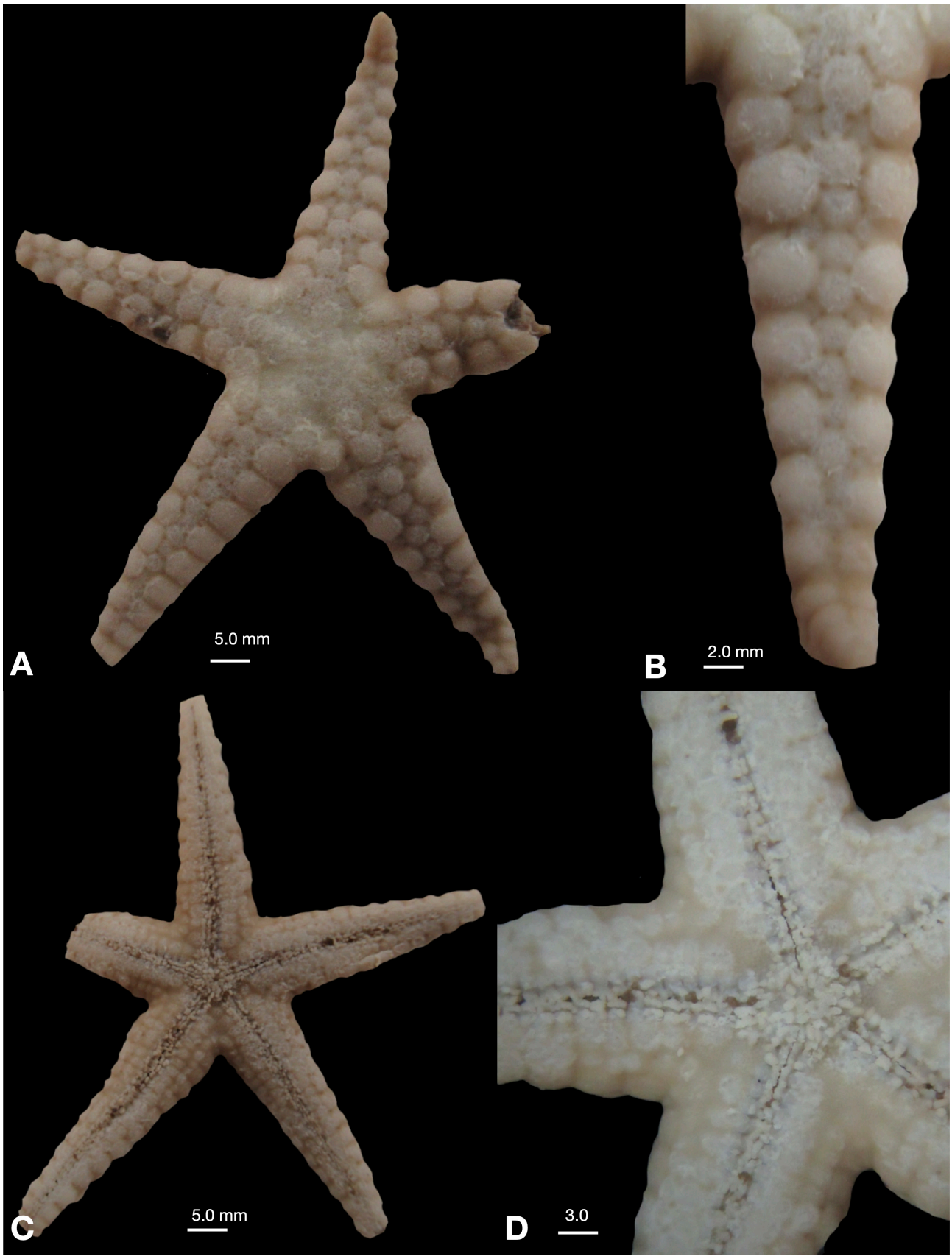

FIGURE 26. ***Fromia nodosa*** A.M. Clark, 1967 MNHN IE-2013-9920. A. Abactinal. B. Abactinal-superomarginal along arm. C. Actinal. D. Oral-adambulacral view.

Comments

Glyphodiscus, distributed primarily in deep-water, 150–600 m, was recently reviewed by Mah (2005), including 3 species, all of which occur in New Caledonia. One species, *Glyphodiscus pentagonalis* has so far been recorded only from New Caledonia.

Glyphodiscus pierectus (Fisher 1913)

FIGURE 27A–E

Iconaster pierectus Fisher 1913: 642

Iconaster (Glyphodiscus) pierectus Fisher 1917: 173; 1919: 306, pls 79, 81, 83, 93

Glyphodiscus pierectus A.M. Clark 1993: 254; Mah 2005: 144; Kogure & Kaneko 2018: 204.

Glyphodiscus mcknighti Rowe 1989: 273, figs 8A, B, 9A, 9B

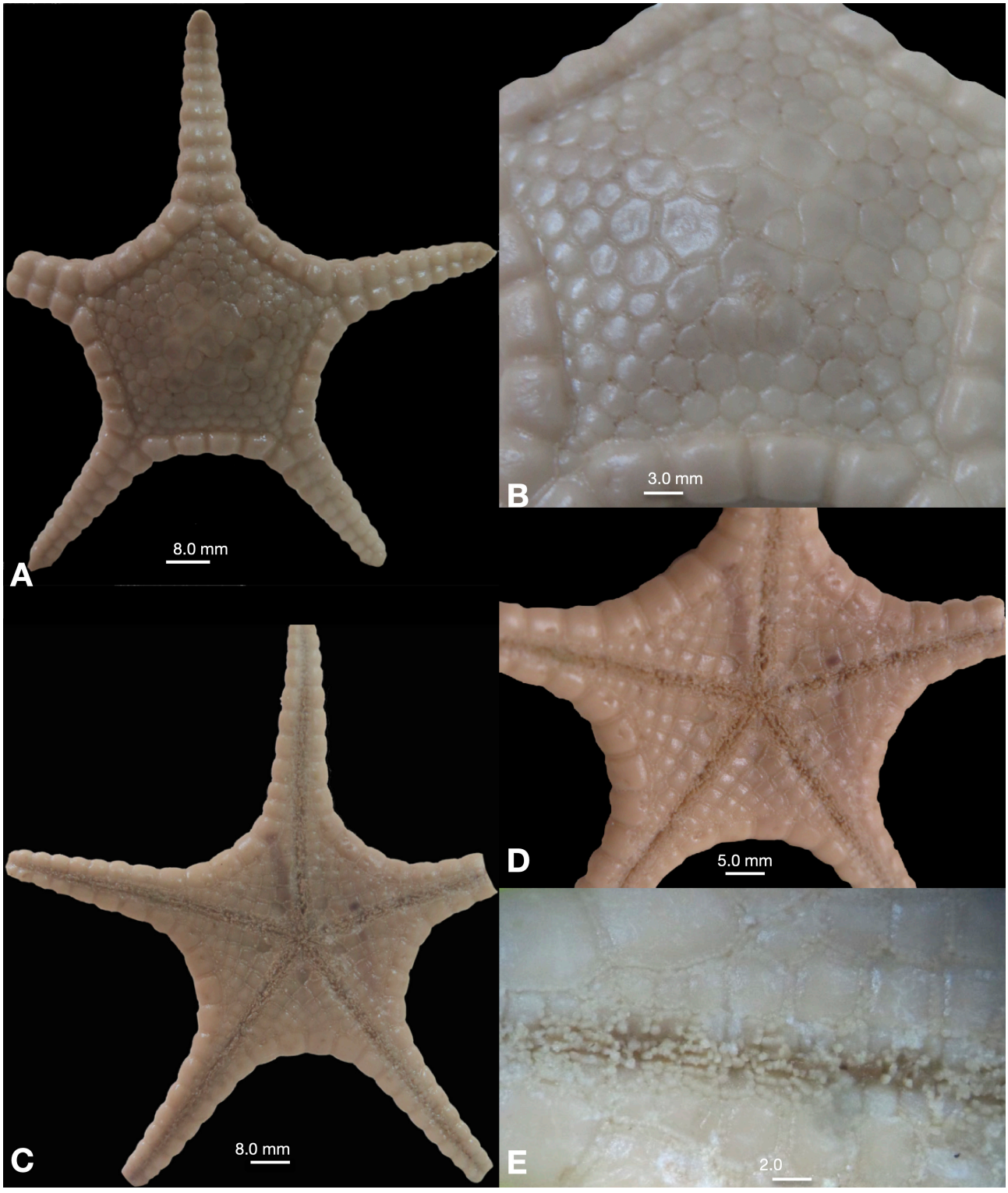

FIGURE 27. ***Glyphodiscus pierectus*** (Fisher, 1913). MNHN IE-2016-1519. A. Abactinal B. Abactinal close. C. Actinal. D. Actinal close. E. Adambulacral furrow.

Diagnosis
Body weakly stellate to stellate R/r=1.9–2.75, arms variably short to long, tapering. A**bactinal, marginal, actinal plates bare, smooth** (Fig. 27A, B)**.** Marginal plates forming elevated ring over abactinal surface, individual plates elongate, surfaces variably smooth to rough. Superomarginal plates, 4 to 6 free on disk, remaining superomarginal plates abutted across radius ranging from 4 to 10 pairs. Furrow spines 3 to 5, subambulacral granules in 2 to 3 irregular rows, each with 3 to 4 granules (Fig. 27E). Ambulacral waist with a rounded surface.

Comments
Although *G. pierierctus* has been previously documented from New Caledonia (Mah 2005) these specimens were those displaying the short-armed morphotype, more similar to the New Zealand morphotype (identified originally as the synonymized *G. mcknighti*). Specimens herein are more similar to the typological morphotype and display much longer arms with a more stellate body form and greater numbers of abutted superomarginals along the arms. The long-armed morphotype is also observed in specimens from Japan (Kogure & Kaneko 2018).

Occurrence/Distribution
South Japan, Philippines, New Zealand, Norfolk Island and Western Australia, the Indian Ocean. 178–550 m.
New Caledonia, 290–443 m.

Material Examined
MNHN IE-2013-9422, S. Ile des Pins, New Caledonia, 22°52'30.5976"S; 167°36'53.4168"E, 290–345 m. Coll. KANACONO DW 4742 23 Aug 2016. 1 wet spec.
MNHN IE-2013-9431, Ile des Pins, New Caledonia, 22°49'8.4"S; 167°25'0.624"E, 394–443 m. Coll. KANACONO DW4714 18 Aug 2016. 1 wet spec.
MNHN IE-2016-1519, Ile des Pins, New Caledonia, 22°50'4.1964"S; 167°30'3.6252"E, 350 –366 Coll. KANACONO CP 4675 13 Aug 2016 1 wet spec.

Lithosoma Fisher 1911

Lithosoma Fisher 1911: 422; 1919: 298; Macan 1938: 387; McKnight 1973: 189; Clark 1993: 260 (checklist)

Diagnosis
Body stellate to strongly stellate, disk large, rays long, slender, triangular. **Abactinal, actinal and marginal plates smooth, no surficial granules, but with a complete ring of peripheral granules. Abactinal plates with glassy tubercles embedded in plate surface. Arms composed primarily of abutted superomarginal plates.** Subambulacral granulation short, spaced from furrow spines, not crowded. Small spatulate excavate pedicellariae present on abactinal, marginal, actinal surface.

Comments
A genus that includes 6 species present throughout the Indo-Pacific from Japan to New Zealand and to the Indian Ocean. These were last summarized by Macan (1938) but summaries of regional species include those of Fisher (1919) for the Philippines and adjacent areas and New Zealand (H.E.S. Clark & McKnight 2001). Although a complete review is beyond the scope of this account, a review of Macan (1938) suggests that character differences between species show overlap and are likely synonyms. For some species, a greater abundance of specimens has been observed in collections than was available to earlier workers (Mah, pers. obs.) suggesting that further attention for this group is desirable.

Although the glassy nodules in *Lithosoma* are much smaller, they appear similar with those in *Astroceramus* and *Plinthaster*.

Lithosoma actinometra Fisher, 1911
FIGURE 28A–F

Fisher 1911:42; 1919: 298 Döderlein 1924: 58.

Diagnosis
Modified from Fisher (1919). Body strongly stellate, R/r=3.1–3.7, **disk large, accurately pentagonal, arms forming long, slender rays that gradually taper into a pointed extremity, composed abactinally of only the superomarginal plates**. Width of ray at proximal end of first pair of superomarginals meet medially equal to length of first 5 superomarginals. **Abactinal plates smooth, round each with minute glassy nodules, 20–100 embedded in plate surface** (Fig. 28B)**. Actinal plates smooth, devoid of granules or other accessories** (Fig. 28E)**.** Furrow margin along adambulacral plate slightly convex, weakly angular. Furrow spines 5 to 10, mostly 7 to 8 (Fig. 28F). **Pedicellariae small, tong-like, present on abactinal, actinal surfaces.**

Comments
In addition to specimens from New Caledonia, additional material shows this species as present in localities throughout the South and Central Pacific and suggesting further variation than was outlined by Fisher (1919).

This species shows a body form that is especially planar with elongate arms (Fg. 28A) and displays superficial similarities with *Nymphaster*, in showing arms composed entirely from abutted superomarginal plates. The Atlantic *Nymphaster arenatus* has been observed *in situ* using its long arms and broad disk in association with soft-sediment bottoms (Mah 2020) and *Lithosoma* with its similar appearance may demonstrate similar behavior.

Distribution/Occurrence
Philippines, Borneo, Papua New Guinea, Solomon Islands, Fiji, Vanuatu, 208–818 m.
New Caledonia, 338 m.

Material Examined
New Caledonia. MNHN IE-2007-6420, Banc Sud Durand, New Caledonia, 22°19'5.9988"S; 168°40'54.0012"E, 338 m. Coll. N/O *Alis*, EXBoDI CP 3856, 14 Sept. 2011. 1 wet spec.

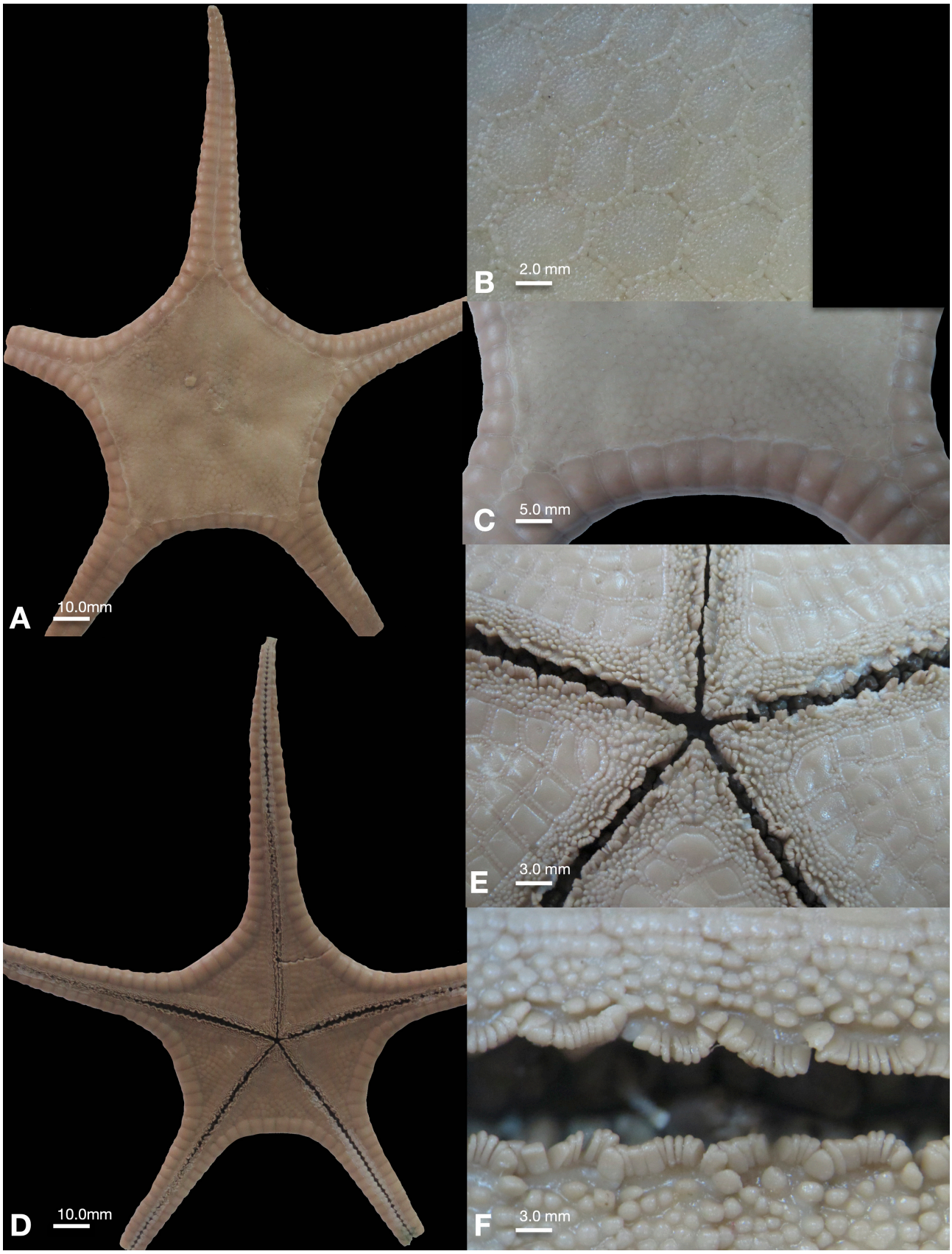

FIGURE 28. ***Lithosoma actinometra*** Fisher, 1911. MNHN IE-2007-6420. A. Abactinal B. Abactinal close. C. Abactinal-superomarginal contact. D. Actinal. E. Actinal-oral. F. Adambulacral furrow.

MNHN IE-2013-7577, S. Grande passe de Touho, New Caledonia, 20°44'49.02"S; 165°20'55.5"E, 541–590 m. coll. SPANBIOS, N/O *Alis*, 15 July 2021. 1 wet spec.

MNHN IE-2013-7585, Houailou region, New Caledonia, 21°4'6.8412"S; 165°41'49.4988"E, 470–543 m. Coll. SPANBIOS, N/O *Alis*, 29 June 2021.1 wet spec.

MNHN IE-2013-7612, Houailou region New Caledonia, 21°8'55.5"S; 165°48'47.2212"E, 523–598 m. Coll. SPANBIOS, N/O *Alis*, 28 June 2021. 1 wet spec.

Solomon Islands. MNHN IE-2013-6936, Solomon Islands, 9°21'S, 160°24'E, 357–359 m. Coll. SALOMON 1, 10 Jan 2001, 1 dry spec. R=10.3 r=2.7.

Fiji. MNHN IE-2022-4227. Ride de Lau, Somo-somo Strait, Fidji Islands. 16°32'35.9988"S; 179°51'54.018"O, 674–688 m. coll. Bouchet, Warén & Richer-IRD, aboard N/A *Alis*, 24 Feb 1999. 1 wet spec.

Vanuatu. MNHN IE-2013-3499, NE Santo, Vanuatu, 14°48'29.9988"S; 167°4'42.0204"E, 700–818 m. Coll. Richer de Forges, IRD, BOA 0, N/O *Alis*. 1 wet spec.

Papua New Guinea. MNHN IE-2007-3173, Golfe de Huon, Tami Island Papua New Guinea, 6°44'0.0024"S; 147°49'59.9808"E, 403–418 m. Coll. S. Samadi & L. Cobari, BIOPAPUA, N/O *Alis*, 1 wet spec.

Mediaster Stimpson, 1857

Mediaster Stimpson 1857: 530; Perrier 1894: 377; Verrill 1899: 178; Fisher 1911: 196; Verrill 1914: 295, 1915: 108; Fisher 1919: 255; Macan 1938: 369; H.L. Clark 1946: 83; Bernasconi 1964: 11; Halpern 1970: 202; Clark and Downey 1992: 251;A.M. Clark 1993: 262 (checklist); Rowe & Gates 1995: 65 (checklist); H.E.S. Clark & McKnight 2001: 69; Mah 2016: 118

Isaster Verrill 1894: 257.

Diagnosis. Goniasterid genus **with tabulate abactinal plates displaying internally radiating ossicles from base at each plate.** Abactinal tabulae plates with granules or spinelets. **Abactinal plates in most, extending to arm tip,** but exceptionally with distalmost superomarginals abutting. Abactinal, marginal, actinal surface covered by granules.

Mediaster trapezium sp. nov.

FIGURE 29A–E

Etymology

The species epithet, trapezium, is Latin alluding to the trapezoidal shaped peripheral granules present on the abactinal plates.

Diagnosis

Body stellate (R/r=1.9 to 2.3), arms triangular, interradial arcs curved. Arm tips pointed but variably tapering. Abactinal plates covered by granules, 19 to 80, mostly 20 to 40, rounded and deciduous, evenly spaced but densely arranged on central surface **with peripheral granules, approximately 20 present around plate periphery, each elongate, trapezoidal, evenly spaced around plate edge.** Marginal plates, 38 to 42 per interradius, wide, surface, plate surfaces covered with granules, approximately 100 to 400, most with 350, evenly spaced. Actinal plates covered by granules, round, 10 to 40, mostly 20 to 30, evenly spaced. Pedicellariae tong-like, 0 to 2 present per interradius, bivalve or trivalve, located at arm base. Furrow spines, 10 to 12, variably straight to strongly curved palmate arrangement, widest centrally, blunt-tipped, quadrate in cross-section. Subambulacrals, six set off from furrow spines by distinct space with blunt tips bearing notched edges. Two further series of subambulacral granules, 4 to 6, each with blunt, but jagged tips, similar to granule tips on adjacent actinal surface. Pedicellariae with two or three-forceps like valves present throughout adambulacral plates but irregularly present amidst granules on plate surface.

Comments

Mediaster trapezium **sp. nov.** is noteworthy for the presence of trapezoid, elongate- shaped peripheral granules present on the abactinal tabulae (Fig. 29B). This species is similar to *Mediaster mollis* and *M. gartrelli* in having a relatively high number of furrow spines, 10–12. Abactinal granulation on each plate in *M. trapezium* is greater than that of *M. mollis* and *M. gartrelli.* The latter is further differentiated in having only round to polygonal granules rather than trapezoid-shaped granules.

Occurrence/Distribution

Fiji, New Caledonia, 756–1450 m.

Description

Body stellate (R/r=1.9 to 2.3), arms triangular, interradial arcs curved. Arm tips pointed but variably tapering (Fig. 29A, D).

Abactinal plates tabulate to ranging in shape from hexagonal to irregularly polygonal to round, polygonal outline especially along radial regions with fasciolar grooves especially well developed along radial plate series, but shallow to absent interradially and distally on arms. On MNHN IE-2007-6355, abactinal plate series tapers to single series distally along arm, with near abutted superomarginal plate series. Abactinal plates largest and most distinctly hexagonal, proximally on disk, becoming smallest and more irregular in shape and size distally, adjacent to superomarginal plate contact. Abactinal plates covered by granules, 19 to 80, mostly 20 to 40, rounded and deciduous, evenly spaced but densely arranged on central surface with peripheral granules, approximately 20 present around plate periphery, each elongate, trapezoidal, evenly spaced around plate edge (Fig. 29B). Fiji specimens with much more elongate peripheral plates. Granules widely spaced radially becoming more densely packed interradially. Where denuded, plates with weakly convex pitting on plate surface. Pedicellariae, small, variably present up to approximately 0 to 20 present interradially, but small, approximately 1.0 mm in length, similar to granules in size with tong-like like valves (fig. 29B). Madreporite quadrate triangular in shape with

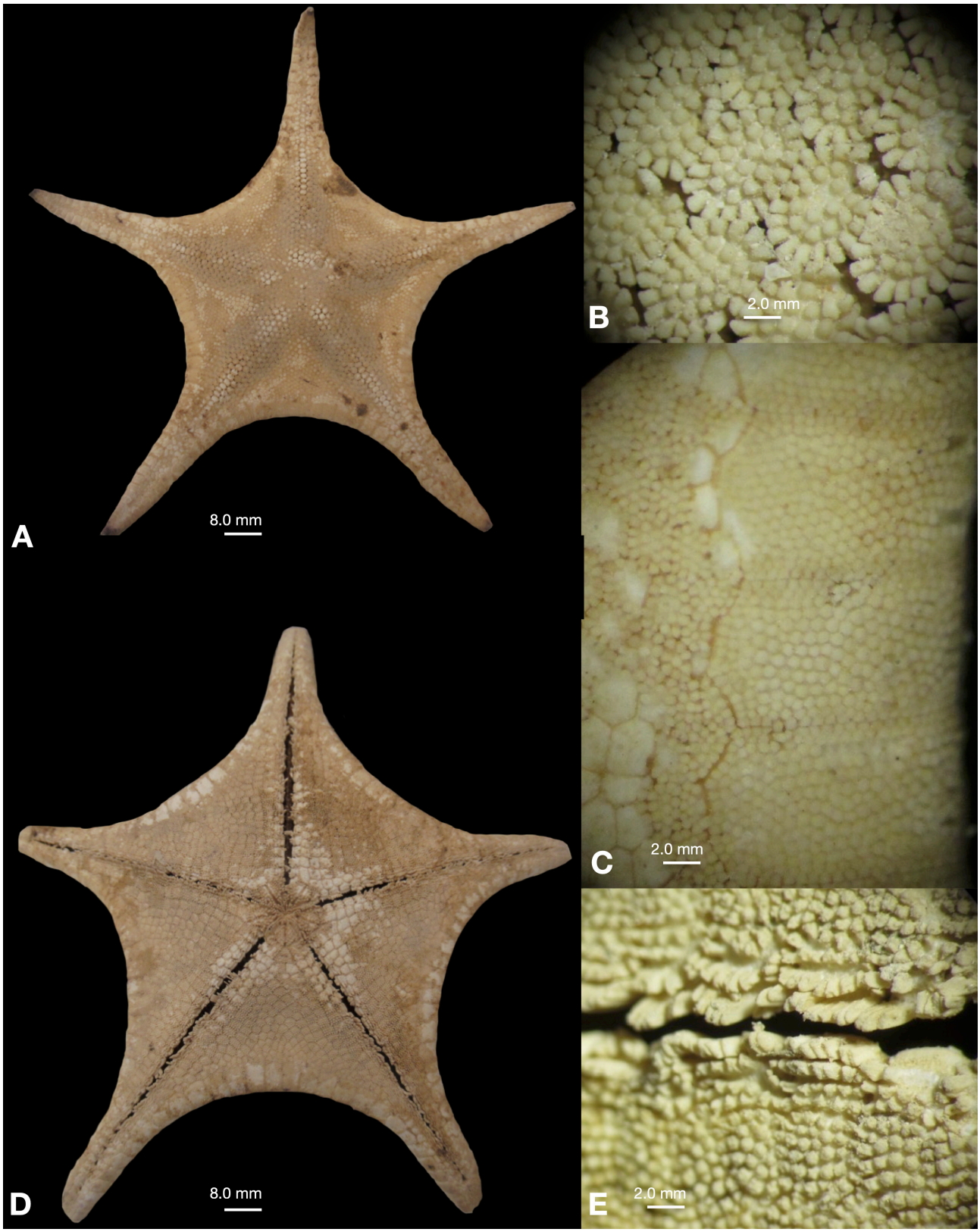

FIGURE 29. ***Mediaster trapezium*** **sp. nov.** Holotype. MNHN IE-2023-172. A. Abactinal. B. Abactinal close. C. Superomarginal surface. D. Actinal. E. Adambulacral furrow.

rounded edges, flanked by three plates. Stellate radiating plates at base of abactinal tabulae present.

Marginal plates, 38 to 42 per interradius, wide superomarginals inferomarginals, slightly offset forming zigzag contact between them. Individual plates wide, abactinal and actinal-lateral edges rounded. Edges of superomarginal and inferomarginal plates rounded. Marginal plate surfaces covered with granules, approximately 100 to 400, most with 350, evenly spaced (Fig. 27C). Peripheral granules identical with those on central plate surface, but forming distinct edge between plates. Shallow fasciolar grooves present between marginal plates. Pedicellariae tong-like, 0 to 3, mostly with 1 on superomarginals. Terminal plates round and triangular to quadrate in shape, with bare surface.

Actinal intermediate region in approximately 6 to 9 well developed series in chevron formation, Individual plates quadrate to polygonal in shape, abutted, extending only to arm base. Plate surface covered by granules, round, 10 to 40, mostly 20 to 30, evenly spaced each with denticulate tips. Shallow fasciolar groove present among actinal plates. Pedicellariae tong-like, 0 to 2 present per interradius, bivalve or trivalve, located at arm base.

Furrow spines, 10 to 12, variably straight to strongly curved palmate arrangement, widest centrally, blunt-tipped, quadrate in cross-section. Subambulacrals, six set off from furrow spines by distinct space with blunt tips bearing notched edges (Fig. 29E). Two further series of subambulacral granules, 4 to 6, each with blunt, but jagged tips, similar to granule tips on adjacent actinal surface. Pedicellariae with two or three-forceps like valves present throughout adambulacral plates but irregularly present amidst granules on plate surface. Oral plate with furrow spines, 20, with two enlarged, blunt spines projecting into mouth. Oral plate diastema, contiguous with actinal fasciolar grooves, with 15–17 spiny granules with jagged tips on either half of oral plate, similar to granules on adjacent actinal plates. Remainder of oral plate with widely spaced jagged spines, triangular to quadrate in cross-section with pointed or jagged tips.

Material Examined

New Caledonia. **Holotype.** MNHN IE-2023-172, Southern New Caledonia, 22º10.5'S 165º59'E, 1060–1450 m. Coll. Bouchet & Richer ORSTOM, N/O Alis, BATHUS 2 CP 767, 17 May 1993. 1 dry spec. R=6.8 r=2.8.

Paratypes. MNHN IE-2023-173, Southern New Caledonia, 22º10.5'S 165º59'E, 1060–1450 m. Coll. Bouchet & Richer ORSTOM, N/O *Alis,* BATHUS 2 CP 767, 17 may 1993. 2 dry spec. R=6.3 r=2.8, R=6.4 r=2.8.

MNHN IE-2007-6393 New Caledonia, 22º23'S 167º22'E, 756–769 m Coll. EXBODI, CP 3842, 10.9.11 1 wet spec. R=6.0 r=2.6.

MNHN IE-2007-6355 New Caledonia, 22º22'S 167º21'E, 776–800 m Coll. EXBODI, CP 3843 9.10.11. 1 wet spec. R=4.7 r=2.3.

MNHN IE-2013-9404 New Caledonia, 23°8'S, 168°5'E to 23°8'S, 168°7'E, 850 m. Coll. KANACONO DW 4757 26.8.16 1 wet spec, R=3.5 r=1.4.

MNHN IE-2013-3964 New Caledonia, 1060–1450 m, Coll. BATHUS 2, CP 7676,17 May 1993. 2 dry specs. R=5.0 r=2.4; R=4.3 r=2.2.

Fiji. MNHN IE-2019-2841. Fidji. 17º19'S 179º34'W, 942–976 m. coll. Bouchet, Waren, & Richer, N/O *Alis*, BORDAU 1, 5 March 1999. 2 dry specs. R=5.6 r=2.8.

Nymphaster Sladen, 1889

Nymphaster Sladen 1885: 612 (*nomen nudum*; diagnosed but no species named); 1889: 294; Fisher 1917: 167; 1919: 261; Spencer & Wright 1966: U62; Halpern 1970: 222; 1970: 88; Downey in Clark & Downey 1992: 253; Mah 2018: 68.

Non-*Dorgiona* Gray 1866 Perrier 1885: 39; 1894: 365; Koehler 1909: 54 (Non *Dorigona* Gray 1866)

Diagnosis

Strongly stellate body form, elongate triangular arms with rapidly tapering, pointed tips. Abactinal surface showing weakly tabulate plates with granules covering surface. **Superomarginals abutted over mid-radius along entire arm length, forming prominent frame around disk.** Adambulacral furrow margin strongly angular, Furrow spines numerous, 7 to 20 spines.

Comments

A genus including 16 living and approximately 12 fossil species (Mah 2024b). Living *Nymphaster* spp. are present in relatively deep-sea settings, for example, the Atlantic *N. arenatus* present at 225–3000 m and have been observed lying flush on deep-sea bottoms (Mah 2020) presumably feeding on food from the soft-sediment.

Fisher (1913, 1919) recorded 9 species from the central Pacific region, 2 species from the tropical Pacific, 4 species from the Indian Ocean, and 1 from the Atlantic. *Nymphaster* spp. are morphologically varied and historical accounts suggest taxonomic difficulties. The synonymy of the Atlantic *Nymphaster arenatus* shows multiple subjective synonyms (Clark & Downey 1992), discussed by Halpern (1970) and described as "difficult." Macan (1938) argued that the Indian Ocean *Nymphaster moebii* was a wide-ranging species similar to *N. arenatus* and suggested that species such as *N. pentagonus* H.L. Clark 1916 should be synonymized with *N. moebii*. Macan (1938) also suggested that *N. moebii* and *N. arenatus* displayed morphological overlap. An unconfirmed account by Samuel *et al.* (2017) reported *N. arenatus* in the Indian Ocean, hinting at the difficulty of this issue.

Description of previously undescribed *Nymphaster* morphospecies herein is argued as a necessary part of further testing taxonomic hypothesis as additional data from additional specimens and species are collected.

Nymphaster brioche sp. nov.

FIGURE 30A–G

Etymology

The species epithet *brioche* is named for the French pastry, alluding to the curving slope shared between the marginal

plates and the pastry's distinctive curved appearance. Noun held in apposition.

Diagnosis
Abactinal plates mostly round, 8 to 30, central regions with 4 to 20, mostly 12 to 15 centrally and 10–20 peripheral granules, which are slightly smaller and set off from those present centrally. First pair of proximal plates abutted on arm widest, approximately 3X the width of superomarginal plates distally, **Both superomarginal and inferomarginal plates with beveled to weakly rounded edge along the abactinal and actinal-lateral contacts with strongly tumid surfaces.** Furrow spines 7 to 11, fewer proximally becoming higher distally. Individual spines slender, straight to concave arrangement. One prominent pedicellariae with elongate, triangular valves present behind/adjacent to furrow spines, remainder of adambulacral plate with 8 to 10 short spines similar in stature to actinal plate granules. **Oral plates with furrow spines, 7–10,**

Comments
This species shares the relatively few oral furrow spine number observed by *N. mucronatus*, *N. euryaplax*, ad *N. dyscritus* as outlined in Fisher (1919), but differs starkly in that it displays distinct subambulacral spines (Fig. 30F, G) and lacks mucronate granules. This species shows some similarity with *Nymphaster meseres* Fisher 1913 as summarized here, and displays similarities with *N. habrotatus*, but differs in displaying tumid superomarginal plates (Fig. 30D), flat in *N. habrotatus*, and fewer oral plate furrow spines, 12 to 14 in *N. habrotatus*. *Nymphaster brioche* **sp. nov.** variably possesses pedicellariae on the adambulacral plate, which is shared with *N. habrotatus* and *N. meseres*.

Occurrence/Distribution
New Caledonia, 758–1450 m.

Description
Body shape stellate (R/r=3.0–4.1), arms triangular, elongate, sharply tapering, pointed tips. Interradial arcs rounded (Fig. 30A, E).

Abactinal plates, limited to disk, absent from arms, primarily round, but polygonal to quadrate plates present interradially. Round plates variably circular to oval-like, especially distally adjacent to contact with the superomarginal plates. Abactinal surface with granules, 8 to 30, central regions with 4 to 20, mostly 12 to 15 centrally and 10–20 peripheral granules, which are slightly smaller and set off from those present centrally (Fig. 30B). All granules widely spaced from one another, save for those on plates interradially adjacent to the contact with the superomarginal plates. Fasciolar grooves shallow, present along radial regions, largely absent interradially. Alveoli of pedicellariae observed, approximately 4 to 6 present but located around radial regions, widely spaced. Pedicellariae had been lost, valves absent. Madreporite below body surface, weakly concave, sulci well-developed, flanked by 4 adjacent plates.

Arms abutted over midline, approximately 18 to 20 pairs. First pair of proximal plates abutted on arm widest (Fig. 30A, D), approximately 3X the width of superomarginal plates distally, but all disk plates very wide becoming more similar in LxW from midpoint to distalmost arm point. Approximately 6 superomarginals on disk free, 4 at R=5.2. Individual superomarginal plates tumid, forming a crenulate outline (Fig. 30D) of the superomarginal series in profile. Dorsal surface of superomarginal plates tumid, with rounded dorsal surface, covered by granules, 150–200, round topped, cylindrical in shape, widely spaced both centrally and peripherally. Overall homogeneous, showing only slight differences from those forming periphery around each plate. Inferomarginal plates with similar granular cover. Inferomarginals and superomarginals wide proximally, becoming more equal in LxW then elongate distally. No pedicellariae. Contacts between abutted superomarginals and between superomarginal and inferomarginal plates offset, forming a zigzag line between them.

Actinal plates quadrate in shape, in 2 to 3 full series, limited to the disk, with irregular plates present distally adjacent to inferomarginal plates. Granules, 5 to 20, mostly 10 to 15, widely spaced, blunt-tipped, homogeneous with little differentiation between central and peripheral series.

Furrow spines 7 to 11, fewer proximally becoming higher distally. Individual spines slender, straight to concave arrangement (Fig. 30F, G). One prominent pedicellariae with elongate, triangular valves present behind/adjacent to furrow spines, remainder of adambulacral plate with 8 to 10 short spines similar in stature to actinal plate granules. Oral plates with furrow spines, 7–10, pointed, quadrate in cross-section. Oral plate surface with pointed triangular spines, to 10 on either side of the central diastema.

Material Examined
Holotype. MNHN IE-2013-6989, Southern New Caledonia, 22°10.5'S, 165°59.1'E, 1060–1450 m. Coll. Bouchet & Richer de Forges, ORSTOM, N/O *Alis,* BATHUS 2 CP 767, 17 May 1993. 1 dry specs. R=7.4 r=2.3.

Paratype. MNHN IE-2013-6987, Fairway Ridge, New Caledonia, 21°4.3'S, 161°31'E, 758 m. coll. IRD, N/O *Alis,* ZONECO 6, 10 Dec 1998. 1 dry specs. R=5.2 r=1.7.

MNHN IE-2023-174. Southern New Caledonia, 22°10.5'S, 165°59.1'E, 1060–1450 m. Coll. Bouchet & Richer de Forges, ORSTOM, N/O *Alis,* BATHUS 2 CP 767, 17 May 1993.

R=7.1 r=1.7.

***Nymphaster defensor* sp. nov.**
FIGURE 31A–F

Etymology
The species epithet is derived from the Latin *defendo,* for guard or protect alluding to the marginal spines and the well-developed size and skeleton of this species.

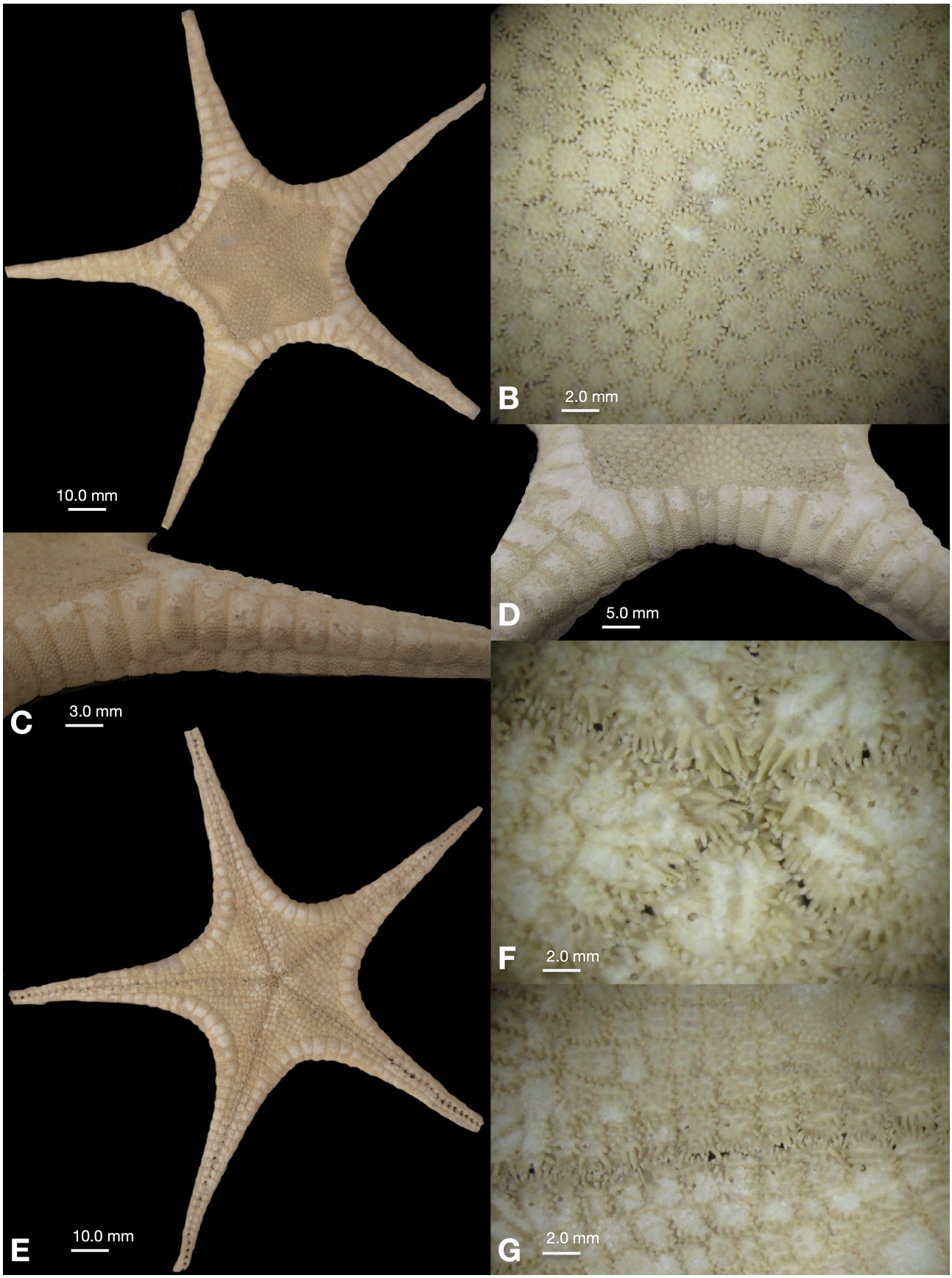

FIGURE 30. ***Nymphaster brioche*** **sp. nov.** MNHN IE-2013-6989. A. Abactinal. B. Abactinal tabulae. C. Lateral D. Superomarginal plates close E. Actinal F. Oral region G. Adambulacral furrow.

Diagnosis

Abactinal plates with smooth, round to polygonal granules, 1 to 40, mostly 7 to 30, on central surface of most plates with approximately 9 to 25 forming evenly spaced periphery around plate edge. **Marginal plates with sharply angular edges. Spines on abactinal-lateral, actino-lateral edges of supero- and inferomarginal plates.** Furrow spines 8 to 10, mostly 9 or 10 at R=13.0. Subambulacral spines in three well-spaced series, the first sits adjacent the furrow spines, and are twice in thickness but similar in height to the furrow spines, with two to four spine-tipped granules or spines in each series set off by distinct space from the furrow space. Oral plates with 10 furrow spines.

Comments

This species shares several characters with *Nymphaster moluccanus* Fisher 1913 as described from the Molucca Islands (Fisher 1913, 1919). Furrow spines on the adambulacral and mouth plates are nearly identical, as well as the number of free superomarginals in contact with the disk and overall appearance of the superomarginal plates along the arms. Significant differences in *Nymphaster* **sp. nov.** include the presence of 1 to 4 spines on the abactinal/actinal-lateral edges along the superomarginal and inferomarginal plates on the disk and arms (Fig. 31C). Abactinal radial plates are distinctly hexagonal (Fig. 31B) versus those in the type, which are rounder and more polygonal. Subambulacral spines in the smaller specimen (MNHN IE-2013-6981), R=8.7 similar in height to original description, but only 2 rows of granules were present, versus 3 in the type. The larger, MNHN IE-2013-6980, R=12.0 had 4 subambulacral spines which larger and thicker, with spines up to 2 to 3x the thickness of the furrow spines, one or two prominent pedicellariae per plate and only a single row of granules, which differs significantly from Fisher's description.

While there are very distinct and apparent differences in these specimens, it should be noted that a wide range of variation has been argued for the Atlantic *Nymphaster arenatus.* One of *N. arenatus*' synonyms, *N. subspinosus* (Perrier, 1881) was distinguished based on the presence of spines on its marginal plates but was subsequently synonymized (Halpern, 1970; Clark & Downey 1992). However, as phylogenetic methods have been applied towards understanding of wide-ranging asteroid species, it has become clear that widely occurring species, such as *Hippasteria phrygiana* and other *Hippasteria* species can display highly variable morphologies but are not always associated with distinct species and conversely, distinct species can be differentiated by relatively few characters (e.g. *H. muscipula*, Foltz *et al.* 2013; Mah *et al.* 2014).

Thus, the characters observed here could distinguish a separate species or could simply indicate variation in a wide-ranging *N. moluccana,* in a similar fashion to *N. arenatus*. Further testing of the population, further specimens, and character variation in these wide-ranging species is desirable.

Distribution/Occurrence

New Caledonia, 420–863 m

Fiji and Vanuatu, 420–1050 m.

Description

Body thick, strongly stellate (R/r=3.1–3.9), arms sharply tapering, triangular in shape with pointed arm tips, trapezoid in cross-section. Interradial arcs weakly curved (Fig. 31A, E).

Abactinal region forming distinct star-shaped region on disk, with distinct superomarginal frame, abactinal plates absent from all but basal regions along arm. Abactinal plates in approximately six rows, distinctly polygonal to hexagonal in outline along radial regions with interradial regions displaying plates in quadrate outline. Abactinal plates with smooth, round granules, 1 to 40, mostly 7 to 30, on central surface of most plates with approximately 9 to 25 forming evenly spaced periphery around plate edge. Granules approximately 3 along a 1.0 mm line, widely spaced (Fig. 31B). Granules on abactinal plates variably wide to closely arranged in curved or linear series. Papulae present along with shallow fasciolar grooves on radial disk regions. Central radial regions wide and hexagonal with adradials becoming more polygonal and quadrate in shape adjacent to interradial plates. Papulae and fascicles absent interradially with quadrate interradial plates in close-set formation. Pedicellariae elongate with rounded forceps-like tips, occurring widely across abactinal surface on both radial and interradial plates. Madreporite polygonal with well-developed sulci, flanked by five or more plates.

Marginal plates, strongly block-like, approximately 36 (at R= 4.1) to 70 per interradius (arm tip to arm tip at R=13.1) for each series (superomarginal & inferomarginals). Approximately 30 of these superomarginals abutted along mid radius along arm. Abutted superomarginals offset from one another forming zig-zag contact along the abactinal surface on the arm. Superomarginals wide interradially becoming elongate distally along arms. On disk, free superomarginals (non-abutted) number 9 to 10 at R=13.1 cm. Abactinal-lateral edge along superomarginal plates rounded but very distinct. Inferomarginal series broadly jutting out from under the superomarginal series forming extended periphery (Fig. 31C). Lateral surface well developed forming sloped edge from abactinal to actinolateral surface. Marginal plate surface covered round, coarse deciduous granules, 200–800, widely spaced, approximately 3 granules counted along a 1.0 mm line. Peripheral granules, approximately 20 on shorter edge in contact with abactinal/actinal surface, 30–40 on elongate edge, forming distinct series from those on central plate surface. Spines, 1 to 3, mostly 2, present along abactinal-lateral edge along superomarginal plates. In larger individuals (R>13.0) one or two sharp, conical spines variably present on inferomarginals especially along actinolateral edge with the higher number present centrally per interradius (Fig. 31C). Spines appear variable, as one of the specimens, MNHN IE-2013-1905

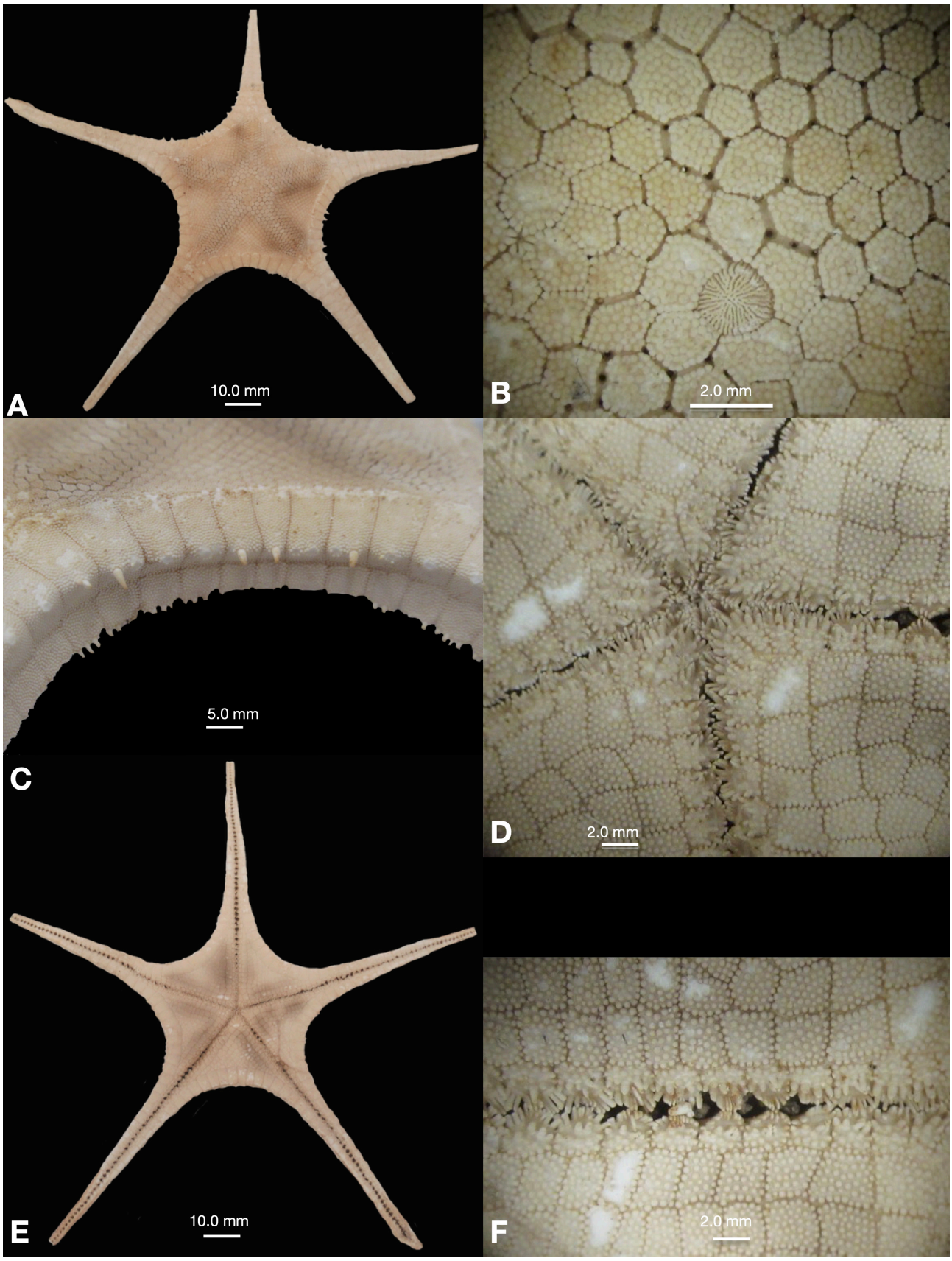

FIGURE 31. ***Nymphaster defensor*** **sp. nov.** MNHN IE-2013-6980. A. Abactinal. B. Abactinal tabulae. C. Lateral D. Actinal close E. Actinal F. Adambulacral furrow.

lacks inferomarginal spines Smaller individuals, R=4.1, lack spines on inferomarginals. Pedicellariae, one or two similar to those observed on abactinal surface, sitting in shallow alveolar pits, present on actinal-facing surface of distal inferomarginal plates. Terminal plate triangular, smooth with no accessories.

Actinal plates in three complete chevron-like series, with each plate in quadrate to polygonal outline (Fig. 31D, E, F). One or two irregular series present in contact distal with inferomarginal contact. Each plate covered by round, evenly distribute4d granules, 10–40, mostly 15 to 30 per surface. Pedicellariae variably present, one individual lacks them versus the holotype with ten pedicellariae present per interradius occurring primarily on the actinal plate series adjacent to the adambulacrals.

Furrow spines nine or ten (at R=13.1), numbering eight at R=4.1, blunt tipped, rounded edges, quadrate in cross-section, arranged in concave, variable from nearly straight to strongly angular series. Subambulacral spines in three well-spaced series, the first sits adjacent the furrow spines, and are twice in thickness but similar in height to the furrow spines, with two to four spine-tipped granules or spines in each series set off by distinct space from the furrow space (fig. 31D, F). Adambulacral plates surfaces with two additional series of short spiny granules, shorter than the subambulacral spines.

Oral plates with ten blunt furrow spines, round to triangular in cross-section (Fig. 31D). One enlarged spine rom each plate projects into mouth. Oral plate surface with four, blunt subambulacral spines, triangular in cross-section, decreasing in size distally along plate. Oral plate with discrete smooth bald area behind proximalmost oral spines, each followed by four spines, triangular to round in cross section, present along distance of oral plate.

Color in life is deep-rich orange.

Material Examined

Holotype. MNHN IE-2013-6980, East coast, New Caledonia, 21º 13'45"S 165º55'1"E, 515–580 m, Coll. BATHUS 1, Bouchet & Richer aboard N/O *Alis,* CP 658, 12 March 1993. 1 dry spec. R=12.0 r=3.3.

Paratypes. New Caledonia. MNHN IE-2013-6981. East coast, New Caledonia, 20°34'S, 165°34.7'E, 591–660 m. Coll. Bouchet & Richer de Forges, ORSTOM, 18 March 1993, 1 dry specs. R=8.7 r=2.5.

MNHN IE-2013-9305 New Caledonia, 22°50'S, 167°18'E to 22°53'S, 167°17'E, 530–545 m. Coll. KANACONO DW 4666, 12.8.16. 1 wet spec. R=12.1 r=3.3.

MNHN IE-2013-9746 New Caledonia, 21°16'S, 159°18'E to 21°16'S, 159°16'E, 490–830 m. Coll. KANADEEP, CP 5013, 20.09.17. 2 wet specs. R=12.1, r=3.1(3 arms broken); R=4.1 r=1.3.

MNHN IE-2013-9763, New Caledonia, 23°54'S, 161°46'E to 23°57'S, 161°47'E, 980–1050 m. Coll. KANADEEP 5000, 179.17. 1 wet spec. R=9.7 r=2.3.

MNHN IE-2013-9756 New Caledonia 21°3'S, 161°8'E to 21°2'S, 161°11'E, 810–840 m. Coll. KANADEEP 5054, 24.09.17. 4 wet specs. R=6.6 r=1.9 R=5.6 r=2.9, R=5.7 r=1.7; R=7.9 r=2.1.

MNHN IE-2007-6417. New Caledonia, 21°46'S, 166°44'E, 574–585 m. Coll. EXBODI CP 3817, 6.9.11. 4 wet specs. R=5.3 r=1,7, R=5.2 r=1.6 R=1.9 r=0.7 R=1.8 r=0.5.

MNHN IE-2007-6364, New Caledonia, 22°15'S, 167°19'E, 750–863 m. Coll., EXBODI, CP 3791, 3.09.11. 15 wet specs (3 examined). R=6.0 r=1.9 R=4.8 r=1.7 R=3.7 r=1.2.

Vanuatu. MNHN-IE-2013-6985. Vanuatu, 16º39'S 168º03'E, 469–525 m. Coll. Bouchet & Richer de Forges, N/O *Alis*, MUSORSTOM 8, CP 1049, 1 Oct 1994. 1 dry spec, R=11.7 r=3.0.

Fiji. MNHN IE-2013-6982. Fiji, 16º45'S 179º59'E, 420–513 m. Coll. Bouchet, Waren & Richer de Forges, N//O *Alis*, BORDAU 1, 4 March 199. 2 dry specs. R=8.5 r=2.6; R=11.5 r=3.4. (specimens broken)

Nymphaster meseres Fisher, 1913

FIGURE 32A–E

Nymphaster meseres Fisher 1913: 639; Fisher 1919: 264, 280
Nymphaster habrotatus Fisher 1913: 639; Fisher 1919: 264, 282.

Diagnosis

Superomarginal plates, especially on disk and proximally on arms, with dorsally flattened surface, and sharply quadrate angles of arm in cross-section and in dorsal outline, especially along abutted superomarginal plates, forming nearly flat profile. Furrow spines, 7 to 8 in concave arrangement, subambulacrals variably with 1 pedicellariae and a single pedicellariae, paddle-like with narrow valves. Oral plates with furrow spines, 10–15.

Synonymy of *Nymphaster habrotatus* Fisher 1913

Based on characters observed on specimens herein, *Nymphaster habrotatus* is argued as a synonym of *Nymphaster meseres* as dictated by page priority. Fisher (1913, 1919) distinguished the two species based on an angular dorsolateral angle which was approximately 90º, versus *N. habrotatus* having a more rounded edge as well as overlapping numbers of furrow spines and spacing of marginal granulation. These characters, especially the dorsolateral angle and the furrow spines show overlap suggesting that the distinction between these two species is inconsistent and suggests one variable species. It is possible that a complex of morphological variation exists among Pacific *Nymphaster* as has been argued in the Atlantic *N. arenatus* but further studies of variation across a larger sample of specimens is desirable.

Occurrence/Distribution

Philippines, Sulu Sea to the Surigao Sea, north of Mindanao, 622–1346 m

New Caledonia, 490–1450 m

Description

Body strongly stellate (R/r=3.0–4.0, disk flat, planar, arms elongate with broad base, quadrate with angular

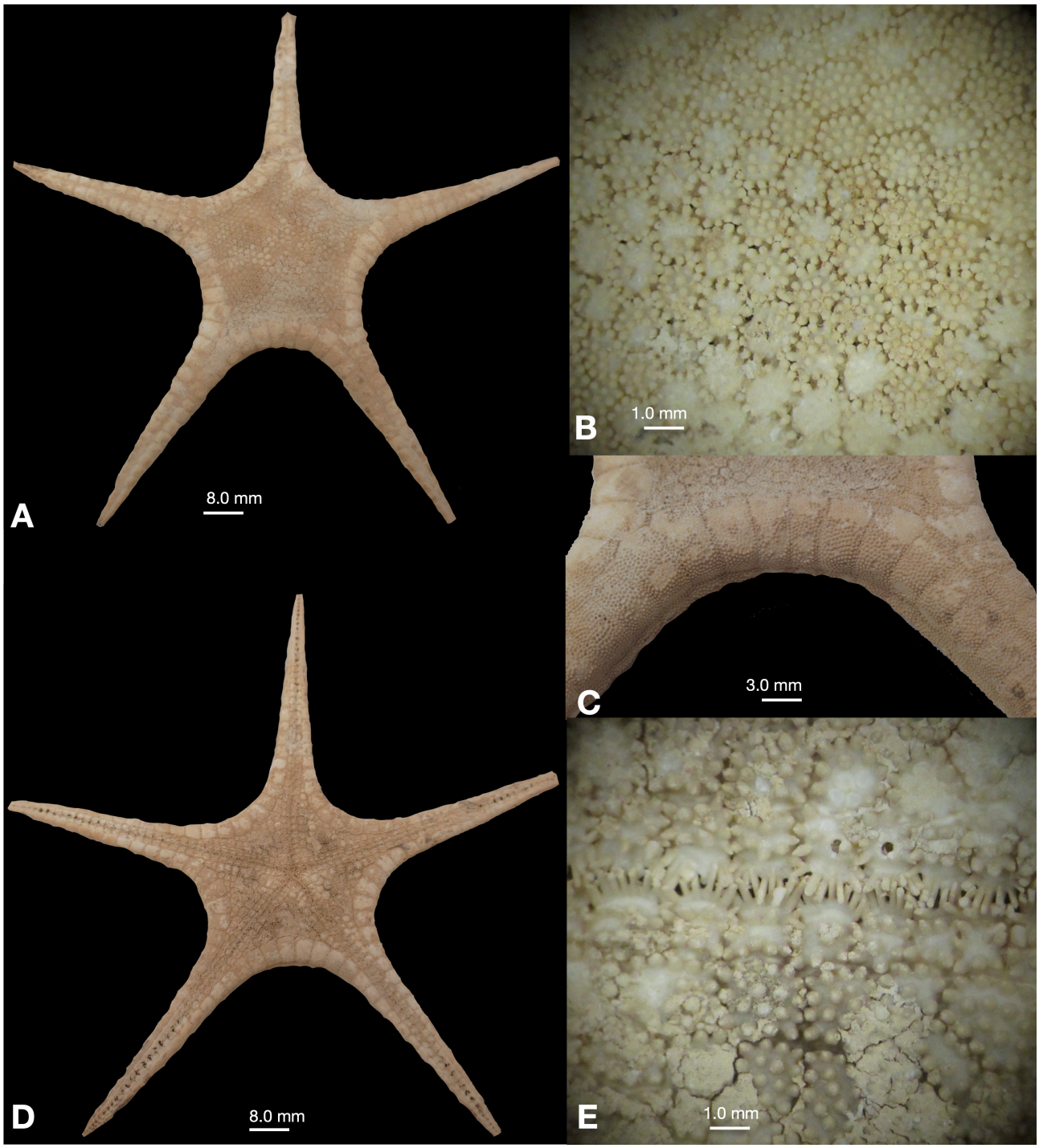

FIGURE 32. ***Nymphaster meseres*** Fisher, 1913 MNHN IE-2013-6992. A. Abactinal. B. Abactinal tabulae. C. Lateral D. Actinal E. Adambulacral furrow.

corners in cross-section. Interradial arcs weakly convex to straight (Fig. 32A, D).

Abactinal plates polygonal to round in shape, with the former present mostly interradially and the latter present along radial regions. Plates along carinal series becoming more oval to oblong along carinal series adjacent to contact with superomarginal plates. Superomarginal plates abutted at arm base (Fig. 32C), abactinal plates limited to disk only. Abactinal plates with granules, rounded tips, cylindrical in shape, approximately 20 to 60, 10 to 20 present centrally, 10 to 50 present around plate periphery (Fig. 32B). Granules, widely spaced, not in direct contact, all homogeneous in size, shape, with no distinct difference between central and peripheral granules. Approximately 4 granule count along a 1.0 mm line. Plate surface without granules are weakly convex with pitting where granules have been removed. Pedicellariae not observed. Madreporite pentagonal to polygonal, sunken below surface, flanked by approximately 5 adjacent abactinal plates.

Superomarginal plates abutted along midline, individual plates wide proximally, especially elongate proximally on disk becoming more equidistant along arm distally (Fig. 32A, C). Both superomarginal and inferomarginal plates with beveled to weakly rounded edge along the abactinal and actinal-lateral contacts (Fig. 32C). Approximately 10–20 superomarginal plates abutted, entirely along arm radius. Edges along each marginal plate series, distinctly angular forming quadrate outlines. Approximately 30 to 36? (arm tips broken), or 15 to 18 per arm supero- and inferomarginal plates in each interradius, arm tip to arm tip. Superomarginals form wide periphery around disk. forming approximately 20% of total disk radius (marginal plate width/"r"= 5.0/25.0 mm) and forming broad proximal region on arm where superomarginals abut proximally along arm. Superomarginals proximally very wide, relative to those along arm, where width and length are more identical. Superomarginal dorsal surface flat, forming level plane on dorsal surface. Superomarginal plates covered by granules, rounded but cylindrical in shape, approximately 80 to 300 total on dorsal and lateral surfaces, each granule corresponding to weak pitting on plate surface. Dorsal surface along superomarginal plates is relatively flat, forming a level surface along the arm. Inferomarginal plates with similar numbers of identical granules to those on superomarginals. Both marginal series becoming smaller, more elongate distally. Granules covering marginal plate surfaces homogeneous, with no distinction between those on central and peripheral plates. No pedicellariae observed.

Actinal plates approximately in 4 to 5 full series, chevron-like arrangement, quadrate proximally becoming more irregular in shape distally adjacent to contact with inferomarginal plates (Fig. 32D). Plate surfaces covered by homogeneous granules, 5 to 25, similar to those on other surfaces, widely spaced. Shallow fasciolar grooves present between actinal plates. No pedicellariae observed.

Furrow spines, 7 to 10, mostly 8 or 9, slender, quadrate in cross-section, weakly concave to straight in arrangement. A single subambulacral alveolar pedicellariae, 2 to 3 elongate, straight valves located adjacent behind furrow spines, variably present, from 20 to 80% of adambulacral plates (Fig. 32E). Remaining adambulacral plates covered by 10 to 15 short, conical spines, widely spaced. Oral plates with slender furrow spines, 10–15, triangular in cross-section, compressed, blunt-tipped. Remainder of oral plate surface with 10–15 spines identical to subambulacral spines, widely spaced on either side of central diastema between oral plates.

Material Examined

MNHN IE-2013-6992, Southern New Caledonia, 24°44'S, 168°07'E, 490–510 m. Coll.

Richer de Forges, ORSTOM, N/O *Alis*, BERYX 11, 17 Oct 1992. 1 dry spec. R=7.2 r=1.8.

MNHN IE-2013-6983. East coast, New Caledonia, 21°41.8'S 166°37.9'E, 650–800 m. Coll. Bouchet & Richer, ORSTOM, N/O *Alis*, BATHUS 1, CP 709, 19 March 1993. 2 dry specs. R=5.8 r=1.5 R=5.3 r=1.5.

MNHN IE-2013-6986, Loyalty Ridge, Loyalty Islands, South Pacific, 20°23'S, 166°20'E to 20°24'S, 166°20'E, 800 m. Coll. N/O *Alis*, MUSORSTOM 6, CP 427, 17 Feb 1989. 1 dry spec. R=7.5 r=2.5 (arms broken).

MNHN IE-2013-6991, Southern New Caledonia, 23°05'S, 166°48'E, 708–830 m. Coll.

Richer de Forges, ORSTOM, N/O *Alis*, 30 March 1994. 1 dry spec. R=7.3 r=1.8.

MNHN-IE-2023-176, Southern New Caledonia, 22°10.5'S, 165°59.1'E, 1060–1450 m. Coll. Bouchet & Richer de Forges, ORSTOM, N/O *Alis,* BATHUS 2 CP 767, 17 May 1993.

1 dry spec. R=6.4 r=2.0.

MNHN-IE-2023-177, Fairway Ridge, New Caledonia, 21°4.3'S, 161°31'E, 758 m. coll. IRD, N/O *Alis,* ZONECO 6, 10 Dec 1998. 2 dry specs R=4.4 r=1.3 R=3.5 r=1.2.

Peltaster Verrill, 1899

Verrill 1899: 168; Tortonese & A.M. Clark 1956: 348; Halpern 1970: 234; Downey 1973: 50; Clark & Downey 1992: 257.

Diagnosis

Body pentagonal to weakly stellate (R/r= 1.1–2.1). Abactinal plates variably weakly tabulate to abutted, irregularly arranged. **Secondary plates present or absent.** Marginal plates 7 to 30, mostly 15 to 20 per interradius. **Abactinal, marginal, actinal plate surfaces covered by abundant to dense cover of granules, in some species, obscuring observable plate boundaries.** Adambulacral spination variable, but generally blunt, and thick with subambulacral spines in 2 or more series.

Comments

The type genus for *Peltaster, P. placenta* occurs throughout the East and West Atlantic and has been argued as a continuous, wide-ranging species (Halpern, 1970; Clark & Downey, 1992) which shows poorly defined boundaries with *Sphaeriodiscus*. Different populations of the Atlantic *P. placenta* show inconsistent characters, which have been argued as variation, but are, in some cases, diagnostic characters for separate genera, such as *Sphaeriodiscus*. Population-level molecular studies are likely required to resolve these issues.

Among the other known *Peltaster* species, *P. micropeltus* (Fisher, 1906) has been re-assigned to *Pillsburiaster*, (Mah, 2024), leaving only one accepted Pacific species, *Peltaster cycloplax* Fisher, 1913.

Peltaster cycloplax Fisher, 1913

FIGURE 33A–F

Fisher 1913: 641; 1919: 290; Fassbender *et al.* 2021: 11, 128, Fig. 125A–C.

Diagnosis

Modified from Fisher (1913, 1919). Body form stellate

(R/r=1.7–2.1). Abactinal plates polygonal to round, secondary plates present primarily on proximal disk. Granules round to polygonal, cover dense, but associated with underlying plates, discontinuous. **Central superomarginal plates strongly tumid, approximately 6, approaching an almost egg-like shape in some individuals** (Fig. 33A, D)**.** Marginal plates 15 to 25 to each interradius. Irregularly shaped bare spot on dorsal surface with sparingly few granules present irregularly. Actinal surface with abundant granular cover, granules each with quadrate to polygonal shape. Most actinal plates with 2-jawed, alveolar pedicellariae (Fig. 33F). Furrow spines 5 to 7 blunt tipped, and compressed, subambulacral spines in two series, 4 to 5 in each, followed by 12 to 15 granules in 2 crowded, irregular series. **Pedicellariae abundant, paddle-like, present on nearly all abactinal, marginal, actinal plates** (Fig. 33B)**.**

Comments

This species was described by Fisher (1913) from the Philippines region with subsequent observations from collections throughout the Indo-Pacific (e.g. Fassbender *et al.* 2021). It is diagnosed by the strongly tumid proximal superomarginal plates as well as the numerous paddle-like pedicellariae present on the abactinal, marginal, and actinal surfaces. Further specimens show the former character, the tumid superomarginals, displaying a much more strongly convex shape in smaller individuals, e.g

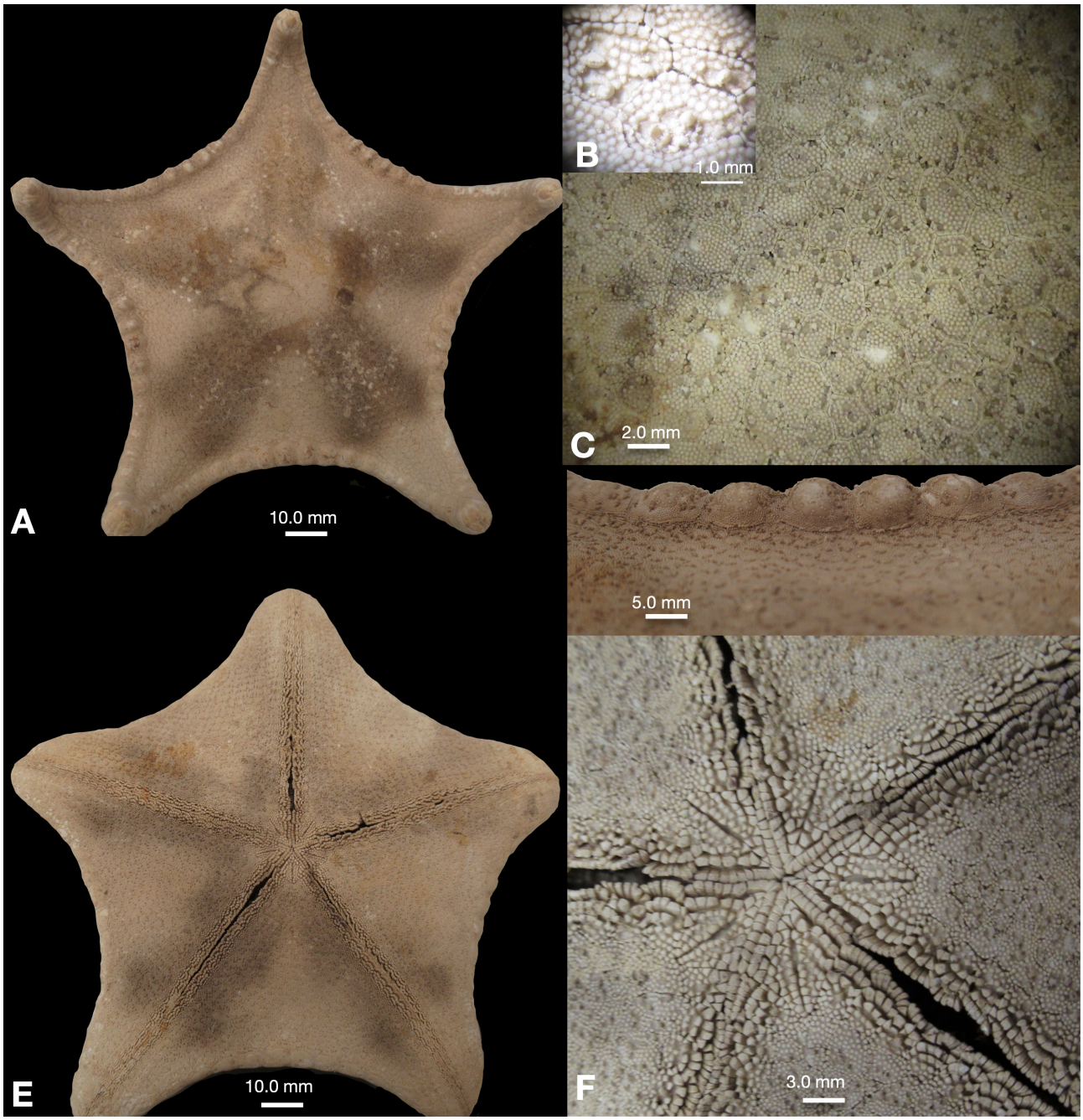

FIGURE 33. ***Peltaster cycloplax*** Fisher, 1913 MNHN IE-2013-6956. A. Abactinal. B. Pedicellariae. C. Closeup of abactinal plates. D. Superomarginal plate surface. E. Actinal. F. Oral, adambulacral regions.

MNHN IE-2013-6950, R=4.9 than in larger individuals, R>8.0, which display distal superomarginals with a much less convex surface along the arm, especially to the terminus. Furrow spines on New Caledonia specimens are slightly higher with a count of 6 to 7 rather than 5 or 6 as in Fisher's (1913, 1919) description. Pedicellariae and other characters are identical to those in Fisher's description.

Occurrence/Distribution
Philippines, Tonga, New Caledonia, the Seychelles, 215–460 m.

New Caledonia, 379–530

Material Examined
New Caledonia. MNHN IE-2009-2123 East coast, New Caledonia, 21°13'10.2"S; 165°53'58.8228"E, 452–460 m. Coll. Bouchet & Richer de Forges, aboard N/O *Alis,* campagne BATHUS 1, 12 March, 1993.

MNHN IE-2013-6950. East coast New Caledonia, 21º13.2'S 165º54'E, 452–460 m. Coll. Bouchet & Richer, ORSTOM, N/O *Alis,* campagne BATHUS 1 CP 656. 1 dry spec. R=4.9 r=2.8.

MNHN IE-2013-6951, West Juneau Bank, South New Caledonia, 23º43.2'S 168º16.2'E, 379–391 m. Coll. Richer, IRD, N/O *Alis*, campagne LITHIST CP 16. 1 dry spec. R=8.4 r=4.5.

MNHN IE-2013-6956, East coast of New Caledonia, 21°14.4'S; 165°54.9'E, 490–530 m. Coll. Bouchet & Richer de Forges aboard N/O *Alis* campaign BATHUS 1, 12 March 1993. 1 dry spec. R=8.8 r=4.4.

MNHN IE-2013-7475. Off the coast of Hienghène, New Caledonia, 20°27'56.5812"S; 164°50'6.4212"E, 411–414 m. Coll. campgne SPANBIOS, 26 July 2021. 1 wet spec.

MNHN IE-2013-9609. SE of Iles des Pins, New Caledonia, 22°56'12.5412"S; 167°48'18.414"E, 385–395 m. Coll. campagne KANACONO, 29 Aug 2016. 1 wet spec.

Tonga. MNHN IE-2013-6624.N Ha'apai group, Tonga Islands, 19º 6'27.5976"S; 174º 18'11.3832'E, 371–437 m. Coll. Bouchet, Waren & Richer, IRD coll. N/O *Alis*, BORDAU 2. 1 dry spec.

Philippines. MNHN IE-2007-1826. Off Lubang, Philippines 9º27'N 123º49'E, 356 m. Coll. MNHN-NUS-NFRDI, PANGLAO 2005, 1 wet spec. R=11.6 r=5.3.

MNHN IE-2013-6651. North Lubang, Philippines. 14º 0'59.9976'N; 120º 16'35.994"E, 215–216 m. Coll. Bouchet *et al.* aboard N/O *Coriolis* MUSORSTOM 2, 27 Nov 1980. 1 dry spec.

***Peltaster meridionalis* sp. nov.**
FIGURE 34A–F

Etymology
The species epithet, *meridionalis*, is Latin for "southern" alluding to this species presence in the southern hemisphere.

Diagnosis
Body pentagonal to weakly stellate (R/r=1.4 to 1.7), abactinal plates polygonal, mostly hexagonal to irregularly round, covered by granules, 20 to 80, widely spaced, abundant. Secondary plates weakly present. **Superomarginal plates 13 –20 (R=4.7 to 5), inferomarginal plates 20–23, covered by granules with a small quadrate, irregularly shaped bald spot on dorsal-facing surface.** Penultimate superomarginals similar in size to other superomarginal plates. **Furrow spines, 6, thick, quadrate in cross-section, subambulacral spines 3 to 5, twice as thick as furrow spines.**

Comments
As outlined here and elsewhere (e.g. Mah 2025), there is a difficult boundary between *Peltaster* and *Sphaeriodiscus.* Verrill (1899) used the presence of secondary plates to distinguish the former and Fisher (1910) distinguished the latter based on the presence of enlarged penultimate superomarginal plates. Diagnostic characters vary among species assigned to both genera, which already share numerous characters and appear very similar. One Atlantic species, *Peltaster placenta* shows overlap of both these characters across its range.

This species lacks the enlarged penultimate superomarginal plates of *Sphaeriodiscus*, but only weakly displays the presence of secondary abactinal plates. Characters observed on this specimens described here suggest placement within *Peltaster*. A similar taxon, "*Philonaster* sp." described by H.E.S. Clark in Clark & McKnight (2001) shows some similarity with the species described here. *Philonaster* Koehler 1909 was synonymized with *Ceramaster* by Fisher (1919). Koehler's (1909) original description appears consistent with this notion. Unfortunately, the specimen outlined by H.E.S. Clark & McKnight (2001) could not be located and further confirmation was not possible.

Occurence/Distribution
New Caledonia, 655–1450 m.

Description
Body stout, weakly stellate (R/r=1.4–1.7), arms short, broad at base, triangular, weakly upturned. Interradial arcs weakly curved (Fig. 34A, D).

Abactinal plates polygonal to round, larger proximally and along radial series (Fig. 34B), becoming smaller, more irregular in shape distally adjacent to contact with superomarginal plates. Granules, 20 to 80, round, form dense cover over plate surface such that they obscure plate boundaries interradially. Granules more widely spaced proximally, becoming more dense adjacent to contact with superomarginal plates. Peripheral granules on interradial plates indistinct relative to those on radial plates. Radial plates especially proximally, in approximately 2 to 3 series, with peripheral granules, 15 to 30, triangular to quadrate in shape, evenly spaced, each approximately 2 to 3 times the size of the round granules covering the remainder of the plate surface. No secondary plates (i.e. those of much

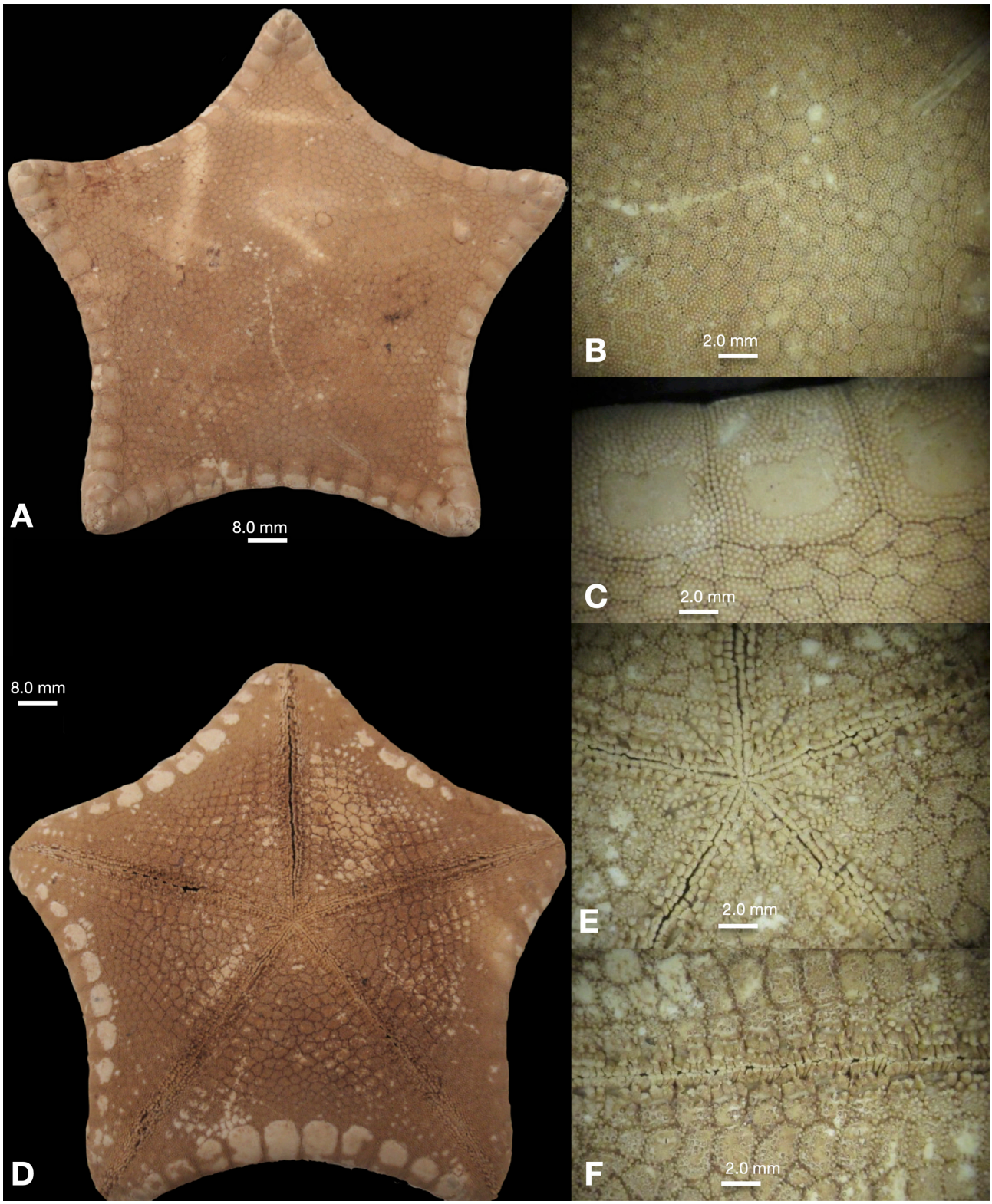

FIGURE 34. ***Peltaster meridionalis*** **sp. nov.** MNHN IE-2013-6966. A. Abactinal. B. Closeup abactinal plates. C. Superomarginal plate surface. D. Actinal. E. Oral region. F. Adambulacral furrow region.

smaller size than the other abactinal plates). Madreporite hexagonal with sulci, well-developed. No pedicellariae.

Marginal plates forming a distinct dorsal-facing periphery, superomarginal plates forming 18.5% (0.5/2.7) of the total "r" (disk diameter) (Fig. 34A, D). Distalmost superomarginals variably in complete to partial contact along midline. Superomarginals, 13 to 20 (at R=4.7 to 5.0), inferomarginal plates 20–23, all consistently wide, with distalmost plates only slightly smaller in size. Superomarginal and inferomarginal series offset forming zigzag contact between the two series. Penultimate superomarginals relatively similar in size with adjacent

superomarginal plates. Superomarginal plates mostly covered by granules, 100–600, dense, closely arranged, with a distinct raised, bare spot on the abactinal surface (Fig. 34C). Granules present primarily on lateral face. Peripheral granules, 20 on wide, 40 on length, similar in size with a linear side. Granules continuous with those on abactinal surface. Inferomarginal plate surface with granules, 200–600 covering plate surface, evenly but densely distributed on surface with a small raised bald spot. No pedicellariae.

Actinal intermediate surface composed of quadrate to polygonal surface in 3 to 5 complete series with a full series extending to arm tip (Fig. 34D). Actinal series shorter, more irregular closer to contact with inferomarginal plates. Actinal plate surface covered by granules, 20 to 60, densely arranged, such that boundaries between actinal plates partially obscured. Peripheral granules quadrate in shape, more widely distributed, weakly evident. Pedicellariae, small, paddle-shaped, 10 to 15, approximately 1.0 to 2.0 mm, per interradius, most abundant on actinal plates adjacent to the adambulacral plates.

Furrow spines 6, thick, triangular to polygonal in cross-section (Fig. 33E, F), mostly blunt tipped but also with notched edges on spine surfaces in straight to weakly palmate arrangement. Subambulacral spines in three series from largest, proximal to furrow spines to smallest spines adjacent to actinal plates. Subambulacral spines adjacent to furrow, 3 to 5, with largest, thickest spines, each subambulacral approximately twice as thick as adjacent furrow spines. Subsequent second and third subambulacral spines each 3 to 6, mostly 5 granular spines, decreasing in size becoming similar in size to actinal granules. Subambulacral spine series spaced from one another. Subambulacral spines widely spaced. Oral plates with 12 to 15, each very thick, blunt-tipped in a single series (Fig. 34E). Oral plates with continued subambulacral spine series, blunt, quadrate in cross-section closely abutted. Distinct diastema between oral plates, each flanked by short, blunt, granule-like spines, 12–13. Remainder with flattened, blunt spine-like granules present on oral plate surface.

Material Examined

Holotype. MNHN IE-2013-6966, Fairway Ridge, New Caledonia, 21º0.5'S, 161º31.2 E, 655 m. Coll. ZONECO 6 CC 13, 1 dry spec. R=4.5 r=3.1.

Paratypes. MNHN IE-2016-1545, South New Caledonia, 22º10.5'S, 165º59.1'E, 1060–1450 m, Coll. BATHUS 2, CP 767, Coll. Bouchet & Richer, ORSTOM, 17 May 1993. 1 dry spec. R=4.7 r=2.7.

MNHN IE-2007-6462, New Caledonia, 21º41'S 166º37'E, 685–880 m, EXBODI, CP 3809, 5.8.11. 1 wet spec. R=4.1 r=2.5.

MNHN IE-2007-6327, New Caledonia, 22º20'S 169º01'E, 400–520 m, EXBODI, CP 3862, 10.9.11, 1 wet spec. R=5.5 r=3.2.

MNHN IE-2007-6397, New Caledonia, 21º46'S 166º44'E, 574–585 m EXBODI, CP 3817, 6.9.11, 1 wet spec. R=4.7 r=2.9.

MNHN IE-2013-6960 New Caledonia, 24°55'S, 168°22"E, 512–502 m. SMIB 3, DW 5 1 dry spec. R=4.8 r=3.5.

MNHN IE-2013-6965 Southern New Caledonia, 620–700 m, Coll. Richer, ORSTOM HALIPRO 1, CH 872, 30 March 1994. 1 dry spec. R=5.3 r=3.76.

Pillsburiaster Halpern, 1970a

Halpern, 1970a: 2; McKnight, 1973: 180; Downey in Clark & Downey, 1992: 258; McKnight, 2001: 102 (key).

Diagnosis

Body pentagonal to weakly stellate. Abactinal plates weakly tabulate. **Abactinal surface densely covered by coarse, hemispherical granules obscuring plate boundaries.**

Comments

Pillsburiaster includes 12, species present between 120–1708 m. Five species occur in the Pacific, including *Pillsburiaster ernesti* (Ludwig 1905) from the East Pacific, *Pillsburiaster micropeltus* (Fisher 1906) from the Hawaiian islands, and 3 species from New Zealand (H.E.S. Clark & McKnight 2001; McKnight 2006), two species in the Atlantic, including *Pillsburiaster geographicus* Halpern 1970 from the tropical Atlantic and *Pillsburiaster calvus* Mah 2011 from Burdwood Bank in the South Atlantic. Four species, *P. annandale* (Koehler 1909), *P. cuenoti* (Koehler 1909), *P. doderleini* (Koehler 1909) and *P. investigatoris* (Alcock 1893) were collected from the Indian Ocean.

Pillsburiaster chondros sp. nov.

FIGURE 35A–F

Etymology

The species epithet *chondros* is Greek for grain, alluding to the granule-like deciduous granules present on the abactinal, marginal and actinal surface.

Diagnosis

Body stout, shape, weakly pentagonal to stellate, R/r=1.5 to 2.1, arms triangular in shape, short with pointed tips. Interradial arcs weakly curved to straight. Abactinal granules 8 to 20, mostly 10 to 12. Superomarginal plates16 at R> 4.0 cm. Marginal plates approximately 16 per interradius. **Furrow spines 8 to 10, A single subambulacral row composed of a pedicellariae present proximally, spines distally, 2 to 4, mostly 3 blunt pointed spines of identical length to that the pedicellariae.**

Comments

Pillsburiaster chondros **sp. nov.** is characterized by the presence of 8 to 10 furrow spines (Fig. 35F), 16 superomarginal plates in large (R>4.0, ht is 5.0 cm) specimens (Fig. 35A), as well as the presence of a single subambulacral pedicellariae and 2 to 4 subambulacral

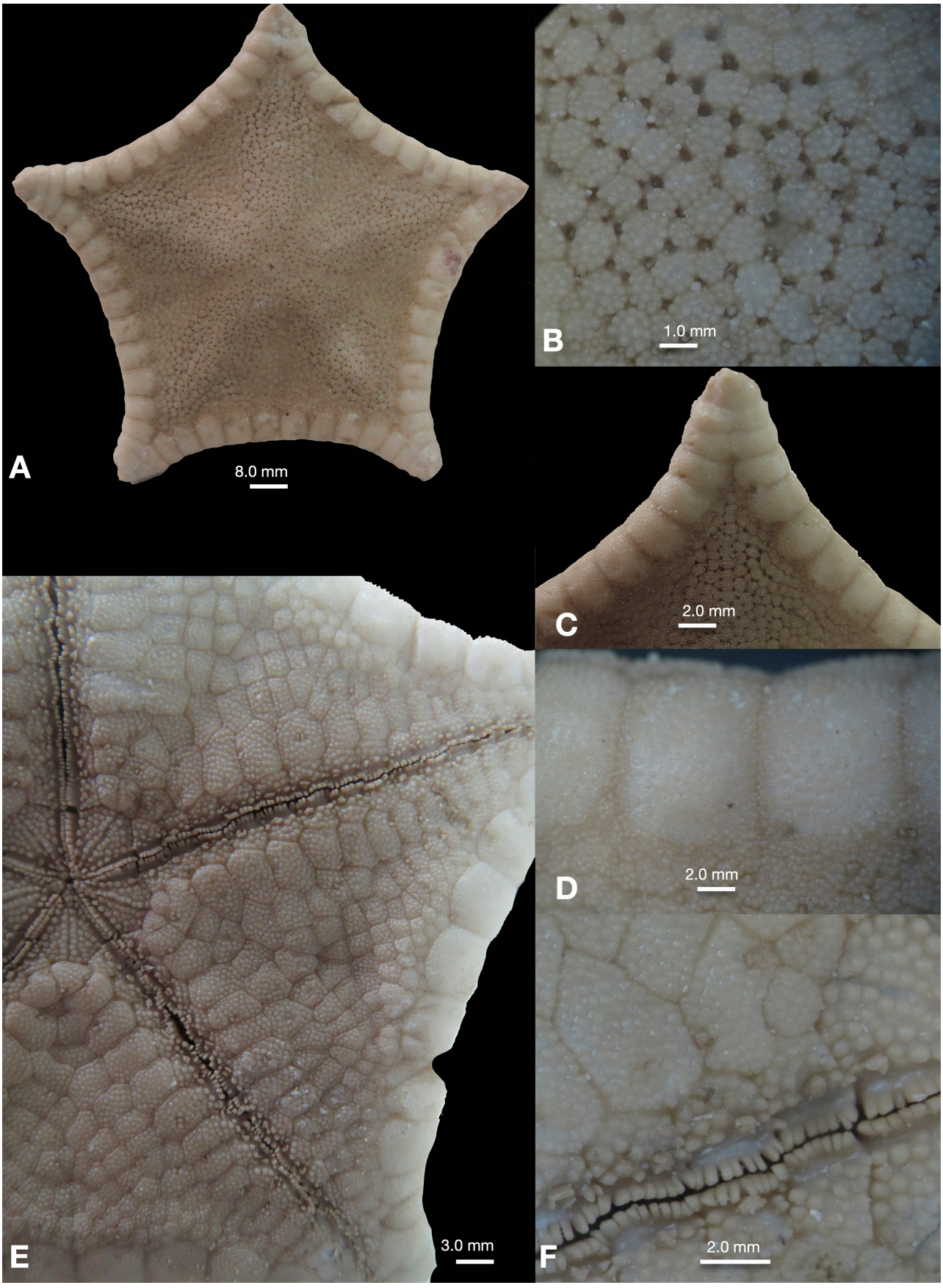

FIGURE 35. ***Pillsburiaster chondros*** **sp. nov.** MNHN IE-2013-9868. A. Abactinal. B. Closeup Abactinal plates. C. Pre-terminal superomarginal plates. D. Closeup superomarginal plates. E. Actinal F. Adambulacral furrow.

spines. The New Zealand *Pillsburiaster aoteanus* McKnight 1973 is similar but differs in having 5 (up to 7) furrow spines and 18 superomarginals per interradius (at R=6.0 cm). *Pillsburiaster maini* McKnight 1973, also from New Zealand differs in being more stellate (R/r=2.2), 5 furrow spines, and 26 to 28 superomarginal plates (at R=4.1) (summary of these latter two species from H.E.S. Clark & McKnight 2001). The third New Zealand species, *Pillsburiaster indutilis* McKnight 2006 displays 5 furrow spines, 14 superomarginals (r=3.3 cm) and scattered embedded hemispherical granules on the superomarginal surface similar to that of *Plinthaster*. Embedded, glassy granules and differing marginal plate shapes were observed in *P. indutilis*, and were more suggestive of *Plinthaster*.

Occurrence/Distribution

New Caledonia, 410–1708 m.

Description

Body stout, shape, weakly pentagonal to stellate, R/r=1.5 to 2.1, arms triangular in shape, short with pointed tips. Interradial arcs weakly curved to straight (Fig. 35A).

Abactinal plates abutted, shapes highly variable, ranging from quadrate with rounded edges to polygonal or round shapes. Plates covered by granules, 8 to 20, mostly 10 to12 round, deciduous in dense cover, approximately 4 to 5 count along a 1.0 mm line at R=4.1 but 3 to 4 along the same count at R=5.0. Complete granule cover present on central disk plates and those adjacent to superomarginal plate contact with radial and adradial plates on most of disk surface demonstrating bare central surface (Fig. 35B). Granules forming periphery or on most of those plates with bare central surface. Radial regions along arms with single papular pores extending from primary plate to approximately 80% of the arm's distance on radial and adradial regions. Pedicellariae, paddle-like, approximately 0.5 to 0.7 mm in length, similar in size to granules, present in greatest abundance interradially adjacent to contact with superomarginal plates, better observed in specimens at R> 5.0 cm. Madreporite pentagonal, slightly raised above abactinal surface.

Marginal plates, 16 superomarginals, inferomarginals per interradius at R=>4.1, 11 superomarginals and inferomarginals at R=1.2, counted arm tip to arm tip (Fig. 35A). Inferomarginal plate series forming slight underhand relative to the superomarginal series. Superomarginals abutted variably in one or two pairs along mid radius on distalmost plates with partial contact on a third (Fig. 35C). Superomarginal plate surface a large central raised patch, quadrate in shape, (Fig. 35D) covered with granules, approximately 90–150, mostly 120 round, deciduous present around edges, especially on abactinal surface adjacent to superomarginal contact and lateral surface adjacent to inferomarginal plates. This bald patch becomes larger distally along superomarginal plates, with the penultimate superomarginal surface largely devoid of granules, save for peripheral granules in a single series, approximately 20 per side. Inferomarginal plate surface completely covered by granules, numbering 400 to 600, abundantly present, densely packed, when granules are absent, surface with shallow, convex pitting along surface. No pedicellaria. Terminal plate triangular, bare surface.

Actinal surface composed of plates, quadrate to irregularly polygonal to irregular in shape, arranged in chevron-like series proximally becoming more irregular in shape and arrangement distally adjacent to inferomarginal plates (Fig. 35E). Actinal plates covered by granules, 20 to 80, mostly 40 to 60, round, deciduous, evenly spaced. Peripheral granules in single series, approximately approximately 6–10 per side. Pedicellariae present, 20 to 30 per interradius, small, paddle-like, approximately 0.5 to 1.0 mm in length, present with greatest abundance distally adjacent to contact with inferomarginal plates. Many present centrally on plate.

Furrow spines 8 to 10, angular to quadrate in cross section with blunt, convex tips forming a straight, nearly continuous series along the ambulacral groove (Fig. 35F). Adambulacral plates with a single subambulacral row composed of a pedicellariae present proximally, variably 2 to 4, mostly 3 blunt pointed spines of identical length to that the pedicellariae. Pedicellariae, forceps-like with elongate valves, significantly larger than others on actinal surface, 1 to 2 present on proximal adambulacral plates decreasing to one and then zero distally. Remainder of adambulacral plate with short, angular granules, 10–15, widely spaced similar to those on actinal intermediate region. Oral plates with furrow spines, 12, quadrate in cross-section with blunt-tips similar to other furrow spines, at apex of oral plate, a longer central spine and an adjacent shorter oral spine. This totals four spines projecting into the mouth, two longer on plate tip and two adjacent shorter spines. Oral plate surface covered by short, angular granules, approximately 40–50, with blunt tips, widely and irregularly spaced. Two series of these granules, 8 to 10, paired along oral plate diastema.

Material Examined

Holotype. MNHN IE-2013-9868, New Caledonia, 21º20'S 157º55'E, 970–963 m. Coll. KANADEEP CP 4964, 7 Sept. 2017, 1 wet spec., R=5.0 r=3.2.

Paratypes. MNHN IE-2013-9755, New Caledonia, 21º02'S 161º11'E, 810–840 m Coll. KANADEEP CP 5054, 24 Sept 2017, 1 wet spec. R=4.1 r=2.7

MNHN IE-2013-9838, New Caledonia 21º20'S 157º90'E, 961 m, Coll. KANADEEP CP 4965, 7 Sept 2017, 2 wet specs. R=5.0 r=3.2; R=1.5 r=0.9.

MNHN IE-2013-9759, New Caledonia, 24º03'S 161º39'E, 960–965 m Coll. KANADEEP CP 4925, 2 Sept 2017, 1 wet spec. R=3.7 r=2.2.

MNHN IE-2013-9882, New Caledonia, 23º52'S 161º53'E, 1115–1088 m Coll. KANADEEP CP 4995, 17 Sept. 2017, 1 wet spec. R=2.5 r=1.6.

MNHN IE-2013-4384, New Caledonia, 23°0.4'S; 168°5.6"E, 1493–1508 m. Coll. KANADEEP 2 CP 5109 1 wet spec. R=4.1 r=2.0.

MNHN IE-2013-1458, New Caledonia, 21º21'S 158º00'E, 1000–978 m, Coll. KANADEEP CP 4963, 7 Sept. 2017, 1 wet spec. R=2.2 r=1.4.

MNHN IE-2013-9805, New Caledonia, 23º48'S

161º52'E, 1158–1175 m. Coll KANADEEP CP 4994 17.09.17, 1 wet spec. R=2.6 r=1.6.

MNHN IE-2013-9764, New Caledonia, 23º57'S 161º47'E, 1050–980 m. Coll. KANADEEP CP 5000 17.9.17, 1 wet spec. R=1.0 r=0.6.

MNHN IE-2013-4401, New Caledonia, 21º1.7'S 168º9.3'E, 1373–1407 m, Coll. KANADEEP 2 CP 5108, 30.09.19 1 wet spec. R=1.2 r=0.7.

MNHN IE-2022-4408, New Caledonia, 24º22.2'S, 168º25.4'E,1652–1708 m. Coll. KANADEEP 2 CP 5087, 27.9.2019. 1 wet spec. R=1.8 r=1.0.

Plinthaster Verrill, 1899

Tosia section B (*Plinthaster)* Verrill 1899: 161; Fisher 1906: 1052.
Pyrenaster Verrill 1899: 166; Fisher 1911: 165
Plinthaster Fisher 1910: 172; 1911: 165; Halpern 1970a: 131; Halpern 1970b: 244; McKnight 1973: 185; Downey in Clark & Downey 1992: 259; H.E.S. Clark in Clark & McKnight 2006: 110.

Diagnosis. Body weakly stellate to pentagonal. Abactinal plates, flat, bare central surface, polygonal, no surficial granulation but with glassy, tubercles in radiating patterns present on subsurface. Marginal plates relatively few per interradius, with widely spaced coarse granules but otherwise smooth or bare. Actinal surface covered by granules. Based on Mah (2018).

Comments

Plinthaster's pentagonal shape would immediately imply relationship with other Goniasteridae displaying an identical form, including abactinal and marginal plate morphology. Similar shaped taxa include *Peltaster, Sphaeriodiscus, Ceramaster, Apollonaster,* and *Pillsburiaster.* However, the granulation present on the abactinal plates as well as the primarily tabulate or weakly tabulate morphology distinguishes those genera from *Plinthaster*. *Plinthaster* is characterized by the flat abactinal plates with a smooth, bare surface, save for the presence of embedded glassy tubercles in the presence of each plate, a character shared with relatively few other goniasterid taxa, including *Astroceramus*. *Astroceramus* is mostly separated by the presence of elongate arms with abutted superomarginal plates, but unusual, pentagonal forms, as observed in *Astroceramus cyclus* **sp. nov.**, described herein suggests overlapping morphology with *Plinthaster*.

Plinthaster currently includes one Pacific, one Atlantic, and two Indian Ocean species. Two species from the Indian Ocean, *P. lenaigae* and *P. unteidtae* were recently described by Mah (2018). One species, *P. ceramoidea* was recorded from Hawaiian waters (Fisher, 1906) whereas *Plinthaster dentatus* has been recorded from both the eastern and western Atlantic (Clark & Downey 1992), with an occurrence recorded from the New Zealand region in the South Pacific (H.E.S. Clark and McKnight 2001). This is addressed herein.

Plinthaster species are known to be widely occurring, and as such, share taxonomic difficulties that are observed in genera such as *Nymphaster*. Character differences are known to be few and many species display a close resemblance. Although *Plinthaster dentatus* is best documented (e.g. Clark & Downey, 1992) additional specimens of *Plinthaster* throughout the Indo-Pacific are known from collections, but await documentation (Mah, unpublished data).

Key to *Plinthaster* species

(0) Superomarginal/Inferomarginal plates 6 but with enlarged penultimate superomarginal plates. Four superomarginal plates on disk present between penultimate superomarginals.....(1)

(1) Penultimate superomarginal plates triangular to droplet-like. Similar in size to adjacent superomarginal plates .... *Plinthaster lenaigae* Mah 2018

(1') Penultimate superomarginal plates rounded to seed-like in shape, edges rounded, approximately twice the size of adjacent superomarginal plates..... ..... *Plinthaster unteidtae* Mah 2018

(0') Superomarginal/inferomarginal plates 8–10/14. (*P. ceramoidea*, exceptionally with 14 superomarginals on holotype).....(2)

(2) Furrow spines 5 to 7. Actinal plate, central surface covered by 4 to 30 granules, widely spaced from one another. Subambulacral spination with one enlarged series of 3 spines, remainder in 2 regular widely spaced, smaller series..... *Plinthaster ceramoidea* (Fisher, 1906)

(2') Furrow spines 8 to 9. Actinal plate, central surface covered by 6 to 70 granules (often 20–60). close to densely arranged. Subambulacral spination with one enlarged series of 3 to 4 spines, remainder in 3 variably regular to irregular series . .....***Plinthaster australis* n sp.**

(0") Superomarginal/inferomarginal plates 12–20/14–22, furrow spines 5 to 7, subambulacral spines, 1 enlarged, 2 to 3 variably regular to irregular, widely spaced or crowded . .....*Plinthaster dentatus* (Perrier, 1884)

***Plinthaster australis* sp. nov.**

FIGURE 36A–F

Etymology

The species epithet *australis* alludes to this species presence in the South Pacific.

Diagnosis

Body pentagonal to weakly stellate (R/r=1.2–1.6). Abactinal plates polygonal, surface smooth with glassy granules embedded in the plate surface. S**uperomarginal plates 8 to 13, inferomarginal plates 10 to 12. Penultimate superomarginal variably triangular and enlarged. Furrow spines 7 to 10, mostly 8 to 9.**

Subambulacral spines in 3 to 5 series, first series adjacent to the furrow spines with 3 to 5 shorter but thick spines, the remaining 3 to 4 series variably serial to irregular but with granules/spines similar to those on adjacent actinal plates.

Comments

Plinthaster australis **sp. nov.** is distinguished from the second Pacific species, *Plinthaster ceramoidea* (Fisher, 1906) based on adambulacral spination and actinal granule number. However, the number of marginal plates per interradius for both Pacific species is similar, and at present, marginal plate number serves to differentiate the Pacific *Plinthaster* species from the Atlantic *Plinthaster dentatus* the Indian Ocean *Plinthaster* species. Further specimens from throughout the distribution of *Plinthaster* could show a breakdown of morphological characters between species, similar to what is observed in other widely occurring goniasterid genera, such as *Nymphaster*. Alternatively, molecular data has shown cryptic species across widely distributed species displaying relatively few to no morphological characters (e.g. *Brisingaster* in Zhang *et al.* 2023).

Occurrence/Distribution

New Caledonia, Wallis and Futuna, Coral Sea, 452–710 m.

Description

Body form strongly pentagonal, R/r=1.2–1.3. Interradial arcs straight (Fig. 36A, E).

Abactinal surface flat with distinctly pentagonal plate field. Individual plates weakly swollen to convex in profile; pentagonal to irregularly round in outline. Largest abactinal plates at disk center and adjacent regions with smaller, more irregular shaped plates distally adjacent to contact with superomarginal plate series. Distinctly recognizable primary circlet with enlarged primary plates present interradially. Abactinal plates with 15–45 (typically 25–35) small granules, oval to quadrate (with rounded edges) in shape, forming discontinuous but regular border surrounding each plate. Larger plates with greater numbers of peripheral granules proximally with smaller distal plates bearing fewer peripheral granules. Each abactinal plate surface covered with 30–300 (typically 150–250) low, glassy, crystalline tubercles, embedded in each plate surface arranged in regular rows, forming well-expressed sunburst pattern (Fig. 36B) in larger individuals. Glassy granules weakly developed on smaller distal plates in contact with superomarginals, and interradially on some smaller individuals. Shallow grooves present between plates, slightly deeper between papulae on radial regions, shallower interradially. Papulae single, present radially only, absent interradially. Madreporite, flush with abactinal surface, triagonal to hexagonal, flanked by three to five abactinal plates with well-developed sulci. Pedicellariae with paddle-shaped blades, present primarily along radial regions. Alveolar pits present in many cases when pedicellariae are absent.

Marginal plates form distinct pentagonal boundary of abactinal surface, comprising 15–18% of the "r" distance (measured from disk center to edge of interradius). Marginal plates quadrate in outline, swollen in profile (Fig. 36C). Each marginal plate with approximately 60–120 (typically about 80–100) elongate, oval shaped accessory granules present in discontinuous but regular series around the periphery of each plate. Shallow grooves present between each plate and between marginals and abactinal and actinal plates. Superomarginals, 8 to 10 (typically eight), with direct correspondence to inferomarginals, 10 to 14 with slight offset distally near arm tips. A smaller individual (IE 2007-3143, R=0.8) had 6 superomarginals per interradius, versus those at R=2.0 which have eight superomarginals per interradius. Subterminal superomarginals enlarged, triangular in outline (Fig. 36C), swollen in all type specimens. Some minor variation on specimens with individual arms lacking swollen subterminals but this character is present on most arms. Inferomarginals smaller, upturned with offset plates relative to superomarginals. Superomarginals covered by 60–150 (typically 80–100) widely spaced, deciduous granules which become more densely packed on the lateral side of the superomarginal plate surface. Superomarginal contact with abactinal plate surface with less abundant granules, more widely spaced. Where granules are absent a granule-shaped pit is present on the superomarginal plate surface. Inferomarginals with 60–100 densely packed granules. Actinal facing granules are pointed and almost spinelet-like, similar to similar pointed granules on actinal plate field. Granules on lateral surface of inferomarginals more hemispherical and similar to those on superomarginal plate surface. Pedicellariae similar to those on radial regions of abactinal plates present on abactinal-facing surface of superomarginal plate. These are not abundant and are present on superomarginal plate surface adjacent to the abactinal surface.

Actinal intermediate plates present in approximately four well-defined chevrons, becoming more jumbled in arrangement distally (Fig. 36E). Actinal plates distinctly quadrate adjacent to adambulacrals but becoming more irregularly polygonal in shape adjacent to inferomarginal plate contact (Fig. 36D). Actinal plates covered by abundant, evenly spaced granules. Each actinal plate with a periphery of approximately 15–50 granules, with central plate surface covered by 6 to 70 granules (often 20–60). Actinal granules are pointed with spinelet to nipple-shaped tips although some are more hemispherical and rounded. Shallow grooves present among actinal plates-sometimes forming bisecting actinal triangular regions in half.

Adambulacral plates squarish to rectangular in outline, separated from other actinal intermediate plates by distinct fasciolar groove. Furrow spines, 8 to 9 laterally compressed, quadrate in cross-section with blunt tips arranged in straight to weakly curved line (Fig. 36F). Specimens from Wallis and Futuna display 9 to 10 furrow spines. Tips of furrow spines with some variable ornamentation, some with notched tips and some with smooth tips. Proximalmost furrow spine in series, half the

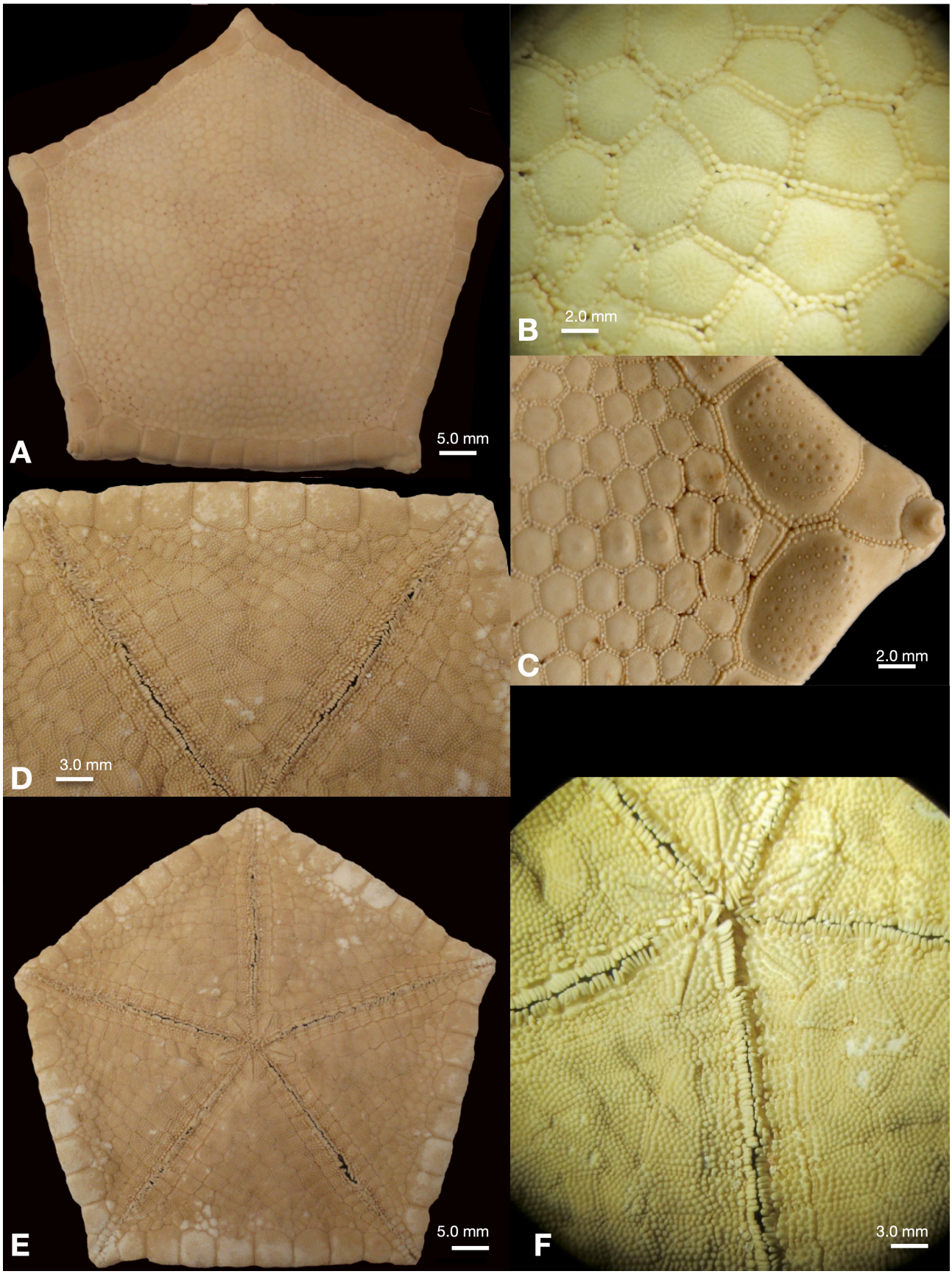

FIGURE 36. ***Plinthaster australis*** **sp. nov.** MNHN IE-2013-6945 A. Abactinal. B. Closeup Abactinal plates. C. Pre-terminal superomarginal plates. D. Actinal intermediate E. Actinal. F. Oral and adambulacral furrow region.

length of the other furrow spines, sometimes clustering with other spinelets on adambulacral plate surface. Subambulacral spines 3 to 4, remainder of adambulacral plate covered by 18–30 thick, short, spinelets, quadrate to polygonal in cross-section, in irregular widely spaced arrangement. These spines are larger than those on actinal plate surface. Largest spines proximally adjacent to furrow spines becoming smaller as they approach the actinal plate spinelets. A paddle-shaped pedicellariae with thick lobate valves is present on the proximal surface of most adambulacral plate (absent on a minority of plates).

Each oral plate covered by 20–40 spinelets, widely to closely spaced, thickened, quadrate to polygonal in cross-section. 12–18 spinelets present on edges of each paired oral plate surface sitting to each side of the tissue filled gap (Fig. 36F). Proximalmost spinelets thickest, largest and abutting against spines pointing into oral cavity. Furrow spines on each oral plate, 12–18 and similar to those on other furrow spines. Those furrow spines pointing directly into mouth at oral plate tip are largest and thickest.

Color in life is yellow to bright orange.

Material Examined

Holotype. New Caledonia. MNHN IE-2013-6942, Loyalty Ridge, New Caledonia, 21˚00.5'S, 167˚32'E, 575 m, Coll. MUSORSTOM 6. 1 dry spec. R=4.5, r=3.4.

Paratypes. New Caledonia. MNHN IE-2013-6946, South of New Caledonia, 620–700m, 23˚02'S, 166˚52'E, 620–700m, Coll. Rich-ORSTOM, st. CH 872, HALIPRO 1. 3 dry specs, R=2.5, r=1.9; R=2.7, r=2.2; R=3.4, r=2.8.

MNHN IE-2013-6952, Fairway Ridge, New Caledonia, 21˚00.5'S, 161˚31.2'E, 655 m, Coll. IRD ZONECO 6. 1 dry spec. R=4.2, r=3.3.

MNHN IE-2013-6948, Fairway Ridge, New Caledonia, 20˚57.9'S, 161˚30.9'E, 536 m, Coll. IRD, ZONECO 6. 1 dry spec, R=3.6, r=3.0.

MNHN IE-2013-6945, 23˚3.4'S, 166˚59'E, 452–464 m, Coll. Bouchet & Richer, ORSTOM BATHUS 2. 1 dry spec., R=4.4, r=3.6.

MNHN IE-2013-6941, Southern New Caledonia, 22˚9.6, 166˚2.8'E, 600–630 m, Coll. Bouchet & Richer-ORSTOM.1 dry spec. R=3.8, r=3.1.

MNHN IE-2013-7049 (EcAh 6038) New Caledonia 19°45.30S, 158°46.50, 675–710 m. Coll. MUSORSTOM 5. 1 wet spec. R=3, r=2.2.

MNHN IE-2007-6409 New Caledonia, 22º22'S 168º57'E, 460–708 m. Coll. EXBODI CP 3864, 15 Sept. 2011. 1 wet spec. R=3.7, r=2.8.

MNHN IE-2007-6479 New Caledonia, 19º44'S 165º44'E 574–610 m. Coll. EXBODI DW 3912, 24 Sept. 2011. 1 wet spec. R=1.7, r=1.2.

MNHN IE-2007-6543 New Caledonia 22º18'S 168º44'E, 450–500 m. Coll. EXBODI CP 3850, Coll. 14 Sept. 2011. 1 wet spec. R=2.9, r=1.6.

MNHN IE-2007-6341 New Caledonia, 22º18'S 171º18'E, 908–1095 m. Coll. EXBODI DW 3878, Coll. 17 Sept. 2011. 1 wet spec. R=2.0, r=1.4.

MNHN IE-2007-6572 New Caledonia, 21º00'S 161º04'E, 338 m. Coll. EXBODI CP 3856, Coll. 14 Sept. 2011. 1 wet spec. R=1.3, r=0.8.

MNHN IE-2013-9832 New Caledonia, 22º22'S 168º57'E 684–714 m. Coll. KANADEEP CP 5052, 24 Sept. 2017. 1 wet spec. R=4.2 r=2.9.

MNHN IE-2013-9849 New Caledonia, 21º03'S 161º07'E, 730–790 m, Coll. KANADEEP CP 5053, 24, Sept. 2017. 1 wet spec. R=3.8 r=2.8.

MNHN IE-2013-7481 Northern New Caledonia, 20º26.9'S 164º52.4'E, 627–632 m, Coll. SPANBIOS CP 5269, 26.7.21, 1 wet spec. R=4.2 r=3.1.

Wallis and Futuna. MNHN IE-2013-5537 Banc Combe, Wallis and Futuna Islands, 12°16'48"S; 177°28'6.0168"E, 780–794 m. Coll. Bouchet *et al.* MUSORSTOM 7 aboard N/O *Alis*, 18 May 1992. 1 wet spec. R=3.3, r=2.7.

MNHN IE-2013-5538, Banc Tuscarora, Wallis and Futuna Islands, 11°47'0.0024"S; 178°27'18.0072"E, 1010–1020 m. Coll. Bouchet *et al.* MUSORSTOM 7 aboard N/O *Alis*, 20 May 1992. 1 wet spec. R=1.8, r=1.1

MNHN IE 2007-7612, Coral Sea, 20°6'59.5188"S; 160°20'17.7792"E, 902–914 m, Coll. Bouchet *et al.*, EBISCO aboard N/O *Alis*, 20 Oct, 2005. 2 wet spec. R=2.7 r=1.9.

Plinthaster ceramoidea (Fisher, 1906)

FIGURE 37A–F

Tosia (*Plinthaster*) Fisher 1906: 1052, pl. XVI, XXII (as *Plinthaster*) Fisher, 1910: 172, 1911: 165; Halpern 1970: 244; A. M. Clark, 1993: 276; Mah, 1997: 67; Chave and Malahoff 1998: Table 1

Diagnosis

Body pentagonal to weakly stellate (R/r=1.2–1.6). Abactinal plates polygonal, surface smooth with glassy granules embedded in the plate surface. **Superomarginal plates 8 to 14, mostly 8 to 10 inferomarginal plates, 10–16, mostly 10–12. Actinal plate, central surface covered by 4 to 30 granules, widely spaced from one another. Furrow spines 5 to 7. Subambulacral spination with one enlarged series of 3 spines, remainder in 2 regular widely spaced, smaller series. variably serial to irregular but with granules/spines similar to those on adjacent actinal plates.**

Comments

Based on specimens referenced herein, this species is known primarily from the Hawaiian Islands region with one apparent record from the Kermadec Islands. Imagery from NOAA ship *Okeanos Explorer* has recorded what appears to be his species, from the Johnson Atoll regions, Musicians Seamounts and the Wake Island area as well.

Observations of this species *in situ* by NOAA Ship *Okeanos Explorer* have shown it primarily on rocky substrates. Living color of these individuals is a solid yellow or orange. Video observations of the Atlantic *Plinthaster dentatus* have shown predation on sponges (Mah, 2020) and the Pacific species may practice similar feeding habits. Indeed, many of the Pacific observations show these individuals close to in proximity to epizoic sponges and cnidarians. All observations of *Plinthaster*

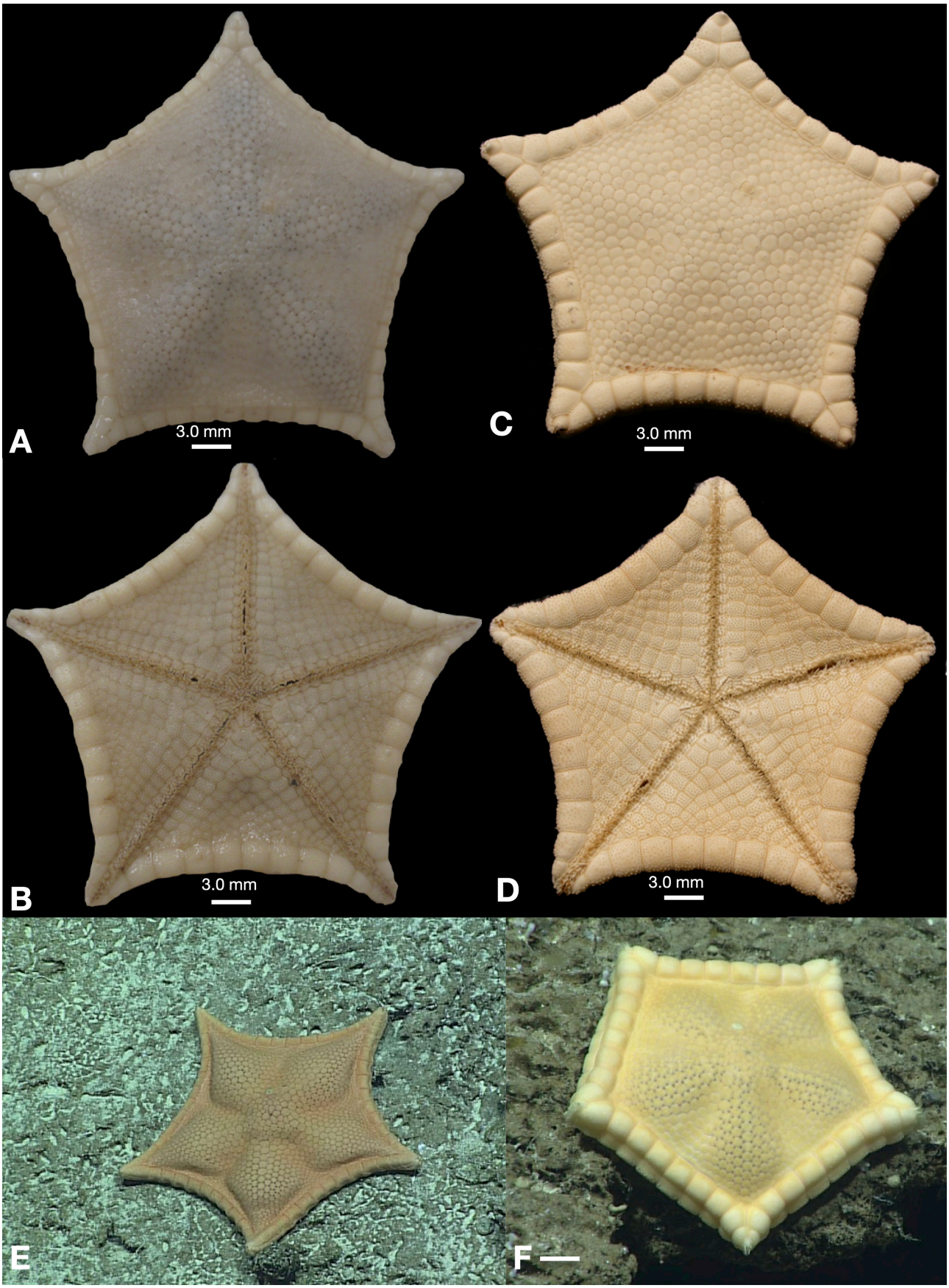

FIGURE 37. ***Plinthaster ceramoidea*** (Fisher, 1906) Holotype USNM 21163. A. Abactinal B. Actinal. BPBM 3522 C. Abactinal D. Actinal. *In situ* observations from the Hawaiian Islands. E. Hawaiian Islands, 535 m. F. Hawaiian Islands, 448.7 m.

ceramoidea show solitary individuals with none showing more than one specimen.

What is the New Zealand *Plinthaster dentatus*?

An assessment of the *Plinthaster* species in the Pacific requires reconciling the apparent presence of the Atlantic *Plinthaster dentatus* from the Kermadec Islands (New Zealand) as recorded by H.E.S. Clark & McKnight (2001). It is argued here this specimen is best explained as a variant of the Pacific species, *Plinthaster ceramoidea* (Fisher 1906).

The New Zealand specimen displays 14 superomarginal and inferomarginal plates, which is seemingly consistent with the higher number of marginal plates observed in the Atlantic *P. dentatus*. Comparison with the Hawaiian/North Pacific *Plinthaster ceramoidea* shows that although most specimens studied display 8 to 10 superomarginal plates per interradius, the holotype shows 14 superomarginal plates. The New Zealand specimen shows 5 to 6 furrow spines and 2 rows of subambulacral spines. Furrow spine number is consistent with the Hawaiian *P. ceramoidea*, 5 to 6 and the number of subambulacral spine rows numbers 2 to 3, including the one series with enlarged spines in addition to 2 rows of smaller spines. Atlantic *P. dentatus* show an overall higher number of superomarginal plates per interradius, numbering 12 to 20 in and 5 to 8 furrow spines overall, in addition to only 1 or 2 subambulacral series, each with accessories and/or granules consistent in size with those on the actinal surface.

In situ observations taken by NOAA ship *Okeanos Explorer* have shown what could be two distinct morphotypes of the same species observed throughout the tropical Pacific/Hawaiian region which correspond to the specimens summarized here (Figs. 37E-F). It is possible however that further exploration of these taxa throughout its range will show further overlapping variation and considering the range of variation observed in *Plinthaster dentatus* and in other wide-ranging Goniasteridae, such as *Hippasteria* or *Nymphaster,* there are additional interpretations for either greater or fewer species than is currently further recongized. Further data, especially for phylogeographic molecular studies are desirable to test boundaries of the morphotypes among *Plinthaster* species in the Pacific.

Occurrence/Distribution

Hawaiian Islands, 294–510 m.

Kermadec Islands, 1188–1224 m.

Description

Body form strongly pentagonal, R/r=1.2–1.3. Interradial arcs weakly curved to straight (Fig. 37A–F).

Abactinal surface flat with distinctly pentagonal plate field. Individual plates weakly swollen to convex in profile; pentagonal to irregularly round in outline. Largest abactinal plates at disk center and adjacent regions with smaller, more irregular shaped plates distally adjacent to contact with superomarginal plate series. Distinctly recognizable primary circlet with enlarged primary plates present interradially. Peripheral border of each plate composed of 15–45 (typically 25–42) small granules, oval to quadrate (with rounded edges) in shape, forming discontinuous but regular. Larger plates with greater numbers of peripheral granules proximally with smaller distal plates bearing fewer accessory granules. Each abactinal plate surface covered with 20–200 (typically 50–150) low, glassy, crystalline granules, embedded in each plate surface arranged in regular rows, forming well-expressed sunburst pattern in larger individuals. Glassy granules weakly developed on smaller distal plates in contact with superomarginals, and interadially on some smaller individuals. Shallow grooves present between plates, slightly deeper between papulae on radial regions, shallower interradially. Papulae single, present radially only, absent interradially. Madreporite, flat to weakly convex, quadrate to polygonal, flanked by three to five abactinal plates with well-developed sulci. Pedicellariae with narrow tong-like to paddle-shaped blades, present primarily along radial regions. Alveolar pits present when pedicellariae are absent.

Marginal plates form distinct pentagonal boundary of abactinal surface, comprising 10–14% of the "r" distance (measured from disk center to edge of interradius). Marginal plates quadate in outline, swollen in profile. Each marginal plate with approximately 60–150 (typically about 80–100) quadrate, oval shaped accessory granules present in discontinuous but regular series around the periphery of each plate. Shallow grooves present between each plate and between marginals and abactinal and actinal plates. Superomarginals, eight to fourteen (typically eight), with direct correspondence to inferomarginals, 10 to 16 with slight offset distally near arm tips (Fig. 37A–F). Subterminal superomarginals enlarged, triangular in outline, swollen in larger specimens. Specimes at R= 3.6 and smaller with non-swollen, non-enlarged superomarginals similar to those present interradially. Some minor variation on specimens with individual arms lacking swollen subterminals but this character is present on most arms. Inferomarginals smaller, upturned with offset plates relative to superomarginals. Superomarginals covered by 60–150 (typically 80–100) widely spaced, deciduous granules, which become more densely packed on the lateral side of the superomarginal plate surface. Approximately 60 per plate surface at R=3.0 cm but R=120–140 at R=4.8 cm). Superomarginal contact with abactinal plate surface with less abundant granules, more widely spaced. Where granules are absent a granule-shaped pit is present on the superomarginal plate surface. Inferomarginals with 60–100 densely packed granules. Actinal facing granules are pointed and almost spinelet-like, similar to similar pointed granules on actinal plate field. Granules on lateral surface of inferomarginals more hemispherical and similar to those on superomarginal plate surface.

Pedicellariae similar to those on radial regions of abactinal plates present on abactinal-facing surface of superomarginal plate. These are not abundant and are present on superomarginal plate surface adjacent to the abactinal surface.

Actinal intermediate plates present in approximately four well-defined chevrons, becoming more jumbled in arragement distally. Actinal plates distinctly quadrate adjacent to adambulacrals but becoming more irregularly polygonal in shape adjacent to inferomarginal plate contact. Actinal plates covered by abundant, evenly spaced granules. Each actinal plate with a periphery of approximately 15–50 granules, with central plate surface covered by six to 70 granules (often 20–60). Actinal granules are more hemispherical and rounded in larger (R=4.8) individuals but more pointed in smaller specimens (R=3.0). Shallow grooves present among actinal plates-sometimes forming bisecting actinal triangular regions in half.

Adambulacral plates squarish to rectangular in outline, separated from other actinal intermediate plates by distinct fasciolar groove. Furrow spines, five to six laterally compressed to thickened, quadrate in cross-section with blunt tips arranged in straight to weakly curved line. Tips of furrow spines with some variable ornamentation, some with notched tips and some with smooth tips. Proximalmost furrow spine in series, half the length of the other furrow spines, sometimes clustering with other spinelets on adambulacral plate surface. Adambulacral plate surface covered by 15–20 thick, short, granular spinelets, quadrate to polygonal in cross-section, in regular widely spaced rows. Subambulacral spine rows three, adjacent to furrow spines with another row including four to five spines adjacent to actinal plates, all subambulacrals widely spaced. These spines are larger than those on actinal plate surface. Largest spines proximally adjacent to furrow spines becoming smaller as they approach the actinal plate spinelets. Narrow tong-like to paddle-shaped pedicellariae with thick lobate valves is present on the proximal surface of most adambulacral plate (absent on a minority of plates).

Each oral plate covered by 20–40 granular short spinelets, widely to closely spaced, thickened, quadrate to polygonal in cross-section. 12–18 spinelets present on edges of each paired oral plate surface sitting to each side of the tissue filled gap. Proximalmost spinelets thickest, largest and abutting against spines pointing into oral cavity.

Color in life is orange.

Material Examined

Holotype. USNM 21163. Pailolo Channel between Maui and Molokia, 507–519 m, Coll. USFC Steamer *Albatross* st. 3883. 1 wet spec. R=3.6, r=2.5.

Paratype. USNM 40359. North of Maui, 402–435 m Coll. USFC Steamer *Albatross* st. 4082. 1 wet spec. R= 2.0, r=1.2.

Paratype. USNM E9641. Pailolo Channel between Maui and Molokia, 468–518 m, Coll. USFC Steamer *Albatross* st. 3865.1 wet spec. R=2.6, r=2.0.

BPBM W3522. Penguin Banks, Molokai, Hawaiian Islands, 412 m. Coll. 28 Oct. 2002. 1 dry spec. R=3.1, r=2.1.

BPBM W3825. South of Mookai, 419–424 m. Coll. E.C. Jones, 26 Oct 1967. 1 wet spec. R=1.6, r=1.0.

CASIZ 172891 off Kona, Hawaii, 19°37'54.1 N, 156°2'12.1, W, 1314 m. 1 wet spec. R=2.2, 4=1.6.

CASIZ 172892 off Kona, Hawaii, 19°37'54.1 N, 156°2'12.1, W, 533 m. 1 wet spec. R=4.8, r=3.5.

In situ images examined

Hawaiian Islands, 19.28656309 166.6673603, 535.4 m. EX1606_IMG_20160812T231627Z_ROVHD_ASR.jpg

Hawaiian Islands, 22.75430248, -160.9288968, 448.7 m.

***Pohakuastra* gen. nov.**

Etymology

The genus is named for *pohaku* the Hawaiian word for "stone" and the feminine Greek for star, -*astra*.

Diagnosis

Body stellate to strongly stellate (R/r=2.3 to 3.2). Arms elongate. **Abactinal plates flat to weakly convex, with no surficial accessories, surface smooth to rough. Superomarginal plates tumid, abutted along midline for most of arm length with no abactinal plates extending onto arms. Superomarginal surface with few to no granules.** Inferomarginals with dense to few granules. **Actinal intermediate plates with granules. Furrow spines 7 to 9, not thick or massive.** Pedicellariae slender, paddle-like when present.

Included species. *Pohakuastra inculta* sp. nov. (type species), ***Pohakuastra flabellum* sp. nov., *Pohakuastra palmatus* sp. nov.**

Comments

Pohakuastra **gen. nov.** is established as a distinct genus with a stellate body form (R/r=2.2–3.2) with elongate arms, the presence of bare abactinal plates, enlarged peripheral granules, and, between 20 to 40 tumid superomarginal plates each with either a bare, smooth surface or relatively few marginal plate granules, superomarginals abutted with abactinal plates absent on the arm, actinal granulation, paddle-shaped pedicellariae and 7 to 9 furrow spines. Adambulacral spination, including furrow and subambulacral spines are relatively narrow and not massive as in *Pergamaster*.

Some characters observed in *Pohakuastra* **gen. nov.** such as the presence of bare abactinal plates are observed in other goniasterids. The stellate shape with elongate arms and relatively large number of marginal plates sets *Pohakuastra* distinctly apart from the more pentagonal taxa with bare abactinal and superomarginal plates such as *Eknomiaster* and *Glyphodiscus*. *Pawsonaster,* in addition to its pentagonal body form with few marginal plates also has shallow fasciolar grooves, an articulated ring of peripheral granules and variably possesses distinct coarse granules on the abactinal plates. *Okeanosaster*, while similar in body shape, R/r=2.22 has much fewer abactinal plates along its arm that extend to the arm terminus, no surficial granules on either the

superomarginal or inferomarginal surface and has an actinal surface completely covered by granules, lacking pedicellariae.

More similar in overall appearance to *Pohakuastra* are *Wallastra* and *Pergamaster*. *Wallastra* has multiple abactinal arm plates present along its elongate arms with many more, n=62–66, marginal plates per interradius, a more strongly stellate body form, R/r=3.46, and the presence of bivalve pedicellariae on the surface of each actinal plate. *Pohakuastra* **gen. nov.** is most similar with the Antarctic *Pergamaster* which also demonstrates those characters but differs in displaying extremely large actinal granules, inferomarginals without a granule-covered surface, and with much larger, thicker adambulacral spination.

The morphological distinctions between the two genera, which share abactinal characters but with several differing actinal and adambulacral characters show apparent association between the Antarctic *Pergamaster* species and the non-Antarctic *Pohakuastra* species.

Key to *Pergamaster* and *Pohakuastra* species

(0) Subambulacral and furrow spines large, thick and very prominent, 2 or 3 per plate, 3 to 4 in *P. ultra.* Actinal granulation, when present very large, approximately 1.0 mm each. Inferomarginal plates bare with large quadrate peripheral granulation. Pedicellariae absent. Only from high-latitudes, Antarctica and adjacent.....*Pergamaster*

(0') Subambulacral and furrow spines, 7 to 9 and actinal granulation relatively fine and more numerous on plate surface or replaced by a paddle-like pedicellariae. Inferomarginal plates with smaller, inconspicuous peripheral granulation. Pedicellariae present, but sparingly present in *Pohakuastra inculta* **sp. nov.** .... *Pohakuastra* **gen. nov.** (1)

(1) Actinal plates with rough-tipped or spiny granules. Furrow spines 7 to 9 ..... ***Pohakuastra inculta* sp. nov.**

(1') Actinal plates lacking granules, a single pedicellariae present centrally on each. Furrow spines 6 to 7 .....(2)

(2) Actinal pedicellariae wide .... ***Pohakuastra flabellum* sp. nov.**

(2') Actinal pedicellariae narrow..... ..... ***Pohakuastra palmatus* sp. nov.**

Pohakuastra flabellum sp. nov.

FIGURE 38A–F

Etymology

The species epithet *flabellum* is derived from the Latin for "fan" alluding to the shape of each pedicellariae valve.

Diagnosis

Body stout, strongly stellate (R/r=2.3). Arms elongate, disk broad. Interradial arcs weakly curved. Smooth abactinal, marginal plates. Superomarginal plates abutted along midline. **Actinal plates with few to no granules, but each plate with a single wide, fan-shaped pedicellariae.** Furrow spines six or seven, blunt tipped, each quadrate in cross-section. A prominent space separates the subambulacral accessories. Subambulacral accessories include a large jaw-like pedicellariae with three to four teeth on each valve present proximally on the plate surface and a large thick spine approximately 1.5–2x as thick as each furrow spine present distally to the pedicellariae on the adambulacral plate.

Comments

Within *Pohakuastra,* this species most resembles *P. palmatus* in that a prominent pedicellariae is present on each actinal plate (Fig. 38F). Although pedicellariae shape appears to be the most distinct character difference, other character differences, such as the number of superomarginal plates in contact with the abactinal plate surface also appear to vary between specimens with comparable size (6 plates at R=2.8 cm in *P. flabellum* versus 8 at R=3.3 in *P. palmatus*). The presence of pedicellariae rather than granules on the actinal plate surface would suggest that *P. flabellum* and *P. palmatus* are more closely related to one another than to *P. inculta* and *P. ultra.*

Occurrence/Distribution

New Caledonia, 680–980 m.

Description

Body stout, strongly stellate (R/r=2.3). Arms elongate, disk broad. Interradial arcs weakly curved (Fig. 38A, D).

Abactinal surface flat forming abutted pavement. Surface mostly devoid of accessories. Abactinal plates round to polygonal, present only on disk, mostly absent from arms save for one or two small, irregular plates present between distal, smaller superomarginals. Six superomarginal plates in contact with free abactinal plates (Fig. 38A). Primary and carinal plates tend to be larger, rounder. Interradial plates smaller more ovoid distally, adjacent to superomarginal contact. Abactinal surface bare and smooth but a minority of plates with one small granule on plate surface. Most plates flat but with a minority of plates showing weak convexity. Small oval granules, 10–50 surround each plate. Pedicellariae not observed.

Madreporite pentagonal with deep sulci, flanked by four abactinal plates. Papulae present radially, approximately six to a plate but absent interradially. Anus covered by eight to 10 coarse granules.

Marginal plates form distinct peripheral frame, numbering 20 per interradius (Fig. 38A, C). Each plate elongate in outline with strongly convex surface, round in cross-section. Superomarginals show 1:1 correspondence with inferomarginals but slightly offset showing zigzag contact between them. Superomarginal and inferomarginal surfaces with 10–20 widely spaced coarse granules. Each marginal with approximately 10–20 granules per side, each granule also widely spaced from one another. Granules more densely arranged on actinal surface of inferomarginals. The distalmost seven superomarginal plates abutting over midline on arm with eighth displaying

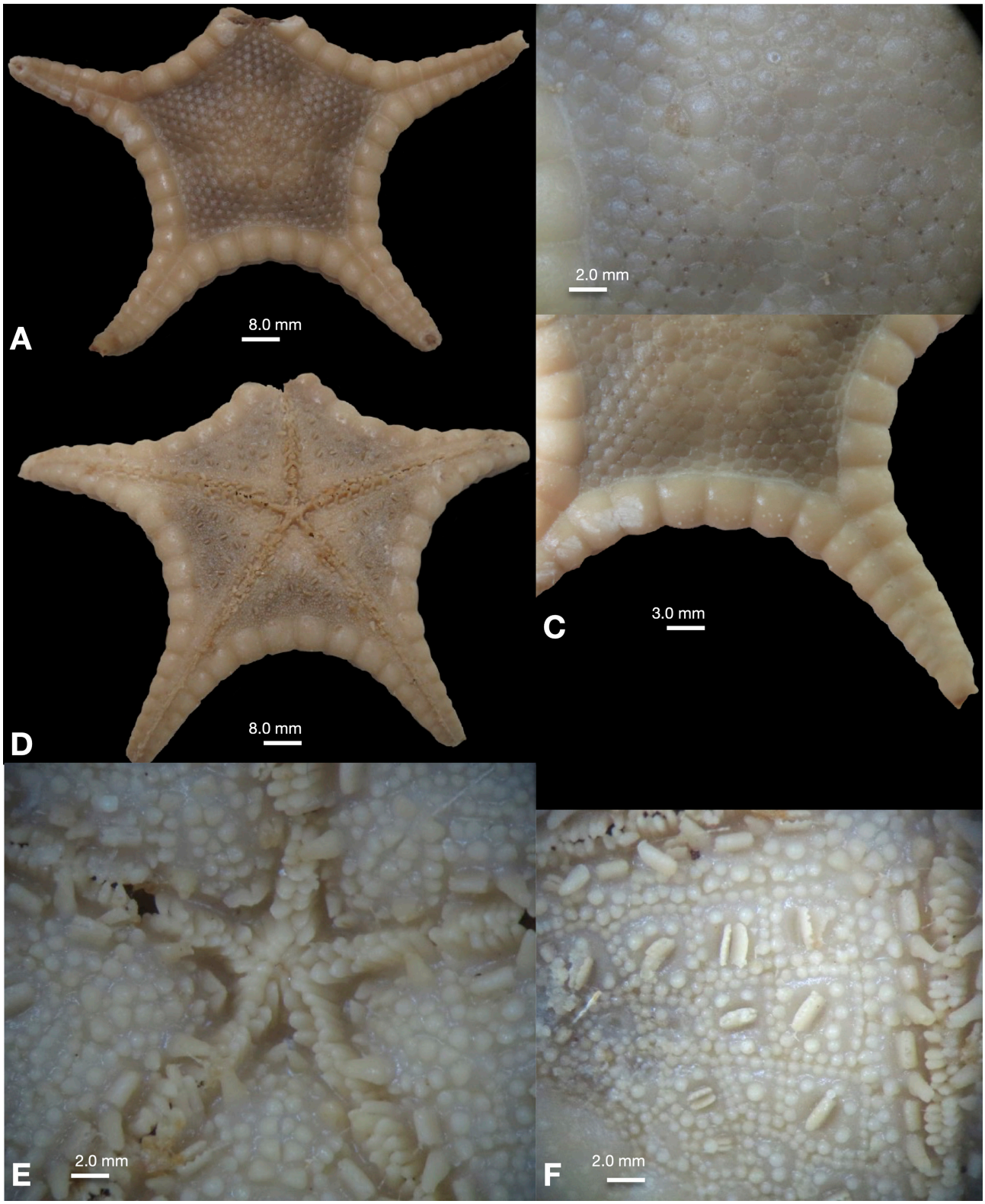

FIGURE 38. ***Pohakuastra flabellum*** **sp. nov.** MNHN IE-2013-4742A. Abactinal. B. Abactinal closeup. C. Abactinal-superomarginal D. Actinal E. Oral region. F. Actinal area showing pedicellariae.

partial contact at arm base. Inferomarginal contact with actinal plate region straight to weakly convex.

Actinal plate surface composed of adambulacral plus approximately 2.5 plate series in chevron series. Actinal plates are quadrate to polygonal but with distinct angular edges. Plates adjacent to inferomarginals more irregular to triangular whereas those adjacent to the adambulacrals are more quadrate. Each plate surface with a single, large flytrap-shaped pedicellariae, occupying the center of each actinal plate (Fig. 38D). Each valve with six to eight teeth. One or two coarse granules present on a minority of plates in addition to the pedicellariae. On plates where

pedicellariae are absent, these granules are twice to three times as large and occupy the whole of the plate. Each plate with six to eight, large, coarse, pointed granules.

Shallow fasciolar grooves present.

Furrow spines six or seven, blunt tipped, each quadrate in cross-section. A prominent space separates the subambulacral accessories (Fig. 38E, F). Subambulacral accessories include a large jaw-like pedicellariae with three to four teeth on each valve present proximally on the plate surface and a large thick spine approximately 1.5–2x as thick as each furrow spine present distally to the pedicellariae on the adambulacral plate. Three to nine large, polygonal subambulacral granules present on adambulacral plate adjacent to actinal plate surface. One to three of these granules two to four times thicker and larger than the others, sitting behind the pedicellariae. Pedicellariae decrease in size becoming nearly actinal granule-like in size on arm. Adambulacral plates along arm also show replacement by pedicellariae with large, coarse granule. Oral plates with eleven furrow spines, narrower than those on post-oral adambulacrals with blunt, rounded tips, quadrate in cross-section. One larger, elongate blunt spine per oral plate projecting into oral cavity. Oral plate surfaces each covered with 15–20 large, jagged granules. Eight of the larger granules paired against its counterpart along each oral plate.

Material Examined

MNHN IE-2013-4742, Porthos (3 Musketeers) Seamount, New Caledonia region. 25.330'S, 168.956'E, 680–980 m, Coll. NORFOLK 2 DW 2068, 26 Oct 2003. 1 wet spec. R=2.8, r=1.2.

Pohakuastra inculta sp. nov.

FIGURE 39A–E

Etymology

The species epithet *inculta* is Latin for "unpolished" alluding to the rough tips on the actinal surface.

Diagnosis

Body strongly stellate (R:r=2.6–3.2). Interradial arcs straight, arms elongate, triangular, tapering rapidly. Abactinal plates polygonal, surface smooth, no accessories. Superomarginal plates abutted over midline, no accessories on superomarginal plate surface. Inferomarginal lateral-ventral surface covered with granules save for a distinct strongly tumid bare patch, irregularly shaped on interradial plates. **Plates with actinal granulation, 6–30 granules each spiny tipped.** Furrow spines seven to nine (mostly seven). Furrow spines blunt, oval in cross-section. First row of subambulacrals, three or four in number, **adjacent to furrow spines are twice as thick as each furrow spine with a blunt or wedge-like tip**. Pedicellariae few, when present, small and tong-shaped.

Comments

Abactinal characters on *Pohakuastra* appear to be much more similar than characters on the actinal surface with *P. inculta* **sp. nov.** displaying very similar abactinal and marginal plates to *P. flabellum* **sp. nov.** and *P. palmatus* **sp. nov.** *Pohakuastra inculta* shares several characters with *Pergamaster* species, including the naked abactinal and marginal plates and the granule-covered actinal plates.

Occurrence/Distribution

New Caledonia, 569–1000 m.

Description

Body stout, strongly stellate (R:r=2.6–3.2). Interradial arcs straight, arms triangular, tapering rapidly (Fig. 39A).

Abactinal plates extending onto proximal arm regions but not extending very far onto arms (Fig. 39C). Surface flat, composed of plates, round to polygonal in outline (Fig. 39B). Larger plates proximally becoming smaller and more irregular adjacent to the contact with the superomarginal boundary. Abactinal plate surface convex, especially centrally on the disk, sometimes with grooved or textured but otherwise smooth surface. For the majority of plates, no granules or other accessory ornamentation present, save for those forming the periphery and the granules on the radial regions. Abactinal plates with 10–40 round, peripheral granules surrounding each plate. Peripheral granules from each plate in contact, forming basal ring around dome-like abactinal plates. Radial regions with four to 12 coarse, slightly larger round granules on plate periphery adjacent to peripheral granules. Carinal series poorly defined. Madreporite triangular, with deep sulci, flanked by four abactinal plates, each sharing contact with six to eight peripheral granules. No pedicellariae observed.

Marginal plates form distinct border around body (Fig. 39A, C). Elongate interradially becoming more quadrate in outline distally. Marginal plate surface is strongly convex in cross-section. Superomarginals are mostly 1:1 with inferomarginals interradially but show offset correspondence with inferomarginals with zig-zag like contact more distally, especially on arms. Superomarginals 36–38, inferomarginals 38–40, from arm tip to arm tip. Smaller indivdiuals (R=3.2) with 24 (arm tip to arm tip). Superomarginals with completely bare, smooth surfaces, sometimes with grooves or superficial textures. Superomarginals very distinctly tumid, forming a "bumpy" outline in each interradius. Inferomarginal surfaces interradially, approximately twelve per interradius, mostly covered by small, round granules on ventral and lateral surface, these granules identical to those on the periphery. Each of the inferomarginal interradial plates with an irregularly shaped, strongly tumid bare patch, devoid of granules. More distal inferomarginal plates are bare with no granules on surface. Plates surrounded by small, quadrate to round granules, approximately 130–160 total, in single close-set series. Superomarginal plates directly abutting across midline on arm, forming a one to one or sometimes zig-zag contact between plates. Eight to nine superomarginal plates in contact with abactinal plate region in each interradius.Smaller individuals (R=3.2) with only six. No pedicellariae observed. There are irregular, smaller marginal plates present between plates in a minority of instances.

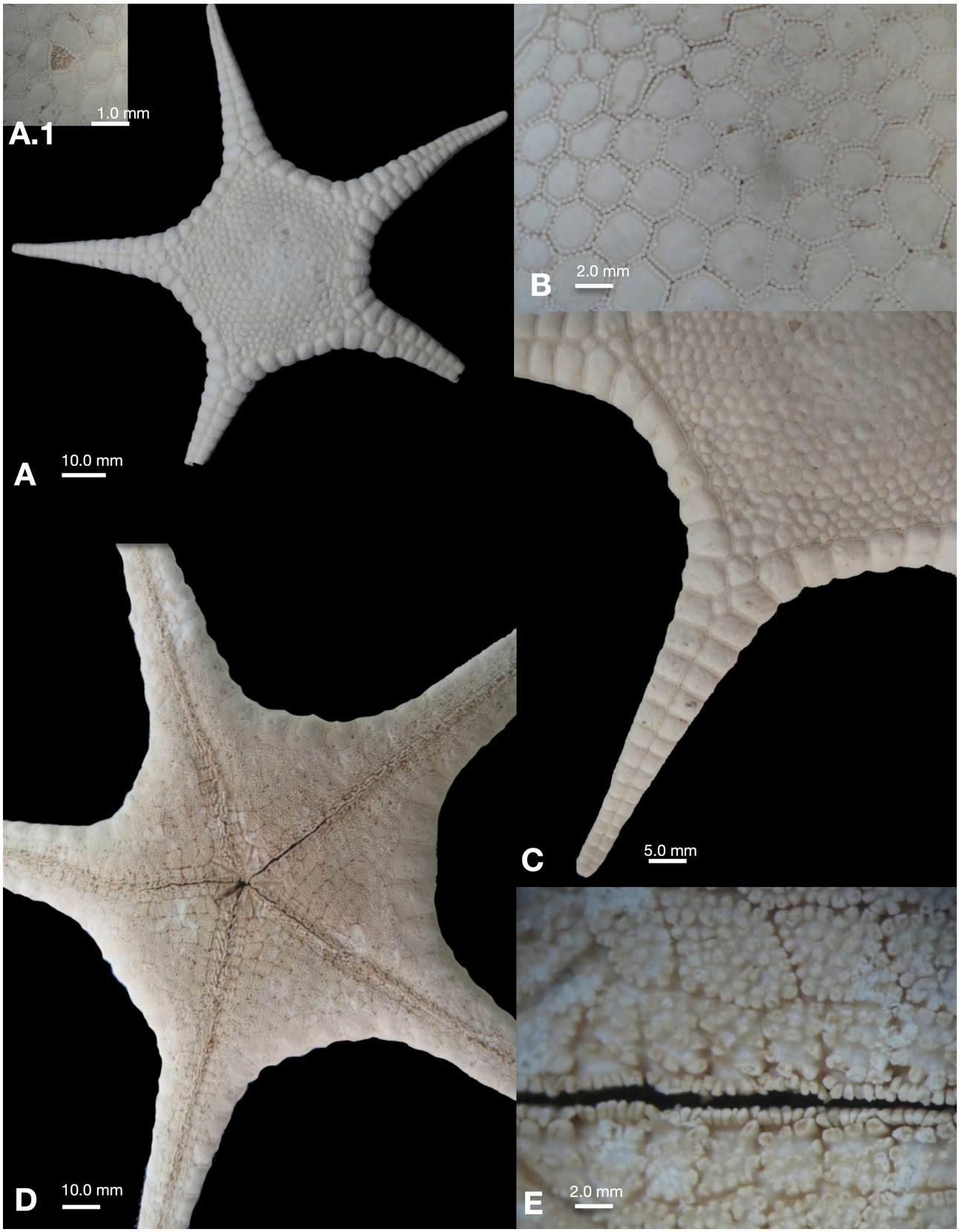

FIGURE 39. ***Pohakuastra inculta*** **sp. nov.** MNHN IE-2013-4707. A. Abactinal. inset: madreporite. B. Abactinal closeup. C. Abactinal-superomarginal plates. D. Actinal. E. Adambulacral furrow.

Actinal surface composed of three to four chevrons composed of quadrate to irregularly shaped plates (Fig. 39D). Actinal plates extending only to basal region of each arm. Each plate surface covered by 6 to 30 coarse, evenly spaced round to polygonal shaped, pointed granules. Approximately 10–40 granules around the periphery of each plate. Granules are evenly distributed on each plate in ordered rows. Pedicellariae not observed.

Adambulacral plates quadrate to rectangular in outline. Furrow spines 7 to 9(mostly seven) (Fig. 39E). Furrow spines blunt, oval in cross-section. First row of subambulacrals, three or four in number, adjacent to furrow spines are twice as thick as each furrow spine with a blunt or wedge-like tip. Subsequent two rows of adambulacral granules identical in number with short, pointed spinelets, becoming smaller as they approach the actinal surface. All spination/accessory structures on adambulacral plates in three or four ordered, well-spaced rows. Furrow spines, nine on mouth plates, similar in appearance to other furrow spines, each with blunt tip. Mouth plate surface with five or six large blunt spines, twice as thick and about 15% taller than furrow spines. Remaining mouth plate surface covered by five or six widely spaced smaller spinelet like granules. Each mouth plate pair separated by a very distinct groove between plates. Small (~1.0 mm) tong-like pedicellariae present on actinal plates adjacent to oral plates.

Material Examined

Holotype. MNHN IE-2013-4707, Zorro Seamount, New Caledonia region, 25.344'S, 168.309'E, 666–1000 m. Coll. NORFOLK 2, DW 2077, 27 Oct 2003. 1 dry spec. R=5.4, r=1.7.

Paratypes. MNHN IE-2013-5757, Zorro Seamount, New Caledonia region, 25.345'S, 168.310'E, 654–877 m. Coll. NORFOLK 2 DW 2078, 27 Oct 2013. 6 wet specs. R=4.4, r=1.5; R=5.7, r=2.1:R=5.2, r=1.8; R=3.9, r=1.7 (arms broken); R=4.1, r=1.4; R=3.2, r=1.2.

MNHN IE-2007-5631 New Caledonia, 21º06'S 160º 46'E, 569–583 m Coll. EBISCO, 21 Oct. 2005, DW 2629, 1 wet spec. R=2.5, r=1.3.

Pohakuastra palmatus sp. nov.

FIGURE 40A–F

Etymology

The species epithet *palmatus* is derived from the Latin for "palm" referring to the pedicellariae shape, which resembles the palm of a hand.

Diagnosis

Abactinal plates bare, limited to disk. Superomarginal plates abutted over midline across arm length. Superomarginal plates with round granules, 2 to 4, widely spaced on weakly raised surfaces, otherwise surfaces devoid of accessories. No actinal granulation. **Single pedicellaria, narrow, spoon-like, with widely spaced tooth-like points on each valve, present on central actinal and adambulacral plates.**

Comments

A species identified by the presence of palm-shaped pedicellariae present on each actinal plate (Fig. 40E), similar in overall form to *P. flabellum* **sp. nov.** in terms of abactinal and marginal plates and the absence of accessories.

Occurrence/Distribution

New Caledonia, 920–930 m.

Description

Body stellate, R/r=2.53, arms elongate, interradial arcs weakly curved. Two arms with damage in the process of regrowth (Fig. 40A, D).

Abactinal plates irregularly polygonal to round, surface flat, bare, with no surficial granules (Fig. 40B) or other accessories but weakly textured (i.e. not bare). Plates variable in size with largest plates 10–25% the diameter of smallest plates (Fig. 40B–C). No abactinal plates on arms (Fig. 40A, C). Superomarginal plates showing free edge in contact with abactinal plates number 8 to 9. Peripheral granules, 10–30, mostly with 15–20, irregular to quadrate in shape, forming distinct border around each plate, comprising approximately 16 to 17% (2/12 mm) of total diameter. Papulae present on radial regions at plate corners. Pedicellariae with slender valves, alveolar pit, but very few, only 1 or 2 observed on each interradius. Madreporite irregularly pentagonal, flanked by four adjacent plates.

Superomarginal plates 10–11 per arm (20–22 per interradius, arm tip to arm tip), including 5–6 superomarginals free and in contact with abactinal surface, 9–10 superomarginals abutted over midline along each arm (Fig. 40A). Marginal plate surfaces mostly bare save for granules, 2 to 4 present on plate present on dorsolateral surface (fig. 40A, C). Inferomarginals with greater numbers of granules, 10–20, mostly 13–15 in addition to pedicellariae, paddle shaped all position on ventral face of each plate. Peripheral granules, approximately 15–20 per side, shallow fascicle present between plates.

Actinal intermediate region small, approximately 2 full series, one irregular, but all present only on disk, none other than adambulacral plates extending onto arm from disk. Actinal plates bare but those proximally each with a single pedicellariae with slender paddle or spoon-shaped valves, each with approximately 4 small teeth, located centrally on each plate (Fig. 40E). Distal plates adjacent to inferomarginals bare.

Furrow spines 6 to 7, mostly 6, blunt-tipped (Fig. 40E). Adjacent to furrow spines, on distal side is a large single spine approximately twice the thickness and height of those on the furrow. Proximally is a pedicellariae, paddle-shaped similar in size to adjacent actinal spination. Remainder of adambulacral plate with approximately pointed triangular spines, 10–12 per plate.

Oral plates with approximately 10–12 furrow spines, blunt, pointed, subambulacral spines 3, triangular in shape, pointed (Fig. 39E). Spines, six present over central diastema between oral plates. Short pointed granules, 3 to 5 present on oral plate surface, otherwise smooth, devoid of accessories.

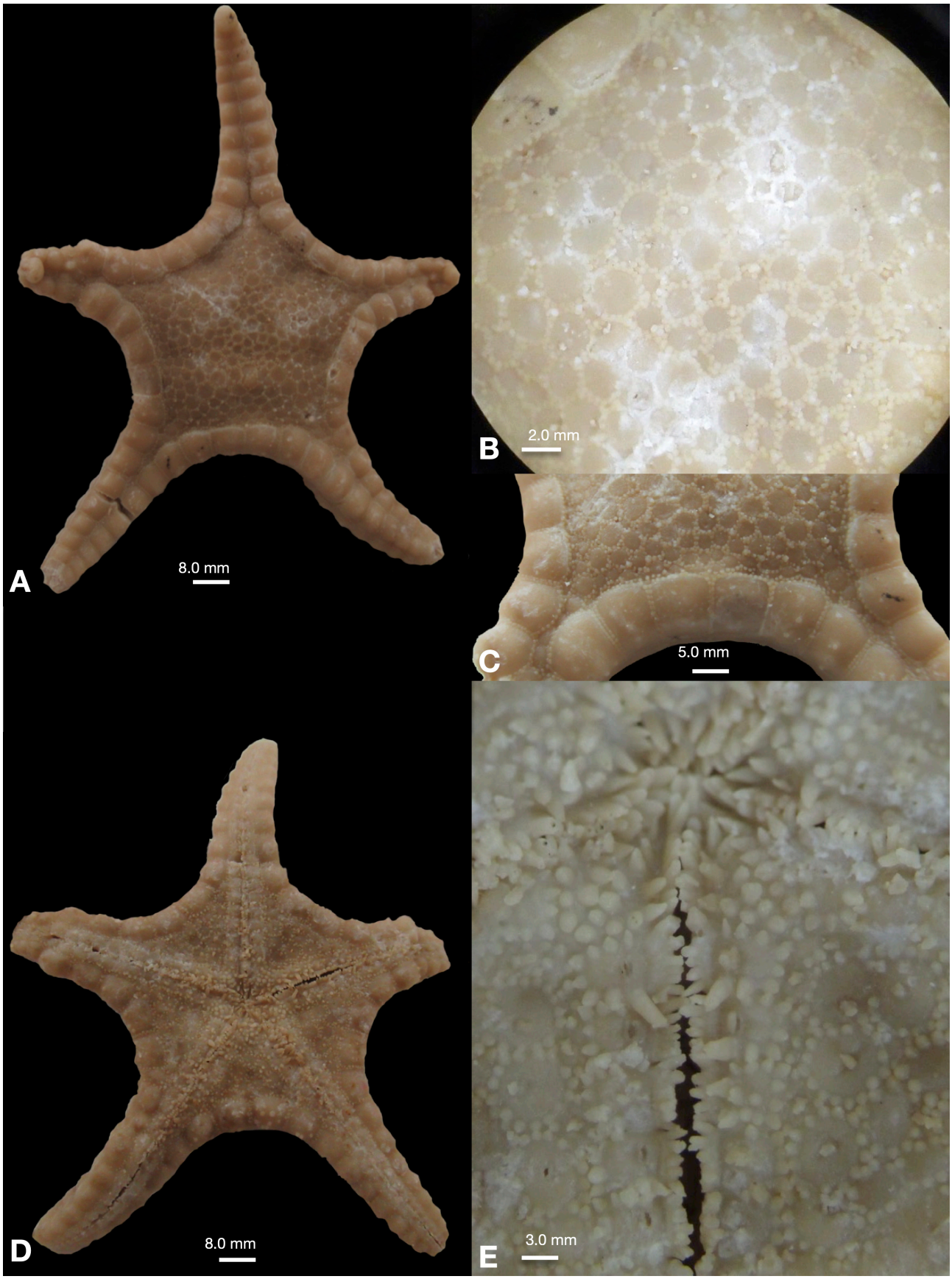

FIGURE 40. ***Pohakuastra palmatus*** **sp. nov.** MNHN IE-2013-4742. A. Abactinal. B.Abactinal closeup. C. Abactinal-superomarginal close. D. Actinal E. Actinal-oral furrow.

Material Examined
Holotype. MNHN IE-2013-1813, "Austral Islands" 22º37'S 152º49'E, 920–930 m. coll. BENTHAUS DW 2020 25.11. 2002. 1 wet spec. R=3.3 r=1.3.

Pseudoceramaster Jangoux 1981b

Pseudoceramaster Jangoux, 1981b: 472; H.E.S., Clark & McKnight 2001: 124; Mah 2024: 24.

Diagnosis
Body stellate, arms triangular, elongate, interradial arcs curved to straight. **Abactinal plates abutted, weakly convex, relatively flat, not tabulate. Abactinal, marginal and actinal plates with abundant granular cover, obscuring plate boundaries.** Adambulacral plates with ordered spine series, furrow spines long and slender.

Comments
A genus that includes 5 species present throughout the Indo-Pacific. Jangoux (1981) described *Pseudoceramaster regularis* from the Philippines, including two other species, P. *misakiensis* from Japan and *P. pulvinus* from the Indian Ocean. More recently, McKnight described *P. hunti* from Three Kings Rise, north of New Zealand (McKnight 1993, H.E.S. Clark, 2001) and Mah *et al.* (2024) described *P. doto* from southern Japan. All species recorded from moderately deep-settings, 174–505 m. Species display rather generalized characters with abutted round to polygonal abactinal plates with a dense granular cover that overlies abactinal and marginal plate surfaces.

Pseudoceramaster hunti McKnight 1993
FIGURE 41A–E

Pseudoceramaster hunti McKnight 1993: 171, figs. 3,4.

Diagnosis
Modified from H.E.S. Clark & McKnight (2001). Body stellate, R/r =2.5, arms elongate, triangular. Interradial arcs curved. **Abactinal plates abutted, large, polygonal to irregular in shape, plates covered by round to polygonal granules, 5 to 20, centrally and 12 to 20 peripheral granules. Granules are closely distributed but evenly spaced, obscuring boundaries between plates** (Fig. 41A, B)**.** Abactinal plates extend from disk to along most of arm distance, with distalmost 9 to 10 superomarginals abutted. **Marginal plates 35–37 per interradius, arm tip to arm tip** (Fig. 41A). Distalmost superomarginals with distinct, irregularly shaped bald spot present. Actinal plates quadrate in shape, boundaries obscured by granules. Slender alveolar pedicellariae present proximally on actinal plates adjacent to oral region and on actinal plates irregularly adjacent to the adambulacral furrow. **Furrow spines, 5 to 8, subambulacral spines large, 2X the width of adjacent furrow spines, but slightly shorter** (Fig. 41D, E)**.** Remaining of adambulacral plates in 3 series, each with 3 to 5 quadrate granules bearing denticulate tips.

Comments
Specimens of *Pseudoceramaster hunti* from New Caledonia were consistent with the description from H.E.S. Clark & McKnight (2001) in displaying a similar number of marginal plates per interradius, and a continuous cover of granules over the abactinal and marginal plate surfaces. Where abactinal and marginal plates are lacking granules, the plate surfaces appear relatively smooth and featureless in contrast to those in *Pseudoceramaster triangularis* **sp. nov.** which display weakly evident pitting resulting from abraded granules. Furrow spines in *P. hunti* are also slightly higher than those in *P. triangularis* along with many more marginal plates.

Based on a comparison between *P. hunti* and other species of *Pseduoceramaster*, *P. hunti,* shares a nearly identical number of marginal plates present per interradius with the Philippine *Pseudoceramaster regularis*, approximately 34 to 37 as well as overlapping numbers of furrow spines and granulation on abactinal and marginal plate surfaces. However, H.E.S. Clark and McKnight (2001) observed that there are two different types of granule types in *P. regularis* as well as a differing number and arrangement of subambulacral spines which could suggest separate species. Further specimens and additional understanding of variation between these species is desirable.

Distribution/Occurrence
North of New Zealand, New Caledonia,

Material Examined
MNHN IE-2013-7000 New Caledonia 22º56'3"S 167º 14'4"E, 398–410 m. Coll. Richer de Forges, VARUBAN dr. 5, 17 Sept. 1986. 1 dry spec. R=5.6 r=2.2.

Pseudoceramaster triangularis sp. nov.
FIGURE 42A–E

Etymology
The species epithet "triangularis" alludes to the triangular arms observed in this species.

Diagnosis
Body stellate, R/r=2.1, arms triangular, relatively short. Abactinal plates polygonal in shape, abutted, plates largely homogeneous in shape, primarily on disk attenuating to few or a single row on arms as superomarginals abut for most of arm distance. Abactinal surface covered by relatively coarse granules, 1 or 2 count along a 2.0 mm line, approximately 10–30, leaving below them underlying pitting where granules have been abraded. Marginal plates 15 to 16 per interradius, arm tip to arm tip at R=1.9. Plate periphery wide, forming approximately 20% of distance "r" on disk. Superomarginal and inferomarginal plates covered by granules identical to those on abactinal surface, but have been abraded leaving pebbly texture on

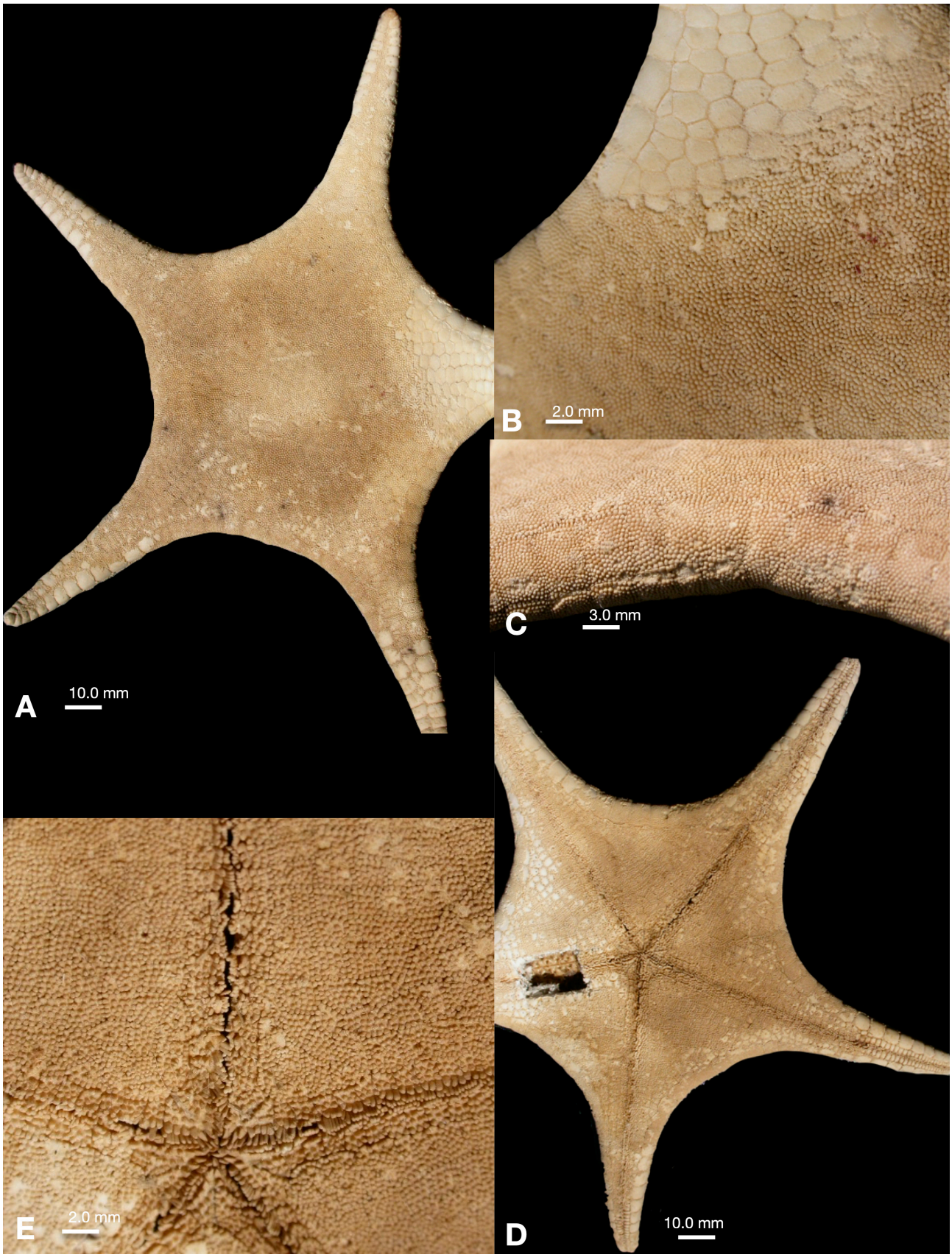

FIGURE 41. ***Pseudoceramaster hunti*** Clark & McKnight, 2001. MNHN IE-2013-7000, A. Abactinal. B. Abactinal surface, close. C. Arms and surface superomarginal plates. D. Actinal. E. Closeup actinal surface, mouth & furrow.

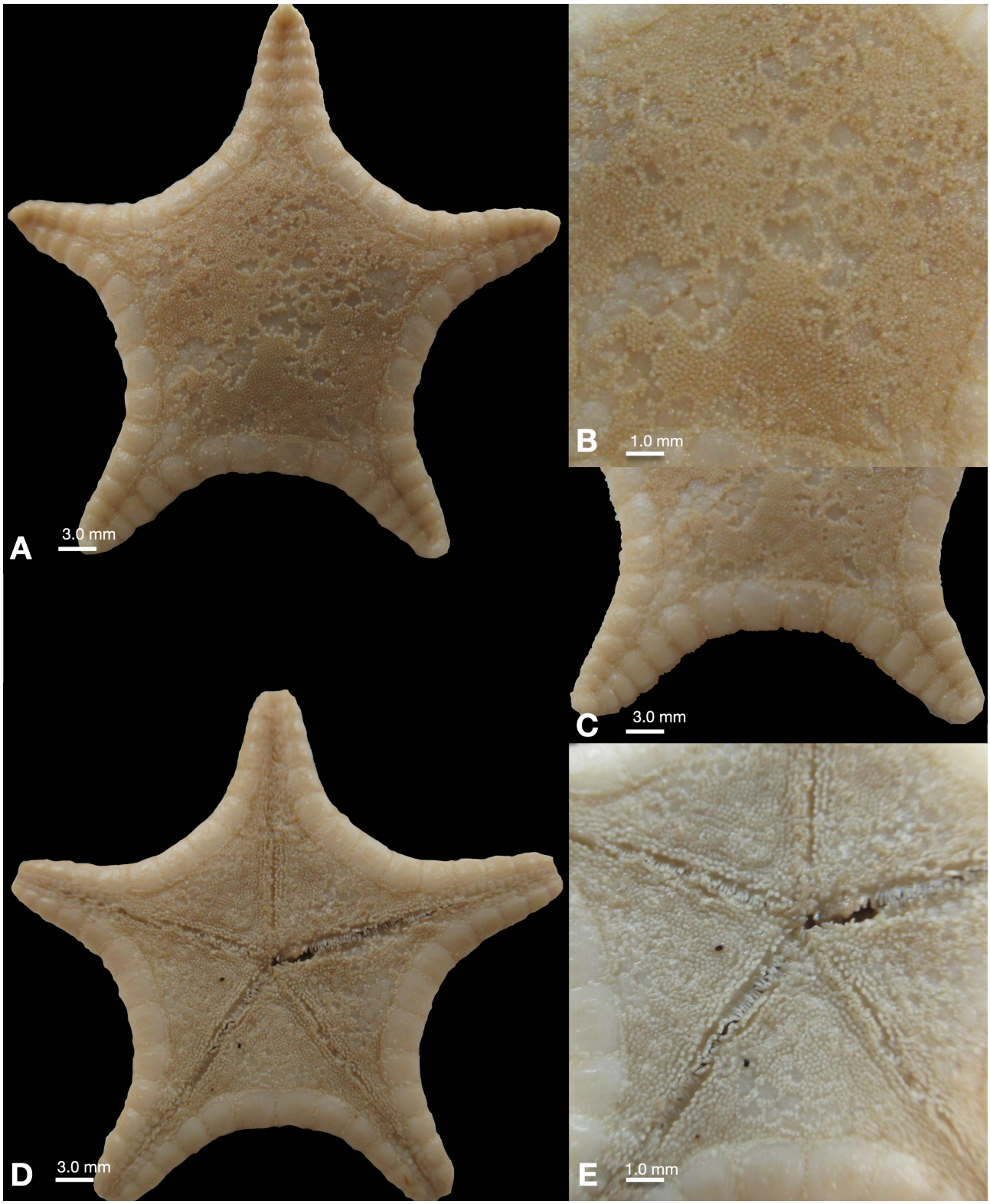

FIGURE 42. ***Pseudoceramaster triangularis*** **sp. nov.** MNHN IE-2013-7337, A. Abactinal. B. Abactinal surface, close. C. Abactinal and superomarginal plate surface D. Actinal. E. Closeup actinal surface, mouth & furrow.

plate surface. Actinal plates covered by small granules, 10–30 similar to those on abactinal surface., rounded but evenly spaced on each plate, but densely arranged, weakly appearing to block underlying plate contours. No pedicellariae observed. Furrow spines, mostly 4, blunt tipped in straight series. Approximately two rows of subambulacral spines, granule-like, approximately 3 to 4 in each series.

Comments

Pseudoceramaster triangularis **sp. nov.** possesses large polygonal, abutted plates with a continuous covering

of granules overlying the abactinal and marginal plate surfaces (abraded in the holotype) (Fig. 42A, B) and is distinguished by having only approximately 15 marginal plates per interradii and distinct triangular shaped arms each with abutted marginal plates (Fig. 42A, D). This differs from *Pseudoceramaster hunti* and *P. regularis* which both have 34 to 37 marginal plates per interradius (at approximately R=5.0 to 5.6). *Pseudoceramaster regularis* has two types of surficial granules present on the abactinal plates separated into central and peripheral positions whereas *P. triangularis* has a largely uniform and continuous covering over the abactinal plate surface. The distinct, shorter triangular shaped arms set *P. triangularis* apart from other species which have more elongate arms.

Distribution/Occurrence
New Caledonia, 410–440 m.

Description
Body stellate, R/r=2.1, arms triangular, relatively short. Interradial arcs weakly curved to straight.

Abactinal plates polygonal in shape, abutted, plates largely homogeneous in shape, primarily on disk attenuating to few or a single row on arms as superomarginals abut for most of arm distance (Fig. 42A). Abactinal surface covered by relatively coarse granules, 1 or 2 count along a 2.0 mm line, approximately 10–30, leaving below them underlying pitting where granules have been abraded. Granular cover is continuous, obscuring boundaries between underlying plates (Fig. 42A, B). Madreporite polygonal, flanked by 3 to 5 plates. No pedicellariae.

Marginal plates 15 to 16 per interradius, arm tip to arm tip (Fig. 42A). Plate periphery wide, forming approximately 20% of distance "r" on disk. Superomarginal and inferomarginal plates covered by granules identical to those on abactinal surface, but have been abraded leaving pebbly texture on plate surface. Distalmost superomarginals directly abutted over midline on arm but with approximately 9 superomarginals not in contact with another superomarginal along arms and disk. Marginal plates proximally more quadrate in shape, becoming more elongate distally. Inferomarginal surface with a small raised quadrate region centrally on each plate where granules are absent. Terminal plate bare, round, diamond shaped.

Actinal region in approximately 3 to 4 series, each plate quadrate to polygonal in shape, arranged in chevron like series (Fig. 42D, E). Actinal plates covered by small granules, 10–30 similar to those on abactinal surface., rounded but evenly spaced on each plate, but densely arranged, weakly appearing to block underlying plate contours. No pedicellariae observed.

Furrow spines, mostly 4, blunt tipped in straight series. Approximately two rows of subambulacral spines, granule-like, approximately 3 to 4 in each series (Fig. 42E). Furrow spines set off from subambulacral series by diastema. Subambulacral spines becoming confluent with actinal granules. Oral plate furrow spines 6 to 8, surface covered by granules similar to those on actinal surface.

Material Examined
Holotype. MNHN IE-2013-7337, New Caledonia, 23º45'S 168º16'E, 410–440 m Coll. TERRASSES, DW 3053, 19 Oct 2008, 1 wet spec. R=1.9 r=0.9 cm.

Rhianastra Mah, 2024

Diagnosis
Strongly stellate body form with sharply triangular arms ending in strongly tapering tips. Arms five, but with one Atlantic specimen showing six. **Abactinal plates tabulate, papular region along six to seven series from disc to arm tip along central radius along arm. Surface covered by dense covering of granules (approximately 3 to 8 count along a 1.0 mm line). Marginal plates, approximately 60–80 per interradius, quadrate in shape, covered by granules**. Furrow spines, 8 to 11, narrow, blunt with square tips in straight to weakly furrow formation. Subambulacral spines adjacent to furrow spines, with 4 to 6 spines, approximately twice as thick as each furrow spine.

Comments
Rhianastra was first described from deep-sea settings in the North Atlantic (Mah 2024) and was known from only a single specimen, but observed twice. It displays a broadly generalized appearance that invites comparison with both Goniasteridae and members of Paxillosida, such as *Ceramaster* and *Pseudarchaster*, respectively.

Rhianastra kanadeepae sp. nov.
FIGURE 43A–F

Etymology
This species is named for the KANADEEP expeditions, whose explorations resulted in the discovery of this and other new deep-sea species. Gender is feminine.

Diagnosis
Body strongly stellate (R/r=6.4), **abactinal surface covered by abundant granules, approximately 6 to 8 count along a 1.0 mm line.** Interradial abactinal plates forming distinct linear series tracking from the central radial series to contact with the superomarginals. **Marginal plates 70–80 per interradius at R=9.3, both superomarginal an inferomarginal plate surface covered by granules. Furrow spines 10–11, subambulacral spines 5 to 6, with bivalve or incipient pedicellariae on adambulacral plates**

Comments
Rhianaster **sp. nov.** is the second species described for this genus and the first from the Pacific. Depth occurrence for the two species is consistent with the Atlantic *Rhianaster isosceles* at 1752–1878 m and *Rhianaster* **sp. nov.** at comparable but shallower depth of 1493–1508 m.

The two species differ on the basis of differing characters, furrow spines in *Rhianaster* **sp. nov.** are

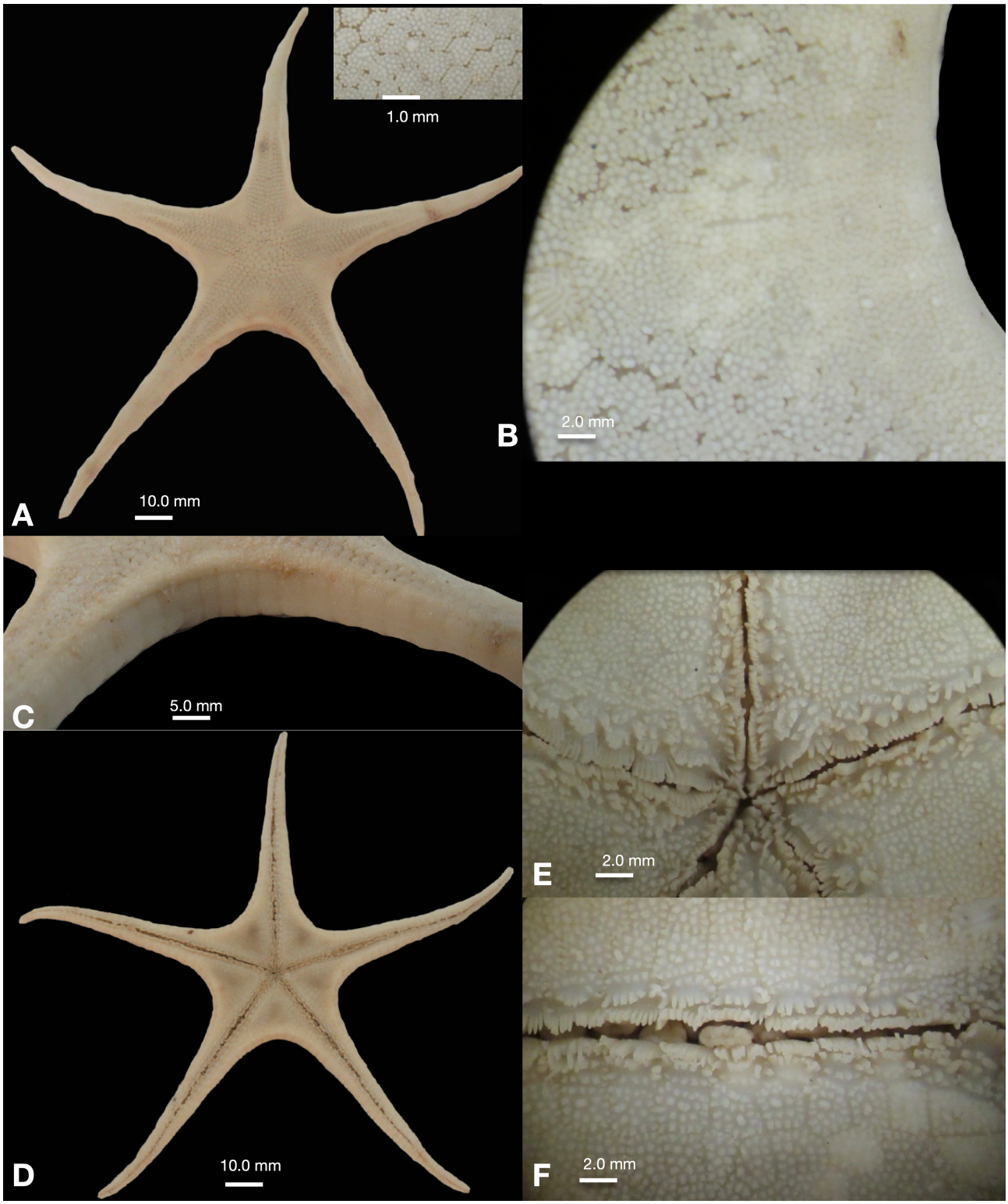

FIGURE 43. ***Rhianastra kanadeepae*** **sp. nov.** MNHN IE-2013-7112. A. Abactinal. inset: plate detail. B. Abactinal plates closeup. C. Lateral D. Actinal. E. Actinal-oral. F. Adambulacral-furrow

10–11, with 70–80 marginal plates per interradius at R=9.3 versus 64–65 marginal plates per interradius and 8 to 10 furrow spines at R=7.6 in *R. isosceles*. Granules on *Rhianaster* **sp. nov.** are finer and more abundant, 6 to 8 along a 1.0 mm line versus 3 count in *Rhianaster isosceles*. *Rhianaster* **sp. nov.** also differs in displaying distinct linear series present between the central radial abactinal plates and the superomarginal plates. These are absent from *Rhianaster isosceles*.

Occurrence/Distribution

New Caledonia, 1493–1508 m.

Description

Body strongly stellate (R/r=6.64), arms triangular, elongate, tips tapering to a point. Interradial arcs curved (Fig. 43A, D). Disk forming distinct, nearly angular edge with marginal plates interradially, these forming a strong lateral facing on disk becoming more dorsal facing distally along arms (Fig. 43C).

Abactinal surface composed of low tabulate plates, each round to polygonal, these flattening out, becoming level with disk surface distally on arms. Approximately 9 to 10 series of abactinal plates extending from proximal arm region narrowing to a single series distally. Fasciolar grooves present but shallow; these especially well developed on radial and arm regions, absent interradially. Papular regions present on radial regions on disk and arms, overlapping with fasciolar grooves, absent interradially where granules and plates are closely abutted. Abactinal plates covered by granules, 10–40, quadrate to polygonal in shape. mostly 20 to 30 per plate, widely spaced on disk (Fig. 43B), becoming closer and more dense on disk adjacent to superomarginal contact, overall approximately 6 to 8 along a 1.0 mm line count. Madreporite quadrate in shape, flanked by tabulate plates, four. Sulci well-developed. Abactinal plates extending to lateral edge of disk in contact with superomarginals, forming a slightly overhang onto lateral surface. Small pedicellariae present, paddle-shaped, approximately 1.0 to 2.0 mm in length, absent from central disk region, present with most abundance on surface of disk around lateral edge adjacent to superomarginal plates.

Marginal plates elongate, quadrate in shape with angular edges (Fig. 43C), approximately 70–80 plates present from arm tip to arm tip, (35–40 per arm side) becoming more quadrate distally along arms. Plates on disk face laterally with no part of surface facing abactinally. Superomarginals becoming more abactinal facing along arms occupying most of abactinal surface distally on arms. Plate surface covered by granules, 80 to 100, polygonal to quadrate in shape widely spaced. Peripheral granules 10–12 per side, approximately 40 to 60 total, more quadrate in shape, widely spaced but paired off with quadrate granule on adjacent plate; peripheral granules slightly depressed relative to those on remainder of plate surface forming distinct bands between plates which level out distally along arms. No pedicellariae. Terminal plates round, bald surface.

Actinal surface in three series, arranged in chevron formation, plates quadrate in shape with one series extending onto the arm (Fig. 43E). Actinal plates covered by angular granules, 10–50, quadrate to polygonal in cross-section with rough or pointed tips, widely spaced. Pedicellariae present on actinal surface, small, 1 to 2 mm in length, paddle like in shape, present primarily on plates adjacent to adambulacral plates/spinelets.

Furrow spines, 10–11, compressed, slender, with blunt tips, arranged in linear series. Subambulacral spines in two series, the series adjacent to the furrow composed of spinelets, 4 to 6, quadrate in cross-section, widely spaced, elongate, comparable in height to those of the furrow (Fig. 43F). Subambulacral spinelets granular, 5 to 6, similar in size, appearance to actinal granules. Proximally on every adambulacral plate, pedicellariae, simple or incipient composed of two elongate valves.

Oral plates with furrow spines, 10–12 similar in appearance to those on adambulacral plates, closely arranged (Fig. 43E). Oral plate surface covered by granules, 12 to 20 per side of each plate, angular in cross-section, blunt tipped, widely spaced, separated by diastema between two halves of the oral plate.

Material Examined

Holotype. MNHN IE-2013-7112, New Caledonia, 23º0.4'S 168º5.6'E, 1493–1508 m Coll. KANADEEP 2, CP 5109, 30 Sept. 2019.1 wet spec. R=9.3 r=1.4.

Rosaster Perrier, 1894

Rosaster Perrier 1894: 386; Fisher 1911: 164; Verrill 1915: 110; Fisher 1919: 240; Macan 1938: 364; Halpern 1970a: 208; 1970b: 57; Clark & Downey 1992: 265; H.E.S. Clark & McKnight 2001: 126.

Nereidaster Verrill 1899: 186 (non-*Nereidaster* Fisher 1911)

Diagnosis

Disk stellate to strongly stellate, arms long, slender, tapering. A**bactinal plates tabulate with distinct bar-like ossicles radiating from base (as in *Mediaster*)** (Fig. 44C)**,** fasciolar grooves well-developed especially over radial regions proximally on arms. **Superomarginal plates medially in contact in most known genera** but separate in *R. mamillatus* Fisher 1913 and *R. symbolicus* (Sladen 1889). Rudimentary superambulacral ossicles absent.

Comments

A genus including 11 species, including 1 Atlantic, 2 Indian Ocean and the remaining present throughout the tropical Pacific. *Rosaster* was differentiated from *Mediaster* based the presence of "rudimentary" superambulacral plates as well as multiple abactinal plates extending to the terminal plate present in the latter. *Rosaster* lacks these superambulacral plates and most but not all species show abutted superomarginals along the arm. However, greater numbers of specimens have become available than were studied by Fisher and some individuals blur the boundary between *Rosaster* and *Mediaster* (unpublished observations). Further data on *Rosaster* is warranted.

Rosaster endilius McKnight 1975

FIGURE 44A–F

Rosaster endilius McKnight 1975: 54, fig. 2; H.E.S. Clark 1982: 38; A.M. Clark 1993: 283; McKnight 1993: 184; H.E.S. Clark & McKnight 2001: 126.

Diagnosis

Modified from Clark & McKnight (2001). Body strongly stellate, R/r=2.2–2.8, arms evenly tapering, interbrachial

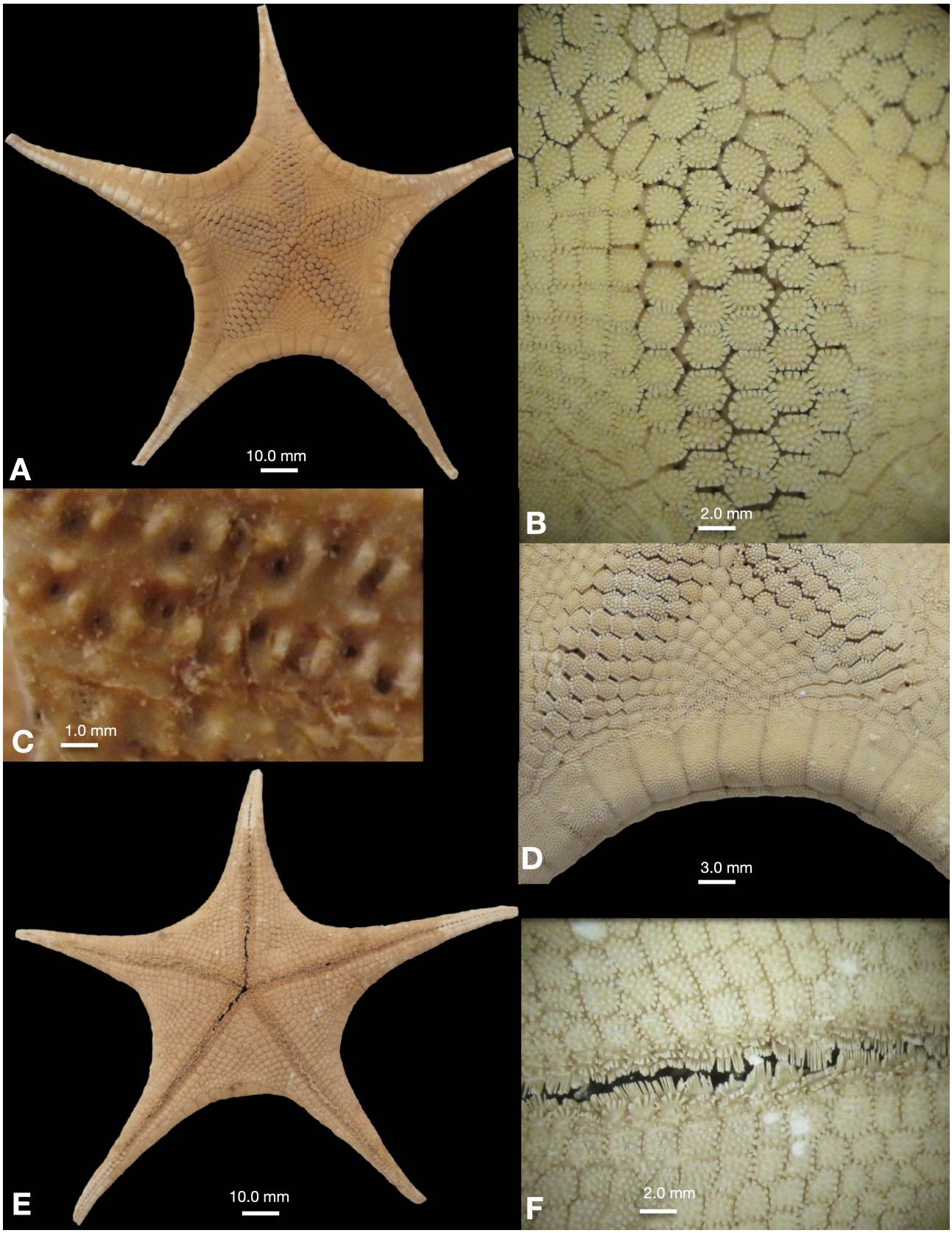

FIGURE 44. ***Rosaster endilius*** McKnight, 1975. MNHN IE-2013-6990. A. Abactinal B. Abactinal plates closeup C. Basal tabular plates. D. Abactinal-superomarginal plates. E. Actinal. F. Adambulacral spines.

arcs widely rounded, marginal plates forming dorsal-facing periphery (Fig. 44A, E). **Abactinal plates tabulate, centrally with 14–16 round granules, peripheral granules, trapezoidal, fasciolar groove well-developed. Marginal plates approximately 22 to 24 per arm, (44 to 48 per interradius)**. Surfaces covered by granules, small distinct hyaline granules on superomarginal plates between and at base of granules adjacent to contact with abactinal plates. Actinal plates with triangular-polygonal granules with denticulate tips. **Pedicellariae present, tong-like. Furrow spines 9 to 12, 11 or 12 distally, long, slender and flattened, diastema present between furrow and subambulacral spination, subambulacral spines in two distinct series, 4 or 5 each.**

Comments
Specimens from New Caledonia are consistent with *Rosaster endilius* from New Zealand but differ in several respects, abactinal granules 15–25 with 20–40 peripheral, triangular-trapezoidal peripheral granules (Fig. 44B), lacking hyaline granules on the superomarginal plates, furrow spines number 11–12 throughout most proximal adambulacrals, show strongly compressed subambulacrals in 2 defined rows, first 4–5 then 2 to 3, each triangular in cross-section (Fig. 44F). Subambulacral spine series in the specimens examined were also more weakly defined than was outlined by H.E.S. Clark & McKnight (2001).

Distribution/Occurrence
New Zealand, 352–850 m.
New Caledonia, 490–585 m.

Material Examined
MNHN IE-2013-6990, Southern New Caledonia, 22º59'S 167º22'E, 490–515 m. Coll. B. Richer, ORSTOM 29 Sept. 1985 MUSORSTOM 4, CP216. 1 dry spec. R=6.6 r=2.5. MNHN IE-2023-175, New Caledonia, 18º49'S 163º19'E, 585 m. Coll. C. Vadon, 20 Sept. 1985, MUSORSTOM 4, CP 198. 1 dry spec. R=7.5 r=2.6.

Sphaeriodiscus Fisher 1910

Sphaeriodiscus Fisher, 1910: 171; 1911: 167; Tortonese & A.M. Clark, 1956: 343; Halpern, 1970b: 79; A.M. Clark & Courtman-Stock, 1976: 249; Downey in Clark & Downey, 1992: 265; H.E.S. Clark & McKnight, 2001: 133; Mah 2011: 44, 2018: 82.

Type Species. *Stephanaster bourgeti* Perrier 1885 by original designation.

Diagnosis. Body pentagonal. **Abactinal plates flat-topped weakly tabulate to abutted, covered by granules. Marginal plates relatively few, tumid with swollen or enlarged penultimates.** Pedicellariae spatulate.

Comments
Outside of the original type species, members of the genus are difficult to characterize, especially relative to similar taxa, such as *Peltaster.* Two species of *Sphaeriodiscus, S. irritatus* and *S. maui* have been transferred to *Allceramaster* herein. Six species are currently described, but work remains ongoing.

Peltaster* versus *Sphaeriodiscus
Taxonomic validity of *Sphaeriodiscus* and its overlap with similar genera such as *Peltaster* and *Ceramaster* are ongoing issues (summary in Mah 2018), with *Sphaeriodiscus* and *Peltaster* displaying several similar characters, including pentagonal to weakly body form, an abundant granular covering on the abactinal and marginal plate surfaces and shallow or weakly tabulate abactinal plates. *Sphaeriodiscus* is defined herein as displaying between 6 and 12 superomarginals per interradius with a penultimate enlarged superomarginal plate and lacking secondary abactinal plates in contrast to *Peltaster* which displays 12 to 30 superomarginals per interradius, with no enlarged penultimate superomarginal plate and with the presence of secondary abactinal plates. Many of the difficulties distinguishing between *Peltaster* and *Sphaeriodiscus* are based on character variation of individuals in each species. Perhaps most problematic of these is the Atlantic *Peltaster placenta* which had been placed into *Sphaeriodiscus* and then returned to *Peltaster* (e.g. Tortonese & Clark 1956; Clark & Downey 1992). Variation within this species is extensive (Tortonese 1984) and creates taxonomic complications that are beyond the current treatment.

Sphaeriodiscus ammophilus (Fisher, 1906)
FIGURE 45A–E

Pentagonaster ammophilus Fisher 1906: 1051
Sphaeriodiscus ammophilus Fisher 1919: 290

Diagnosis
Body pentagonal, R/r=1.2, flat. interradial arcs straight to weakly curved. **Abactinal plates planar, polygonal, close-set, covered by granules, close-set 75–80 centrally, approximately 40 peripherally. Pedicellariae, narrow tong-like. Marginal plates large, sub quadrate, 6 plates per interradius, surface of each covered by widely spaced granules.** Actinal surface covered by polygonal to round granules. Furrow spines 4 to 6, subambulacral spines 2, followed by irregular spinelets, 6 to 9.

Comments
Individuals here were identified based on the distinctive planar abactinal surface and the abutted plates with flat-topped granules (Fig. 45A, B). Furrow spine number was also consistent with Fisher's description. Superomarginal plates in specimens herein was higher, n=8 (Fig. 45A, D) versus n=6, in spite of having an essentially identical distance "R." Granules on the superomarginal surface (Fig. 45C) were also fewer than those on the holotype, n=10–15 versus n=20–30 at R=2.3 and R=2.4.

Distribution/Occurrence
Hawaiian Islands, 403–470 m.
New Caledonia, 464–550 m.

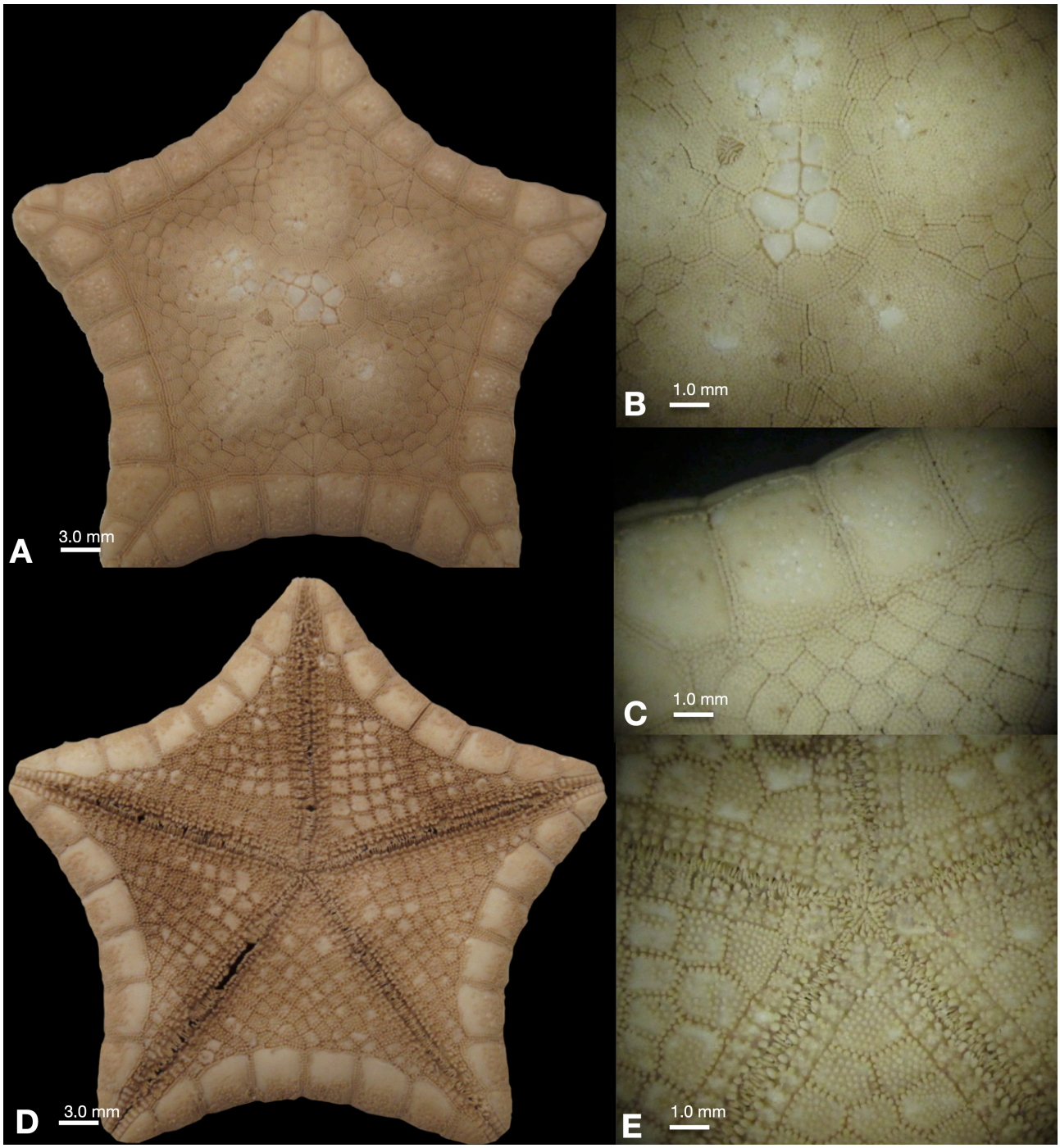

FIGURE 45. ***Sphaeriodiscus ammophilus*** (Fisher, 1906) MNHN IE-2013-6973. A. Abactinal. B. Abactinal plates closeup. C. Superomarginal plate surface. D. Actinal. E. Actinal-oral-adambulacral region.

Material Examined

MNHN IE-2013-6957 South New Caledonia, 23º03'S 166º 59'E, 464–480 m, Coll. Richer, N/O *Alis*, ORSTOM campagne HALIPRO 1, CP 877, 31 Mar 1994. 1 dry spec. R=2.3 r=1.9.

MNHN IE-2013-6973 New Caledonia, 18º52.8 S 163º21.20'E, 550 m. Coll. MUSORSTOM 4, st. CP 194, 19 Sept. 1985. 2 dry specs. R=2.2 r=1.3; R=2.0 r=1.4.

Sphaeriodiscus simplex **sp. nov.**

FIGURE 46A–E

Etymology

The species epithet *simplex* is latin, alluding to the generalized appearance of this species.

Diagnosis

Body pentagonal, R/r=1.2, thick, interradial arcs nearly straight. **Abactinal plates round to abutted, largely**

similar in shape, but variable in shape. Shallow fasciolar grooves present. Plate surfaces with 10 to 100 glassy knobs embedded in plate surface. Additionally, surficial granules1 to 15, present but mostly 1 to 6 per plate. Marginal plates wide, accounting for approximately 33% (0.3/1.0) of distance "r", 4 superomarginals and 6 inferomarginals per interradius. Surface of both marginal series with granules, numbering 20 to 150, mostly approximately 100, granules homogeneous, leaving minute pitting on plate surface, all widely spaced but irregularly arranged. Furrow spines 5 to 8, mostly 6 to 7, spines blunt, compressed. Subambulacral spines in 3 rows, proximal most with spines 2 to 3, each similar in height but twice the thickness of the furrow spines. Subsequent rows 3 or 4 spines, each shorter and more similar in size and shape with those on actinal surface.

Comments

A species distinguished by the presence of numerous glassine granules and a meager covering of surficial granules on each abactinal plate, similar to those present on other pentagonal goniasterids such as *Plinthaster*. The penultimate superomarginals are more comparable in size with the more proximal superomarginals. Some observed characters are inconsistent with the more diagnostic *Sphaeriodiscus* characters, however Fisher (1906, 1910) eventually placed *Pentagonaster ammophilus* into *Sphaeriodiscus* presumably based on the abactinal and

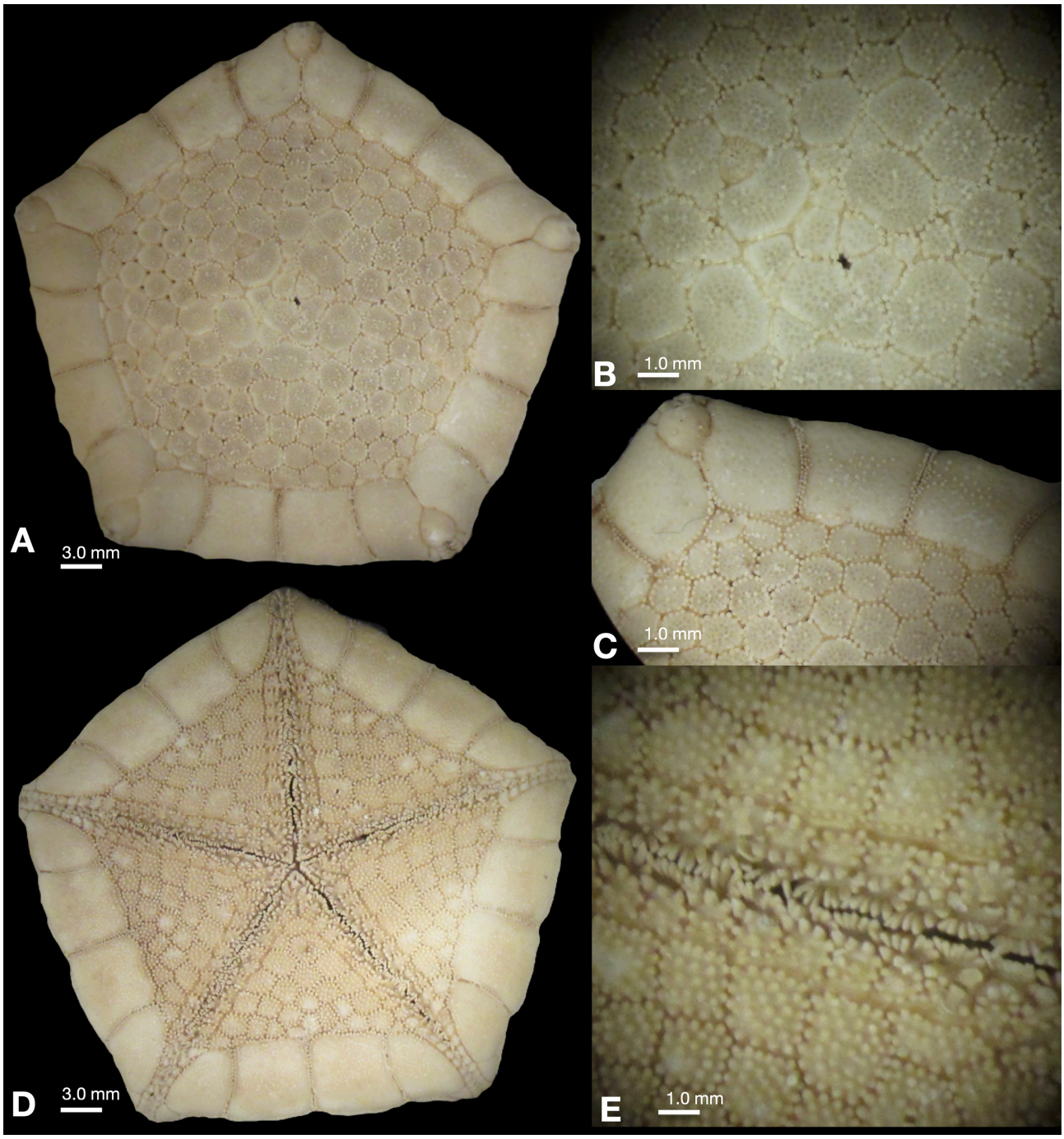

FIGURE 46. ***Sphaeriodiscus simplex*** **sp. nov.** MNHN IE-2013-6970. A. Abactinal. B. Abactinal plates close. C. Pre-terminal superomarginal plates. D. Actinal E. Adambulacral furrow spines.

marginal characters. *Sphaeriodiscus simplex* **sp. nov.** is similar to *S. ammophilus* and for now, I argue its best taxonomic place until subsequent analysis.

Occurrence/Distribution
New Caledonia, 550 m.

Description
Body pentagonal, R/r=1.2, thick, interradial arcs nearly straight (Fig. 46A, D)

Abactinal plates round to abutted, largely similar in shape, but variable in shape. Shallow fasciolar grooves present. Plate surfaces with 10 to 100 glassy knobs embedded in plate surface. Additionally, surficial granules1 to 15, present but mostly 1 to 6 per plate (Fig. 46A, B). Primary circlet plates interradially enlarged relative to those adjacent, each plate approximately 2 to 4X the size of smaller adjacent plates. Madreporite triangular with well-developed but shallow sulci. Flanked by 3 abactinal plates. No pedicellariae.

Marginal plates wide, accounting for approximately 33% (0.3/1.0) of distance "r", superomarginals 4, inferomarginals 6 per interradius (Fig. 46A, D). Pre-terminal supeormarginal plates more rhombus in shape with five sides (Fig. 46C), but similar in size with adjacent superomarginal plates. Penultimate inferomarginals triangular, irregular in size, approximately 20% of the size of adjacent marginal plate. Surface of both marginal series with granules, numbering 20 to 150, mostly approximately 100, granules homogeneous, leaving minute pitting on plate surface, all widely spaced but irregularly arranged.

Actinal plates in 2 full series, with chevron arrangement proximally and irregular plates adjacent to inferomarginals (Fig. 46D). Surface covered by cylindrical granules, peripheral granules approximately 4 to 5 per side, totaling 12 to 20, widely spaced, set off from center (Fig. 46C–D). Central granules rounder, 10 to 25, approximately 18 to 20 on most, widely spaced in ordered rows. Pedicellariae present, but only 0 to 2 per interradius, mostly only 1, paddle-shaped and present on proximalmost actinal plate adjacent to oral plates. Shallow fasciolar grooves present.

Furrow spines 5 to 8, mostly 6 to 7, spines blunt, compressed. Subambulacral spines in 3 rows, proximal most with spines 2 to 3, each similar in height but twice the thickness of the furrow spines (Fig. 46E). Subsequent rows 3 or 4 spines, each shorter and more similar in size and shape with those on actinal surface. Oral plates with 6 to 7 furrow spines, each triangular in cross-section with one pair of spines adjacent to medial oral spines projecting into mouth. Oral plate surface with 4 to 5 short angular spines on either side of central diastema, remainder of oral plate with 2 to 4 spinelets similar to others on central diastema, angular in cross-section.

Material Referenced
Holotype. MNHN IE-2013-6970, New Caledonia, 18º52.80'S 163º 21.70'E, 550 m. Coll. MUSORSTOM 4, CP 194, 1 dry spec. R=1.2 r=1.0.

Discussion

Goniasterid Diversity of New Caledonia
This account describes 19 new occurrences, 3 new genera and 28 new species of Goniasteridae in three subfamilies from the New Caledonian region. Table 1 lists all the known Goniasteridae from New Caledonia, a total of 70 species, in 38 genera among four subfamilies. Globally, a total of 367 species and 82 living genera of Goniasteridae have been described (Mah 2025a and descriptions herein) indicating that approximately 19% of the total known species and 46% of known genera are represented in New Caledonian waters. It is argued that goniasterid diversity in this area is high for the Asteroidea given the relatively constrained geographic area.

When considered by depth, very few species occur <100 meter depths in reef or otherwise littoral or nearshore settings, including *Anchitosia, Fromia* and *Neoferdina*. The remaining goniasterid taxa, including most genera documented here are present between 150 and 1500 m (Table 1). Depths below 1500 m await further exploration.

Several genera, display a relatively large number of members that are present only in New Caledonia. *Calliaster* for example, includes 5 new species although some taxa, such as *C. kanak* also known from New Zealand most have as yet not been recorded elsewhere, *Kanakaster*, a member of the subfamily Ferdininae included 5 species, *Pohakuastra* **gen. nov.** included 3 species, and the corallivore *Circeaster* also included 3. Most species (5/7) of *Kanakaster* and *Pohakuastra* (3/4), are known only from New Caledonia. *Glyphodiscus pentagonalis* is known only from New Caledonia, but *Glyphodiscus* includes 2 other wider-ranging species, *G. pierierctus* and *G. magnificus* that also occur in New Caledonia.

Some goniasterid species summarized herein are recorded only from New Caledonia and have not yet been recorded from adjacent regions, such as New Zealand (H.E.S. Clark & McKnight 2001, 2006). Three unusual monotypic species, including *Chimeraster acutus*, *Akelbaster novaecaledoniae* and *Eosaster nadiae,* have, so far, only been collected from New Caledonia. *Eknomiaster beccae* has yet to be encountered outside of New Caledonia.

In contrast, several deep-sea species (>200 m) found in New Caledonia are widely occurring throughout the Indo-Pacific. *Calliderma emma* for example is recorded from Hawaii to the western Indian Ocean, off the coast of Madagascar, 253–327 m (Fisher, 1906, Mah, 2017).

All of the species in the genus *Anthenoides*, known from New Caledonia, including *A. cristatus*, *A. epixanthus*, and *A. granulosus* are widely occurring with *A. cristatus* present from the Indian Ocean to New Zealand and *Ogmaster capella* is present widely from Madagascar to the South China Sea/Japan to New Caledonia between 0 and 263 m.

TABLE 1.

Species	Family	Depth	Citation	Outside of New Caledonia?
Akelbaster novaecaledoniae Mah 2007	Goniasteridae (Pentagonasterinae)	225–400	Mah, 2007	Known only from New Caledonia
Alloceramaster irritatus (H.E.S. Clark in H.E.S Clark & D.G. McKnight, 2001)	Goniasteridae	428–470	herein; Clark & McKnight 2001	New Zealand, 530 m
Alloceramaster maui (McKnight, 1973)	Goniasteridae	758–780	herein; Clark & McKnight 2001	New Zealand, 926–1180
Anchitosia queenslandensis (Livingstone, 1932)	Goniasteridae (Pentagonasterinae)	0–58	Jangoux 1982; Mah 2007	Australia, Okinawa, New Caledonia,
Anthenoides cristatus (Sladen, 1889)	Goniasteridae	289–510	herein, Clark & McKnight 2001	Indian Ocean, Philippines, PNG, Marquises, South China Sea, New Zealand, 134–1350
Anthenoides epixanthus (Fisher, 1906)	Goniasteridae	398–463	herein, Clark & McKnight 2001	Rapa Nui, Hawaii Central Pacific, New Zealand
Anthenoides granulosus (Fisher, 1913)	Goniasteridae	192–580 m	herein, Clark & McKnight 2001	Philippines, PNG, Vanuatu, Kermadec Islands 143–731 m
***Astroceramus astrikos* sp. nov.**	Goniasteridae	370–621	herein	Known only from New Caledonia
***Astroceramus cyclus* sp. nov.**	Goniasteridae	409–439	herein	Known only from New Caledonia
Atheraster arandae (Mah, 2006)	Goniasteridae	2160	Mah 2006	New Caledonia, Madagascar, North Pacific?
Atheraster umbo Mah, 2024	Goniasteridae	1589–1896	herein, Mah 2024	Tasmania, to Cocos Islands, 1589–1896
Bathyferdina aireyae Mah, 2017	Goniasteridae	91–408	Mah 2017	Philippines, Vanuatu, Solomon Islands
***Calliaster aquamontis* sp. nov.**	Goniasteridae	425–540	herein	Known only from New Caledonia
***Calliaster hystrix* sp. nov.**	Goniasteridae	140–428	herein	Known only from New Caledonia
***Calliaster kanak* sp. nov.**	Goniasteridae	180–470	herein	New Zealand, 90–153
***Calliaster kyros* sp. nov.**	Goniasteridae	274–460	herein	Known only from New Caledonia
***Calliaster nazaninae* sp. nov.**	Goniasteridae	150–282	herein	Known only from New Caledonia
Calliderma emma Gray, 1847	Goniasteridae	253–327	Mah, 2018	Hawaiian Island,s South China Sea, Philippines to Madagascar, 138–407
Ceramaster australis H.E.S. Clark, 2001	Goniasteridae	460–967	Clark & McKnight 2001	Papua New Guinea, New Zealand, 148–415 m
Ceramaster fortis Mah, 2025	Goniasteridae	1000–1019	herein, Mah 2025	Western Australia, 794 m
***Chimeraster acutus* gen. nov. sp. nov.**	Goniasteridae	570	herein	Known only from New Caledonia
***Circeaster mandibulum* sp. nov.**	Goniasteridae (Circeasterinae)	320–470	herein	Known only from New Caledonia
Circeaster pullus Mah, 2006	Goniasteridae (Circeasterinae)	620–700	Mah 2006	Hawaiian Islands, 620–2305 m
Circeaster sandrae Mah, 2006	Goniasteridae (Circeasterinae)	745–1000	Mah 2006	South Pacific, Marquesas, Tonga, 705–1000 m
Cladaster katafractarius Mah, 2018	Goniasteridae	530–807	Mah 2018	Western Indian Ocean, 530–807

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TABLE 1. (Continued)

Species	Family	Depth	Citation	Outside of New Caledonia?
***Cladaster salebra* sp. nov.**	Goniasteridae (Corallivorous group)	1054	herein	Known only from New Caledonia
***Discoplintha reganae*, gen. nov. sp. nov.**	Goniasteridae	150–320	herein	Philippines, 150–320
Dissogenes petersi Jangoux, 1981	Goniasteridae	390–442	Jangoux 1981; Clark & McKnight 2001	New Zealand, 195–500
Eknomiaster beccae Mah, 2006	Goniasteridae (Pentagonasterinae)	215–1074	Mah 2006	Known only from New Caledonia
Eknomiaster macauleyensis Clark & McKnight, 2001	Goniasteridae (Pentagonasterinae)	530–535	Mah 2006, Clark & McKnight 2001	Norfolk Ridge, Wanganella Bank, 216–691 m
Eosaster nadiae Mah, 2017	Goniasteridae (Ferdininae)	215–600	Mah 2017	Known only from New Caledonia
Fromia balansae Perrier, 1875	Goniasteridae	18–55	Mah & Fujita 2024	Southern Japan, Mauritius, Marshall Islands, Samoa
***Fromia bathybia* sp. nov.**	Goniasteridae	290–590	herein	Known only from New Caledonia
Fromia heffernani (Livingstone, 1931)	Goniasteridae	0–40.0	Mah 2017	Indo-Pacific, South China Sea, to Maldives, GBR, Australia, etc.
Fromia indica (Perrier, 1869)	Goniasteridae	3–27.0	Mah 2017	Southern Japan, Fiji and New Caledonia, Ceylon, Andaman Islands (Bay of Bengal), Sodwana Bay, Natal coast South Africa, Madagascar
Fromia milleporella (Lamarck, 1816)	Goniasteridae	0–86	Mah 2018	Indo-Pacific, South China, Australia south pacific to Madagascar, 0–86 m
Fromia nodosa A.M. Clark, 1967	Goniasteridae	53–54	herein	widespread, Marshall Islands, south Pacific, Philippines to Indian Ocean, 10–54 m
Glyphodiscus magnificus Mah, 2005	Goniasteridae	190–340	Mah 2005	Vanuatu & Palau, 162–335
Glyphodiscus pentagonalis Mah, 2005	Goniasteridae	460–532	Mah 2005	Known only from New Caledonia
Glyphodiscus pierierctus (Fisher, 1913)	Goniasteridae	290–550	Mah 2005	Philippines, New Zealand, Western Australia, 178–550
Hippasteria muscipula Mah, Neill, Eleaume & Foltz, 2014	Goniasteridae (Hippasterinae)	820	Mah *et al.* 2014	Hawaiian Islands, New Zealand, South Pacific 425–1500 m
Iconaster uchelbeluuensis Mah, 2005	Goniasteridae	68	Mah 2005	Philippines, Palau 68–122 m
Kanakaster convexus Mah 2017	Goniasteridae (Ferdininae)	215–430	Mah 2017	Known only from New Caledonia
Kanakaster discus Mah 2017	Goniasteridae (Ferdininae)	275–500	Mah 2017	Known only from New Caledonia
***Kanakaster longibrachia* sp. nov.**	Goniasteridae (Ferdininae)	310–380	herein	Known only from New Caledonia
Kanakaster plinthinos Mah 2017	Goniasteridae (Ferdininae)	275–350	Mah 2017	Known only from New Caledonia

.....continued on the next page

TABLE 1. (Continued)

Species	Family	Depth	Citation	Outside of New Caledonia?
Kanakaster solidus Mah 2017	Goniasteridae (Ferdininae)	240–404	Mah 2017	Known only from New Caledonia
Lithosoma actinometra Fisher, 1911	Goniasteridae	208–818	herein	Philippines, PNG, Solomons, Fiji, New Caledonia
Mediaster mollis Mah, 2018	Goniasteridae	756–1450	Mah 2018	Madagascar
***Mediaster trapezium* sp. nov.**	Goniasteridae	756–1450	herein	Fiji
***Neoferdina akala* sp. nov.**	Goniasteridae	230–249	herein	Known only from New Caledonia
Neoferdina cumingi (Gray, 1840)	Goniasteridae	0–59	Mah 2017	Indo-Pacific
Neoferdina offreti (Koehler, 1910)	Goniasteridae	0–66	Mah 2017	Indo-Pacific
***Nymphaster brioche* sp. nov.**	Goniasteridae	758–1450	herein	Known only from New Caledonia
***Nymphaster defensor* sp. nov.**	Goniasteridae	515–863	herein	Fiji and Vanuatu, 420–1050
Ogmaster capella (Muller & Troschel, 1842)	Goniasteridae	235–263	Mah 2018	Tropical Pacific to Indian Ocean, 0–147 m
Peltaster cycloplax Fisher, 1913	Goniasteridae	379–530	herein	Philippines, tonga, Seychelles
***Peltaster meridionalis* sp. nov.**	Goniasteridae	655–1450	herein	Known only from New Caledonia
***Pillsburiaster chondros* sp. nov.**	Goniasteridae	410–1708	herein	Known only from New Caledonia
***Plinthaster australis* sp. nov.**	Goniasteridae	452–710	herein	Wallis and Futuna, 452–710 m
***Pohakuastra flabellum* gen. nov. sp. nov.**	Goniasteridae	680–980	herein	Known only from New Caledonia
***Pohakuastra inculta* gen. nov. sp. nov.**	Goniasteridae	569–1000	herein	Known only from New Caledonia
***Pohakuastra palmatus* gen. nov. sp. nov.**	Goniasteridae	920–930	herein	Known only from New Caledonia
Pseudoceramaster hunti McKnight, 1993	Goniasteridae	398–140	herein	New Zealand,
***Pseudoceramaster triangularis* sp. nov.**	Goniasteridae	410–440 m	herein	Known only from New Caledonia
***Rhianastra kanadeepae* sp. nov.**	Goniasteridae	1493–1508	herein	Known only from New Caledonia
Rosaster endilius McKnight, 1975	Goniasteridae	352–850	herein, Clark & McKnight 2001	New Zealand
Sphaeriodiscus ammophilus (Fisher, 1906)	Goniasteridae	464–550	herein	Hawaiian Islands, 403–470
***Sphaeriodiscus simplex* sp. nov.**	Goniasteridae	550	herein	Known only from New Caledonia
Stellasteropsis fouadi Dollfus, 1936	Goniasteridae	124	Mah 2017	Primarily in the Indian Ocean

Goniasterid Diversity Trends

Although the species documented herein were not studied in a rigorous statistical framework, the total number of goniasterid species for this region could be construed as relatively high, at least for those present within approximately 100 to 1500 m. This is broadly consistent with diversity patterns outlined by O'Hara *et al.* (2019) for ophiuroids present in what they define as the tropical upper bathyal zone, 200–700m between 0 and 35ºS. However, characterization of New Caledonian Asteroidea, especially the Goniasteridae is ongoing and extinction/speciation rates are poorly understood making it unclear if dynamics suggest this region as a "cradle" or a "museum" for biodiversity.

Morphological Trends Among New Caledonian Goniasteridae

Species within *Astroceramus, Glyphodiscus*, and *Kanakaster* all show an acutely distinct variation in morphological form, within the same genus, there are forms that range from pentagonal or discoid to others that are more stellate with short to elongate arms. These pentagonal to discoid forms are comparable in size to other adults and do not appear to be size-dependent nor do they appear to be the result of sublethal predation. In the three genera herein, the pentagonal species, *Astroceramus cyclus* **sp. nov.**, *Glyphodiscus pentagonalis* Mah 2005, and *Kanakaster discus* Mah, 2017 and *K. plinthinos* Mah, 2017 are known primarily from New

Caledonia, whereas the more stellate forms are present in New Caledonia but also more widely across their range. The pentagonal forms of these genera are, as yet, unknown from areas outside of New Caledonia, suggesting a possible association with this region. Monotypic forms, such as *Akelbaster novaecaledoniae*, with their distinctive pentagonal shapes are also, at present, known only from New Caledonia. Additionally, several pentagonal-shaped goniasterid species, including *Alloceramaster irritatus, Alloceramaster maui, Discoplintha reganae, Eknomiaster beccae, Eknomiaster macauleyensis, Peltaster* spp., *Pillsburiaster chondros, Plinthaster australis*, are present in this region.

One explanation is that body forms are associated with a functional ecological constraint, particularly that of feeding on epizoic prey, such as sponges. In the tropical Atlantic, deep-sea goniasterids with pentagonal or weakly stellate forms such as *Plinthaster* and *Peltaster*, have been observed feeding on sponges (Mah 2023). Several shallow-water goniasterids with similar body shapes, such as the Australian *Tosia* and *Pentagonaster* also feed on sponges and encrusting invertebrates (Marsh & Fromont, 2020).

Alternatively, Mah & Foltz (2011) have shown several of these pentagonal goniasterids, including morphologically disparate members as *Ceramaster, Tosia,* and *Sphaeriodiscus*, as members of a single clade, suggesting that at least for some taxa, this could simply be a shared character. Other pentagonal Goniasteridae, such as *Peltaster* were not included in this clade however and phylogenetic support for this character as monophyletic is uncertain.

Another noteworthy character observed on strongly stellate Goniasteridae is the presence of numerous abutted superomarginal plates over the midline of the arm, as observed in *Nymphaster,* the strongly stellate members of *Astroceramus* and to a lesser extent *Glyphodiscus* and *Kanakaster* (e.g., *Kanakaster longibrachia* **sp. nov.**). A majority of superomarginals are abutted along most of the arm distance creating inflexible elongate arms with a greater surface area along the actinal surface. *Nymphaster arenatus* has been observed *in situ* splayed out or sitting at the surface of unconsolidated sediment (Mah, 2023) suggesting that this morphology could be associated with life on soft sedimented bottoms. Hawaiian observations of *Astroceramus callimorphus* shows this species on unconsolidated, coarse sandy bottoms (Mah, unpublished. data) suggesting it displays a comparable life mode.

More ambiguous however, is the presence of relatively few abutted superomarginals, a character observed on numerous genera, but variably observed among a single to several pairs of plates distalmost on the arm tip, such as in *Plinthaster dentatus* or *Discoplintha reganae* **gen. nov. sp. nov.** It is unclear if this is associated with some aspect of functional morphology or possibly a simple matter of developmental variation.

Biogeographic Comparisons

Assessment of goniasterid taxa from New Caledonia and New Zealand showed considerable taxonomic overlap. New Caledonian Goniasteridae were compared with species summarized by H.E.S. Clark & McKnight (2001) and McKnight (2006). Ten species were shared between the listings between the two localities (Table 1). This includes *Anthenoides cristatus, A. epixanthus, A. granulosus, Calliaster kanak* **sp. nov.** *Ceramaster australis, Eknomiaster macauleyensis, Pseudoceramaster regularis, Rosaster endilius, Alloceramaster irritatus*, and *A. maui* (the latter two, ex. *Sphaeriodiscus*). As indicated earlier, *Anthenoides* species are distributed widely throughout the Indo-Pacific. Only two taxa from New Zealand were not found in New Caledonia, including *Astropatricia marita* McKnight 2006 and *Enigmaster scalaris* McKnight & H.E.S. Clark 1996. Taxonomic refinement is likely to have a significant impact on these assessments. *Enigmaster scalaris* for example displays an unusual pattern of marginal plate enlargement around each arm tip, but otherwise seems very similar to *Ceramaster*.

Presence of Glassy Tubercles

Multiple taxa encountered herein show the presence of glassy tubercles embedded on the abactinal plate surface (e.g., 17B, 23B) among those included here, *Astroceramus* (Fig. 17B), *Discoplintha* (Fig. 23B), *Kanakaster* (Fig. 9B), *Lithosoma* (Fig. 28B), *Plinthaster* (Fig. 36B), *Fromia bathybia* **sp. nov.** (Fig. 25D), and *Sphaeriodiscus simplex* **sp. nov.** (Fig. 46B). Other taxa where these glassy tubercles have been observed include *Ogmaster, Stellaster* and most genera within the Oreasteridae. These tubercles have been utilized largely as taxonomic character within asteroid systematics, but work by Dubois & Hayt (1990) has suggested a resemblance with lens-like ossicles, which have since been recognized in other echinoderms (Aizenberg *et al.* 2001; Gorzelak *et al.* 2014). However, contrary data has suggested that photoreceptor networks in ophiuroids are independent of "lenses" in brittle stars (Sumner-Rooney *et al.* 2018) undermining the notion that these serve a photoreceptive function.

In some taxa, such as *Sphaeriodiscus simplex* **sp. nov.** (Fig. 46B), or in *Stellaster* spp. these glassy tubercles appear to be present underlying surficial granules. It is argued that in these taxa, glassy tubercles might instead be a means of replacement or incipient granules rather than lenses. However, in genera such as *Astroceramus* and *Plinthaster*, surficial granules are absent and function of these tubercles remains uncertain.

Consideration of Subgroupings within the Goniasteridae

A survey of the taxa described suggest further groupings with revisions based on observed diagnostic characters but full designations await more complete revisionary work. Not every taxon included herein was considered. Research into goniasterid affinities is ongoing. However, consideration of subgroupings will likely extend beyond the boundaries of what has "historically" been considered the Goniasteridae (e.g., A.M. Clark, 1993; Spencer & Wright, 1966). The most evident case of this is consideration of *Goniaster*, the type genus for the Goniasteridae and its clear affinity with the Asterodiscididae (Mah 2005, 2021). Several subgroupings considered here show validity but exact membership is a matter of active research.

The "Mediasterinae" as suggested by Verrill (1899) is diagnosed by the tabulate plates as well as the distinct radial ossicles present at the base of the abactinal plates. Contrary to some of the included genera suggested by Verrill, such as *Nymphaster*, three genera display these exact characters, including *Mediaster* Stimpson 1857*, Rosaster*Perrier 1894, and the Australian *Nectria* Gray 1840. Verrill's Mediasterinae is complicated by the previous designation of the Nectriinae as designated by Perrier (1894) which predates and would be a junior synonym if used in this context. Included genera would include not only *Mediaster* and *Rosaster*, but also *Nectria* and *Nectriaster*, a possible synonym of *Nectria* (H.L. Clark 1946). *Mediaster* and *Rosaster* have been supported as sister taxa by molecular (Mah & Foltz, 2011).

Another pre-existing subfamily grouping with character support but uncertain composition is that of the "Anthenoidinae" which is supported by the presence of a distinct dermis over the body surface and stellate abactinal plates. Fisher (1919) outlined this group as including *Anthenoides, Stellaster,* and *Atelorias*, whereas Spencer & Wright (1966) added *Ogmaster* von Martens 1865 and *Siraster* H.L. Clark 1915. Spencer & Wright provided a brief diagnosis for this grouping but character and taxon argumentation was absent from Fisher's account. Characters surveyed from this account suggest *Anthenoides, Ogmaster, Stellaster* and possibly *Chimeraster* **gen. nov.** are supported by characters from Spencer & Wright. Morphological affinities of *Atelorias* remain uncertain.

Aziz & Jangoux (1985b) argued for diagnostic characters that suggested close relationship for *Calliaster* and *Milteliphaster* pending further revision within the many species within *Calliaster*. Genera, such as *Astrothauma* and *Mabahissaster* within this grouping were based on variable characters had been synonymized by Mah (2017). A molecular phylogeny of the Valvatacea, including the Goniasteridae (Mah & Foltz 2011) showed support for *Calliaster* plus the Hippasterinae, which are goniasterid taxa that share numerous prominent and conical spines on the abactinal and marginal plates, suggesting support for affinities.

On prior accounts (e.g. Mah 2025) the morphological resemblance between several goniasterid genera displaying a broadly pentagonal/weakly stellate body form, partially to fully tabulate abactinal surface (mostly on the radial regions), complete granular covering across the abactinal, marginal and actinal surface and with a variably developed bald patch on the superomarginal plate surface has presented difficult boundaries between similar goniasterid genera. This includes *Alloceramaster, Bathyceramaster, Ceramaster, Peltaster*, *Sphaeriodiscus,* and possibly *Apollonaster* and *Pillsburiaster.*

Conclusions

Summary of Taxonomic Acts

1. Three new genera and 28 new species are described. A further 19 species of Goniasteridae are new occurrences in New Caledonia.
2. *Anthenoides tenuis* Liao & Clark, 1989 is a junior synonym of *Anthenoides cristatus* (Sladen 1889).
3. *Anthenoides laevigatus* Liao & Clark 1989 is a synonym of *Anthenoides epixanthus* (Fisher 1906).
4. The genus *Dissogenes* is moved to the Goniasteridae from the Ophidiasteridae.
5. *Nymphaster habrotatus* Fisher 1913 is argued as a synonym of *Nymphaster meseres* Fisher 1913 as dictated by page priority.
6. *Sphaeriodiscus irritatus* and *Sphaeriodiscus maui* are moved to *Alloceramaster* Mah 2025.

List of Species Reported Herein

New species in boldface. New occurrence in plain text. A full table of Goniasteridae from New Caledonia in Table 1.

Circeasterinae

Atheraster umbo Mah 2024
***Circeaster mandibulum* sp. nov.**

Corallivorous Clade members

***Calliaster aquamontis* sp. nov.**
***Calliaster hystrix* sp. nov.**
***Calliaster kanak* sp. nov.**
***Calliaster kyros* sp. nov.**
***Calliaster nazaninae* sp. nov.**
***Cladaster salebra* sp. nov.**

Ferdininae

***Kanakaster longibrachium* sp. nov.**
***Neoferdina akala* sp. nov.**

Goniasterinae

Alloceramaster irritatus (H.E.S. Clark in H.E.S Clark & D.G. McKnight, 2001)
Alloceramaster maui (McKnight, 1973)
Anthenoides cristatus (Sladen, 1889)
Anthenoides epixanthus (Fisher 1906)
Anthenoides granulosus Fisher 1913
***Astroceramus astrikos* sp. nov.**
Astroceramus callimorphus Fisher 1906
***Astroceramus cyclus* sp. nov.**
***Astroceramus pernachus* sp. nov.**
***Astroceramus titthos* sp. nov.**
Ceramaster australis H.E.S. Clark & McKnight 2001
Ceramaster fortis Mah 2025
***Chimereaster acutus* sp. nov.**
***Discoplintha reganae* gen. nov. sp. nov.**
Dissogenes petersi Jangoux, 1981
***Fromia bathybia* sp. nov.**
Fromia nodosa A.M. Clark 1967
Glyphodiscus pierierctus (Fisher, 1913)
Lithosoma actinometra (Fisher 1911)
***Mediaster trapezium* sp. nov.**
***Nymphaster brioche* sp. nov.**
***Nymphaster defensor* sp. nov.**
Nymphaster meseres Fisher, 1913

Peltaster cycloplax Fisher 1913
***Peltaster meridionalis* sp. nov.**
***Pillsburiaster chondros* sp. nov.**
***Plinthaster australis* sp. nov.**
Plinthaster ceramoidea Fisher, 1906
***Pohakuastra flabellum* sp. nov.**
***Pohakuastra inculta* sp. nov.**
***Pohakuastra palmatus* sp. nov.**
Pseudoceramaster hunti Clark & McKnight 2001
***Pseudoceramaster triangularis* sp. nov.**
***Rhianastra kanadeepae* sp. nov.**
Rosaster endilius McKnight, 1973
Sphaeriodiscus ammophilus (Fisher 1906)
***Sphaeriodiscus simplex* sp. nov.**

Acknowledgements

This work could not have been made possible without the assistance of the scientific and curatorial staff of the Museum national d'historie Nationale in Paris, Marc Eléaume, Nadia Ameziane, Sarah Samadi, Philippe Bouchet, and Anouchka Krygelmans, This report would not have been possible without the scientific teams and crews of the Paris expeditions in New Caledonia, for the N/O *Alis* including AZTEQUE, BATHUS 1, BATHUS 2, BERYX II, BIOCAL, CHALCAL 2, EXBODI, HALIPRO 1, KANADEEP, KANADEEP 2, KANACONO,LITHIST ,MUSORSTOM 4,MUSORSTOM 6,NORFOLK 2,SMIB 3,SMIB 4,SMIB 5,SPANBIOS,TERRASSES, VAUBAN, and ZONECO 6. Further expeditions throughout the Indo-Pacific included BIOPAPUA, BOA 0,BORDAU, BORDAU 2,CORINDON 2, MADEEP,MUSORSTOM 8,MUSORSTOM 9, SALOMON 1, and SALOMON BOA 3. I am grateful to curatorial assistance from Holly Bolick at the Bernice P. Bishop Museum in Honolulu, Hawaii. Kate Neill from the New Zealand Institute of Water and Atmosphere (NIWA) provided numerous images of type material from the NIWA collections for which I am grateful. I am also thankful to Amanda Robinson and Adam Stergis, curatorial technicians in the Department of Invertebrate Zoology, USNM for their assistance. I am grateful to two anonymous reviewers who provided constructive comments that greatly improved the manuscript.

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