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A new Indo-West Pacific species of *Actinopyga* (Holothuroidea: Aspidochirotida: Holothuriidae)

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Abstract

Actinopyga is one of the five genera commonly recognised in the family Holothuriidae. This small genus has sixteen species currently considered valid. The present paper describes a new Indo-West Pacific species, *Actinopyga caerulea*, of which the most striking character is its bluish coloration. The ossicle assemblage of the new species resembles mostly that of *A. bannwarthi* Panning, 1944 and *A. flammea* Cherbonnier, 1979.

Key words: Echinodermata, Holothuroidea, *Actinopyga*, new species, Indo-Pacific

Introduction

Recent expeditions (in 2003 and 2004) to the Union des Comores, an archipelago in the northern Mozambique Channel, yielded several specimens of a species that had previously been photographed at several localities in the Pacific Ocean (Erhardt & Moosleitner 1995; Erhardt & Baensch 1998; Lane pers. comm.; Myers pers. comm.; Colin pers. comm.; see also plate 1). Cherbonnier & Féral (1984) recorded, and later Féral and Cherbonnier (1986) published a photograph of a specimen from New Caledonia which they identified incorrectly as *Actinopyga crassa* Panning, 1944. Other specimens have been photographed and no voucher material collected, making definitive identification impossible. Erhardt & Moosleitner (1995) identified their photographed specimen from Thailand as *A. crassa*, Erhardt & Baensch (1998) drew upon the expertise of F.W.E Rowe, who put the name *Actinopyga* (?) *bannwarthi* to their photographed specimen from the Philippines. The recently collected Comoros material, together with a specimen collected earlier in Papua

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New Guinea by one of us (C.M.), allows a definitive identification of the previously photographed specimens. All are here recognized as a species new to science.

Systematics of the genus *Actinopyga* Bronn, 1860

Currently *Actinopyga* Bronn, 1860 is one of the five nominal genera that are commonly recognised in the family Holothuriidae (Rowe 1969; Rowe & Gates 1995; Massin *et al.* 2004; Kerr *et al* 2005; Samyn *et al.* 2005). Within this genus sixteen species — *Actinopyga agassizii* (Selenka, 1867); *A. albonigra* Cherbonnier & Féral, 1984; *A. bacilla* Cherbonnier, 1988; *A. bannwarthi* Panning, 1944; *A. caroliniana* Tan Tiu, 1981; *A. crassa* Panning, 1944; *A. echinites* (Jaeger, 1833); *A. flammea* Cherbonnier, 1979; *A. fusca* Cherbonnier, 1980; A. *lecanora* (Jaeger, 1833); *A. mauritiana* (Quoy & Gaimard, 1833); *A. miliaris* (Quoy & Gaimard, 1833); *A. obesa* (Selenka, 1867); *A. palauensis* Panning, 1944; *A. serratidens* Pearson, 1903 and *A. spinea* Cherbonnier, 1980 — are generally recognised as valid (Samyn 2003, complemented with *A. fusca* Cherbonnier, 1980 missed by this author). Rowe (*in* Rowe & Gates, 1995) tentatively also maintained *A. lubrica* (Sluiter, 1894) as a member of the genus, but noted that this ill-known species (only known from two syntypes) probably represents *Holothuria (Platyperona) difficilis* Semper, 1868, hereby following H.L. Clark's (1921; 1946) earlier remark. We agree that *A. lubrica* is best transferred to *Holothuria* Linnaeus, but refrain from assigning it to one of its species as long as the type material has not been re-examined in depth.

Panning (1944; but see also Rowe 1969) was the last to review this taxon. In his revision, which he admitted to be very difficult, he recognized five species (all but one having subspecies) belonging to three main groups. He did not assign *A. mauritiana* to any of his groups. A schematic overview of Panning's system is given in table 1.

His first group ('*Act. lecanora*') includes species characterised by having simple, smooth rosettes which only occasionally have lateral extensions and have their ends swollen (especially in the ventral body wall). His second group ('*Act. echinites*') brings together two species, *A. echinites* and *A. serratidens*, each with three subspecies (see table 1). This group is characterised by a narrowing and elongation of the rosettes of the ventral body wall. In recognising the distinction between *A. echinites* and *A. serratidens,* Panning (1944) drew mainly on the form of the rosettes of the dorsal body wall, which, according to him, largely lack median projections in *serratidens.* Panning's last group is the so-called '*obesa*-Gruppe' in which he included two subspecies of *A. obesa* (see table 1). This group is characterised by the presence of rough, often branched rods. Lastly, Panning (1944) briefly mentioned the difficulty he had in placing the ubiquitous species *A. mauritiana*. He opted for the safest solution and kept it as a separate species in the genus. He remarked that some ossicles of the ventral body wall (grains) resemble those found in the genus *Bohadschia* Jaeger, 1833, and that the ossicle assemblage of the dorsal body wall is reminiscent of the *obesa*-group.

Global distribution of the genus

Actinopyga is present in shallow-waters (0–100m) of a wide circum-tropical belt; it has representative species in the Atlantic (Caribbean area), the Indian and the Pacific Ocean (see table 2). The genus is associated with well-developed coral reefs.

TABLE 1. Species and groups as recognized by Panning (1944).

Group 1 — '*Act. lecanora*'
A. lecanora lecanora
A. lecanora miliaris
Group 2 — '*Act. echinites*'
A. echinites echinites
A. echinites plebeja
A. echinites crassa
A. serratidens agassizii
A. serratidens serratidens
A. serratidens bannwarthi
Group 3 – '*Act. obesa*'
A. obesa obesa
A. obesa palauensis
Not assigned to any group
Actinopyga mauritiana

TABLE 2. Valid species of *Actinopyga*, with type locality and known geographical distribution.

Currrent Valid Species	Type locality	Known Geographical Distribution
A. agassizi (SELENKA, 1867)	Florida, Tortugas Island	Caribbean Sea, Florida, Bermuda and the Bahamas (Panning 1944; Hendler et al. 1995)
A. albonigra CHERBONNIER & FÉRAL, 1984	Ilot Maître, New Caledonia	New Caledonia (Cherbonnier & Féral 1984); Ambon (Massin 1996)
A. bacilla CHERBONNIER, 1988	Nosy Bé, Madagascar	Madagascar (Cherbonnier 1988)
A. bannwarthi PANNING, 1944	Suez, Egypt	Possibly restricted to the Red Sea (Panning 1944; Samyn 2003) although some Indo-Pacific material has been assigned to this species (Cherbonnier 1988; Rowe & Gates 1995)

TABLE 2. (continued)

Currrent Valid Species	Type locality	Known Geographical Distribution
A. caroliniana TAN TIU, 1981	Mactan Isles, Philippines	Mactan Isles, Philippines (Tan Tiu 1981)
A. crassa PANNING, 1944	Port Moresby, Papua New Guinea[*a] Querimba Islands, Mozambique[*]	Red Sea, Querimba Archipelago, Madagascar, New Guinea, New Caledonia (Panning 1944; Cherbonnier 1988; Samyn 2003)
A. echinites (JAEGER, 1833)	Sulawesi (as Celebes), Indonesia	Tropical Indo-West Pacific Ocean, including the Red Sea (Panning 1944; Conand 1998; Rowe & Gates 1995; Samyn 2003)
A. flammea CHERBONNIER, 1979	166°14’ E/ 22°21’S, New Caledonia	New Caledonia (Cherbonnier 1979)
A. fusca CHERBONNIER, 1980	Ilot Maître, New Caledonia	New Caledonia (Cherbonnier, 1980)
A. lecanora (JAEGER, 1833)	Sulawesi (as Celebes), Indonesia	Indo-west Pacific, including the Red Sea (Panning 1944; Massin 1999; Samyn 2003)
A. mauritiana (QUOY & GAIMARD, 1833)	Mauritius	Tropical Indo-west-central Pacific, including the Red Sea (Panning, 1944; Clark & Rowe 1971; Rowe & Gates 1995; Samyn 2003)
A. miliaris QUOY & GAIMARD, 1833	Vanikoro Islands (Solomon Islands)	Indo-west Pacific, including the Red Sea (Panning, 1944; Massin 1999; Samyn 2003)
A. obesa (SELENKA, 1867)	Hawaii (as Sandwich Islands)	Indo-west-Pacific, excluding the Red Sea (Cherbonnier 1988; Rowe & Gates, 1995; Samyn 2003)
A. palauensis PANNING, 1944	Palau Islands, New Caledonia	Palau Islands, New Caledonia (Panning 1944; Cherbonnier & Féral 1984)
A. serratidens PEARSON, 1903	Sri Lanka (as Ceylon)	Indo-west-Pacific, including the Red Sea (Panning 1944; Cherbonnier 1988)
A. spinea CHERBONNIER, 1980	Ilot Canard, New Caledonia	New Caledonia (Cherbonnier 1980)
A. caerulea sp. nov.	Ikoni, Grande Comore, Union des Comores	Indo West-Pacific, excluding the Red Sea (present paper)

a. Panning (1944) only designated syntypes. According to Article 76.1 of the ICZN, the type locality thus encompasses the localities of all of them.

Material and methods

Collecting was carried out by SCUBA-diving up to depths of 50 m. Specimens from the Comoros were anaesthetized in approximately 5% magnesium chloride until they stopped responding to probing; transferred to 100% buffered alcohol for one day, transferred to 70% buffered alcohol after a second and a third day and stored in 70% buffered alcohol for permanent storage. The specimen from Papua New Guinea was anaesthetized in 3.5% magnesium chloride for 4 hours, preserved in 10% buffered formalin and later transferred to 75% buffered alcohol for permanent storage. They were studied according to conventional methods outlined by Rowe & Doty (1977) and others. Ossicles were removed from various tissues in household bleach, washed in three to seven changes of distilled water, dried, mounted for permanent storage and illustrated with the *camera lucida.* For the SEM, samples were dried and mounted on aluminium stubs, coated with gold in a sputter coater and observed with a JEOL JSM-5400LV scanning electron microscope.

The holotype of the new species is deposited in the collections of the Royal Museum of Central Africa, Tervuren, Belgium (RMCA); the first paratype is in the collections for the Centre National de Documentation et de Recherche Scientifique, Moroni, Comoros (CNDRS), the second paratype is in the Royal Belgian Institute of Natural Sciences, Brussels, Belgium (RBINS); the third paratype is in the collections of the Musée National d'Histoire Naturelle, Paris, France (MNHN); and the fourth paratype is in the collections of the Natural History Museum, London, United Kingdom (NHM). The RBINS also holds one non-type specimen from Papua New Guinea.

Systematic account

Ordo Aspidochirotida Ludwig, 1894

Family Holothuriidae Ludwig, 1894

Genus *Actinopyga* Bronn, 1860

Diagnosis [Type-species: *Muelleria echinites* Jaeger, 1833 by subsequent designation (Clark & Rowe 1967)].

Life size from moderate to very large (400 mm) in length; body stout with thick and firm body wall, covered by prominent ambulatory tube feet ventrally and, numerous, modified, elongate tube feet (= "papillae") dorsally; mouth ventral, surrounded by 15–30 large, peltate tentacles; calcareous ring firm, radial pieces about twice as large as interradial pieces; anus dorsal to terminal, guarded by five, nearly always prominent, heavily calcified terminal tube feet (= "anal teeth"). Ossicles in body wall rosettes and straight to branched, smooth or spiny, rods; tentacles with rods of various sizes and forms, often spiny at extremities; tube feet and papillae with rods and rosettes similar to those of body wall, but often with more complex branched rods; longitudinal and cloacal retractor muscles with rods similar to the simple, smooth ones from the body wall; gonad with rods similar to those of body wall; cloacal wall with spiky rods. Tables, buttons or other ossicle types absent from all tissues. Cuvierian organs present or absent, when present never expelled, non-sticky and composed of three distinct parts: (i) smooth proximal half of trunk, (ii) slightly rugged distal half of trunk, and (iii) highly ragged elongated primary and secondary branches.

***Actinopyga caerulea* sp. nov.**

(Figures 1A–J, 2A–E, 3A–E, 4A–G, 5; plate 1A–C)

Actinopyga crassa; Cherbonnier & Féral 1984 : 664, fig. 3 A–K; Féral & Cherbonnier 1986 : 70–71; Erhardt & Moosleitner 1995: 1153 (non *A. crassa* Panning, 1944)
Actinopyga (?) *bannwarthi*; Erhardt & Baensch 1998: 1076 (non *A. bannwarthi* Panning 1944)

Name-bearing types

Holotype, RMCA 1803; Paratype 1, CNDRS 2004.09; Paratype 2, RBINS IG 30376; Paratype 3, MNHN EcHo 8081; Paratype 4, NHM 2005.2405.

Material examined

Union des Comores (Grande Comore, Ikoni), 22.XI.2003, 37 m depth, coll. Y. Samyn & D. VandenSpiegel, RMCA 1803 (holotype); Union des Comores (Grande Comore, H.L.M Langouste), 11.X.2004, 28 m depth, coll. Y. Samyn, D. VandenSpiegel & C. Massin, CNDRS 2004.09 (paratype 1); Union des Comores (Grande Comore, Itsandra), 20.XI.2003, 23 m depth, coll. Y. Samyn & D. VandenSpiegel, RBINS IG 30376 (paratype 2); Union des Comores (Grande Comore, Aérodrome), 16.V.2005, 26 m depth, coll. Y. Samyn & D. VandenSpiegel, NMHN EcHo 8081 (paratype 3); Union des Comores (Grande Comore, Itsandra), 16.V.2005, 21 m depth, coll. Yves Samyn & D. VandenSpiegel, NHM 2005.2405 (paratype 4); Papua New Guinea (Madang Province, Madang's Reef, Wongat Island), 05.X.1996, 25 m depth, coll. C. Massin, RBINS, IG 28 455/22.

Type locality

Union des Comores, Grande Comore, Ikoni.

Type material (2 syntypes) of *Actinopyga serratidens* var. *bannwarthi* Panning, 1944: ZMH E5902 (Zoologishes Institut und Zoologisches Museum der Universität Hamburg); Egypt (Suez), 1913, depth unknown, coll. Dr E. Bannwarth.

Non type material (1 specimen) of *A. mauritiana* (Quoy & Gaimard, 1833) (misidentified as *A. bannwarthi* Panning, 1944 by Cherbonnier (1988)): Madagascar (Nosy Be, Andilana), 20.VIII.1959, coll. G. Cherbonnier, EcHh 5082 (Muséum National d'Histoire Naturelle, Paris, France).

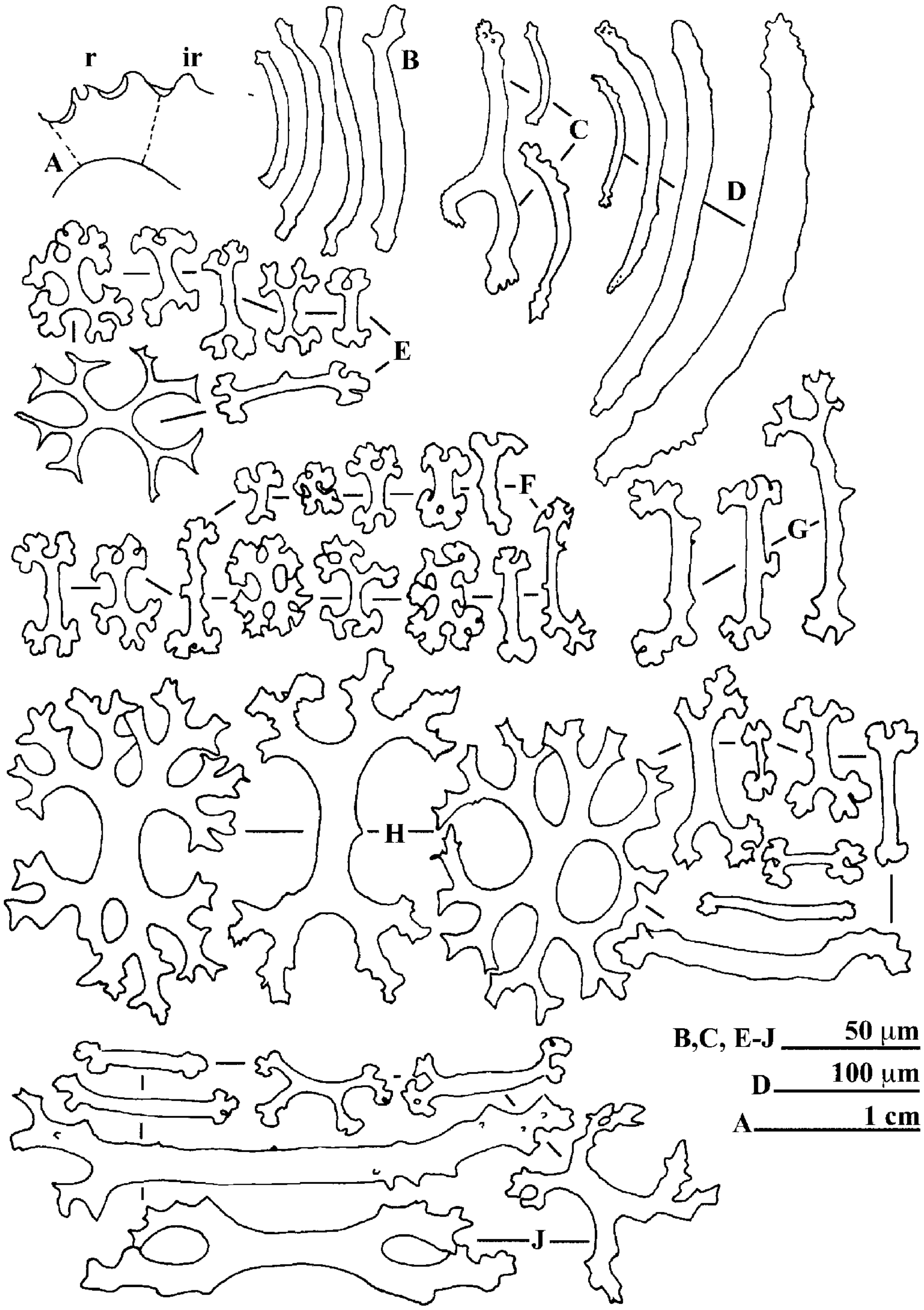

FIGURE 1. *Actinopyga caerulea* sp. nov. (Papua New Guinea). A, Calcareous ring,: r = radial piece, ir = interradial piece. B, Rods from base of tentacles. C, D Rods from tip of tentacle. E, Rosettes from ventral body wall. F, Rosettes from dorsal body wall. G, Elongated rod-like rosettes from dorsal body wall. H, Rosettes from tip of dorsal papillae. J, Rods from base of dorsal papillae.

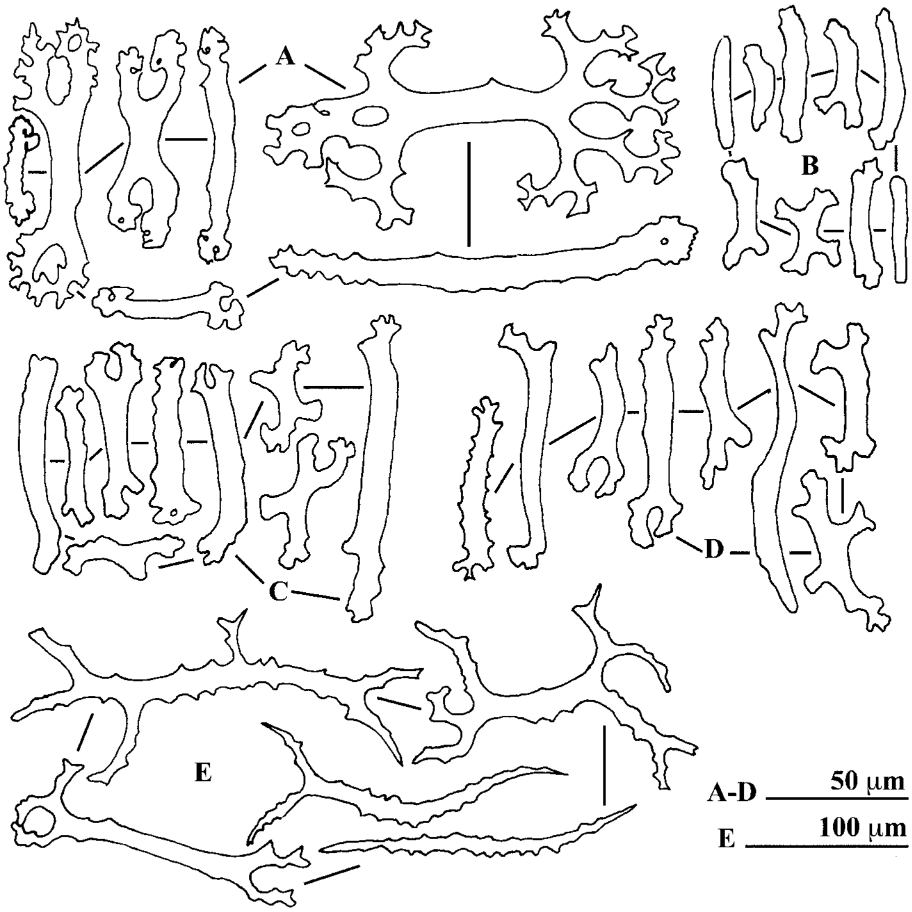

FIGURE 2. *Actinopyga caerulea* sp. nov. (Papua New Guinea) A, Rods from ventral tube feet. B, Rods from longitudinal muscle. C, Rods from cloacal retractor muscles. D, Rods from cloacal wall. E, Rods from gonad.

Non type material (2 specimens) of *A. crassa* Panning, 1944: Seychelles (Mahé), 07.IX.1969, coll. Mission zoologique MRAC-ULB, RMCA 1186.

Description

Very large species; living specimens up to 400 mm long and 140 mm wide mid-body; preserved specimens from 225 to 280 mm long and from 85 to 110 mm wide mid-body. Body loaf-shaped with slight ventral flattening (more or less cylindrical with some distal tapering). Colour in life bluish with patches of white devoid of tube feet at anterior and posterior ends and, discontinuously, along sides (Plate 1). Colour in type material in alcohol largely preserved, but faded to dull brown in specimen from Papua New Guinea. White patches remain clearly visible on all specimens. Body wall smooth, up to 14 mm thick. Mouth ventral, surrounded by 15–18 large, peltate, uniformly bluish-grey tentacles, in turn surrounded by a stout collar of bluish papillae, fused at their base. Anus terminal, guarded by five prominent, calcareous, teeth, each bearing numerous tubercles. Ventral tube feet stout, distributed unevenly, *albeit* somewhat concentrated in ambulacral areas. Dorsal "papillae" large, conical at base, near cylindrical at top; bluish at base, slightly lighter at top; scattered over ambulacral and interambulacral areas, though absent in white zones. Cuvierian organ absent. Single, club-shaped Polian vesicle, about one seventh of length of preserved animals. Stone canal and associated madreporite not observed in all the specimens studied. Gonad observed only in the specimen from Papua New Guinea. Calcareous ring huge, radial pieces about twice as large as interradial pieces (Figure 1A). Details of surface of calcareous ring obscured by thick layer of tissue.

Ossicles: Tentacles with rods only; base of tentacles with few, straight to slightly curved, smooth rods, 50–90 µm long (Figure 1B); tip of tentacles with similar but larger rods, up to 500 µm long (Figure 1C, D), occasionally distally branching (Figures 1C, 3A). Ventral body wall with rosettes of various forms, some elongated with endings swollen, others wider and more spiny, 15–65 µm long (Figures 1E, 3B). Dorsal body wall with small rosettes that have their endings swollen, 20–60 µm long (Figures 1F, 3C) and elongated rod-like spiny rosettes, 255–100 µm long (Figures 1G, 3D). The proportion of rosettes with swollen endings versus spiny rod-like rosettes as well as the size of the rosettes are highly variable within a single specimen, depending on site of bivium sampled. The same phenomenon occurs in specimens coming from different geographic localities: holotype from Comoros Islands with more spiny ossicles in dorsal body wall than the specimen from Papua New Guinea. Base of dorsal papillae with rosettes and rod-like rosettes, 25–65 µm long, as well as dichotomously branched spiny rods, 100–160 µm long (Figures 1J, 3E). Tip of dorsal papillae with spiny rods of various form; from simple to complex branching, 50–200 µm long (Figures 1H, 4A). Ventral tube feet with smooth rods, 25–40 µm long, spiny rods, 40–150 µm long, and stout spiny rods, 100–140 µm long, with perforated extremities (Figures 2A, 4B); terminal disc, up to 1,000 µm across, composed of several pieces; centrally several perforated plates with large holes (Figure 4C) surrounded by 10–12 perforated plates with smallest holes at periphery (Figure 4D). Cloaca with spiky rods, similar in shape as those from dorsal papillae, 50–100 µm long (Figures 2D, 4E). Longitudinal and cloacal retractor muscles with simple, smooth, occasionally branched rods, 35–55 µm long (Figures 2B, C, 4F, G). Gonad with spiny, branched rods, 160–250 µm long (Figure 2E).

Etymology

The name *caerulea,* Latin, refers to the unique blue colour of the species.

Ecology

This species is characteristic of somewhat deeper tropical waters; it has been observed from 12 to 45 m. The species is predominantly a detritus/deposit feeder on coral patches on the outer slope of coral reefs; it forages actively during the day.

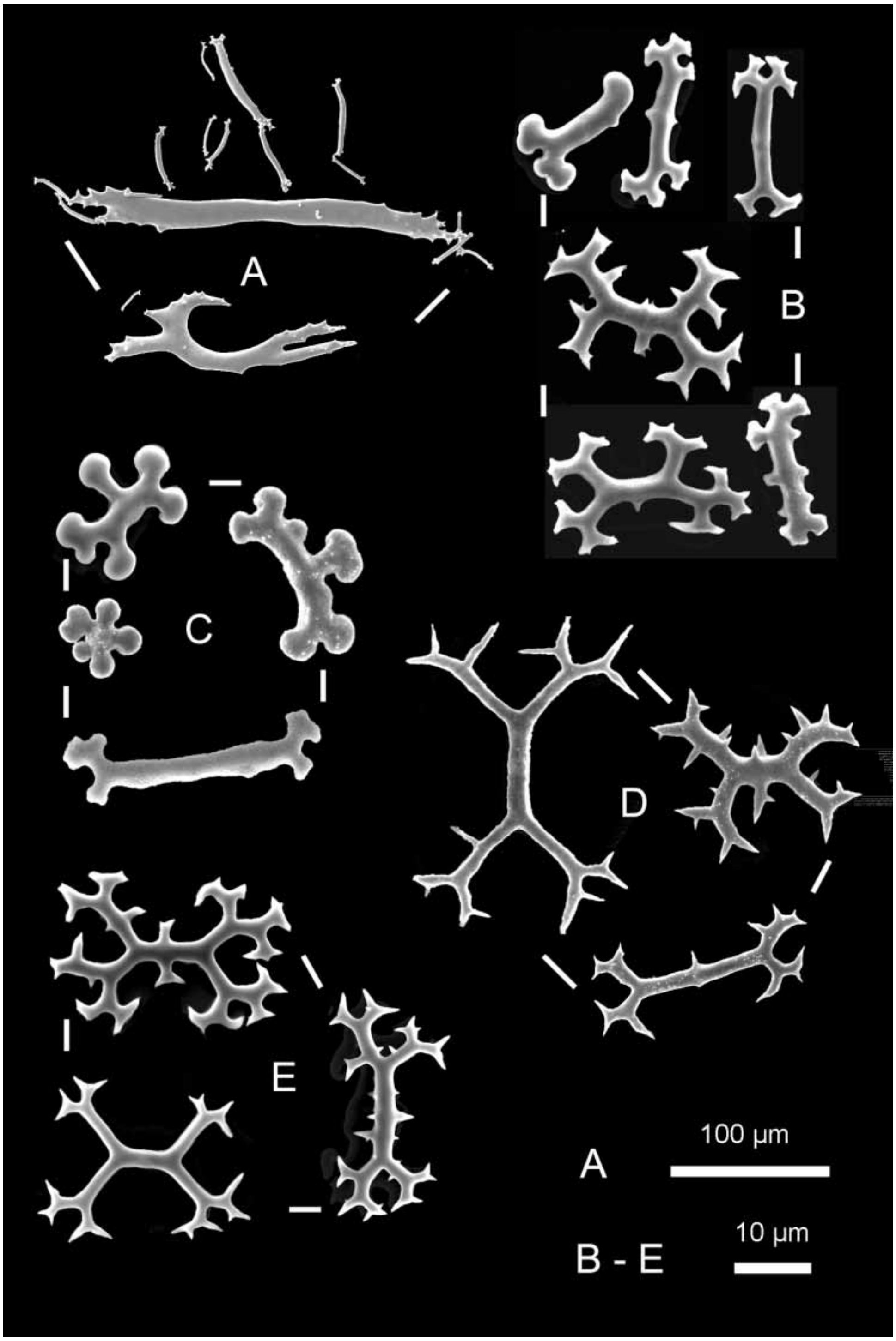

FIGURE 3. *Actinopyga caerulea* sp. nov. (Comoros, holotype) A, Rods from tentacle. B, Rosettes from ventral body wall. C, Rosettes from dorsal body wall. D, Spiny, rod-like rosettes from dorsal body wall. E, Rosettes from base of dorsal papillae.

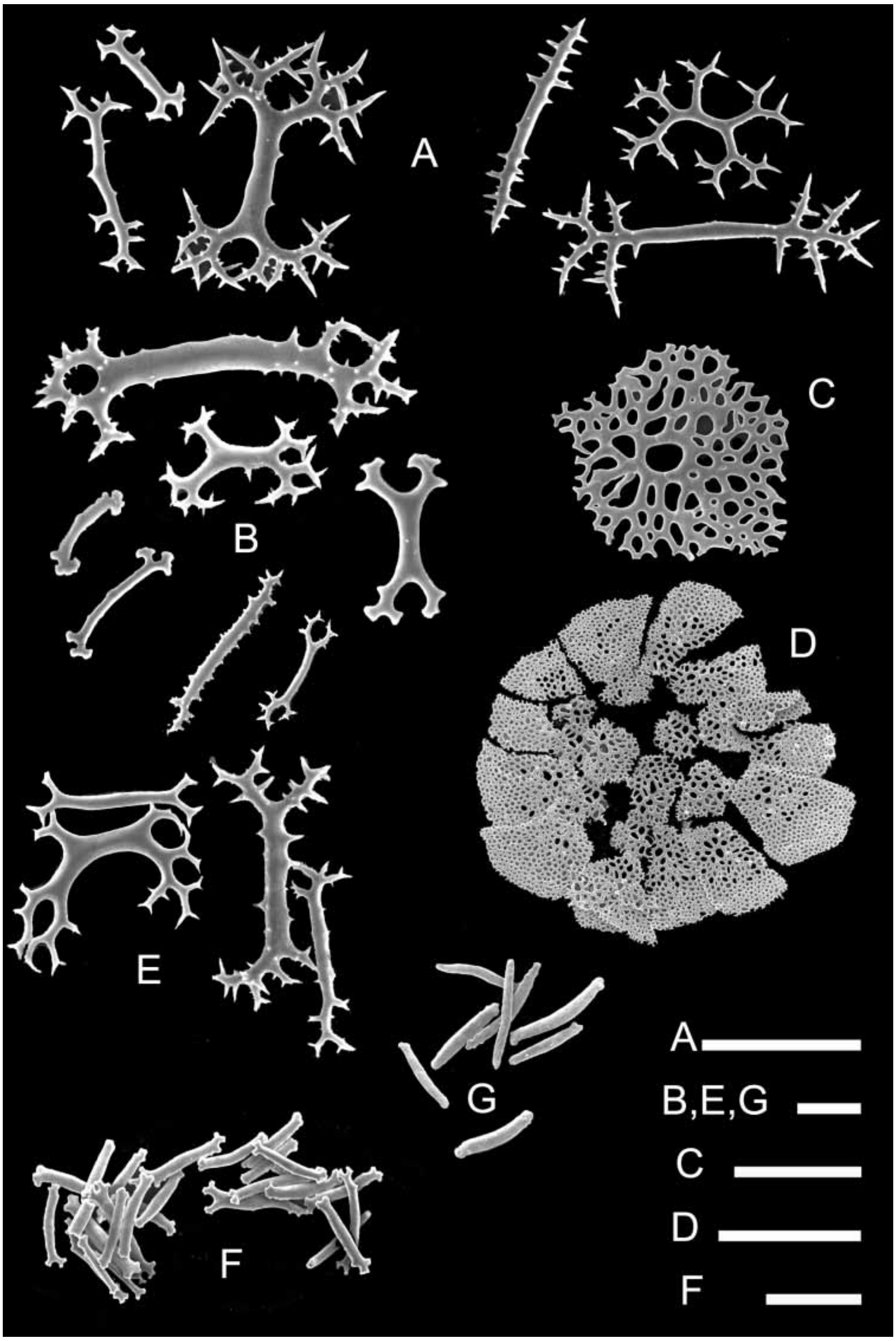

FIGURE 4. *Actinopyga caerulea* sp. nov. (Comoros, holotype) A, Rods from tip of dorsal papillae. B, Rods from ventral tube feet. C, Central plate from fragmented terminal disc. D, *In toto* view of fragmented terminal disc. E, Spiny rods from cloacal wall. F, Rods from cloacal retractor muscle. G, Rods from longitudinal muscle. Scale A& F = 50 µm; Scale B,E,G = 10 µm; Scale C = 100 µm; Scale D = 200 µm.

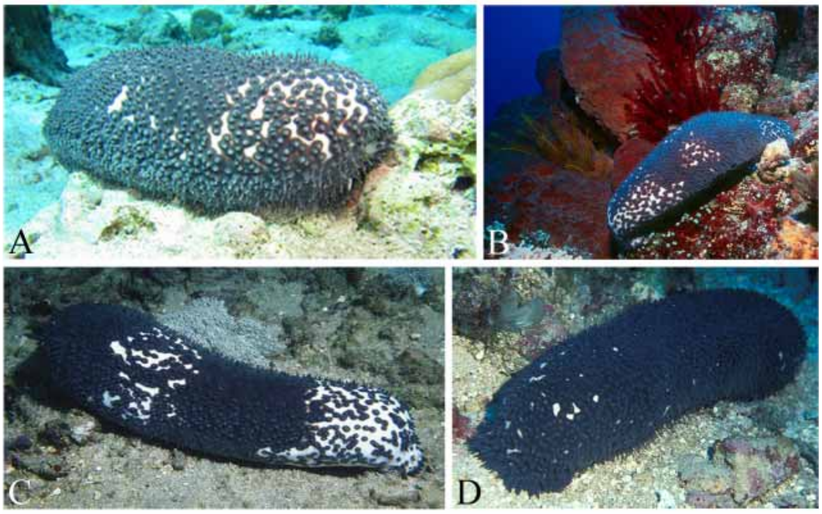

PLATE 1. *Actinopyga caerulea* sp. nov. as photographed *in situ* in Comoros (A), Sulawesi (B), Bali (C) and Papua New Guinee (D). (Picture A by D. VandenSpiegel; B by D. Lane; C by R. Myers and D by P. Colins).

Geographic distribution

Tropical Indo-Pacific; confirmed sightings have been made in Thailand (see Erhardt & Moosleitner 1995, as *A. crassa*), the Philippines (see Erhardt & Baensch 1998, as *A.* (?) *bannwarthi*), Indonesia [Bali (Myers pers. comm.) and Sulawesi (Lane pers. comm.)], Papua New Guinea [Kavieng (Colin pers. comm), Hansa Bay (Colin pers. comm.) and Madang (present paper)], New Caledonia (see Féral & Cherbonnier 1986, as *A. crassa*) and the Archipelago of the Comoros (type locality). Figure 5 shows the known distribution of this species, including locations requiring confirmation of identification.

Discussion

Actinopyga caerulea sp.nov belongs to what Panning (1944) has termed the '*echinites* group. It shares with *A. bannwarthi* the presence of spiny rosettes (cf. Panning 1944, Fig. 22, p. 54). However, rosettes from *A. bannwarthi* are less spiny and have many more lateral extensions than those from *A. caerulea.* Another striking difference between the two species lies in the colouration: the two syntypes of *A. bannwarthi* are uniform dark chocolate brown dorsally (Figure 6A) and light brown to yellow ventrally (Figure 6B), with no white patches devoid of tube feet on the lateral and dorsal surfaces of the body. The two species differ also in terms of distribution: *A. caerulea* has not yet been found in the Red Sea, whereas *A. bannwarthi* seems restricted to it. Sloan *et al.* (1979, as *A.* sp. cf. *A. bannwarthi*), Cherbonnier (1988) and Rowe & Gates' (1995) records of *A. bannwarthi* need verification. Certainly one of the Malagasy specimens identified by Cherbonnier (1988) is *A. mauritiana* and not *A. bannwarthi.*

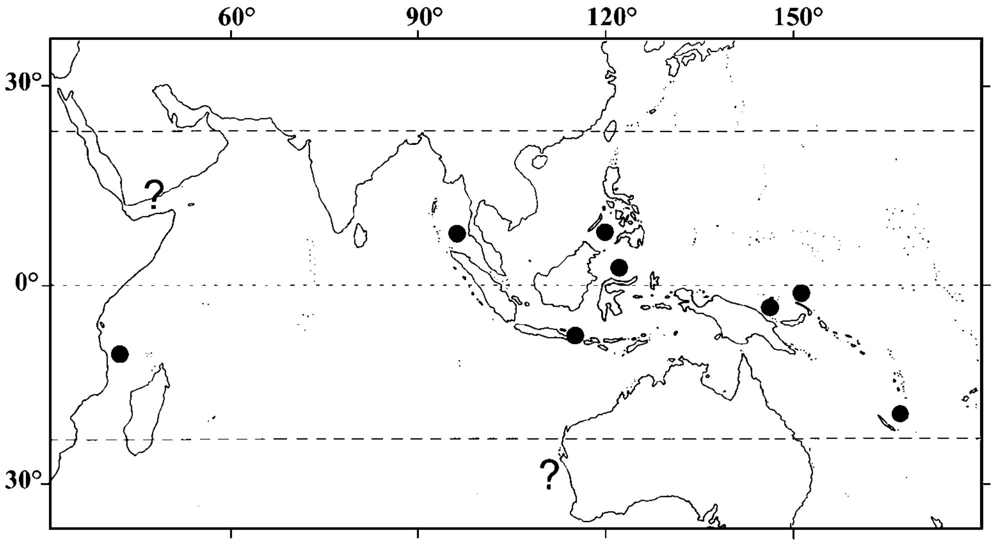

FIGURE 5. *Actinopyga caerulea* sp. nov. Known geographic distribution with uncertain records flagged with a question mark.

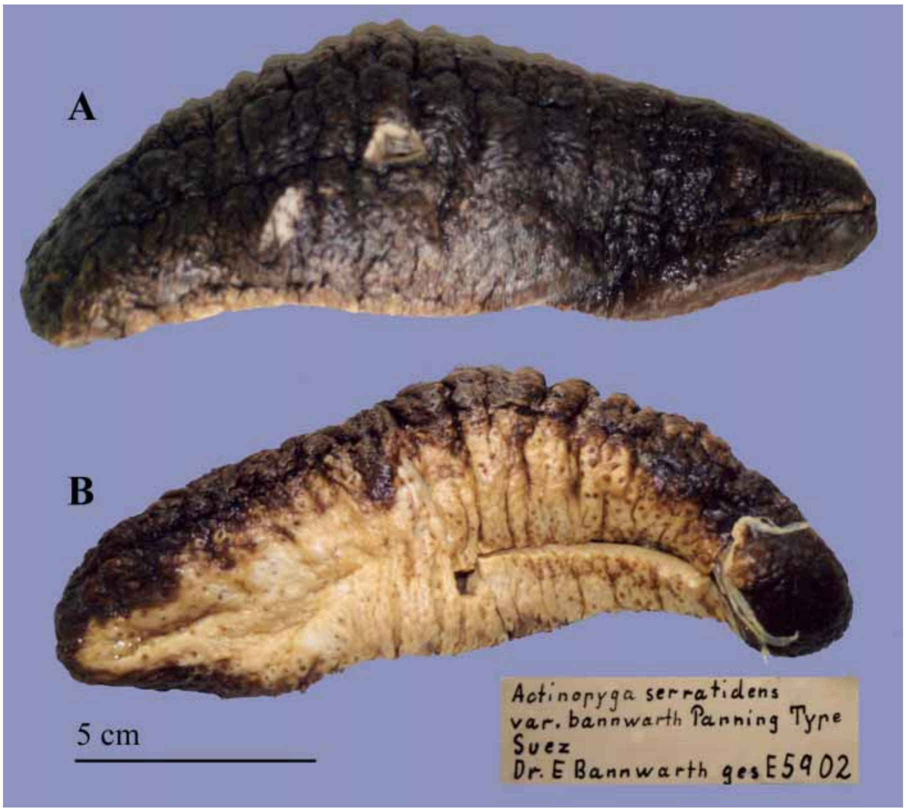

FIGURE 6. One of the two syntypes of *A. bannwarthi* Panning, 1944 as deposited in the ZMH (ZMH E. 5902) (A) dorsal view, (B) ventral view.

With comparative voucher material now at hand, we conclude that we are not dealing with *Actinopyga crassa* (see Erhardt & Moosleitner 1995). The latter species differs markedly from *A. caerulea* in the presence of stout, slightly curved rods in the ventral body wall and in the presence of elongated narrow rod-like rosettes with lateral extensions in the dorsal body wall (cf. Panning 1944, fig 19, p. 51).

The more recently described *A. flammea* also appears to belong to Panning's (1944) '*echinites* group', an observation we share with Cherbonnier (1979). Nevertheless, *A. caerulea* can again be easily distinguished from *A. flammea*, in life, because *A. caerulea* has a conspicuous bluish and white colouration, and *A. flammea* has a uniformly brick red body wall and prominent, greyish, tubercular "papillae". Further, *A. caerulea* differs markedly from *A. flammea* in not having closed rosettes in the ventral body wall (see Cherbonnier 1979, fig. 2F,G, p. 5).

Our observation of a compound endplate in the ventral tube feet is not new. This character has already been noted for several species in *Actinopyga*, *Bohadschia*, *Pearsonothuria graeffei* (Semper, 1868), as well as in certain Stichopodidae (Massin 1996; 1999; unpublished data) and Synallactidae, notably species of *Synallactes* Ludwig, 1894 (Massin, 1992). More detailed systematic study of such "fragmentation" in all the genera of Aspidochirotida will help to determine whether this phenomenon is due to common descent or not. For now, we can note that an endplate of a large diameter (≥ 500 µm across) does not *ipso facto* imply that the endplate will be compound. Indeed, some aspidochirotid species have a simple, single endplate of over 500 µm across, while others possess a compound endplate that is 350 µm across.

Acknowledgments

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