

## An annotated checklist of crinoids (Echinodermata) collected by the South Java Deep-Sea biodiversity cruise 2018

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**Abstract.** A total of 40 crinoid specimens were collected from deep waters at Sunda Strait and southern coast of West Java by the South Java Deep-Sea Biodiversity Expedition in 2018. A total of 14 species, comprising two sea lilies (Isocrinida) and 12 feather stars (Comatulida) belonging to ten genera in eight families were recognised from this area. The most abundant species collected was *Teliocrinus springeri liliaceus*. *Phanogenia serrata* and *Glyptometra inaequalis* are recorded from Indonesian waters for the first time. An undetermined species of *Aglaometra* that appears to be closely allied to *Aglaometra valida* is also described. *Athrypsometra mira* and *Athrypsometra minima* are suggested to be synonymous.

**Key words.** echinoderm, Crinoidea, feather star, sea lily, Indonesia, Indian Ocean

### INTRODUCTION

The crinoids of the deep waters of the Sunda Strait and southern coast of Java Island are still poorly studied. Previous studies (Hartlaub, 1912; AH Clark, 1912a, 1931, 1941, 1947; AH Clark & AM Clark, 1967) have recorded 20 species in six feather star families from the Sunda Strait alone, mostly from shallow waters (less than 50 m deep) (Table 1). No crinoids have been recorded from the southern coast of West Java.

The current study reports the crinoids collected by the South Java Deep-Sea (SJADES) Biodiversity Expedition from deep Indonesian waters of the Sunda Strait and the Indian Ocean off the southern side of Java Island in 2018. The synonyms and distribution ranges, and brief descriptions of the specimens are given for each species.

### MATERIAL AND METHODS

Crinoid specimens were collected by beam trawls and dredges by the KR. *Baruna Jaya VIII* of the Indonesian Institute of Sciences (Lembaga Ilmu Pengetahuan Indonesia, or LIPI) from March 23 to April 8, 2018, during the South Java Deep-Sea Biodiversity Expedition 2018 (SJADES 2018). Specimens were collected from 15 stations at depths ranging

from 92 m to 1,091 m. They were fixed and preserved in 99% ethanol and after examination were deposited at the Bogor Zoology Museum, Cibinong, Indonesia (RCO), Lee Kong Chian Natural History Museum, National University of Singapore (ZRC), and the National Museum of Nature and Science, Japan. For comparison, relevant specimens deposited in the National Museum of Nature and Science, Japan (NSMT) were also examined.

Morphological terms follow Messing (1997, 2001) and Roux et al. (2002). Abbreviations and formulae in this paper are as follows. **Cirri**: Roman numerals indicate the number of cirri. **C**: cirral or segment of cirrus, numbered from the base by Arabic numeral (e.g., c4 indicates fourth cirral of the cirrus). **D/H**: diameter-to-height ratio of centrodorsal. **L/W**: length-to-width ratio of ossicles (radials, cirri segments, or pinnule segments). **Br**: division series numbered from the ray base preceded by a Roman numeral and followed by Arabic numeral to indicate the number of ossicles (e.g., Ibr 2 indicates the first division series composed of two ossicles). **Br**: brachial or individual ray ossicle, numbered from the base of each division series or arm by subscript Arabic numeral (e.g., Ibr<sub>2</sub> indicates the second brachial of the first division series; br<sub>1</sub> indicates the first brachial of the undivided arm). **+**: articulation joined by syzygy between brachials (e.g., IIbr 4(3+4) indicates the second division series composed of four brachials, where the third and fourth brachials are joined by syzygy; br<sub>3+4</sub> indicates br<sub>3</sub> and br<sub>4</sub> joined by syzygy). **P**: pinnule, numbered from the most proximal by subscript Arabic numeral (e.g., P<sub>1</sub>, P<sub>2</sub>...) for the exterior pinnules and letters (e.g., P<sub>a</sub>, P<sub>b</sub>...) for interior pinnules. P<sub>M</sub> and P<sub>D</sub> indicate pinnules on middle and distal portion of arms, respectively. Relative lengths of pinnules are shown using equal and unequal signs following Kogo (1998) (e.g., P<sub>1</sub>>P<sub>2</sub>=P<sub>3</sub>=P<sub>4</sub>=P<sub>5</sub><P<sub>M</sub>=P<sub>D</sub>). In some species, we described pinnule lengths separately, because some specimens do not have the complete pinnule set.

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Table 1. Crinoid species recorded from the Sunda Strait and the southern waters of Java. The species found in this study are shown in bold face. ND: no data. Question marks mean questionable data.

Family	Species	Previous depth record in the studied area (m)	Depth record in this study (m)	Global depth range (m)	References of occurrence in the studied area
Isocrinidae	<i>Hypalocrinus naresianus</i>		603–686	603–2,470	
Cainocrinidae	<i>Teliocrinus springeri liliaceus</i>		517–727	366?–847	
Comatulidae	<i>Alloeocomatella pectinifera</i>		448–469	3–469	
	<i>Comatella stelligera</i>	30		0–210	AH Clark, 1931
	<i>Capillaster asterias</i>	35		35–56	AH Clark, 1931
	<i>Capillaster sentosus</i>	36		0–135	AH Clark, 1931
	<i>Capillaster multiradiatus</i>	30–52	92–103	0–ca. 300	AH Clark, 1931
	<i>Comatula (Comatula) pectinata</i>	25–36		0–73	AH Clark, 1931
	<i>Comatula (Comatula) micraster</i>	35–45		22–109	AH Clark, 1931
	<i>Phanogenia gracilis</i>	36		4–50	AH Clark, 1931
	<i>Phanogenia distincta</i>	36		15–290	AH Clark, 1931
	<i>Phanogenia serrata</i>		92–103	55?–210?	
	<i>Comanthus briareus</i>	36		1–120	AH Clark, 1931
	<i>Comanthus parvicirrus</i>	30		1–110	AH Clark, 1931
Zygometridae	<i>Zygometra comata</i>	30		0–150	AH Clark, 1941
Himerometridae	<i>Heterometra quinduplicava</i>	52		0–80	AH Clark, 1941
	<i>Heterometra amboinae</i>	36		0–50	AH Clark, 1941
	<i>Amphimetra mollerii</i>	35–52		0–55	AH Clark, 1941
	<i>Amphimetra tessellata</i>	ND		0–109	Hartlaub, 1912
Mariametridae	<i>Mariametra vicaria</i>		92–103	53–103	
	<i>Oxymetra erinacea</i>	36		0–50	AH Clark, 1941
	<i>Stephanometra indica</i>	ND		0–73	Hartlaub, 1912
Charitometridae	<i>Glyptometra inaequalis</i>		1,078–1,091	362–1,185	
Thalassometridae	<i>Aglaometra valida</i>		528–637	457–1,165	
	<i>Aglaometra</i> sp.		637–689		
Colobometridae	<i>Decametra parva</i>	49		1–90	AH Clark, 1947
	<i>Oligometra serripinna</i>	38–40		0–90	AH Clark, 1947
Antedonidae	<i>Dorometra nana</i>	shallow water		0–60	AH Clark & AM Clark, 1967
	<i>Antedoninae</i> gen. sp.		805–977		
	<i>Thaumatometra</i> sp.		425–442		
	<i>Arthrypsometra mira</i>		325–362	325–924	
	<i>Arthrypsometra minima</i>		383–425	383–2,060	
Pentametrocrinidae	<i>Pentametrocrinus varians</i>		864–870	457–2,727	

## RESULTS

A total of 40 specimens were collected: 21 feather star and 19 sea lily specimens. The feather stars belong to 12 species and eight genera in six families: Comatulidae, Mariametridae, Charitometridae, Thalassometridae, Antedonidae, and Pentametrocrinidae. The sea lilies belong to two species in two genera of Cainocrinidae and Isocrinidae (Table 1). The most abundant species was *Teliocrinus springeri liliaceus* (AH Clark, 1909d): 18 specimens were collected at five different stations.

Five families (Charitometridae, Thalassometridae, Pentametrocrinidae, Cainocrinidae, and Isocrinidae) are recorded for the first time from southern Java waters. This study also recognised 10 new records for southern Java waters: *Hypalocrinus naresianus* (Carpenter, 1884), *Teliocrinus springeri liliaceus*, *Alloeocomatella pectinifera* (AH Clark, 1911c), *Phanogenia serrata* (AH Clark, 1907c), *Mariametra vicaria* (Bell, 1894), *Glyptometra inaequalis* (Carpenter, 1888), *Aglaometra valida* (Carpenter, 1888), *Arthrypsometra mira* (AH Clark, 1909e), *Arthrypsometra minima* (AH Clark, 1912d), and *Pentametrocrinus varians* (Carpenter, 1882). This increases the number of species

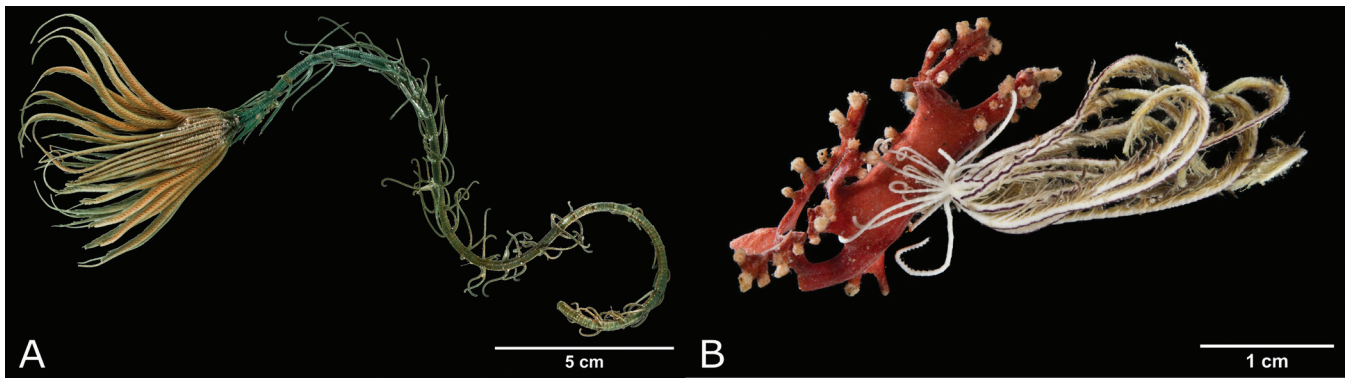


Fig. 1. Living colouration of *Teliocrinus springeri liliaceus* (A, RCO.ECH.3166) and *Mariametra vicaria* (B, RCO.ECH.3361).

known from the area from 20 species to 30. Among these species, *Phanogenia serrata* and *Glyptometra inaequalis* are recorded from Indonesian waters for the first time, and *Athyropsometra minima* is recorded for the second time after AH Clark (1912d).

## TAXONOMIC SECTION

### Order Isocrinida

#### Family Isocrinidae Gislén, 1924

##### *Hypalocrinus* AH Clark, 1908f

##### *Hypalocrinus naresianus* (Carpenter, 1884)

*Pentacrinus naresianus* Carpenter, 1884: 324–328, pl. 27 fig. 11–13, pls. 28–30.

*Isocrinus naresianus* – Döderlein, 1907: 20.

*Hypalocrinus naresianus* – AH Clark, 1908f: 152; 1909a: 409; 1923: 12; Oji, 1991: 32, 33; Roux et al., 2002: 820; Oji & Kitazawa, 2006: 220; Eléaume et al., 2007: 450.

**Material examined.** One specimen. RCO.ECH.3159; St. CP35, south of Boyongkareuceng Cape, Indian Ocean, Indonesia; 603–686 m; rocks, mud, clay; beam trawl; March 29, 2018.

**Description.** Stalk rounded pentagonal in cross-section, almost 3 times longer than crown, 4.5 mm in diameter throughout; internodals including 6–8, mostly 7, columnals with smooth surface. Cirri V per nodal, about 30 segments, 20 mm long; basal cirrals much wider than long; following cirrals gradually becoming elongated; cirrals in distal half as long as wide, with slight aboral tubercle. Basals triangular, 1.0 mm high, 1.8 mm wide, separated from each other. Radials 2.5 mm high, 4.5 mm wide, laterally in contact. IBr 2 jointed by symmorph; single IIBr 2 present; division series with smooth surface, with lateral sides in close contact. Arms 11, 130 mm long (broken at  $br_{95}$ ; full length estimated at about 160 mm); brachials smooth;  $br_3$  and  $br_4$  jointed by symmorph. First pinnule arising from  $br_2$ .

**Distribution.** Kermadec Islands, New Zealand; Fiji; Celebes Sea (Carpenter, 1884). Philippines (AH Clark, 1909a).

Ogasawara Islands, Japan (Oji, 1991). Kumano-nada Sea and Enshu-nada Sea, Japan (Oji & Kitazawa, 2006). East of Taiwan (Eléaume et al., 2007). South of Java, Indonesia (this study). Depth range: 603–2,470 m (Carpenter, 1884; Eléaume et al., 2007; this study).

**Remarks.** The examined specimen has 11 arms although the species normally has 10 arms, except for a specimen with 16 arms reported by Oji (1991). However, other characters such as the rounded stalk, the symmorph in IBr, and the arm bases in close contact with each other agree well with previous descriptions of the species.

#### Family Cainocrinidae Simms, 1988

##### *Teliocrinus* Döderlein, 1912

##### *Teliocrinus springeri liliaceus* (AH Clark, 1909d) (Fig. 1A)

*Hypalocrinus liliaceus* AH Clark, 1909d: 150.

*Comastrocrinus liliaceus* – AH Clark, 1912a: 257.

*Teliocrinus springeri liliaceus* – Roux et al., 2009: 38.

*Teliocrinus asper* Döderlein, 1912: 22 (part).

*Teliocrinus monarthrus* HL Clark, 1928: 365.

**Material examined.** 18 specimens. RCO.ECH.3160 (1), RCO.ECH.3161 (4), RCO.ECH.3162 (1), RCO.ECH.3163 (1), NSMT E-13727 (2), NSMT E-13728 (1), ZRC.ECH.1843 (3); St. CP26, Indian Ocean (east of Tinjil Island); 517–727 m; mud; beam trawl; March 28, 2018. RCO.ECH.3164 (1); St. CP48, Indian Ocean (south of Gedeh Cape, Java); 689–637 m; some mud and fishing line; beam trawl; April 1, 2018. RCO.ECH.3165 (1); St. CP51, Indian Ocean (Pelabuhanratu Bay); 569–657 m; coarse sand, mud, and plastic trash; beam trawl; April 2, 2018. RCO.ECH.3166 (1); St. CP39, Indian Ocean (south of Cilacap); 528–637 m; some mud; beam trawl; March 30, 2018. RCO.ECH.3167 (1), NSMT E-13726 (1); St. CP23, Sunda Strait (south of Panaitan Island); 559–571 m; gravel with some mud; beam trawl; March 27, 2018.

**Description.** [RCO.ECH.3167] Stalk pentagonal in cross section, 30 cm long, uniform in diameter, 5.0–5.8 mm; internodals of 9–10 columnals with smooth surface. Cirri V per nodal, 47–54 segments, 34–37 mm long; basal cirrals wider than long, gradually becoming elongated to  $c7-8$ ;

middle and distal cirrals as long as wide; distal cirrals sometimes with blunt aboral process. Basals globular, 1.9 mm long, 1.2–1.4 mm wide, separated from each other. Radials rounded, 2.6 mm long, 4.0–4.3 mm wide, in lateral contact; distal edge everted, often with large blunt spines. IBr 2 joined by synostosis or cryptosyzygy; IIBr 4; IIIBr 1–3 (mostly 1); IVBr 3; distal edge of division series ossicles everted, flange-like, sometimes with blunt spines. Arms 31, 145 mm long; proximal brachials with distal margin everted; middle through distal brachials smooth. First pinnule arising from br<sub>2</sub>.

**[Other specimens]** 17 specimens. Stalk almost 2.5 times longer than arm length; internodals including usually 10 columnals. Cirri 40–51 segments, 26–40 mm long. Basals longer than wide. Radials L/W 0.5–0.7. IIBr 4 and sometimes 2, except one specimen (RCO.ECH.3162) with all IIBr 2. IIIBr and IVBr variable, 1–3 (mostly 1). Arms 21–35, 107–140 mm long.

**Distribution.** Off the coast of Myanmar (AH Clark, 1909d). West of Sumatra, Indonesia (Döderlein, 1912). Southwestern Bay of Bengal (AH Clark, 1912a). Northwest of Australia? (HL Clark, 1928). South of Java, Indonesia (this study). Depth range: 366?–847 m (Roux et al., 2009).

**Remarks.** The specimens were identified by the rigid articulations in IBr and IIBr. The smooth distal arms agree with the subspecies *T. springeri liliaceus* (Roux et al., 2009). RCO.ECH.3162 has all IIBr 2 as in *Endoxocrinus* AH Clark, 1908f. However, the number of ossicles of IIIBr and IVBr (1–3 ossicles, frequently 1) differs somewhat from that of *Endoxocrinus* (2 or 3 ossicles, frequently 3) (David et al., 2006). This subspecies appears to be the most abundant in the study area, especially from the eastern part of Tinjil Island (St. CP26; 11 specimens).

## Order Comatulida

### Superfamily Comatuloidea Fleming, 1828

#### Family Comatulidae Fleming, 1828

#### Subfamily Comatellinae Summers, Messing & Rouse, 2014

#### *Alloeocomatella* Messing, 1995

#### *Alloeocomatella pectinifera* (AH Clark, 1911c)

*Comissia pectinifer* AH Clark, 1911c: 644; 1912b: 78; 1913: 6; 1918: 19; 1929: 636; 1931: 255, 256, pl. 25; Messing, 1994: 239. *Comissia pectinifera* – AM Clark & Davies, 1965: 598, 603, 604; AM Clark & Rowe, 1971: 6, 14; Zmarzly, 1985: 348, 350–352; Meyer, 1986: 203; Hogget & Rowe, 1986: 122; Bradbury et al., 1987: 190, 191. *Comissia* sp. cf. *pectinifera* – Zmarzly, 1985: 348, 351, 352; Meyer, 1986: 206, 207. *Alloeocomatella pectinifera* – Messing, 1995: 445; 1998b: 189; 2001: 291; 2007: 94, 99; Crossland & Price, 1999: 25, 28;

Marsh, 2000: 99; Kirkendale & Messing, 2003: 526, 540; Byrne et al., 2004: 160; Deheyn et al., 2006: 163; Kogo, 2002: 6–7; Kogo & Fujita, 2005: 328; Kogo et al., 2019: 231. *Comissia magnifica* – Kogo, 1998: 20, fig. 15 (not *Comissia magnifica* Gislén, 1922).

**Material examined.** One specimen. RCO.ECH.3168; St. DW17, Sunda Strait (Seamount reef); 448–469 m; gravel, dead corals, and small rocks; dredge; March 26, 2018.

**Description.** Centrodorsal discoidal, 2.5 mm across; polar area slightly convex, 0.4 times centrodorsal diameter. Cirri XXV, up to 13 segments, 8.7 mm long, arranged in two rows; c4 longest, L/W 2; succeeding segments shorter, constricted centrally; aboral spine gradually developed from c6; opposing spine small. Radials visible. IBr 2. Arms 10, longest remaining length 21 mm (broken at br<sub>31</sub>); brachials spinous, longer than broad; first arm syzygy at br<sub>3+4</sub>; distal intersyzygial interval 3. P<sub>1</sub> with 31 segments, 4 mm; P<sub>2</sub> with 28 segments, 2 mm; pinnules beyond P<sub>2</sub> mostly broken; proximal pinnules with short, spinous segments; succeeding pinnules elongated, spinous. Terminal combs present as far as P<sub>2</sub>, consisting of 18–20 segments; teeth single, triangular, slightly curved, confluent with lateral margins of pinnulars furthest from arm, with bases of adjacent teeth separated. One P<sub>1</sub> forked at the 13<sup>th</sup> pinnular, which has the first comb tooth.

**Distribution.** Christmas Island (AH Clark, 1911c). From We Island, Sumatra to Banda Sea, Indonesia (AH Clark, 1931; AM Clark & Rowe, 1971; Crossland & Price, 1999; Kogo et al., 2019; this study). Maldives (AM Clark & Davies, 1965). Great Barrier Reef, Australia (Bradbury et al., 1987; Byrne et al., 2004). Kwajalein Atoll, Marshall Islands (Zmarzly, 1985). Madang, Papua New Guinea (Messing, 1994). Nansei Islands, Japan (Kogo, 1998, 2002; Kogo & Fujita, 2005). Guam (Kirkendale & Messing, 2003). Palau (Messing, 2007). Depth range: 3–469 m (Messing, 1995; this study).

**Remarks.** The genus *Alloeocomatella* is characterised by the long proximal pinnule combs (20–37 teeth in adult individuals) and smoother texture due to fewer and weaker pinnule spines (Summers et al., 2017). The size of the examined specimen is similar to the immature specimen of *A. pectinifera* described by Messing (1995), although the number of proximal pinnule segments and comb teeth are fewer than in that specimen. This study expanded the depth range of this species from shallow waters (Messing, 1995) to 469 m deep.

#### Subfamily Comatulinae Fleming, 1828

#### *Capillaster* AH Clark, 1909f

#### *Capillaster multiradiatus* (Linnaeus, 1758)

*Asterias multiradiata* Linnaeus, 1758: 663; Müller, 1843: 133. *Comatula (Alecto) multiradiata* – Müller, 1849: 261. *Actinometra multiradiata* – Carpenter, 1882: 521, 523; 1888: 322, pl. 66 figs. 1–3. *Comaster multiradiata* – AH Clark, 1909a: 391.



*Capillaster multiradiata* – AH Clark, 1909b: 134; 1911a: 530; 1911b: 16; 1912a: 74; 1912b: 4; 1913: 5; 1918: 14; 1931: 173, pl. 3 fig. 5, pl. 11 fig. 30, pl. 13 fig. 34, pl. 14 figs. 35–36, pl. 81 figs. 222–223; 1934: 10; 1936: 296; 1937: 99; Reichensperger, 1913: 84; HL Clark, 1915: 101; 1921: 14.

*Capillaster multiradiata* var. *coccodistoma* – AH Clark, 1911d: 247.

*Capillaster multiradiatus* – AM Clark & Davies, 1965: 598; AH Clark, 1934: 10; AM Clark, 1966: 26; AM Clark & Rowe, 1971: 6, 15; AM Clark, 1972: 76; Fishelson, 1974: 184; Gibbs et al., 1976: 108; Tortonese, 1977: 275; Meyer & Macurda, 1980: 75, fig. 6a; Mossa et al., 1980: 107, 113, 116; Marshall & Rowe, 1981: 382; Chen et al., 1988: 75, figs. 3, 23D; Fabricius, 1994: 1228; Messing, 1994: 239; 1998b: 189; Liao & AM Clark, 1995: 4, 14, fig. 4; Kogo, 1998: 17, fig. 12; 2002: 6; Crossland & Price, 1999: 25, 28; Kogo & Fujita, 2005: 327; Mekhova & Britayev, 2012: 915; Sadhukhan & Raghunathan, 2013: 433; Messing & Tay, 2016: 633–635, fig. 4A, B, D; Tay & Low, 2016: 660; Kogo et al., 2019: 232.

*Capillaster* cf. *multiradiatus* – Messing, 2007: 98.

*Comatula fimbriata* Lamarck, 1816: 534.

*Comaster fimbriata* – AH Clark, 1908c: 201.

*Actinometra coccodistoma* Carpenter, 1882: 747.

*Capillaster coccodistoma* – AH Clark, 1931: 212; 1937: 99.

*Actinometra coppingeri* Bell, 1882: 535.

*Comaster coppingeri* – AH Clark, 1908c: 202.

*Capillaster clarki* Reichensperger, 1913: 85.

*Comanthus (Vania) parvicirra* – Gislén, 1922: 50 (not *Alecto parvicirra* Müller, 1841).

**Material examined.** One specimen. RCO.ECH.3169; St. DW16, Sunda Strait (Seamount reef); 103–92 m; gravel, sand, and some mud; dredge; March 26, 2018.

**Description.** Centrodorsal discoidal, 3.0 mm across; polar area flat, with concave centre, 0.9 times centrodorsal diameter. Cirri stout, XVI, up to 23 segments, 12 mm long, in one row; c4 longest, L/W 1.2; succeeding segments shorter, almost squarish; aboral spine gradually developed from c11; opposing spine small. Radials not visible. IBr 2 and IIBr 4(3+4); division series rough. Arms 13, longest remaining length 46 mm (broken at br<sub>62</sub>); first three brachials rough; succeeding brachials smooth; first arm syzygy at br<sub>2+3</sub>; distal intersyzygial interval 6. Comparative pinnule length  $P_1 > P_2 = P_3 = P_4 = P_5 < P_M = P_D$ ; proximal pinnules with short segments; succeeding pinnules elongated, spinous. Terminal combs present as far as P<sub>1</sub>, consisting of 4–7 segments; teeth single, triangular, slightly curved, confluent with lateral margins of pinnulars furthest from arm; bases of adjacent teeth separated; terminal segment with single tooth.

**Distribution.** Philippines (AH Clark, 1911a). Madagascar (AH Clark, 1911b; Marshall & Rowe, 1981). From We Island, Sumatra to Banda Sea, Indonesia (AH Clark, 1936; Crossland & Price, 1999; Kogo et al., 2019). Andaman Islands and Nicobar Islands, India; from off Sittwe (formerly Akyab) to Mergui Archipelago, Myanmar (AM Clark & Rowe, 1971; AM Clark, 1972). Red Sea (Fishelson, 1974; Tortonese, 1977). Palau (Meyer & Macurda, 1980; Messing, 2007). Southern Taiwan (Chen et al., 1988). Madang, Papua New Guinea (Messing, 1994). From Gulf of Tonkin to Taiwan Strait, South China Sea (Liao & AM Clark, 1995; Lane et al., 2000). Nansei Islands, Japan (Kogo, 1998, 2002; Kogo & Fujita, 2005). Southern Vietnam (Mekhova & Britayev,

2012). Singapore (Messing & Tay, 2016; Tay & Low, 2016). Depth range: 0–ca. 300 m (Lane et al., 2000).

**Remarks.** The genus *Capillaster* is easily distinguished from other tropical Indo-western Pacific confamilials by IIBr and following brachitaxes composed of 3(2+3) and undivided arms arising from IIBr and following brachitaxes with first syzygy at br<sub>2+3</sub> (AH Clark, 1931). The examined specimen fits the description of *C. multiradiatus* in numbers of cirri and arms, and texture of basal part of rays.

### *Phanogenia* Lovén, 1866

#### *Phanogenia serrata* (AH Clark, 1907c)

*Comatula serrata* AH Clark, 1907c: 154.

*Comaster serrata* – AH Clark, 1908d: 317; 1912a: 89; 1918: 37; 1931: 451, pl. 52 fig. 154; Gislén, 1922: 37, figs. 21–25; Utinomi & Kogo, 1968: 48; Hoggett & Rowe, 1986: 118.

*Comaster serratus?* – Kogo, 1998: 28, fig. 23.

*Phanogenia serrata* – Kogo, 2002: 8; 2006: 227; Kogo & Fujita, 2005: 330; 2014: 46, figs. 5, 6.

*Comaster parvicirra* – AH Clark, 1908d: 306. (not *Alecto parvicirra* Müller, 1841)

**Material examined.** One specimen. RCO.ECH.3332; St. DW16, Sunda Strait (Seamount reef); 103–92 m; gravel, sand, and some mud; dredge; March 26, 2018.

**Description.** Centrodorsal discoidal, 2.5 mm across; polar area flat, 0.5 times centrodorsal diameter. Cirri XIV, up to 9 segments, 4.5 mm long, in one row; c4–c5 longest, L/W 2; succeeding segments shorter; aboral spine gradually developed from c7; opposing spine small. Radials visible. IBr 2, IIBr 2 or 4(3+4), IIIBr 2(1+2) or 4(1+2, 3+4), and IVBr 2(1+2). Arms 28, longest remaining length 20 mm (broken at br<sub>38</sub>); brachials spinous; first arm syzygy at br<sub>3+4</sub> for brachials arising from IBr and br<sub>1+2</sub> for brachials arising from II–IVBr; distal intersyzygial interval 3. Comparative pinnule length  $P_1 > P_2 = P_3 = P_4 = P_5$ ; proximal pinnules with squarish, spinous segments; middle and distal pinnules with pinnulars squarish to slightly elongated and spinous. Proximal tooth saucer-like and transverse; terminal combs present as far as P<sub>4</sub>, of 4–8 segments; teeth single, triangular, slightly curved, confluent with lateral margins of pinnule segments furthest from arm, with base separated from neighbouring one; terminal segments with single tooth.

**Distribution.** From Nansei Islands to Sagami Bay and the Ogasawara Islands, Japan (AH Clark, 1931; Kogo, 1998, 2002; Kogo & Fujita, 2005, 2014). Sunda Strait, Indonesia (this study). Depth range: 55?–210? m (AH Clark, 1931; Kogo & Fujita, 2014).

**Remarks.** The genus *Phanogenia* is distinguishable from confamilial genera by IIBr and following division series 2(1+2) or 4(3+4); first arm syzygy at br<sub>1+2</sub>; pinnule combs at intervals to near arm tip, comb teeth tall, triangular to spade-shaped, confluent with the outer edge of pinnule, and proximal tooth saucer-like and transverse (Summers et al., 2017). Following AH Clark (1931) and Kogo (2002), the

examined specimen was identified as *Phanogenia serrata* based on the number of arms (up to 30) and the number of comb teeth on the proximal pinnules (5–8 teeth). *Phanogenia serrata* was previously known only from Japan's waters (Messing, 1998a), and this is the first record of *P. serrata* outside of Japanese waters. Although the arm number is a chief key to distinguish *Phanogenia* with well-developed cirri, it varies with growth (Summers et al., 2017). It is possible that the examined specimen would be a juvenile of *P. distincta* (Carpenter, 1888) with 30–50 arms or *P. fruticosa* AH Clark, 1911a with 37–63 arms, both of which are known from the area covered by the SJADES survey.

### Superfamily Himerometroidea AH Clark, 1908a

#### Family Mariametridae AH Clark, 1909d

##### *Mariametra* AH Clark, 1909d

##### *Mariametra vicaria* (Bell, 1894) (Fig. 1B)

*Antedon vicaria* Bell, 1894: 396, 400; AH Clark, 1908e: 499; 1912a: 38.

*Mariametra vicaria* – AH Clark, 1912a: 142; 1913: 30; 1918: 108; 1941: 573–579; AM Clark, 1972: 106; Liao & AM Clark, 1995: 42; Lane et al., 2000: 477; Kogo, 2002: 21; Kogo & Fujita, 2005: 340; Mekhova & Britayev, 2012: 923.

*Mariametra margaritifera* AH Clark, 1909d: 145; 1912a: 141, fig. 16; 1918: 108.

**Material examined.** Two specimens. RCO.ECH.3335 (1), RCO.ECH.3361 (1); St. DW16, Sunda Strait (Seamount reef); 103–92 m; gravel, sand, and some mud; dredge; March 26, 2018.

**Description.** [RCO.ECH.3335] Centrodorsal discoidal, 4.2 mm across; polar area flat and granulated, 0.6 times centrodorsal diameter. Cirri XXX, up to 46 segments, 14.5 mm long, in two rows; c8–c10 longest, L/W 1.5; succeeding segments shorter; aboral spine gradually developed from c10; opposing spine as tall as penultimate segment. Radials not visible. I–IIIBr 2, thickly covered with high small tubercles. Arms 29, longest remaining length 37 mm (broken at br<sub>70</sub>); brachials spinous laterally, with distal edges everted; arms with aboral purple stripe; first arm syzygy at br<sub>3+4</sub>; distal intersyzygial interval 17. Comparative pinnule length  $P_1 < P_a < P_2 < P_3 < P_4 > P_5 < P_M < P_D$  or  $P_1 < P_a < P_2 < P_3 > P_4 > P_5 < P_M < P_D$ ; proximal pinnules enlarged, flagellate, longer than distal pinnules; first three segments of  $P_1$  and  $P_2$  with carination on aboral side.

[RCO.ECH.3361] Centrodorsal 1.8 mm across; polar area 0.3 times centrodorsal diameter. Cirri XVII, up to 12 segments, 7 mm long, in three rows; c4–c6 longest, L/W 2; aboral spine gradually developed on distal cirrals. Arms 14, longest remaining length 27 mm (broken at br<sub>74</sub>); distal intersyzygial interval 6.

**Distribution.** Macclesfield Bank, South China Sea (AH Clark, 1912a). Mergui Archipelago, Myanmar (AH Clark,

1912a; AM Clark, 1972). Sunda Strait and Sape Strait, Indonesia (AH Clark, 1918; this study). Paracel Islands, South China Sea (AH Clark, 1941). East of Malay Peninsula (AM Clark, 1972). Hainan, China (Liao & AM Clark, 1995). Bay of Nhatrang, Vietnam (Lane et al., 2000; Mekhova & Britayev, 2012). Nansei Islands, Japan (Kogo, 2002; Kogo & Fujita, 2005). Depth range: 53–103 m (Lane et al., 2000; this study).

**Remarks.** Genus *Mariametra* is characterised by division series laterally ornamented with small spines or tubercles and  $P_3$  longer and stouter than  $P_2$ , often the longest and stoutest proximal pinnule (Hess & Messing, 2011). The examined specimens were identified as *M. vicaria* based on outer cirri segment broader than long, the presence of purple stripe on the aboral surface of arms, and  $P_3$  longer and stouter than  $P_4$  (AH Clark, 1941). RCO.ECH.3335 showed variation on the comparative length between  $P_3$  and  $P_4$ , in which some arms have  $P_4$  longer than  $P_3$ . Nevertheless, the outer cirri segment size ratio and the presence of purple stripe on the aboral surface of arms defined the specimen as *M. vicaria*. *Mariametra vicaria* is distinguished from other congeners that inhabit Indonesian waters, *M. tuberculata* AH Clark, 1912f, and *M. tenuipes* AH Clark, 1912f, based on shorter size ratio of the outer cirri segments (AH Clark, 1912f, 1941).

### Superfamily Tropiometroidea AH Clark, 1908a

#### Family Charitometridae AH Clark, 1909c

##### *Glyptometra* AH Clark, 1909c

##### *Glyptometra inaequalis* (Carpenter, 1888)

*Antedon inaequalis* Carpenter, 1888: 244–246, fig. 5A, pl. 2 fig. 5a–d, pl. 51 fig. 2; AH Clark, 1912a: 35.

*Charitometra inaequalis* – AH Clark, 1907b: 361; 1908c: 227.

*Pachylometra inaequalis* – AH Clark, 1909c: 21; 1912a: 35, 216; 1913: 48; 1918: 184.

*Glyptometra inaequalis* – AH Clark, 1950: 243–246; McKnight, 1967: 293; 1977: 126; 1984: 141; O'Hara, 1998a: 146; 1998b: 170; Speel & Dearborn, 1983: 24.

**Material examined.** Two specimens. RCO.ECH.3353 (1); St. CP40, Indian Ocean (south of Cilacap); 1,078–1,091 m; rocky?; beam trawl; March 30, 2018. RCO.ECH.3356 (1); St. CP39, Indian Ocean (south of Cilacap); 528–637 m; some mud; beam trawl; March 30, 2018.

**Description.** [RCO.ECH.3353] Centrodorsal low hemispherical, 5.6 mm across, 2.8 mm tall, D/H 2; polar area flat, 0.2 times centrodorsal diameter. Cirri stout, XXX, up to 14 segments, 17 mm long, arranged in two columns per radial area, closely crowded; c3 longest, L/W 1.3; succeeding segments shorter, almost squarish, but antepenultimate slightly longer than wide again; aboral spines absent; opposing spine blunt. Radials not visible. I–IIIBr 2 with weak rounded synarthrial swelling; adjacent division series and arm bases in close lateral contact. Arms 10, longest remaining length 44 mm (broken at br<sub>37</sub>); weak, rounded synarthrial swelling between br<sub>1</sub> and br<sub>2</sub>; weak, round

tubercle on  $br_3$ ; succeeding brachials smooth; first arm syzygy at  $br_{3+4}$ ; distal intersyzygial interval 3. Pinnules prismatic; comparative pinnule lengths  $P_1=P_2>P_3<P_4>P_5<P_M$ ;  $P_1$  and  $P_a$  with segments compressed, with keel-like projection on aboral side (conspicuous in  $P_a$ ), segments broader than long; middle pinnules with middle segments broadened, gradually tapering to the tip.

**[RCO.ECH.3356]** Centrodorsal thick discoidal, 6.7 mm across; polar area 0.2 times centrodorsal diameter. Cirri XXXIV, up to 21 segments, 17 mm long, arranged in two columns per radial area;  $c_4$ – $c_5$  longest, L/W 1.5–2; distal segments with aboral process gradually developed. IIBr mostly 4(3+4), rarely 2; arms 17, 150 mm long; first arm syzygy varies, at  $br_{1+2}$ ,  $br_{3+4}$ , or  $br_{4+5}$ .

**Distribution.** From Kermadec Islands to Chatham Islands, New Zealand (Carpenter, 1888; McKnight, 1977). Kandavu, Fiji (Carpenter, 1888). Philippines (AH Clark, 1950). Off Tasmania to Macquarie Island, Australia; Southern Ocean (Speel & Dearborn, 1983). South of Java, Indonesia (this study). Depth range: 362–1,185 m (McKnight, 1977; O'Hara, 1998a).

**Remarks.** Genus *Glyptometra* is characterised by arms aborally rounded with or without ornamentation, proximal pinnules shorter than following pinnules, and genital pinnules tapering evenly from the broadened earlier segments to tip (Hess & Messing, 2011). *Glyptometra inaequalis* is characterised by cirri of uniform width throughout with longest segment longer than wide, and brachials not everted (AH Clark, 1950). This is the first record of *G. inaequalis* in Indonesia. The difference on arm number between the examined specimens (10 in RCO.ECH.3353 and 17 in RCO.ECH.3356) is caused by the presence of IIBr. RCO.ECH.3353 developed one IIBr on only one ray while RCO.ECH.3356 developed one to two IIBr on every ray.

#### Family Thalassometridae AH Clark, 1908a

##### *Aglaometra* AH Clark, 1913

##### *Aglaometra valida* (Carpenter, 1888)

(Figs. 2A–D, 3A, B)

*Antedon valida* Carpenter, 1888: 104, pl. 15 figs. 5–8.

*Crotalometra valida* – AH Clark, 1909a: 404; 1912a: 33, 209.

*Aglaometra valida* – AH Clark, 1913: 47; 1918: 163–164; 1950: 108–109, pl. 13 figs. 38–39; Messing et al., 2000: 653–661, figs. 10a–c, 11e–f, 12b, 13a–f, 14a–b, table 2a–b.

*Antedon incerta* Carpenter, 1884: 57, 83, pl. 54 figs. 6–7 (nomen nudum); 1888: 106, pl. 18 figs. 4–5.

*Crotalometra incerta* – AH Clark, 1909a: 404; 1912a: 33, 209.

*Aglaometra incerta* – AH Clark, 1913: 47; 1918: 163, 165; 1950: 108, 114.

*Crotalometra eupedata* AH Clark, 1909a: 404; 1912a: 209.

*Aglaometra eupedata* – AH Clark, 1913: 47; 1918: 163–164; 1921: 179, fig. 225.

*Crotalometra propinqua* AH Clark, 1911a: 549; 1912a: 209.

*Aglaometra propinqua* – AH Clark, 1918: 163, 165; 1950: 108, 116, pl. 15 fig. 47.

*Crotalometra sulcata* AH Clark, 1912e: 427.

*Aglaometra sulcata* – AH Clark, 1918: 163–164, pl. 21 fig. 53; 1950: 109, 118, pl. 13 fig. 40.

*Crotalometra vera* AH Clark, 1912e: 427.

*Aglaometra vera* – AH Clark, 1918: 163, 165, pl. 21 fig. 54.

**Material examined.** Six specimens. RCO.ECH.3333 (1), NSMT E-13724 (1), St. CP47, Indian Ocean (south of Pameungpeuk); 530–476 m; coarse sand; beam trawl; April 1, 2018. RCO.ECH.3357 (2), NSMT E-13725 (1), ZRC. ECH.1842 (1); St. CP39, Indian Ocean (south of Cilacap); 528–637 m; some mud; beam trawl; March 30, 2018.

**Comparative material.** *Thalassometra gracilis* (Carpenter, 1888): NSMT-E5246 (4); R.V. Tansei-maru KT-02-03, St. D2; East China Sea (Northwest of Okinawa Island); 1,557–1,540 m; 3 m beam trawl; April 28, 2002. NSMT-E5249 (3); R.V. Tansei-maru KT-02-03, St. D2; East China Sea (Northwest of Okinawa Island); 1,557–1,540 m; 3 m beam trawl; April 28, 2002. *Thalassometra latipinna* (Carpenter, 1888): NSMT-E5254 (91); R.V. Tansei-maru KT-02-03, St. C3; East China Sea (North of Miyakojima Island); 1,601–1,618 m; 3 m beam trawl; April 25, 2002.

**Description.** [NSMT E-13724] Two specimens. Centrodorsal low, conical, 4.4 mm across; polar area 0.4 times centrodorsal diameter. Cirri XVIII–XXI, up to 60 segments, 40 mm long, slender, in two columns per radial area, separated midradially by smooth, narrow strip; sockets of each column crowded interradially against those of adjacent radial area;  $c_6$ – $c_8$  longest, L/W 1.5–2;  $c_6$  transition segment; succeeding segments polished, becoming shorter; aboral spine gradually developed from  $c_{10}$  or  $c_{18}$ ; opposing spine absent or blunt. Radials narrowly visible. IBr 2 with weak synarthrial swelling (Fig. 2A), with ossicles serrated or rough and lateral margins weakly everted (Fig. 2B); adjacent Ibr<sub>1</sub> in lateral contact. Arms 8–10, 80–90 mm long, aborally rounded; br<sub>1</sub> and br<sub>2</sub> with weak synarthrial swelling (Fig. 2A) and lateral margins weakly everted (Fig. 2B); distal edge of distal brachials fringed with spines; first arm syzygy at  $br_{3+4}$ ; distal intersyzygial interval 7–8. Pinnules prismatic, aborally spinous; comparative pinnule lengths  $P_1>P_a>P_2>P_3>P_4>P_5<P_M<P_D$ ;  $P_1$  slightly stouter than  $P_2$ ; basal 4–5 segments of proximal pinnules with lateral margins extended as irregular spinose flange (Fig. 3A); all pinnulars relatively short; first two pinnulars of middle and distal pinnules short and slightly larger than succeeding segments; middle pinnules with short pinnulars following basal two, and distal pinnules with pinnulars elongated following basal two.

**[RCO.ECH.3357]** Four specimens. Centrodorsal 2.8–3.6 mm across, 1.8–4.2 mm tall, D/H 0.9; polar area 0.4 times centrodorsal diameter. Cirri XXX, up to 60 segments, 42–52 mm long, arranged in two columns per radial area, separated midradially by smooth, narrow strip; sockets of each column crowded interradially against those of adjacent radial area;  $c_6$ – $c_7$  longest, L/W 1.5. IBr 2 with slight synarthrial swelling (Fig. 2C) and lateral margins weakly everted (Fig. 2D). Arms 10, 53–75 mm long; br<sub>1</sub> and br<sub>2</sub> with weak synarthrial swelling (Fig. 2C) and lateral margins weakly everted (Fig.



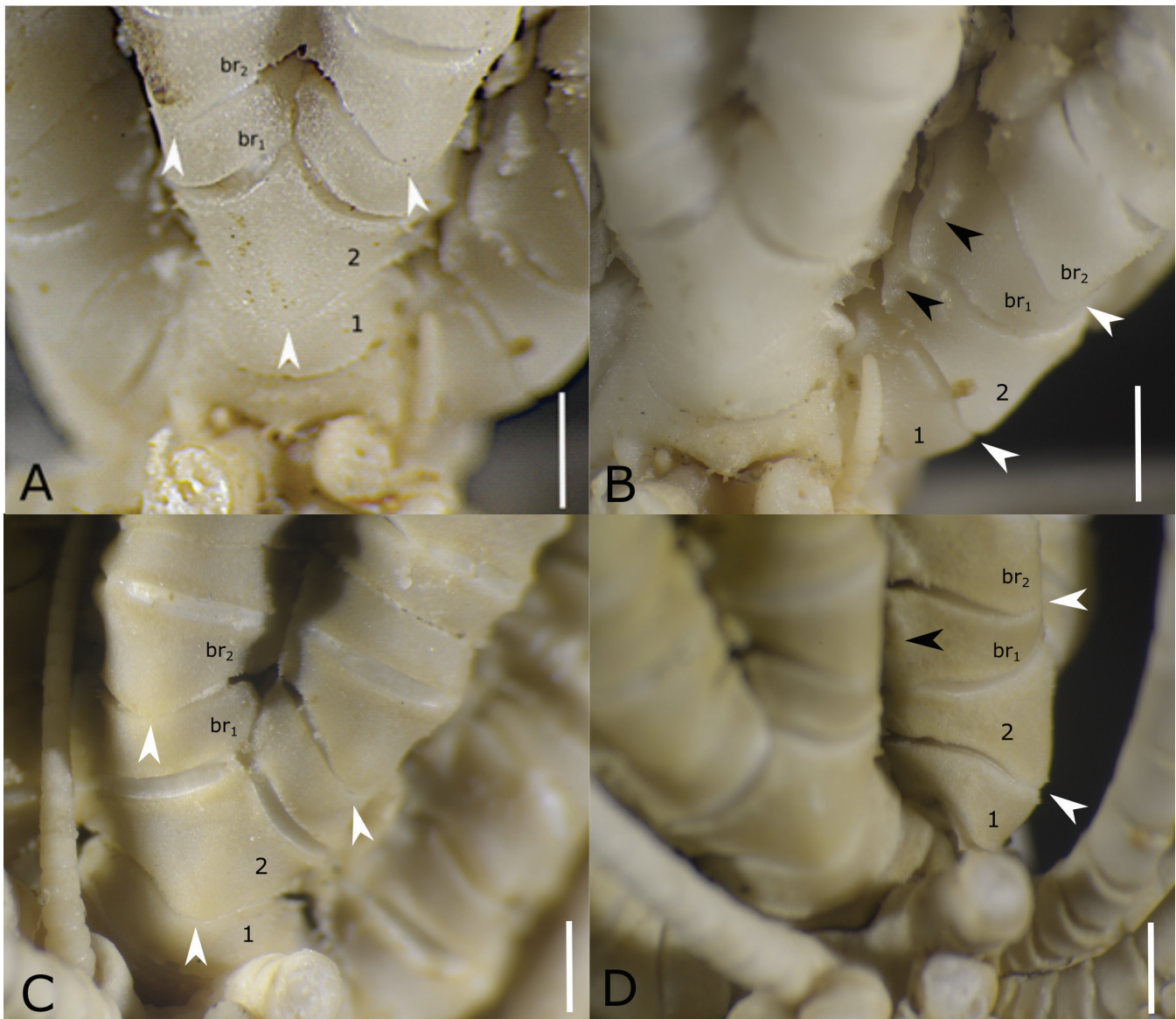


Fig. 2. Ornamentation on basal part of rays of *Aglaometra valida* (A, B, NSMT E-13724; C, D, RCO.ECH.3357). “1” indicates Ibr<sub>1</sub>; “2” indicates Ibr<sub>2</sub>; br<sub>1</sub> and br<sub>2</sub> indicate the first and second ossicle of an arm respectively; white arrowheads indicate synarthrial swelling; black arrowheads indicate everted ossicle margins. Scale bars = 1 mm.

2D). Basal 4–5 pinnulars of proximal pinnules with lateral margins extended as irregular spinose flange (Fig. 3B).

**Distribution.** Kermadec Islands, New Zealand (Carpenter, 1888). From northern Sulawesi to Kai Islands and south of Java, Indonesia (Carpenter, 1888; AH Clark, 1912a, 1912e, 1913, 1918, 1950; Messing et al., 2000; this study). From Malavatu Island to east of Mindanao, Philippines (AH Clark, 1909a, 1911a, 1912a). Depth range: 457–1,165 (possibly 1,264) m (Messing et al., 2000).

**Remarks.** *Aglaometra valida* is known to show range of variation on the ornamentation on IBr, although the ornamentations are generally consisting of everted lateral margin and serrated distal margin of the ossicles, and synarthrial swelling between Ibr<sub>1</sub> and Ibr<sub>2</sub> (Messing et al., 2000: fig. 10a–c). The examined specimens show the characteristic ornamentation on IBr (Fig. 2), which is quite similar to that of *A. valida* collected from eastern Indonesian

waters (Messing et al., 2000) and supports the identification of the examined specimens as *A. valida*. The examined specimens also have spinous basal segments on the proximal pinnules (Fig. 3A, B).

*Aglaometra* sp.  
(Figs. 3C, D, 4A, B, 5A, B)

**Material examined.** Two specimens. RCO.ECH.3364 (1), RCO.ECH.3366 (1); St. CP48, Indian Ocean (south of Gedeh Cape, Java); 689–637 m; some mud and fishing line; beam trawl; April 1, 2018.

**Description.** [RCO.ECH.3364] Centrodorsal truncated conical (Fig. 4A), 3.2 mm across, 5.3 mm tall, D/H 0.6; polar area flat, 0.5 times centrodorsal diameter. Cirri stout, XV, up to 60 segments, 35.5 mm long, arranged in two columns per radial area, separated midradially by smooth, narrow strip; sockets of each column crowded interradi-ally



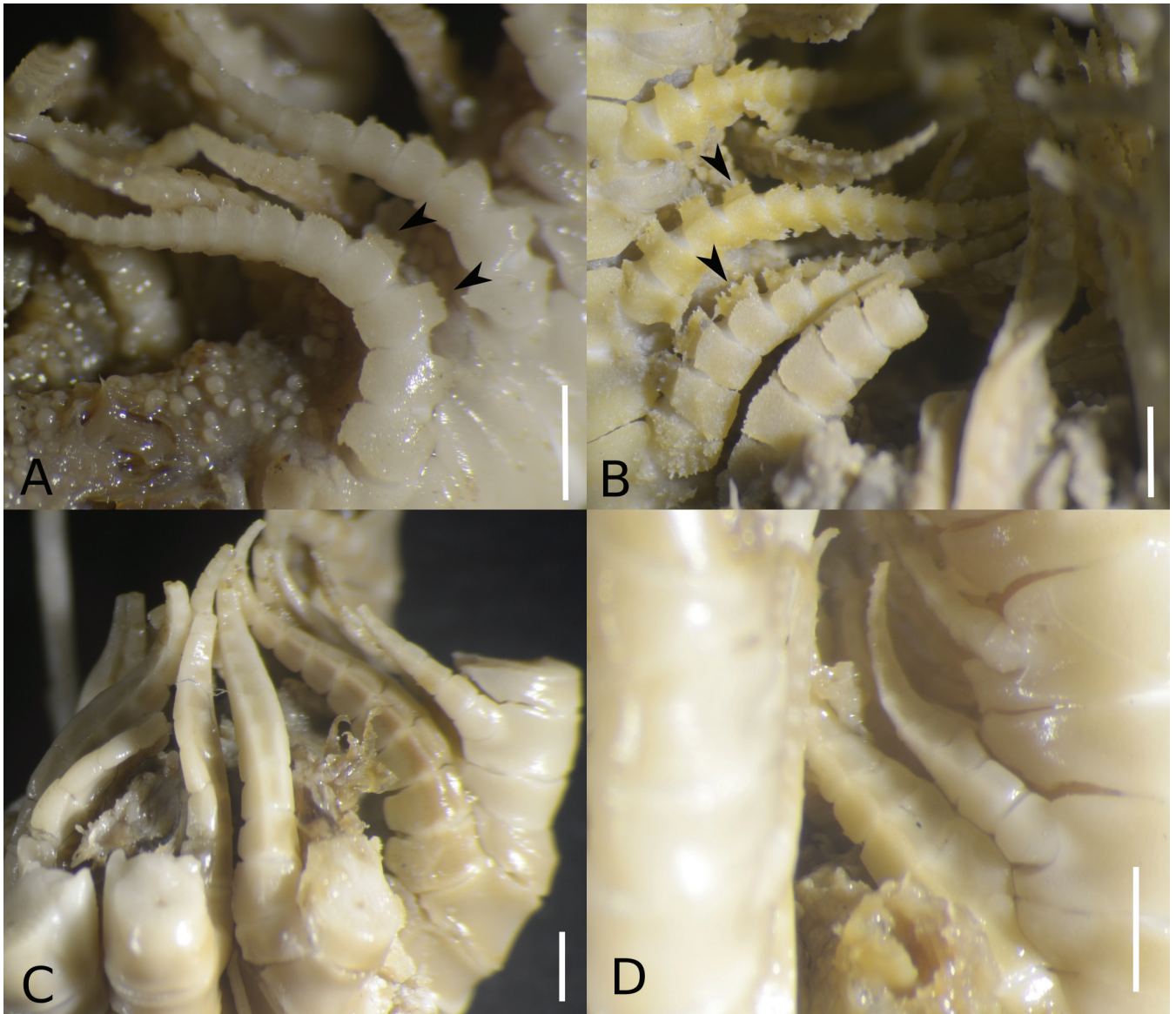


Fig. 3. Proximal pinnules of *Aglaometra valida* (A, NSMT E-13724; B, RCO.ECH.3357) and *Aglaometra* sp. (C, RCO.ECH.3364; D, RCO.ECH.3366). Black arrowheads indicate spinose flanges. Scale bars = 1 mm.

against those of adjacent radial area; each column separated by smooth, narrow midradial line; c4–c6 longest, L/W 2.5; c7 transition segment; succeeding segments polished; middle segments elongated; distal segments compressed laterally, broader than wide, with aboral spine gradually developed; opposing spine small. Radials narrowly visible, with distal border everted. IBr 2 with weak synarthrial swelling; proximal and distal borders of ossicles strongly everted, forming flange-like projection (Fig. 5A). Arms 10, longest remaining length 19 mm (broken at br<sub>14</sub>), aborally rounded; proximal and distal borders of br<sub>1</sub> and br<sub>2</sub> strongly everted (Fig. 5A); br<sub>1</sub>–br<sub>4</sub> in lateral contact with neighbouring arms; brachials smooth; first arm syzygy at br<sub>3+4</sub>; distal intersyzygial interval unknown. Pinnules prismatic; comparative pinnule length  $P_1 > P_4 > P_2 > P_3 > P_4 > P_5$ ; proximal segments of proximal pinnules expanded with carination on aboral side and smooth lateral margins (Fig. 3C), L/W 0.5; P<sub>1</sub> stoutest.

[RCO.ECH.3366] Centrodorsal conical (Fig. 4B), 4.1 mm across, 4.1 mm tall, D/H 1.0; polar region 0.5 times

centrodorsal diameter. Cirri XXX, broken without distal part, arranged in two columns per radial area, separated midradially by smooth, narrow strip; sockets of each column crowded interradially against those of adjacent radial area; c7–c10 longest, L/W 1.0. Radials narrowly visible, with distal border everted bearing midaboral knob or swelling. IBr 2; proximal and distal borders of ossicles everted (Fig. 5B). Arms 10, longest remaining length 43 mm (broken at br<sub>42</sub>), compressed laterally; proximal border of br<sub>1</sub> everted (Fig. 5B); br<sub>1</sub>–br<sub>6</sub> oblong, smooth; first arm syzygy at br<sub>3+4</sub>; distal intersyzygial interval 4. Proximal segments of proximal pinnules expanded with carination on aboral side and smooth lateral margins (Fig. 3D).

**Remarks.** The examined specimens were identified as *Aglaometra* based on having 10 arms aborally rounded without median carination, P<sub>1</sub> longer and stouter than P<sub>2</sub>, and succeeding pinnules slenderer and styliform, and the ossicles of the division series and arm bases with smooth or spinous margins (AH Clark, 1950). They are similar to *Aglaometra*

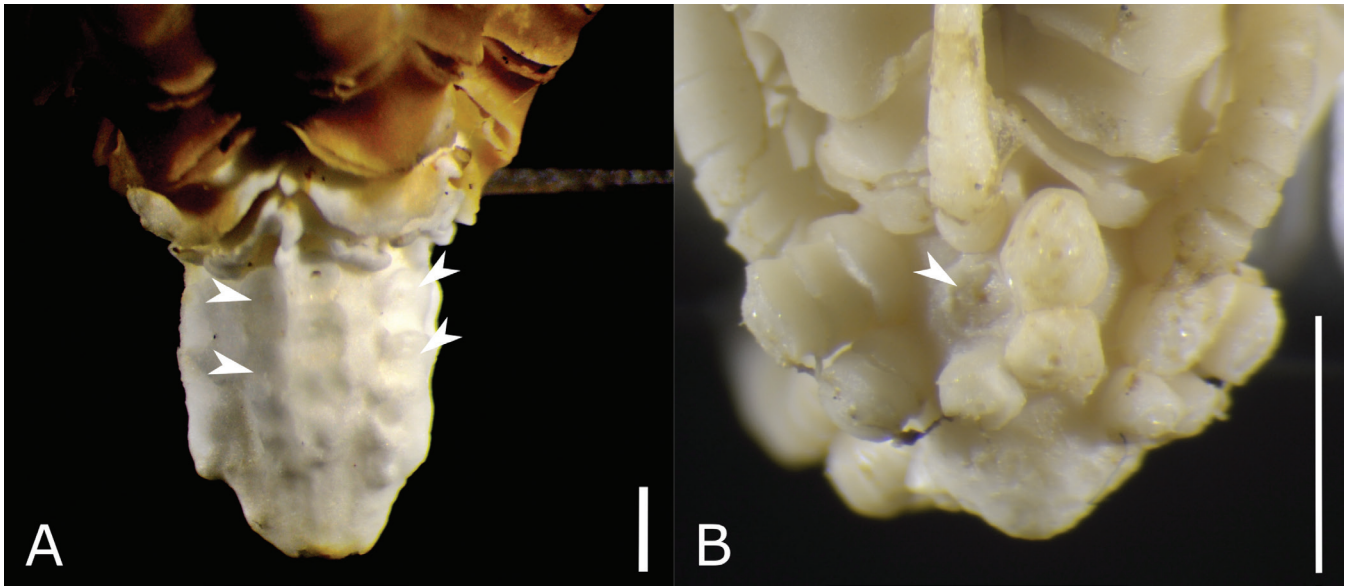


Fig. 4. Centrodorsal of *Aglaometra* sp. (A, RCO.ECH.3364; B, RCO.ECH.3366). White arrowheads indicate cirrus sockets. Scale bars = 1 mm.

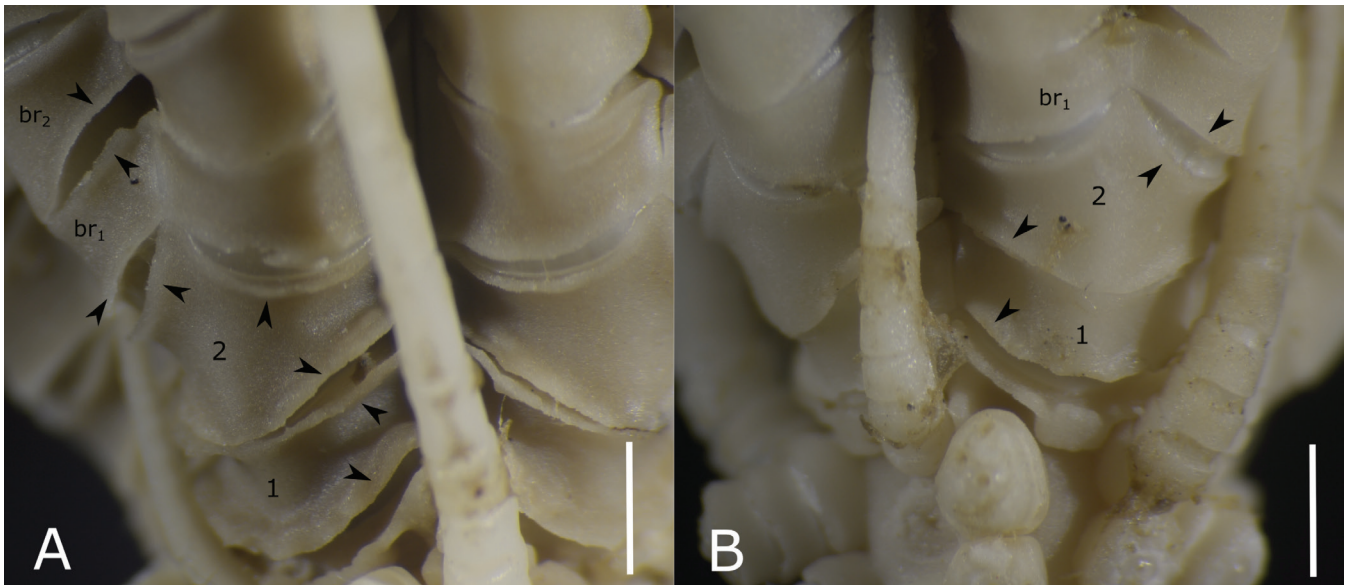


Fig. 5. Ornamentation on basal part of rays of *Aglaometra* sp. (A, RCO.ECH.3364; B, RCO.ECH.3366). Abbreviations as in Fig. 1. Scale bars = 1 mm.

*valida* but differ in the centrodorsal, the ornamentation on the basal part of rays, and the basal segments of the proximal pinnules. The centrodorsal of RCO.ECH.3364 is enlarged, truncated conical, with the aboral portion abruptly converging (Fig. 4A), while the centrodorsal of RCO.ECH.3366 is more or less conical or hemispherical (Fig. 4B). In the examined specimens, the distal margin of radials and both proximal and distal margins of the IBr components form flange-like projection (Fig. 5), but they are almost smooth in *A. valida* (Fig. 2). The examined specimens also have proximal pinnules with smooth basal segments (Fig. 3C, D), unlike *A. valida* with spinous segments (Fig. 3A, B). The combination of the IBr and proximal pinnules ornamentations does not fall within the range of variation reported in Messing et al. (2000), suggesting that the examined specimens might differ from *A. valida*.

## Superfamily Antedonoidea Norman, 1865

### Family Antedonidae Norman, 1865

#### Subfamily Antedoninae Norman, 1865

#### Antedoninae gen. sp.

**Material examined.** One specimen. RCO.ECH.3363; St. DW32, Indian Ocean (south of Boyongkareuceng Cape); 977–805 m; coarse sand and mud; dredge; March 29, 2018.

**Description.** Centrodorsal discoidal, 1.3 mm across; polar area with tiny spines, 0.6 times centrodorsal diameter. Cirri X, up to 20 segments, 3 mm long, fragile, arranged in two rows; c3 longest, L/W 1.5; succeeding segments shortened,



laterally compressed; aboral spine absent; opposing spine blunt. Radials narrowly visible. IBR 2; proximal and distal margin of ossicle finely spinous; adjacent division series and arm bases in close lateral contact. Arms 10, longest remaining length 12 mm (broken at  $br_{27}$ ); synarthrial swelling on division series and between first two brachials; succeeding brachials fringed with tiny spines; first arm syzygy at  $br_{3+4}$ ; distal intersyzygial interval 3. Pinnules mostly broken;  $P_1$  with 8 segments remaining, L/W 3; all pinnules with first three segments short, middle, and distal segments elongated, distal edges of segments fringed with tiny spines.

**Remarks.** The subfamily Antedoninae is characterised by cirri arranged in more or less alternating transverse rows on the discoidal to even rounded conical centrodorsal (AH Clark & AM Clark, 1967), and the examined specimen agrees well with this diagnosis. However, molecular data has repeatedly returned family Antedonidae as not monophyletic (Hemery et al., 2013; Rouse et al., 2013), and the status of the included subfamilies remains uncertain. In the examined specimens, the pinnules are mostly broken or lost, which makes it difficult to identify to the genus level.

#### Subfamily Bathymetrinae AH Clark, 1909g

##### *Thaumatometra* AH Clark, 1908a

##### *Thaumatometra* sp.

**Material examined.** Two specimens. RCO.ECH.3352 (1), RCO.ECH.3367 (1); St. CP08, Sunda Strait (between Tabuan Island and Sumatra); 425–442 m; coarse sand, gravel, and rubble; beam trawl; March 25, 2018.

**Description.** [RCO.ECH.3352] Centrodorsal hemispherical, 4.6 mm across, 3.7 mm tall, D/H 1.2; polar area 0.4 times centrodorsal diameter. Cirri slender and fragile, CL, with up to 7 segments remaining, 5.7 mm long (distal part broken), arranged in 7 rows;  $c_5$ – $c_6$  longest, L/W 4–5; succeeding segments elongated. Radials not visible. IBR 2; adjacent division series in close lateral contact. Arms 10, longest remaining length 25 mm (broken at  $br_{24}$ ); strong synarthrial swelling on division series and first two brachials; arm brachials smooth; first arm syzygy at  $br_{3+4}$ ; distal intersyzygial interval 3. Pinnules mostly broken;  $P_1$  with first six segments squarish, longest segment with L/W 3; succeeding pinnules with first two segments short, then elongated.

[RCO.ECH.3367] Centrodorsal 3.8 mm across, 2.5 mm tall, D/H 1.5; polar area 0.1 times centrodorsal diameter. Cirri totally lost, but cirrus scars CXLV, arranged in 5–6 rows. IBR2 with fine spines on lateral side. Arms 10, longest remaining length 35 mm (broken at  $br_{41}$ );  $P_1$  consisting of 19 segments, with first four segments squarish.

**Remarks.** The subfamily Bathymetrinae is characterised by numerous cirri with elongated segments, stiff and slender  $P_1$  composed of elongated segments, and  $P_2$  commonly the first genital pinnule (Hess & Messing, 2011). Within the subfamily,

*Fariometra* AH Clark, 1917, and *Thaumatometra* include the species having more than 50 cirri with the elongated segments more than four times longer than broad. The two genera differ mainly in the number of cirrus segments: 21–36 in *Fariometra* and 10–20 in *Thaumatometra* (AH Clark & AM Clark, 1967). Although cirri were broken or lost in the examined specimens, their smooth brachials were similar to that of *Thaumatometra*, rather than of *Fariometra* with spinose distal margins. The specimens appear to be close to *Thaumatometra thysbe* AH Clark, 1912d, which is known from Savu Sea, Indonesia (AH Clark, 1918), in the proportion of cirrus segments. Nevertheless, the cirri and pinnules on the specimens are mostly broken or lost, preventing further identification to confirm the species.

#### Subfamily incertae sedis

##### *Arthrypsometra* Messing & White, 2001

##### *Arthrypsometra mira* (AH Clark, 1909e)

*Psathyrometra mira* AH Clark, 1909e: 648; 1912a: 235, fig. 43; 1912c: 270; 1915: 116–117; 1918: 225, 227; 1937: 87, 94; AH Clark & AM Clark, 1967: 519; AM Clark, 1967: 167; James, 1983: 88; Messing et al., 2000: 634; Sastry, 2005: 12; 2007: 18. *Arthrypsometra mira* – Messing & White, 2001: 175; Kogo & Fujita, 2005: 354; Kogo, 2006: 241.

*Psathyrometra parva* AH Clark, 1911a: 562; 1912a: 236; 1915: 116–117; 1918: 225, 228.

*Psathyrometra major* AH Clark, 1912c: 270 (nomen nudum); 1912d: 140; 1915: 116–117; 1918: 224, 227, pl. 26 fig. 87.

*Psathyrometra inusitata* AH Clark, 1912c: 270 (nomen nudum); 1912d: 141; 1915: 116; 1918: viii, 225, 229, fig. 13, pl. 26 figs. 88–89; James, 1983: 88.

*Psathyrometra wireni* Gislén, 1922: 134, figs. 128–132, 138, pl. 2 fig. 12.

**Material examined.** One specimen. RCO.ECH.3334; St. CP20, Sunda Strait (south of Panaitan Island); 325–362 m; mud, gravel, and abundant plastic trash; beam trawl; March 27, 2018.

**Description.** Centrodorsal conical, 5.3 mm across and 4.7 mm tall, D/H 0.9; polar area convex, smooth; radial areas separated by shallow interrational furrows. Cirri XLIX, arranged in 3 columns per radial area. Radials narrowly visible. IBR 2. Arms 10, longest remaining length 27 mm (broken at  $br_{21}$ ); brachials smooth; first arm syzygy at  $br_{3+4}$ . Comparative pinnule length  $P_1 > P_8 > P_2 > P_3 > P_4 = P_5$ ; proximal and distal segments of proximal pinnules elongated, middle segments squarish.

**Distribution.** From west of Alappuzha (or Alleppey) to Andaman Islands, India (AH Clark, 1909e, 1912c). Balayan Bay, Philippines (AH Clark, 1911a, 1918). From west of Sumatra to Ceram Sea and Flores Sea, Indonesia (AH Clark, 1912a, 1918; AM Clark, 1967; this study). Nansei Islands to Sagami Bay, Japan (Gislén, 1922; Kogo & Fujita, 2005; Kogo, 2006). Off Zanzibar (AH Clark, 1937). Depth range: 325–924 m (AH Clark & AM Clark, 1967; this study).



Table 2. Characteristics of centrodorsal of *Athrypsometra* and *Psathyrometra*. ND: no data.

Species	Interradial areas	Centrodorsal diameter (D, mm)	Centrodorsal height (H, mm)	D/H ratio of centrodorsal	Cirri socket arrangements	Cirri number	References
<i>Athrypsometra mira</i>							
Holotype	Shallow furrows	4.0	4.0	1.0	2 converging columns	XL	AH Clark, 1909e
RCO.ECH.3334	Shallow furrows	5.3	4.7	0.9	3 columns	XLIX	This study
<i>Athrypsometra minima</i>							
Holotype	Flat or shallow furrows	1.8	1.6	1.1	2 columns	ND	AH Clark, 1912d
RCO.ECH.3358	Flat	4.3	3.7	1.2	3 columns	XLV	This study
<i>Psathyrometra parva</i>							
Holotype	Shallow furrows	3.2	4	0.9	2 converging columns	ND	AH Clark, 1911a
<i>Psathyrometra major</i>							
Holotype	Deep furrows	5.5	5	1.1	3 columns	ND	AH Clark, 1912d
<i>Psathyrometra inusitata</i>							
Holotype	Flat	3.2	2.4	1.3	3 columns	ND	AH Clark, 1912d

**Remarks.** The examined specimen agrees well with the description of *Athrypsometra mira* in having a conical centrodorsal not higher than broad, cirrus sockets arranged in three columns in each radial area, and a shallow furrow in each interradian area (AH Clark, 1909e). Messing & White (2001) established *Athrypsometra* to accommodate *Athrypsometra mira* and other three species originally in the genus *Psathyrometra*, currently assigned to Zenometridae, mainly based on the lack of externally visible basals and cirrus sockets without a concave fulcral bowl surrounding the lumen. *Athrypsometra* is still assigned to Antedonidae, but see comment about this family in Antedoninae gen. sp. Remarks section.

#### *Athrypsometra minima* (AH Clark, 1912d)

*Psathyrometra minima* AH Clark, 1912d: 141; 1915: 116; 1918: viii, 226, 228, pl. 26 fig. 91; AH Clark & AM Clark, 1967: 526, fig. 26.

*Athrypsometra minima* – Messing & White, 2001: 175.

**Material examined.** One specimen. RCO.ECH.3358; St. CP50, Indian Ocean (Pelabuhanratu Bay); 383–425 m; mud; beam trawl; April 2, 2018.

**Description.** Centrodorsal conical, 4.3 mm across and 3.7 mm tall, D/H 1.2; polar area convex, smooth; interradian areas flat. Cirri XLV, arranged in 3 columns per radial area. Radials narrowly visible. IBr 2. Arms 10, longest remaining length 67 mm (broken at br<sub>42</sub>); brachials smooth; first arm

syzygy at br<sub>3+4</sub>; distal intersyzygial interval 4. Comparative pinnule length P<sub>1</sub>>P<sub>a</sub>>P<sub>2</sub><P<sub>3</sub>>P<sub>4</sub>>P<sub>5</sub><P<sub>M</sub>=P<sub>D</sub>; pinnulars smooth, elongated.

**Distribution.** South of Java and Flores Sea, Indonesia (AH Clark, 1912d; this study). Depth range: 383–2,060 m (AH Clark, 1912d; this study).

**Remarks.** The examined specimen was identified as *Athrypsometra minima* based on the similarity to the original description (AH Clark, 1912d) of its centrodorsal D/H and morphology of its interradian areas. *Athrypsometra minima* is only known from the holotype collected from the Flores Sea, Indonesia. In their key, AH Clark & AM Clark (1967) distinguished the species from *A. mira* (previously *Psathyrometra mira*) on the basis of its flat or slightly raised centrodorsal interradian areas. However, in the description section, they mentioned that both *A. minima* and *A. mira* could have flat to shallow interradian furrows, which confuses the distinction between them. Table 2 shows the centrodorsal characters of *A. mira*, *A. minima*, and *Psathyrometra* species. The flat interradian furrows, which are diagnostic for *A. minima* by AH Clark & AM Clark (1967), are also present in the *P. inusitata* holotype (AH Clark, 1912d). The range of D/H ratio and socket arrangement of *A. minima* also fall within the range of *A. mira* specimens. These differences may reflect size/developmental differences rather than specific differences, suggesting *A. minima* may be a synonym of *A. mira*.

**Family Pentametrocrinidae AH Clark, 1908a*****Pentametrocrinus* AH Clark, 1908a*****Pentametrocrinus varians* (Carpenter, 1882)**

*Eudiocrinus varians* Carpenter, 1882: 495–496; 1888: 81, pl. 7 figs. 3–7; Hamann, 1907: 1576; AH Clark, 1907a: 569; 1908b: 271. 1908d: 319; 1912a: 33, 251; 1912c: 271; 1913: 67; 1915: 215; 1918: 260, 262; 1937: 97; AH Clark & AM Clark, 1967: 804; AM Clark, 1972: 146; Kogo, 1998: 137, fig. 113; Messing et al., 2000: 633; Sastry, 2005: 14; 2007: 23; Kogo & Fujita, 2005: 354; Lörz et al., 2012: 48; Sadhukhan & Raghunathan, 2013: 433; Kogo & Fujita, 2014: 127.

*Eudiocrinus* sp. – Wood-Mason & Alcock, 1891: 443; AH Clark, 1912a: 285.

**Material examined.** One specimen. RCO.ECH.3365; St. CP22, Sunda Strait (south of Panaitan Island); 864–870 m; mud; beam trawl; March 27, 2018.

**Description.** Centrodorsal low hemispherical, 3.7 mm across; polar area convex, 0.4 times centrodorsal diameter. Cirri XXVIII, arranged in two rows. Radials not visible. Arms 5, longest remaining length 22 mm (broken at br<sub>23</sub>); brachials smooth; first arm syzygy at br<sub>4+5</sub>; distal intersyzygial interval 3; adjacent br<sub>1</sub> in lateral contact; P<sub>1</sub> on right side of br<sub>2</sub> in aboral view for one ray and on left side of br<sub>2</sub> on other rays; P<sub>a</sub> always present on br<sub>3</sub>; P<sub>2</sub> with gonad.

**Distribution.** Off Luzon, Philippines (Carpenter, 1882; AH Clark, 1913). Andaman Islands, India (Wood-Mason & Alcock, 1891; AH Clark, 1912a, 1912c). From Nansei Islands to Ogasawara Islands, Japan (AH Clark, 1907a, 1908d; Kogo, 1998; Kogo & Fujita, 2005, 2014). Sunda Strait and Flores Sea, Indonesia (AH Clark, 1918; this study). Southern Arabian Sea (AH Clark, 1937). Off Mozambique (AM Clark, 1972). Depth range: 457–2,727 m (AH Clark & AM Clark, 1967).

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