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Shallow-water Comatulids (Echinodermata: Crinoidea: Comatulida) of the Ashizuri-Uwakai Sea, Shikoku Island, Southern Japan

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A faunal investigation of shallow-water (<50 m) comatulids of the Ashizuri-Uwakai Sea, Shikoku Island, southern Japan was performed between mid-2011 and early 2015, using scuba. It revealed that 30 species of seven families are distributed in the area, including two tropical species, *Clarkcomanthus mirabilis* (Rowe, Hoggett, Birtles, and Vail, 1986) and *Clarkcomanthus mirus* (Rowe, Hoggett, Birtles, and Vail, 1986) that are recorded in Japanese waters for the first time, as well as two species recently described during the research. Seventy-five percent of the listed species are tropical species, and 70% are shared with the fauna of the Ryukyu Islands, the southernmost part of Japan. These results agree with the general feature of the Ashizuri-Uwakai Sea in which the biota is strongly influenced by the Kuroshio Current flowing from the south.

Key Words: feather stars, marine fauna, new records, Kuroshio Current.

Introduction

The order Comatulida is the most diverse group of extant crinoids, including approximately 550 species (Messing 2017). Comatulids, also known as feather stars or stalk-less crinoids, inhabit various environments and depths of the ocean, unlike stalked crinoids that are restricted to deeper waters. The species diversity of comatulids is highest in the central Indo-Malayan region (the Philippines, islands of Malaysia and Indonesia, and New Guinea), where the number of species is estimated to reach about 200 (Messing 1997; Messing *et al*. 2000; Kogo and Fujita 2005). Japan is located outside this region, but nevertheless its comatulid fauna is rich with as many as 146 species (Kogo 1998, 2002; Kogo and Fujita 2005; Obuchi *et al*. 2009; Fujita and Obuchi 2012; Obuchi 2013, 2014; Obuchi and Omori 2015; Obuchi and Fujita 2017). The Japanese fauna shares most species with the Indo-Malayan region, which indicates the strong influence of the Kuroshio Current, which originates from off the Philippines and flows off the Pacific coast of southern Japan (A. H. Clark 1912; Kogo and Fujita 2005).

The Ashizuri-Uwakai Sea, on the southwestern coast of Shikoku Island, southern Japan, is the coastal area from Cape Ashizuri on the east to Cape Sata facing the Bungo Channel on the west. The marine biota of this area is characterized by a dominance of tropical species supported by the offshore Kuroshio Current, regardless of its high latitude (Iwase 2004). For example, the number of zooxantellate scleractinian corals in this area is up to 170 species, which is comparable to numbers in some tropical coral reef areas (Nishihira and Veron 1995; Nomura and Mezaki 2005). Additionally, over the last decades, the numbers of tropical species of fish and seaweeds have been rapidly increasing as water temperature rises (Tanaka *et al*. 2012; Nakamura *et al*. 2013).

Investigations of marine biota are important for providing baseline information for determining how particular fauna change over time, possibly in response to global-scale climate change impacts. No intensive survey of comatulid fauna has previously been conducted in this area and there is only scattered information about this group in the literature. For instance, in a review of the Japanese crinoid fauna, Kogo (1998) recorded six species collected in the Ashizuri-Uwakai Sea and its environs. Kogo and Fujita (2005) added two species, and Kogo and Fujita (2014) subsequently reported three more species with both accounts being in faunal summaries of adjacent areas. Among these reports, four species of three families were found in shallow depths (<50 m): *Comatella stelligera* (Carpenter, 1888), *Comaster nobilis* (Carpenter, 1888), *Lamprometra palmata* (Müller, 1841), and *Tropiometra afra macrodiscus* (Hara, 1895). However, the actual number of species in this area is expected to be much higher, since more species have been recorded in neighbor waters, such as in Kyushu area and Sagami Bay (Kogo and Fujita 2005, 2014).

The author conducted a faunal investigation of shallow-water comatulids of the Ashizuri-Uwakai Sea from 2011 to 2016 using scuba (Obuchi 2013; Obuchi and Omori 2015; Obuchi 2016; Obuchi and Fujita 2017). This paper presents the results of that investigation. Additionally, a morphological key to the species of comatulids crinoids is included to assist with their identification.

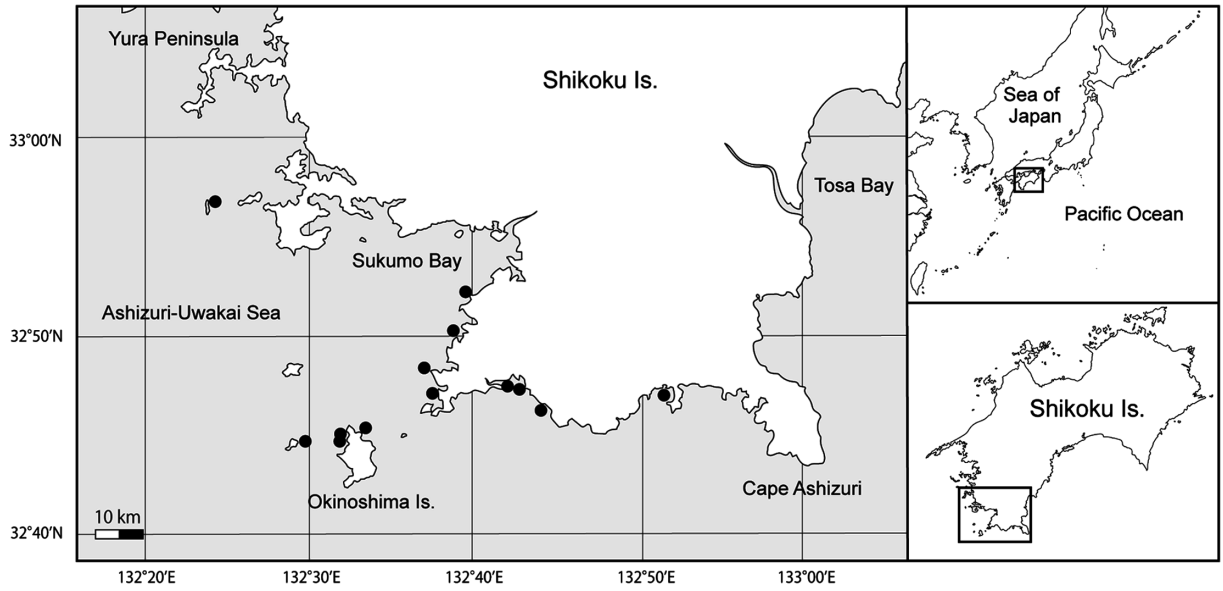

Fig. 1. The Ashizuri-Uwakai Sea, Shikoku Island, southern Japan. Black circles indicate the sampling sites.

Materials and Methods

Crinoids were collected in the Ashizuri-Uwakai Sea (32°42′–57′N, 132°24′–52′E; Fig. 1) at depths shallower than 50 m between mid-2011 and mid-2016, using scuba. Specimens were fixed in 70% ethanol and examined under a dissection microscope. General identification followed A.H. Clark's monographs (A. H. Clark 1931, 1941, 1947; A. H. Clark and A. M. Clark 1967). Rowe *et al.* (1986), Kogo (1998) and Messing (2001) were also referred to in order to identify species of the family Comatulidae. Synonym lists are shown only for the species which are new to the Japanese fauna. Descriptions follow the terminology of Messing (1997), while the comparative lengths of proximal pinnules were represented using inequality signs according to Kogo (1998). Abbreviations used in this paper include:

c: cirral, segment of cirrus, numbered from the base.

L/W, W/L: length-to-width and width-to-length ratios of ossicles.

Br: division series. Preceding Roman character indicates the position from the base.

br: brachial, small ossicle of ray, numbered from the base of each division series or free arm.

+: articulation jointed by syzygy.

P: pinnule, numbered from the most proximal with numerals on the outer side of arm bifurcation (*e.g.*, P_1), and alphabetically on the inner side (*e.g.*, P_a). P_D indicates pinnule on division series.

The feeding postures were described according to Meyer and Macurda (1980) and Messing (1994, 1997). An arcuate fan consists of two layers of arms, forming a quarter to semicircular sector. A radial fan is with the arms extended radially and arrayed in single plane. A parabolic fan is a modified version of the former, with arms remarkably curved toward the aboral side from which the current comes. Although species hiding in crevices or cracks tend not to form distinctive fan-like postures, extended arms still work as the feeding apparatus. Some of these species arrange pinnules along each side of arms in parallel, and others arrange pinnules alternately in two or more directions: the former was defined as the simple arm fan, and the latter as a multidirectional posture. The multilayered arrays observed in the species with numerous arms are irregularly crowded arm fans to a ball-like posture.

As for the distributional information of species, with the exception of species newly recorded here, only the limits of ranges and outlier records were given.

Materials examined were listed in the appendix. Specimens were deposited in the Biological Institute on Kuroshio (BIK) and the Osaka Museum of Natural History (OMNH).

Results

In total, 109 specimens were assigned to 30 species belonging to 18 genera of seven families (Table 1). Among them, *Comanthus scintillus* Obuchi and Fujita, 2017 and *Belonometra kogoi* Obuchi and Omori, 2015 have been described on the basis of the specimens collected during this research. *Clarkcomanthus mirabilis* (Rowe, Hoggett, Birtles, and Vail, 1986) and *Clarkcomanthus mirus* (Rowe, Hoggett, Birtles, and Vail, 1986) were reported here as new to the Japanese fauna.

Family **Comatulidae** Fleming, 1828

1. ***Comatella stelligera*** (Carpenter, 1888)

[Japanese name: Futoude-ogasawara-umishida]

Morphology. Centrodorsal hemispherical, 9.5 mm across; polar area concave, 0.5 times of centrodorsal diameter. Cirri XXXVIII, up to 24 segments, 25 mm long, arranged in two

Table 1. Shallow-water comatulid species of the Ashizuri-Uwakai Sea.

Family	Species	Distribution*
Comatulidae	*Comatella stelligera*	T
	Phanogenia distincta	T
	Comaster nobilis	T
	Comanthus parvicirrus	T
	Comanthus gisleni	T
	Comanthus scintillus	T?
	Comanthus suavia	T
	Comanthus wahlbergii	T
	Anneissia intermedia	M
	Anneissia japonica	M
	Anneissia solaster	M
	Clarkcomanthus albinotus	T
	Clarkcomanthus comanthipinna	T
	Clarkcomanthus exilis	T
	Clarkcomanthus littoralis	T
	*Clarkcomanthus mirabilis***	T
	*Clarkcomanthus mirus***	T
Zygometridae	*Catoptometra magnifica*	T
	Catoptometra rubroflava	M
Himerometridae	*Himerometra magnipinna*	T
Mariametridae	*Lamprometra palmata*	T
Colobometridae	*Pontiometra andersoni*	T
	Basilometra boschmai	T
	Cenometra bella	T
	Alisometra owstoni	M
	Iconometra japonica	M
Tropiometridae	*Tropiometra afra macrodiscus*	T
Antedonidae	*Dorometra parvicirra*	T
	Antedon serrata	M
	Belonometra kogoi	T?

* Abbreviations T, tropical species; M, temperate species. ** New to Japanese fauna.

rows; c6–8 longest, L/W 1.4; distal segments polished, with aboral spine gradually developing. Radials invisible. I–IIIBr series composed of 2 ossicles; IIIBr arising both sides of IIBr. Arms 39, 200 mm long, arrayed in single plane; brachials rugose, shorter than broad; first arm syzygy at br_{1+2}, rarely br_{3+4}; distal intersyzygial intervals 3 or 4; single arm of examined specimen with brachials slender and smoother, besides difference of coloration. Comparative pinnule length $P_1>P_2>P_3>P_4>P_5$; P_1 and P_2 enlarged; P_{2-4} with rounded keel on side toward arm tip of proximal two segments. Terminal combs present as far as P_4, consisting of 15–20 segments; teeth single, confluent with lateral margins of pinnule segments closest to arm, with base separated from neighboring one; terminal segments with discrete teeth. Disk regenerating.

Posture. Hiding under overhangs or between foliose corals, with arms in multidirectional posture to multilayered arrays.

Coloration in life. Two basic patterns: one uniformly reddish brown, and another dark red wholly spotted with yellow. The examined specimen corresponding to the former, but a single arm of it to the latter.

Distribution. Sagami Sea, Japan (Kogo and Fujita 2014) to Western Australia and Great Barrier Reef (Rowe and Gates 1995). Tonga to Sri Lanka (A. H. Clark 1931). Ogasawara (Gislén 1922) and Guam (Kirkendale and Messing 2003).

Remarks. Genus *Comatella* A. H. Clark, 1908 is characterized by all division series of 2 ossicles, the first arm syzygy at br_{1+2}, the terminal combs confluent with lateral margins of the pinnule segments closest to the arm. According to A. H. Clark (1931), a form with IIIBr series arising from both sides of IIBr axillaries, like the examined specimen, could be identified as *Comatella nigra* (Carpenter, 1888). However, this symmetric bifurcation seems commonly found in large specimens of this genus (Obuchi, personal observation). Here, the identification followed Messing's (2001) concept that the axillaries beyond IBr with distal facet asymmetrical and oblique so that the rays are twisted in *C. nigra*, whereas the arms are arrayed in a single plane in *C. stelligera*.

The examined specimen had the one arm remarkably different from others in terms of the slenderness and smoothness of the brachials, and the coloration. It indicates intra-specific variation or alternation with growth, which supports Messing's (2001) view that small forms of *Comatella* with spotted arms, formerly identified as *Comatella maculata* (Carpenter, 1888) by coloration, are the young of *C. stelligera*.

2. ***Phanogenia distincta*** (Carpenter, 1888)
[Japanese name: Koashi-hitofushi-umishida]

Morphology. Centrodorsal low hemispherical, 4.6–4.8 mm across; polar area flat, 0.4–0.7 times of centrodorsal diameter. Cirri XXIV–XXXII, up to 12 segments, 12 mm long, arranged in two rows; c3–5 longest, L/W 1.8; distal segments with aboral spine gradually developing. Radials almost invisible. IBr series composed of 2 ossicles, IIBr of 4(3+4), and IIIBr of 2(1+2). Arms thin, presumably 40, up to 125 mm long; brachials shorter than broad, with distal ends everted and spinose; first arm syzygy at br_{1+2}; distal intersyzygial intervals 3. Comparative pinnule length $P_D>>P_1>>P_2>P_3=P_4=P_5$; P_D and P_1 enlarged; segments remarkably spinose, with distal ends flared. Terminal combs present to arm tips at intervals, consisting of 8–13 segments; teeth single, large, curved inward, confluent with lateral margins of pinnule segments; proximal segment with transverse spoon-like tooth; terminal segments with discrete teeth. Disk lost.

Posture. Hiding under overhangs or between foliose corals, with arms in multidirectional posture to multilayered arrays. Found at depths deeper than 20 m.

Coloration in life. Arms bright orange; pinnules bright orange or white, often with blue tips; centrodorsal and cirri white. Examined specimens with pink swellings of gonads on base of middle pinnules.

Distribution. Sagami Sea, Japan (Gislén 1927) to West Australia (Rowe and Gates 1995). New Caledonia (A. H. Clark 1931) to Madagascar (A. M. Clark 1972). Guam (Kirkendale and Messing 2003).

Remarks. Genus *Phanogenia* Lovén, 1866 is unique in having narrow arms with the first syzygy at br_{1+2}, the spinose pinnules, and terminal combs appearing to the arm tips. The examined specimens were identified on the basis of the number of arms and L/W of cirrus segments with less than two. According to the key to Comatulidae in Kogo (1998), the specimens were identifiable as *Phanogenia brevicirra* (Bell, 1894), which was considered as a junior synonym of *P. distincta* (A. M. Clark 1972).

3. ***Comaster nobilis*** (Carpenter, 1888)
[Japanese name: Hana-umishida]

Morphology. Centrodorsal thin, slightly raised from level of radials, 4.4–5.2 mm across. No functional cirri, except few rudimentary ones and scars. Radials exposed, length 0.3 times of centrodorsal diameter. IBr series composed of 2 ossicles, IIBr of 4(3+4), IIIBr of 2 on outer and of 4(3+4) on inner side of rays, and IV–VIBr of 4(3+4); proximal rays fused by additional interradial plates present, making calyx aborally solid. Arms up to 104, 135 mm long; brachials shorter than broad, with distal ends everted; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D>>P_1>P_2=P_3=P_4=P_5$; P_D enlarged. Terminal combs present as far as P_{3-5}, consisting of 7–17 segments; combs of P_D with single, knob-like small teeth; ones of following pinnules with teeth paired, both straight, confluent with lateral margins of pinnule segments; paired teeth on proximal few segments fused into transverse bar. Disk remarkably large, five to eight times as wide as centrodorsal, smooth.

Posture. Fully exposed on rocky pinnacles, with arms in multilayered arrays.

Coloration in life. Various with the most common pattern being arms of yellow to orange and pinnules blotched with white, black, yellow and orange. Some animals almost entirely white with some pinnules blotched with black.

Distribution. Kii Peninsula, Japan (Kogo 1998) to northern New South Wales, Australia (Rowe *et al*. 1986). New Caledonia (Rowe *et al*. 1986) to Sri Lanka (A. H. Clark 1931).

Remarks. Genus *Comaster* L. Agassiz, 1836 is characterized by having numerous arms with the first syzygy at br_{3+4}, asymmetric bifurcation beyond IIIBr series, and the central mass integrated by interradial plates. This species is unique in almost lacking functional cirri.

4. ***Comanthus parvicirrus*** (Müller, 1841)
[Japanese name: Koashi-umishida]

Morphology. Centrodorsal thin, slightly raised from level of radials, 3.0–4.0 mm across; polar area flat, 0.7–0.8 times of centrodorsal diameter. Cirri weak, III–XIII, up to 14 segments, 8.5 mm long, arranged in single row with gaps; c5–7 longest, L/W 1.2; distal 4–5 segments with aboral transverse ridge. Radials exposed, length 30% of centrodorsal diameter. IBr series composed of 2 ossicles, and II–IVBr of mostly 4(3+4), rarely 2. Arms up to 41; anterior arms up to 180 mm long, 2.1–2.3 times longer than posterior ones; brachials shorter than broad, with distal ends everted; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D>P_1>>P_2<P_3<P_4=P_5$; P_D and P_1 enlarged; distal pinnules on anterior arms remarkably slender, with middle segments L/W 4.0. Terminal combs present to near arm tips at intervals, but sometimes to two third of arms, consisting of 7–13 segments; teeth confluent with lateral margins of pinnule segments, curved inward, basally contacted with adjacent one; small secondary teeth occasionally present on some segments; terminal segment with discrete large tooth; proximal segment with transverse saucer-shaped tooth. Disk three to four times as wide as centrodorsal.

Posture. Dwelling within cracks or crevices, or between stony corals, with anterior arms in multidirectional posture.

Coloration in life. Arms green to greenish yellow with dark articulations; pinnules dark green, often with yellow tips.

Distribution. Toyama Bay, Japan (Kogo 1998) to New South Wales, Australia (Rowe *et al*. 1986). Tonga (A. H. Clark 1931) to Mozambique (A. M. Clark 1972). Ogasawara Islands (Gislén 1922) and Guam (Kirkendale and Messing 2003).

Remarks. Genus *Comanthus* A. H. Clark, 1908 is characterized by the first arm syzygy at br_{3+4}, and the terminal combs with large and confluent teeth and saucer-like proximal teeth. *Comanthus parvicirrus* is recognized by the terminal combs distributed to almost the arm tips, and the distal pinnules with smooth and slender segments. During this research, some unfamiliar forms of Comatulidae were collected, which were similar to this species in general morphology, but had intermediate characters between *Comanthus* and *Clarkcomanthus* Rowe, Hoggett, Birtles, and Vail, 1986. They appeared to consist of at least two groups by the shape and distribution of terminal combs. Here, these specimens were excluded from the examined materials. They need further study to identify the genus to which they belong, and to determine the boundaries between each form.

5. ***Comanthus gisleni*** Rowe, Hoggett, Birtles, and Vail, 1986
[Japanese name: Gisuren-umishida]

Morphology. Centrodorsal thin, slightly raised from level of radials, 2.0–4.0 mm across; polar area flat, 0.7–0.8 times of centrodorsal diameter. Cirri weak, VII–XIII, up to 14 segments, 8.0 mm long, arranged in single row with gaps; c4–7 longest, L/W usually 1.2, up to 1.8; distal 4–5 segments with aboral transverse ridge. Radials narrowly exposed, length less than 15% of centrodorsal diameter. IBr series composed of 2 ossicles, and II–IIIBr of mostly 4(3+4), rarely 2. Arms up to 29; anterior arms up to 155 mm long, 2.1–2.4 times longer than posterior ones; brachials shorter than broad, with distal ends everted; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D>P_1>>P_2<P_3<P_4=P_5$; P_D and P_1 enlarged; middle segments of distal pinnules with fringing spines on distal end. Terminal combs present to near arm tip at in-

tervals, consisting of 7–14 segments; teeth single, confluent with lateral margins of pinnule segments, curved inward, basally contacted with adjacent one; terminal segment with discrete large tooth; proximal segment with transverse saucer-shaped tooth. Disk five to six times as wide as centrodorsal.

Posture. Likely nocturnal. Dwelling within cracks or crevices, or between stony corals, with anterior arms in multidirectional posture.

Coloration in life. Uniformly black with orange pinnule tips. Sometimes the aboral side of arms is cream.

Distribution. Nii-Jima Island, northern Izu Islands, Japan (Kogo 1998) to Great Barrier Reef (Rowe *et al*. 1986).

Remarks. This species is closely similar to *C. parvicirrus*, and distinguished mainly by the presence of the spines fringing the distal ends of the segments of the distal pinnules. Morphologies of examined specimens were mostly consistent with the original description, but the coloration was different. The dark mid-longitudinal line on arms constantly observed in Australian specimens was absent from those examined here.

6. ***Comanthus scintillus*** Obuchi and Fujita, 2017
[Japanese name: Hanabi-umishida]

Morphology. Centrodorsal thin, slightly raised from level of radials, 2.6–3.4 mm across; polar area flat, 0.7–0.8 times of centrodorsal diameter. Cirri weak, II–IX, up to 16 segments, 8.0 mm long, arranged in single row with gaps; c4–7 longest, L/W usually 1.3; dorsal 4–5 segments with aboral transverse ridge. Radials narrowly exposed, length less than 15% of centrodorsal diameter. IBr series composed of 2 ossicles, and II–IIIBr of mostly 4(3+4), rarely 2. Arms up to 38; anterior arms usually 150 mm long, 2.1–2.4 times longer than posterior ones; brachials shorter than broad, with distal ends everted; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D > P_1 >> P_2 < P_3 < P_4 = P_5$; P_D and P_1 enlarged; middle segments of distal pinnules with fringing spines on distal end, but sometimes indistinct. Terminal combs present as far as $P_{11–18}$ at intervals, consisting of 6–11 segments; teeth single, confluent with lateral margins of pinnule segments, curved inward, basally contacted with adjacent one; terminal segment with discrete large tooth; proximal segment with transverse saucer-shaped tooth. Disk three to five times as wide as centrodorsal.

Posture. Dwelling within cracks or crevices, or between stony corals, with anterior arms in multidirectional posture.

Coloration in life. Uniformly red with small yellow spots scattered; distal arms sometimes densely spotted and almost yellow.

Distribution. Southern Izu Peninsula (H. Kohtsuka, personal communication) to Miyako Island, Ryukyu Islands (Obuchi and Fujita 2017).

Remarks. This species is characterized by the restricted distribution of combed pinnules to the middle of its arms, and the presence of spines fringing distal ends of the segments of the distal pinnules. Its general appearance is close to *C. parvicirrus* and *C. gisleni*. The specimens identifiable as this species were collected in southern Izu peninsula and southern Kyushu (H. Kohtsuka, personal communication), which suggests this species is distributed in the temperate to subtropical zones.

7. ***Comanthus suavia*** Rowe, Hoggett, Birtles, and Vail, 1986
[Japanese name: Nagare-koashi-umishida]

Morphology. Centrodorsal thin, pentagonal, 2.3–2.7 mm across, at almost same level of radials; polar area flat, more than 0.9 times of centrodorsal diameter. No cirri, but for few obsolete scars; young specimen possessing IV weak cirri composed of 13 segments. Radials exposed, length about 50% of centrodorsal diameter; subradial clefts distinct. IBr series composed of 2 ossicles, and II–VBr of mostly 4(3+4), rarely 2. Arms up to 42; anterior arms up to 210 mm long, 2.0–2.3 times longer than posterior ones; brachials shorter than broad, with distal ends everted; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D > P_1 >> P_2 < P_3 < P_4 = P_5$; P_D and P_1 enlarged. Terminal combs present as far as $P_{9–11}$ at intervals, consisting of 7–13 segments; teeth paired; primary teeth confluent with lateral margins of pinnule segments, curved inward, basally contacted with adjacent one; terminal segment with discrete large tooth; proximal segment with transverse saucer-shaped tooth. Disk five to six times as wide as centrodorsal.

Posture. Dwelling within cracks or crevices, or between stony corals, with anterior arms in multidirectional posture.

Coloration in life. Arms striped with white brachials and red-purple or black articulations; pinnules aborally white and laterally red-purple or black, often with yellow tips.

Distribution. Ashizuri-Uwakai Sea (present study) to Great Barrier Reef (Rowe *et al*. 1986).

Remarks. This species can be identified by the absence of cirri, the restricted distribution of combed pinnules to the middle of arms. This species was previously recorded from the Ashizuri-Uwakai Sea by the author (Obuchi 2013). However, reinvestigation revealed that the specimens reported there differed from ones identified here as *C. suavia* in the number of the cirri, the extent of exposure of radials, and coloration. They were not identical to any other congeners and appeared to be undescribed. Thus, they were not listed in the specimens examined here.

8. ***Comanthus wahlbergii*** (Müller, 1843)
[Japanese name: Makieda-koashi-umishida]

Morphology. Centrodorsal thick discoidal, 3.0–4.1 mm across; polar area flat, 0.7–0.8 times of centrodorsal diameter. Cirri curved inward, XXV–XXXIV, up to 17 segments, 8.5–12.0 mm long, arranged in single, partly two rows; c5–7 longest, L/W 1.7; distal segments laterally compressed, broader than proximal ones, with weak aboral process. Radials invisible. IBr series composed of 2 ossicles, IIBr of mostly 4(3+4) and partly 2, and IIIBr of 4(3+4). Arms usually about 20, up to 37; anterior arms up to 115 mm long, 1.3–2.0 times longer than posterior; brachials short-

er than broad, with distal ends everted; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D>P_1>>P_2=P_3=P_4=P_5$; P_D and P_1 enlarged; segments finely spinose, especially on distal end. Terminal combs present as far as P_{8-10} at intervals, consisting of 7–10 segments; teeth paired; primary teeth confluent with lateral margins of pinnule segments, curved inward, basally contacted with adjacent one; small secondary teeth placed closely to primaries; terminal segment with discrete tooth; proximal segment with transverse saucer-shaped tooth. Disk three to four times as wide as centrodorsal, with fleshy papillae on anal tube.

Posture. Nocturnal. Dwelling within cracks or crevices, or between stony corals. Anterior arms extended in nighttime, exhibiting multidirectional posture.

Coloration in life. Arms brown, distally light yellow, sometimes with dark mid-aboral line in proximal part; pinnules aborally green-yellow, or black with yellow tips; centrodorsal dark brown, with yellow marking on center.

Distribution. Oki Island, Japan (Kohtsuka and Kogo 2012) to New Zealand (Rowe *et al.* 1986), Samoa (Rowe *et al.* 1986) to South Africa (A. M. Clark 1972). Guam (Kirkendale and Messing 2003).

Remarks. The large centrodorsal with complete rows of cirri enables this species to be distinguished from other congeners. This species is distributed throughout the West Pacific and Indian Ocean, and shows wide morphological variation according to each region (Rowe *et al.* 1986). One specimen (BIK-EC-CR0013) had as many as 37 arms, which was greater than any previous records and comparable to the form from South Africa, formerly considered as subspecies *C. wahlbergii multiradiata* Gislén, 1938. However, it did not differ from others in other morphological characters.

9. ***Anneissia intermedia*** (A. H. Clark, 1916)
[Japanese name: Ashiboso-ohban-umishida]

Morphology. Centrodorsal hemispherical, 8.7–11.3 mm across; polar area concave, 0.4–0.5 times of centrodorsal diameter. Cirri XLVII–LV, up to 26 segments, 30.0 mm long, arranged in two to three rows; c7–10 longest, L/W 1.2; distal ten segments with blunt aboral process. Radials invisible. IBr series composed of 2 ossicles, IIBr of 4(3+4), and IIIBr of mostly 2, rarely 4(3+4). Arms up to 48, 240 mm long; brachials shorter than broad with distal ends everted; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D>P_1>P_2>P_3>P_4=P_5$; P_D to P_2 enlarged; segments broader than long; proximal segments with narrow keel on side toward arm tip. Terminal combs present as far as P_{2-3}, consisting of 13–30 segments; teeth single, non-confluent, knob-like; terminal segments fused to sharp tip. Disk large, five to six times as wide as centrodorsal, smooth.

Posture. Fully exposed on rocky pinnacles, forming arcuate fan to multilayered arrays.

Coloration in life. Two distinct patterns: one with orange arms and white pinnules, and the other wholly light yellow.

Distribution. Oki Island, Japan (Kohtsuka and Kogo 2012) to Fujian, China (Liao and A. M. Clark 1995).

Remarks. Genus *Anneissia* Summers, Messing, and Rouse, 2014 was established by recent taxonomic revision (Summers *et al.* 2014), and consists of large forms of former *Oxycomanthus* Rowe, Hoggett, Birtles, and Vail, 1986 having thick centrodorsal with robust cirri and terminal combs with non-confluent teeth. This species can be distinguished by having IIIBr series composed of 2 ossicles, from other congeners with IIIBr of 4(3+4).

10. ***Anneissia japonica*** (Müller, 1841)
[Japanese name: Nippon-umishida]

Morphology. Centrodorsal hemispherical, approximately 10 mm across; polar area concave, 0.5–0.6 times of centrodorsal diameter. Cirri LVII–LXIX, up to 25 segments, 27.0 mm long, arranged in two to three rows; c5–8 longest, L/W 1.3; distal ten segments with blunt aboral process. Radials invisible. IBr series composed of 2 ossicles, IIBr of 4(3+4), and IIIBr of 4(3+4). Arms 38, up to 135 mm long; brachials shorter than broad, with distal ends everted; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D>P_1>P_2>P_3=P_4=P_5$; P_D and P_1 enlarged; proximal segments finely spinose at distal end, with narrow keel on side toward arm tip. Terminal combs present as far as P_{2-3}, consisting of 4–13 segments; teeth single, non-confluent, knob-like; terminal segments fused to sharp tip. Disk two to three times as wide as centrodorsal, smooth.

Posture. Hiding under overhangs or between foliose corals, with arms in multilayered arrays.

Coloration in life. Rays dark brown with pinnule tips orange to white. Some animals with pinnules aborally white.

Distribution. Endemic to Japan: Aomori (Kogo and Fujita 2014) to Kagoshima (Kogo and Fujita 2005).

Remarks. The specimens were identified by having about 40 arms and more than 50 cirri. This species is considered endemic to Japan (Kogo and Fujita 2014). Specimens recently recorded from southern Vietnam have fewer cirri, 28–36 in number (Mekhova and Britayev 2012), compared to previous records from Japan with at least 40 cirri (Kogo and Fujita 2014). It is likely that they are different species, although which species they would be referred to is unclear. A specimen recorded in southern Korea seems young due to fewer arms and is difficult to identify (Shin 2001).

11. ***Anneissia solaster*** (A. H. Clark, 1907)
[Japanese name: Utena-umishida]

Morphology. Centrodorsal thick discoidal, 5.4–7.3 mm across; polar area 0.7–0.9 times of centrodorsal diameter, with slight depression at center in large specimen. Cirri XVII–LI, up to 23 segments, 24.0 mm long, arranged in one, partly two rows; c5–8 longest, L/W 1.8; distal ten segments with aboral process. Radials invisible. IBr series composed of 2 ossicles, IIBr of 4(3+4), and IIIBr of 4(3+4). Arms 20–29, usually 90–125 (up to 150) mm long; brachials shorter than broad, especially in distal half arms, with distal ends everted and spinous; first arm syzygy at br_{3+4};

distal intersyzygial intervals 4. Comparative pinnule length $P_D>P_1>P_2>P_3=P_4=P_5$; P_D and P_1 enlarged; distal end of basal segments conspicuously everted and spinose. Terminal combs present as far as P_{2-3}, consisting of 7–20 segments; teeth single, non-confluent, straight, blade-like; terminal segments fused to sharp tip. Disk two to three times as wide as centrodorsal, with fleshy papillae on anal tube.

Posture. Likely nocturnal. Hiding under overhangs or between foliose corals. Some arms extended in multidirectional posture at nighttime.

Coloration in life. Three patterns: first with ivory arms, pinnules distally dark orange, brown centrodorsal, and orange cirri; second uniformly dark purple to dark brown; third uniformly light yellow.

Distribution. Noto Peninsula, northern Japan (Kohtsuka and Kogo 2001) to off Amami Islands, East China Sea (Kogo and Fujita 2005).

Remarks. This species is recognizable by the number of arms being less than 30, and basal segments of proximal pinnules with spinose projection.

12. *Clarkcomanthus albinotus*
Rowe, Hoggett, Birtles, and Vail, 1986
[Japanese name: Fushinaga-kuraaku-umishida]

Morphology. Centrodorsal thin, pentagonal, 2.8–3.4 mm across, at almost same level of radial; polar area 0.7–0.8 times of centrodorsal diameter; subradial clefts distinct. No functional cirri, but for few cirrus scars. Radials exposed, length 18–30% of centrodorsal diameter. IBr series composed of 2 ossicles, IIBr of 2 or 4(3+4), and IIIBr of 4(3+4); each ray well separated. Arms 28–31; anterior arms up to 170 mm long, 1.5–1.9 times longer than posterior; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D>P_1>>P_2=P_3=P_4=P_5$; P_D and P_1 enlarged, with longest segments L/W 1.2; distal pinnules long, almost same length as P_1; segments of pinnules beyond P_3 finely spinose, with distal-oral edge projected like spine. Terminal combs present to P_2, consisting of 6–10 segments; tooth paired; primary tooth confluent with lateral margin, straight, widely spaced from adjacent one; secondary tooth smaller but distinct; terminal and proximal segments diminished tooth. Disk three to five times as wide as centrodorsal.

Posture. Dwelling within cracks or crevices, or between stony corals, with anterior arms in multidirectional posture.

Coloration in life. Arms yellow to dark brown, sometimes whitish at distal half, with pale mid-aboral line on proximal part; pinnules aborally striped with yellow and black, often with red tips.

Distribution. Kii Peninsula, Japan (Kogo and Fujita 2014) to southern Queensland, Australia (Rowe *et al*. 1986).

Remarks. Genus *Clarkcomanthus* is characterized by the first arm syzygy at br_{3+4}, reduced centrodorsal with few cirri, and the terminal combs with small teeth confluent or not. The examined specimens were identified by restricted distribution of the terminal combs, the presence of secondary teeth on the combs, and some segments of proximal pinnules longer than wide.

13. *Clarkcomanthus comanthipinna* (Gislén, 1922)
[Japanese name: Kohige-kushi-umishida]

Morphology. Centrodorsal small, thin discoidal, 2.0–3.0 mm across; polar area flat, 0.6–0.8 times of centrodorsal diameter. Cirri up to XI, 16 segments, 10.5 mm long, arranged in single rows with gap; c5–8 longest, L/W 1.5; distal 3–5 segments with weak aboral process or transverse bar. Radials exposed, length 30–40% of centrodorsal diameter. IBr series composed of 2 ossicles, and II–IVBr of mostly (3+4), rarely 2; each ray well separated. Arms 20–29; anterior arms up to 210 mm long, 1.7–2.1 times longer than posterior; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D>P_1>>P_2=P_3=P_4=P_5$; P_D and P_1 enlarged. Terminal combs present as far as P_{2-4}, consisting of 7–18 segments; tooth single, non-confluent, straight, widely spaced from adjacent one; terminal segments fused to sharp tip. Disk four to seven times wide of centrodorsal, with fleshy papillae on tip of anal tube.

Posture. Dwelling within cracks or crevices, or between stony corals, with anterior arms in multidirectional posture.

Distribution. Sagami Sea (Kogo and Fujita 2014) to southern Queensland, Australia (Rowe and Gates 1995), and to New Caledonia (Rowe *et al*. 1986).

Coloration in life. Various. Rays khaki to black; pinnules aborally white, often with yellow tip; dark mid-longitudinal line present on arms.

Remarks. This species is recognizable by restricted distribution of the terminal combs and combs with pointed tip. In some specimens examined here, the terminal combs occured as far as P_4. In specimens from Australia, they are more restricted, usually to P_2 (Rowe *et al*. 1986).

14. *Clarkcomanthus exilis*
(Rowe, Hoggett, Birtles, and Vail, 1986)
[Japanese name: Hige-kushi-umishida]

Morphology. Centrodorsal small, thin discoidal, 2.2–2.6 mm across; polar area flat 0.7–0.9 times of centrodorsal diameter. Cirri less developed, up to XII, 13 segments, 6.0 mm long, arranged in single rows with gap; c4–7 longest, L/W 1.4; distal 3–5 segments with weak aboral process. Radials exposed, length up to 20% of centrodorsal diameter. IBr series composed of 2 ossicles, IIBr of 2 or 4(3+4), and IIIBr of 4(3+4); each second ossicles fused by thin epidermis. Arms 20–30, up to 90 mm long; anterior arms sometimes distinct, up to 1.8 times longer than posterior; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule m $P_D>P_1>>P_2=P_3=P_4=P_5$; P_D and P_1 enlarged; segments finely spinose. Terminal combs present to P_1, rarely to P_2, consisting of 6–14 segments; tooth single, non-confluent, straight, widely spaced from adjacent one; terminal segments fused to sharp tip. Disk four to six times as wide as centrodorsal.

Posture. Nocturnal. Hiding under overhangs or between foliose corals. Anterior arms extended in multidirectional

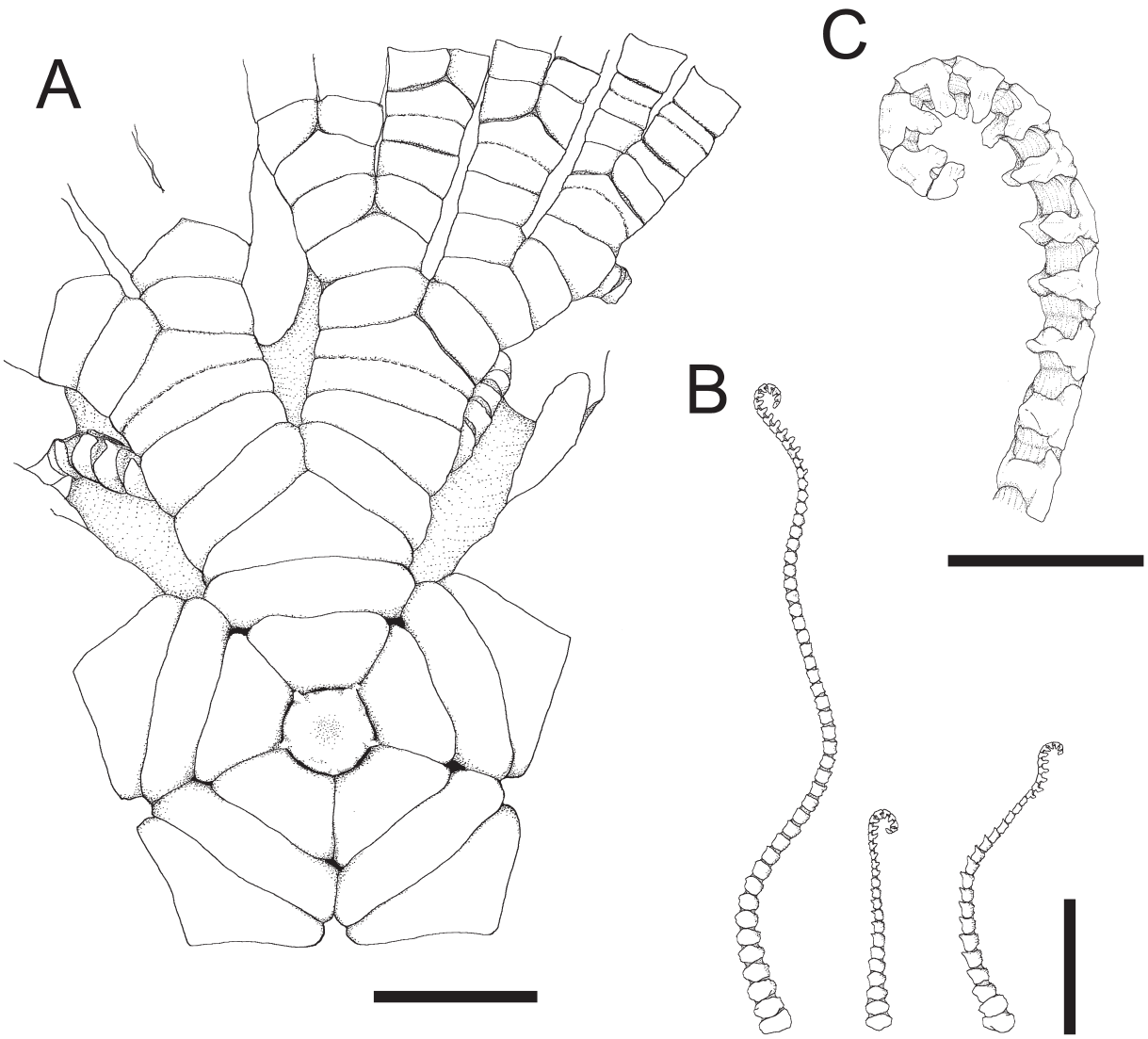

Fig. 2. *Clarkcomanthus mirabilis* (Rowe, Hoggett, Birtles, and Vail, 1986), BIK-EC-CR0034. A, centrodorsal and proximal ray, aboral view; B, proximal pinnules (P_1 to P_3, left to right), lateral view; C, terminal comb on P_1, oblique lateral view. Scale bars 5 mm for A and B, and 1 mm for C.

posture at nighttime.

Coloration in life. Rays banded with red and white, sometimes yellow in distal part.

Distribution. Sagami Bay, Japan (Kogo and Fujita 2014) to southern Queensland, Australia, and to Fiji (Rowe *et al.* 1986). Guam (Kirkendale and Messing 2003).

Remarks. This species is recognizable by its small size, restricted distribution of the terminal combs to only P_1, and the combs with pointed tip.

15. ***Clarkcomanthus littoralis*** (Carpenter, 1888)
[Japanese name: Kuraaku-umishida]

Morphology. Centrodorsal flat, pentagonal, 2.9–3.9 mm across, at almost same level of radials; polar area 0.6–0.8 times of centrodorsal diameter. Cirri weak, 0–XI, most of which rudimental, up to 15 segments, 11.5 mm long, arranged in single row with gap; c5–6 longest, L/W 1.4; distal segments with aboral process. Radials exposed, length less than 15% of centrodorsal diameter. IBr series composed of 2 ossicles, IIBr of 2 or 4(3+4), and III–IVBr of mostly 4(3+4), rarely 2. Arms up to 51, 160 mm long; anterior arms sometimes distinct, 1.7 times longer than posterior; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4. Comparative pinnule length $P_D > P_1 >> P_2 = P_3 = P_4 = P_5$; P_D to P_1 enlarged, with segments broader than long; segments of pinnules beyond P_3 with distal-oral edge projected like spine. Terminal combs present as far as P_{1-2}, consisting of 6–9 segments; tooth usually paired, rarely single; primary tooth confluent with lateral margin, straight, widely spaced from adjacent one; secondary tooth much smaller; terminal and proximal segments diminished discrete tooth. Disk four to five times as wide as centrodorsal.

Posture. Nocturnal. Hiding under overhangs or between foliose corals. Some arms extended in multidirectional posture at nighttime.

Coloration in life. Rays grey to black, with narrow stripes of white articulation, often distally whitish.

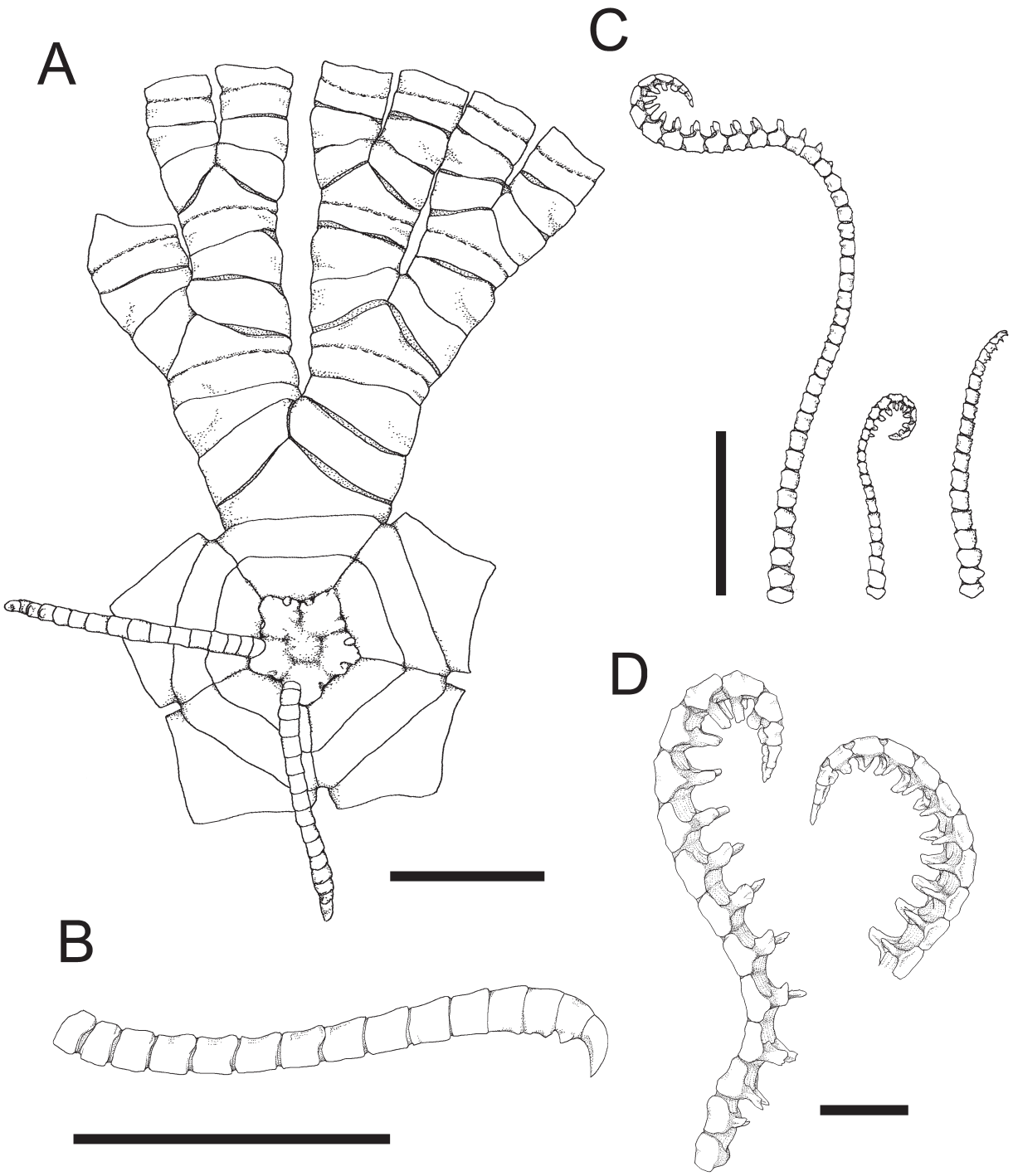

Fig. 3. *Clarkcomanthus mirus* (Rowe, Hoggett, Birtles, and Vail, 1986), BIK-EC-CR0036. A, centrodorsal and proximal ray, aboral view; B, cirrus, lateral view; C, proximal pinnules (P_1 to P_3, left to right), lateral view; D, terminal comb on P_1, lateral views from side away from arm (left) and from side close to arm (right). Scale bars 5 mm for A–C, and 1 mm for D.

Distribution. Ashizuri-Uwakai Sea, Japan (present study) to Great Barrier Reef. Tonga to West Australia (Rowe *et al.* 1986). North Mariana Islands (Kirkendale and Messing 2003).

Remarks. The examined specimens were identified by the oral pinnules with broad segments, and the terminal combs restricted to P_3 and composed of paired small teeth not fused at distal-most segments. Compared to the specimen from the Ryukyu Islands, the examined specimens were generally smooth: projections on distal end of brachials and on distal-oral edge of pinnule segments were less developed. Rowe *et al.* (1986) recognized three groups in the specimens from Australia on the basis of coloration. Specimens from the Ryukyu Islands with green to yellow coloration agreed with the group including the holotype, while the group to which the examined specimens refer to was unclear.

16. ***Clarkcomanthus mirabilis***
(Rowe, Hoggett, Birtles, and Vail, 1986)
[New Japanese name: Miyabi-kushi-umishida]
(Figs 2, 4A)

Comanthus mirabilis Rowe, Hoggett, Birtles, and Vail, 1986: 226, fig. 6B, C; Rowe and Gates 1995: 144; Messing 1998: table 1.

Clarkcomanthus mirabilis: Summers *et al.* 2014: 336.

Morphology. Centrodorsal small, rounded pentagonal, 2.3–2.9 mm across, smooth, concave at center, at same level of radials or slightly depressed; neither cirri nor cirrus scars; subradial clefts distinct (Fig. 2A).

Radials thick, length 0.8 times of centrodorsal diameter; small pit present at each distal corner (Fig. 2A). Division series broad, smooth, aborally rounded; IBr series composed of 2 ossicles; IIBr of mainly 4(3+4), rarely 2; III–VBr of 2 or 4(3+4); first ossicles in each division series fused with each other; second ossicles perfectly separated; series of four ossicles with pinnule arising on second ossicles; rays well separated (Fig. 2A).

Arms 64, 130 mm long, arrayed in single plane. Brachials shorter than broad; distal ends smooth at proximal arm, everted on middle to distal arm. First arm syzygy at br_{3+4}; second between br_{11+12} and br_{21+22}; distal intersyzygial intervals 4.

Comparative pinnule length $P_D > P_1 >> P_2 = P_3 < P_4 < P_5$. P_D and P_1 enlarged; segments of pinnules beyond P_1 with distal-oral edge projected like spine (Fig. 2B). Terminal combs always present to P_2, and distributed as far as P_{7-8} at intervals; combs consisting of 14–18 segments in P_D and P_1, 5–11 in subsequent pinnules; teeth paired; primary tooth confluent with lateral margin of pinnule segments, straight, with base apart from adjacent one; secondary tooth usually smaller than, but sometimes almost same size as, primary; proximal segment with transverse bridge formed by fusion of paired teeth, or with small teeth; terminal segment with discrete tooth (Fig. 2C). In BIK-EC-CR0034, P_1 composed of 38–51 segments, 18.0–21.5 mm long; P_2 20–23, 9.5–10.5 mm; P_3 13–23, 8.5–11.5 mm; P_4 13–28, 10.5–14.0 mm; P_5 15–29, 11.5–14.0 mm; middle pinnules 17–22, 12.5–16 mm; distal pinnules 19–21, 13.5–15.0 mm.

Disk large, hemispherical, six to eight times as wide as centrodorsal, paved with hemispherical calcareous nodules; mouth marginal; anal cone central.

Posture. Exposed on rocky pinnacles, or hiding under overhangs, forming multilayered arrays.

Coloration in life. Rays white but densely blotched with orange, reddish purple and brown (Fig. 4A).

Distribution. Ashizuri-Uwakai Sea, Okinawa Island (this study), northern/central Sulu Sea, Papua New Guinea (Messing 1998), Indonesia, Great Barrier Reef (type locality) and New Caledonia (Rowe *et al* 1986). This report extends the range of this species northward. Bathymetrical range 3–30 m.

Remarks. New to Japanese waters. The examined specimens were identified by reduced centrodorsal without cirri, the terminal combs with distinct secondary teeth, and the disk paved with calcareous nodules. The general morphology of the specimens agreed well with the original description from Great Barrier Reef. As mentioned by Rowe *et al.* (1986), this species is morphologically similar to *Clarkcomanthus alternans* (Carpenter, 1881), which has not been recorded in the Ashizuri-Uwakai Sea but has been reported from Okinawa Island (Kogo 1998). They can be distinguished by the feature of IIIBr series: characteristically twisted in *C. alternans*, but not in *C. mirabilis*. *Clarkcomanthus mirabilis* also resembles *C. littoralis*, in having reduced centrodorsal, more than 40 arms, and the pinnules with distal-oral projections. They differ in the cirri and terminal combs: *C. mirabilis* lacks cirri and has the combs as far as P_7, whereas *C. littorals* has few cirri or scars, and the combs are present to only P_2. Additionally, the comb teeth tend to be more developed in *C. mirabilis*, although this is sometimes unclear. When living, they can be easily distinguished by their behavior: *C. mirabilis* is diurnal, while *C. littoralis* is strictly nocturnal.

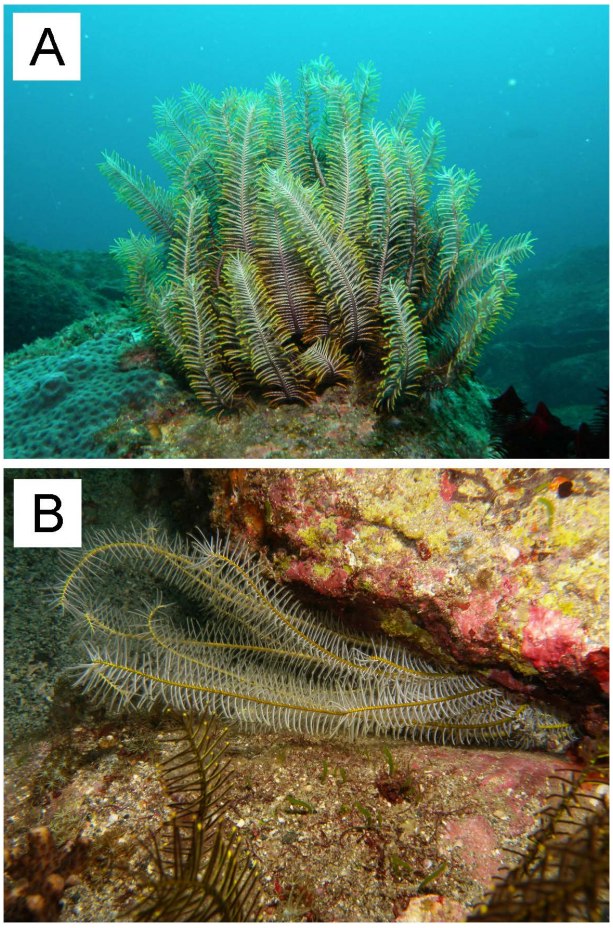

Fig. 4. Live colorations of two comatulids new to Japanese fauna. A, *Clarkcomanthus mirabilis* (Rowe, Hoggett, Birtles, and Vail, 1986), BIK-EC-CR0034. B, *Clarkcomanthus mirus* (Rowe, Hoggett, Birtles, and Vail, 1986), BIK-EC-CR0036.

17. ***Clarkcomanthus mirus***
(Rowe, Hoggett, Birtles, and Vail, 1986)
[New Japanese name: Oboro-kushi-umishida]
(Figs 3, 4B)

Oxycomanthus mirus Rowe, Hoggett, Birtles, and Vail, 1986: 255, figs 3C, 9C, D; Rowe and Gates 1995: 150; Messing 1998: table 1.
Oxycomanthus cf. *mirus*: Kirkendale and Messing 2003: 533.
Clarkcomanthus mirus: Summers *et al*. 2014: 336.

Morphology. Centrodorsal small, pentagonal, thin, slightly raised from level of radials, 2.6–3.2 mm across, divided into five radial parts by shallow cleft (Fig. 3A); polar area concave, smooth; few cirri or scars present on margin; subradial cleft distinct.

Cirri small, non-functional, up to III, 15 segments, 9.0 mm long; c6–9 longest, L/W 1.3; distal few segments with weak transverse ridge (Fig. 3B).

Radials visible, with length 0.3–0.4 times of centrodorsal diameter. Division series smooth; IBr composed of 2 ossicles; II–IIIBr of 4(3+4) ossicles, with pinnule arising on second ossicles; first ossicles in each division series fused with each other, second ossicles perfectly separated; rays well separated (Fig. 3B).

Arms 37; anterior arms up to 300 mm, about twice longer than posterior. Brachials shorter than broad; distal ends smooth at proximal arm everted on middle to distal arm. First arm syzygy at br_{3+4}; second between br_{11+12} to br_{12+13}; distal intersyzygial intervals 4, occasionally 3.

Comparative pinnule length $P_D>P_1>>P_2<P_3<P_4=P_5$. P_D and P_1 enlarged; all segments wider than long (Fig. 3C). Terminal combs present to P_1 or P_2, consisting of 12–21 segments; primary tooth straight, blade-like, not confluent with lateral margin of pinnule segments, with base apart from adjacent one; secondary tooth distinct, peg-like, smaller than, but sometimes almost same size as, primary; primary and secondary teeth fused into thin transverse bridge at proximal segment; terminal segments fused together and tapering to sharp point (Fig. 3D). In OMNH-Iv6237, pinnules on IIIBr composed of 52 segments, 27.0 mm long; P_1 of 44–49 segments, 29.0 mm; P_2 of 23–28, 8.0–9.0 mm; P_3 of 20–22, 10.0–11.0 mm; P_4 of 21–24, 12.5 mm; P_5 of 20–22, 13.0–14.5 mm; middle pinnules of 20–22, 12.0 mm; distal pinnules of 22–24, 13.5 mm.

Disk hemispherical, smooth, remarkably large, more than ten times as broad as centrodorsal, covering until IIIBr series; mouth marginal; anal cone central.

Posture. Dwelling within cracks or crevices, or between stony corals, with anterior arms in multidirectional posture.

Coloration in life. Arms greenish yellow with brachials jointed by dark syzygy; pinnules white, sometimes with blue tip; disk yellowish white (Fig. 4B). Examined specimens with pink swellings of gonads on middle pinnules.

Distribution. Ashizuri-Uwakai Sea (this study), northern/central Sulu Sea (Messing 1998), Great Barrier Reef (type locality), New Caledonia (Rowe *et al*. 1986), and Guam (Kirkendale and Messing 2003). This report extends the range far north. Bathymetrical range 3–20 m.

Remarks. New to Japanese waters. This species is identified by the presence of characteristic peg-like secondary teeth on the terminal combs. The large swollen disk is also unique, although it tends to be shrunken after fixation. The general morphologies of the examined specimens were identical to the original description, however, the anterior and posterior arms were indistinct unlike the type specimens. In some comatulid species, especially ones inhabiting reef structures, lengths of anterior and posterior arms vary according to habitat [*e.g*., *Comanthus parvicirrus* in Messing (1994)], and this could be the case with this species.

Family **Zygometridae** A. H. Clark, 1908c

18. ***Catoptometra magnifica*** A. H. Clark, 1908d
[Japanese name: Ohkobu-umishida]

Morphology. Centrodorsal hemispherical, 5.4 mm across; polar area deeply concave, about 0.4 times of centrodorsal diameter. Cirri stout, curved inward, knobby with segments centrally constricted, XLVI, up to 21 segments, 22.0 mm long, arranged in three rows; c5–8 longest, L/W 1.4. Radials visible at distal corners. Division series slender with ossicles as long as broad; IBr composed of 2(1+2) ossicles, and II–IIIBr of 2; each ray well separated. Arms 40, 120 mm long; brachials beyond proximal quarter of arms swollen wedge shaped, L/W 1.0; first arm syzygy at br_{3+4}; distal intersyzygial intervals 6–12. Comparative pinnule length $P_1<P_2>P_3>P_4>P_5$; P_{1-3} enlarged; basal segments of proximal to middle pinnules with keel on side toward arm tip. Disk flat stellate, two times as wide as centrodorsal.

Posture. Fully exposed on rocky pinnacles, with arms in multilayered arrays.

Coloration in life. Uniformly red or orange; rays often banded with red and orange.

Distribution. Sagami Sea (Kogo and Fujita 2014) to Lesser Sunda Islands. Ogasawara Islands (A. H. Clark 1941).

Remarks. Genus *Catoptometra* A. H. Clark, 1908 is characterized by having IBr series united by syzygy and no aboral process on cirri. This species is relatively common in the Ashizuri-Uwakai Sea, and can be recognized by the arms more than 30, and all division series composed of 2 ossicles.

19. ***Catoptometra rubroflava*** (A. H. Clark, 1907)
[Japanese name: Akashima-kobu-umishida]

Morphology. Centrodorsal low hemispherical, 4.7 mm across; polar area 0.6 times of centrodorsal diameter. Cirri short but stout, XXX, up to 17 segments, 15.0 mm long, arranged in two rows; all segments wider than long; opposing spine minute. Radials invisible. IBr series composed of 2(1+2). Arms 10, 180 mm long; brachials beyond proximal quarter of arms wedge shaped, L/W 1.0; first arm syzygy at br_{3+4}; distal intersyzygial intervals 4–6. Comparative pinnule length $P_1<P_2=P_3=P_4>P_5$; P_1 shortest; basal segments of proximal to middle pinnules distally everted and finely spinose, making knobby profile of pinnules. Disk flat stellate, two times wide of centrodorsal.

Posture. Attached on underside of overhangs, forming simple arm fans.

Coloration. Uniformly red; centrodorsal slightly faded.

Distribution. Noto Peninsula, Japan (Kogo 1998) to Hong Kong (Liao and A. M. Clark 1995).

Remarks. This species is distinguished by the stout cirri with the segments wider than long. The examined specimen had only 10 arms, fewer than previous records of 11–21 arms (A. H. Clark 1941; Kogo and Fujita 2014). However, the other characters were not different from the comparative specimen from Kagoshima Bay with 13 arms.

Family **Himerometridae** A. H. Clark, 1908b

20. ***Himerometra magnipinna*** A. H. Clark, 1908d

[Japanese name: Takanoha-umishida]

Morphology. Centrodorsal hemispherical, 9.5–13.3 mm across; polar area 0.4 times of centrodorsal diameter. Cirri stout, L–LXI, up to 44 segments, 47 mm long, arranged in three, partly four rows; all segments broader than long; segments in distal quarter with aboral spine gradually developing. Radials invisible. IBr series composed of 2, IIBr of 2 or 4(3+4), III–VBr of 2 on innerside and 4(3+4) on outerside of bifurcation; division series beyond IIBr often present only in outerside of rays. Arms up to 63, 160 mm long; brachials beyond middle arms exceedingly short, W/L more than 8; first arm syzygy at br_{3+4}; distal intersyzygial intervals 3–20. Comparative pinnule length $P_D > P_1 > P_2 > P_3 = P_4 = P_5$; P_D to P_2 enlarged; all segments smooth, L/W up to 1.2. Disk flat, stellate, two times as wide as centrodorsal.

Posture. Fully exposed on rocky pinnacles, forming arcuate fan.

Coloration in life. Arms light purple; some pinnules white and others dark purple, which makes blotched pattern on rays; cirri and disk dark purple.

Distribution. Ashizuri-Uwakai Sea (Obuchi 2013) to Great Barrier Reef (Rowe and Gates 1995), and to Andaman Sea (Putchakarn and Sonchaeng 2004).

Remarks. Genus *Himerometra* A. H. Clark, 1907 is recognized by short brachials, and the proximal pinnules are short until P_3. This species can be identified by enlarged proximal pinnules with more than 30 cylindrical segments without keels (see Obuchi 2013).

Family **Mariametridae** A. H. Clark, 1909b

21. ***Lamprometra palmata*** (Müller, 1841)

[Japanese name: Higasa-umishida]

Morphology. Centrodorsal low hemispherical, 5.7–8.4 mm across; polar area flat, 0.4–0.6 times of centrodorsal diameter. Cirri L–LXXI, up to 35 segments, 28 mm long, arranged in three rows; c8–15 longest, L/W 1.2; distal half segments with low aboral process. Radials invisible. All division series, I–IVBr, composed of 2 ossicles with straight lateral expansion; Arms up to 48, 135 mm long; first arm syzygy at br_{3+4}; distal intersyzygial intervals 3–16. Comparative pinnule length $P_1 < P_2 > P_3 > P_4 = P_5$; P_{1-3} enlarged; segments smooth, L/W up to 1.4. Disk flat stellate, two to three times as wide as centrodorsal.

Posture. Nocturnal. Fully exposed on rocky pinnacles in nighttime, forming arcuate fan.

Coloration in life. Rays banded with brown, red and cream, with white and purple blotches.

Distribution. Sado Island, northern Japan (Honma and Kitami 1978) to Great Barrier Reef (Rowe and Gates 1995). Tonga to Mauritius and Red Sea (A. H. Clark 1941). Guam (Kirkendale and Messing 2003).

Remarks. Genus *Lamprometra* A. H. Clark, 1913 is characterized by enlarged but not spine-like proximal pinnules, of which P_2 is the largest. Recent taxonomic revision showed the monospecificity of this genus (Rankin and Messing 2008).

Family **Colobometridae** A. H. Clark, 1909a

22. ***Pontiometra andersoni*** (Carpenter, 1889)

[Japanese name: Tengu-umishida]

Morphology. Centrodorsal globular, 11.1 mm across; polar area flat, 0.4 times of centrodorsal diameter. Cirri remarkably elongated, LXXV, up to 76 segments, 80 mm long, arranged in three rows, distally polished; all segments broader than long; aboral spines gradually developing in distal two thirds, becoming three apexes in distal 20 segments. Radials invisible. I–VBr composed of 2 slender ossicles with L/W about 1.0, with straight lateral expansion; each ray well separated, with even Ibr_1 not laterally contacted. Arms 86, 140 mm long; first arm syzygy at br_{3+4}; distal intersyzygial intervals 16–20. Comparative pinnule length $P_1 >> P_2 = P_3 = P_4 = P_5$; P_1 on outer side of rays enlarged, but not so on inner side; segments smooth, L/W up to 1.8. Disk thick, stellate, three times as wide as centrodorsal.

Posture. Fully exposed on rocky pinnacles with body elevated by long cirri, forming parabolic fan.

Coloration in life. Rays light to dark brown with white blotches, sometimes with white stripes.

Distribution. Ashizuri-Uwakai Sea (this study) to Great Barrier Reef (Rowe and Gates 1995). New Caledonia to westward to Andaman Islands (A. H. Clark 1947).

Remarks. This species has a characteristic appearance with long cirri reaching half the length of the arm. The slender division series and enlarged P_1 are also unique. Genus *Pontiometra* A. H. Clark, 1907 is monospecific.

23. ***Basilometra boschmai*** A. H. Clark, 1936

[Japanese name: Kotengu-umishida]

Morphology. Centrodorsal globular, 5.5–6.7 mm across; polar area flat, 0.3–0.4 times of centrodorsal diameter. Cirri stout, tapering, XLII–L, up to 53 segments, 33 mm long, arranged in three rows; all segments broader than long; aboral transverse bar with two apexes, gradually developing at distal half segments. Radials exposed only at distal corners. Division series slender; IBr series composed of 2 ossicles, IIBr of 4(3+4), IIIBr of 2, IV–VBr with 2 or 4(3+4); each ossicle L/W about 1.0, with tubercular lateral expansions; synarthrial tubercles on articulation; each ray well separated.

Arms up to 87, 155 mm long; first arm syzygy at br_{3+4}; distal intersyzygial intervals 3–20. Comparative pinnule length $P_D<P_1=P_2=P_3>P_4>P_5$; P_{1-3} enlarged, stiffened, spine-like, with segments spinose on distal ends; P_a and often P_b absent; P_2 and sometimes P_1 absent on arms arising inner side of bifurcation. Disk flat, stellate, two times as wide as centrodorsal, paved with small calcareous plates.

Posture. Fully exposed on gorgonian perches, forming multi-layered radial fan.

Coloration in life. Uniformly dark brown; arms sometimes striped with yellow; disk sometimes white.

Distribution. Kii Peninsula (Kohtsuka and Kato 2012) to Western Australia (Rowe and Gates 1995), and to Gulf of Thailand (Lane *et al*. 2000).

Remarks. This species is recognizable by the numerous arms, IIBr composed of four ossicles, and stiffened pinnules. Genus *Basilometra* A. H. Clark, 1936 is monospecific.

24. ***Cenometra bella*** (Hartlaub, 1890)
[Japanese name: Kosaju-umishida]

Morphology. Centrodorsal hemispherical, 4.7 mm across; polar area 0.4 times of centrodorsal diameter. Cirri robust, XXVIII, up to 36 segments, 24 mm long, arranged in two rows; segments L/W up to 0.8; segments on distal half with two aboral process fused into transverse bar in distal 10 segments. Radials narrowly visible. IBr to IIIBr series composed of 2 ossicles, with flange-like lateral process. Arms 26, up to 120 mm long; first arm syzygy at br_{3+4}; distal intersyzygial intervals 6–9. Comparative pinnule length $P_1<P_2>P_3>P_4=P_5$; P_2 remarkably stout, horn-like, recurved, with segments finely spinose on distal end. Disk lost.

Posture. Fully exposed on rocky pinnacles or gorgonian perches, forming arcuate to radial fan.

Coloration in life. Arms light brown; pinnules yellow but dark at proximal part; cirri tan.

Distribution. Ashizuri-Uwakai Sea (this report) to Fiji, and to Myanmar (A. H. Clark 1947). Ogasawara Islands (Gislén 1922) and Guam (Kirkendale and Messing 2003).

Remarks. This species can be identified by the horn-like P_2 that is remarkably stouter than other pinnules.

25. ***Alisometra owstoni*** (A. H. Clark, 1912)
[Japanese name: Toge-shimofuri-umishida]

Morphology. Centrodorsal hemispherical, 4.0–5.2 mm across; polar area flat, 0.7–0.8 times of centrodorsal diameter. Cirri robust, XXXVIII–XLII, up to 22 segments, 17 mm long, arranged in two, partly three rows; segments L/W up to 1.0, with aboral transverse bar near proximal end; distal segments sometimes with additional transverse bar near distal end. Radials concealed. IBr and IIBr series composed of 2 ossicles, with low synarthrial tubercle. Arms 20, up to 115 mm long; first arm syzygy at br_{3+4}; distal intersyzygial intervals 3–6. Comparative pinnule length $P_1=P_2=P_3>P_4=P_5$; P_{1-3} enlarged, stiffened, spine-like, with segments finely spinose on distal end. Disk flat, stellate, two times wide of centrodorsal.

Posture. Fully exposed on gorgonian perches, forming radial fan.

Coloration in life. Rays banded with dark brown and cream, with white and orange spots.

Distribution. Endemic to Japan: Sagami Bay (Kogo and Fujita 2014) to the Ryukyu Islands (Kogo and Fujita 2005).

Remarks. Genus *Alisometra* A. H. Clark, 1947 is characterized by small body sizes and spine-like proximal pinnules. This genus includes two species, which are bounded by morphologies related to body sizes, such as arm length and the number of cirri. The examined specimens fell into the larger form, *A. owstoni*, although the number and length of arms were larger than previous specimens with 10–12 arms of about 50 mm long (A. H. Clark 1912; Kogo and Fujita 2014).

26. ***Iconometra japonica*** (Hartlaub, 1890)
[Japanese name: Shimofuri-umishida]

Morphology. Centrodorsal low hemispherical to thick discoidal, 3.4–3.6 mm across; polar area flat, more than 0.9 times of centrodorsal diameter. Cirri stout, XVII–XXVI, up to 28 segments, 14.5 mm long, arranged in single row; all segments short, L/W up to 0.6; aboral transverse bar present near distal end in proximal segments, and located at median in distal segments. Radials invisible. IBr series composed of 2 ossicles, with synarthrial tubercles. Arms 10, up to 95 mm long; brachials shorter than broad; first arm syzygy at br_{3+4}; distal intersyzygial intervals 5–9. Comparative pinnule length $P_1<P_2>P_3>P_4=P_5$; P_2 longest, but sometimes same length as P_1 and P_3, with smooth segments; pinnules beyond P_3 with segments spinose on distal ends. Disk flat, stellate, two to three times wide of centrodorsal.

Posture. Fully exposed on gorgonian perches, forming radial fan.

Coloration in life. Various. Rays black, red-purple, or yellow, with white spots, sometimes banded with brown and cream.

Distribution. Endemic to Japan: Noto Peninsula (Kohtsuka and Kogo 2001) to Ashizuri-Uwakai Sea (this study).

Remarks. Genus *Iconometra* A. H. Clark, 1929 includes small ten-armed species with enlarged but not spine-like proximal pinnules, of which P_2 is the longest. This species is distinguishable by its aboral transverse bars on the cirrus segments located at distal ends in early segments.

Family **Tropiometridae** A. H. Clark, 1908b

27. ***Tropiometra afra macrodiscus*** (Hara, 1895)
[Japanese name: Oh-umishida]

Morphology. Centrodorsal thick discoidal, 7.3 mm across; polar area flat, 0.7 times of centrodorsal diameter. Cirri stout, XXXIV, up to 37 segments, 37 mm long, arranged in two, partly three rows; segments broader than long, without aboral ornamentation excepting opposing spine. Radials exposed at distal corners. IBr series composed of 2 ossicles. Arms 10, 210 mm long, remarkably massive,

5 mm at first syzygy; brachial short, with distal ends almost parallel; first arm syzygy at br_{3+4}; distal intersyzygial interval 14–23. Comparative pinnule length $P_1<P_2<P_3>P_4=P_5$; proximal pinnules with ridge on basal segments; distal pinnules with aboral ridge, making profiles triangular. Disk stellate, three times as wide as centrodorsal.

Posture. Hiding on underside of overhangs, but sometimes fully exposed, forming simple arm fans.

Coloration in life. Uniformly dark brown or dark orange.

Distribution. Sadogashima Island, Japan (Honma and Kitami 1978) to eastern Malay Peninsula (Lane *et al.* 2000). Ogasawara Islands (A. H. Clark 1947).

Remarks. This large species is easily recognized by its massive 10 arms. Within the species, subspecies *macrodiscus* is regarded as a northern form, however there is no clear morphological difference to distinguish it from the nomenotypical subspecies, *Tropiometra afra afra* (Hartlaub, 1890) which is distributed southward from the Philippines.

Family **Antedonidae** Norman, 1865

28. ***Dorometra parvicirra*** (Carpenter, 1888)
[Japanese name: Yukari-umishida]

Morphology. Centrodorsal hemispherical, 3.6 mm across; polar area 0.3–0.4 times of centrodorsal diameter. Cirri delicate, LII, up to 16 segments, 14 mm long, arranged in three rows; distal end of segments flared, overlapping base of following; c5–8 longest, L/W 1.8; no aboral ornamentation excepting opposing spine. Radials invisible. IBr series composed of 2 ossicles between which slightly constricted; each ray separated well. Arms 10, up to 105 mm long; brachials slender in distal half arms; first arm syzygy at br_{3+4}; distal intersyzygial interval 3. Comparative pinnule length $P_1<P_2<P_3>P_4=P_5$; P_3 longest and remarkably stout. Disk hemispherical, smooth, two to three times as wide as centrodorsal.

Posture. Attached on underside of boulders with arms spread.

Coloration in life. Various. Ground color dark yellow, light red, brown or black, often with white spots; arms sometimes striped with dark articulation.

Distribution. Noto Peninsula, northern Japan (Kogo 1998) to southern Queensland, Australia and Western Australia (Rowe and Gates 1995). Ogasawara Islands (A. H. Clark and A. M. Clark 1967).

Remarks. Genus *Dorometra* A. H. Clark, 1917 includes small species with enlarged P_3, and the cirri with the segments distally flared. This species is recognizable by P_2 intermediate in size between P_1 and P_3, and its body size which is large for the genus.

29. ***Antedon serrata*** A. H. Clark, 1908a
[Japanese name: Togebane-umishida]

Morphology. Centrodorsal hemispherical, 1.8–2.0 mm across; polar area 0.4–0.6 times of centrodorsal diameter. Cirri delicate, LII, up to 14 segments, 6 mm long, arranged in two to three rows; distal end of segments flared, overlapping base of following; c5–8 longest, L/W 2.0; no aboral ornamentation excepting opposing spine. Radials invisible. IBr series composed of 2 ossicles with articulation constricted; each ray separated well. Arms 10, up to 40 mm long; brachials slender in distal half arms; first arm syzygy at br_{3+4}; distal intersyzygial interval 3. Comparative pinnule length $P_1>P_2<P_3=P_4<P_5$; P_1 enlarged, flexible; proximal to middle pinnules with segments distally flared and rugose, making profiles knotty. Disk hemispherical, three times as wide as centrodorsal, with fleshy papillae, especially on anal cone.

Posture. Attached on underside of boulders with arms spread.

Coloration in life. Widely various: BIK-EC-CR0076 with rays banded red-brown and white, and disk white with small brown spots, BIK-EC-CR0077 with rays light brown but pink at proximal part, and yellow disk, and BIK-EC-CR0078 uniformly light brown with small white spots.

Distribution. Aomori, northern Japan (Kogo 1998) to Hainan Island (Liao and A. M. Clark 1995).

Remarks. Genus *Antedon* de Fréminville, 1811 is characterized by P_3 similar to following pinnules, and P_2 intermediate between P_1 and P_3 in lengths. This species is unique in having segments of the proximal pinnules remarkably flared and spinose on the distal end.

30. ***Belonometra kogoi*** Obuchi and Omori, 2015
[Japanese name: Matsuba-umishida]

Morphology. Centrodorsal low hemispherical, 7.6–8.0 mm across; polar area 0.2–0.3 times of centrodorsal diameter. Cirri delicate, numerous, XC–CXXX, up to 22 segments, 30 mm long, much crowded; peripheral cirri longer than apical ones, about twice; distal end of segments flared, overlapping base of following; c5–10 longest, L/W 3.0; no aboral ornamentation excepting opposing spine. Radials invisible. IBr series composed of 2 ossicles; each ray separated well. Arms 10, up to 190 mm long, flexible; all brachials broader than long; first arm syzygy at br_{3+4}; distal intersyzygial interval 3. Comparative pinnule length $P_1=P_2<P_3=P_4>P_5$; pinnules, except most-proximal two, remarkably slender, with longest segments L/W more than 3.0. Disk globular, smooth, three to four times as wide as centrodorsal.

Posture. Hiding on underside of overhangs, but sometimes fully exposed, with arms in multidirectional posture.

Coloration in life. Uniformly dark yellow to black, faded in distal arms and pinnules.

Distribution. Ashizuri-Uwakai Sea and Okinawa Island, at depths deeper than 20 m (Obuchi and Omori 2015).

Remarks. The monospecific genus *Belonometra* was recently established on the basis of the specimens from the Ashizuri-Uwakai Sea (Obuchi and Omori 2015). It is peculiar in having a large size for the family, numerous cirri and slender pinnules.

Morphological Key to Shallow-water Comatulids of the Ashizuri-Uwakai Sea

1. Terminal combs present on pinnules, at least on proximal ones 2
– No terminal combs on pinnules 18
2. First arm syzygy at br_{1+2} 3
– First arm syzygy at br_{3+4} 4
3. All division series composed of 2 ossicles; comb teeth confluent with margin of segments closest to arm . . . . . *Comatella stelligera*
– Division series composed of 2 and 4(3+4) ossicles; comb teeth confluent with margin of segments away from arm . . . . . *Phanogenia distincta*
4. Small interradial plates present between basal rays; arms more than 80, often exceeding 100 . . *Comaster nobilis*
– No interradial plates; arms less than 60 5
5. Terminal combs consisting of large triangular teeth contacted to neighbor one at base; proximal segment with large saucer-like transverse tooth; terminal segment with discrete tooth 6
– Terminal combs consisting of teeth separated from neighbor one; proximal segment with low tooth, or transverse bridge formed by fusion of paired teeth; teeth diminished or fused into sharp tip at terminal segments. 10
6. Radials fully concealed by centrodorsal with row of well-developed cirri . . . . . *Comanthus wahlbergii*
– Radials exposed, at least at distal margin; centrodorsal small with few cirri 7
7. Combed pinnules restricted to one third of arms 8
– Combed pinnules present on distal arms 9
8. No cirri in mature specimens; lengths of radials almost half of centrodorsal diameter . . . . *Comanthus suavia*
– Few cirri present; radial narrowly exposed . . . *Comanthus scintillus*
9. Middle segments of distal pinnules with fringing spines on distal end. . . . . *Comanthus gisleni*
– Middle segments of distal pinnules smooth . . . . . *Comanthus parvicirrus*
10. Cirri stout, more than XV; radials perfectly concealed by large centrodorsal; pinnule combs always with unpaired tooth 11
– Cirri weak, less than XV or totally absent, arranged on small centrodorsal with gap; radials exposed at least partly; pinnule combs with paired or unpaired tooth 13
11. IIIBr series composed mostly of 2, partly 4(3+4); arm length often exceeding 200 mm . . . . . *Anneissia intermedia*
– IIIBr series of 4(3+4); arm length less than 180 mm . . . 12
12. More than 30 arms; centrodorsal hemispherical, with two to three rows of cirri; pinnules with smooth keel on basal segments . . . . . *Anneissia japonica*
– Arms not more than 30; centrodorsal discoidal, with one, partly two rows of cirri; pinnules with everted and spiny basal segments. . . . . *Anneissia solaster*
13. Terminal combs present as far as P_8; proximal segment of combs with paired discrete tooth or transverse bridge formed by fusion of them . . . . . *Clarkcomanthus mirabilis*
– Terminal combs restricted to some proximal pinnules; proximal segment of combs with tooth diminished in size 14
14. Terminal combs with sharp tip formed by fusion of some segments and teeth 15
– Terminal segments of pinnule comb not fused, with small discrete teeth 17
15. Pinnule combs with peg-like secondary tooth; disk remarkably large, more than ten times as large as centrodorsal . . . . . *Clarkcomanthus mirus*
– Pinnule combs unpaired; disk less than eight times as wide as centrodorsal 16
16. Medium sized with arm length exceeding 100 mm; comb present as far as P_4; dark mid-aboral line on arms. . . . . *Clarkcomanthus comanthipinna*
– Small sized with arm length less than 100 mm; comb present to P_1, rarely to P_2; arm banded with red and white . . . . . *Clarkcomanthus exilis*
17. Segments of proximal pinnules broader than long; distal pinnules much shorter than P_1; no mid-aboral line on arms. . . . . *Clarkcomanthus littoralis*
– Middle segments of pinnules on division series longer than broad; distal pinnules almost as long as P_1; pale mid-aboral line on arms . . . . . *Clarkcomanthus albinotus*
18. IBr series united by syzygy 19
– IBr series not united by syzygy 20
19. More than 20 arms . . . . . *Catoptometra magnifica*
– Less than 19 arms. . . . . *Catoptometra rubroflava*
20. At least some cirrus segments with a pair of tubercles or single transverse ridge on aboral side. 21
– Cirrus segments with single spine or tubercle, or without aboral ornamentation 25
21. Cirri long, exceeding one third of arm length, with more than 60 segments. . . . . *Pontiometra andersoni*
– Cirri short, less than one fifth of arm length, with less than 50 segments. 22
22. P_2 much stout, recurved, horn-like . . . . *Cenometra bella*
– P_2 not so different from other proximal pinnules 23
23. More than 30, usually 50–80, arms; medium to large sized with arm length exceeding 150 mm . . . . . *Basilometra boschmai*
– Less than 30 arms; small sized with arm length usually less than 120 mm 24
24. P_{1-3} stiff, spine-like; up to 20 arms . . . *Alisometra owstoni*
– P_{1-3} not stiffened; usually 10 arms. . . *Iconometra japonica*
25. More than 10 arms 26
– Only 10 arms 27
26. Division series beyond IIBr composed of 4(3+4); brachials extremely short, W/L more than six, with articulation almost parallel *Himerometra magnipinna*
– All division series of composed 2 ossicles; brachials not so short . . . . . *Lamprometra palmata*
27. Pinnules with longitudinal ridge on aboral side, trian-

gular in cross section
..... *Tropiometra afra macrodiscus*
– Pinnules without longitudinal ridge, cylindrical in cross section..... 28
28. Pinnules much slender; large sized with arm length exceeding 150 mm..... *Belonometra kogoi*
– Pinnules not so long; small sized with arm length less than 100 mm 29
29. Proximal pinnules conspicuously knobbed due to segments distally everted; P_1 longer than P_3
..... *Antedon serrata*
– Proximal pinnules smooth; P_3 enlarged, longer than P_1
..... *Dorometra parvicirra*

Discussion

The present study revealed that 30 comatulid species of seven families are distributed in the shallow waters of the Ashizuri-Uwakai Sea (Table 1), adding 26 new records to earlier reports from this area (Kogo 1998; Kogo and Fujita 2005, 2014). Compared with adjacent areas at same depth range (<50 m), the species richness of the Ashizuri-Uwakai Sea exceeds that of Sagami Bay with 20 species (Kogo and Fujita 2014), and is less than the Ryukyu Islands with 39 species [compiled data from the present and previous studies (Kogo and Fujita 2005; Obuchi *et al*. 2009; Obuchi 2013, 2014; Obuchi and Omori 2015; Obuchi and Fujita 2017)]. The shallow-water comatulid diversity is the highest in the Indo-Malayan region, which supports about 100 nominal species (Messing 1997, 1998). However, at smaller scales or local areas, the number of species varies within the region: it is highest in the Jolo Archipelago, Philippines, with more than 50 species and lower in the Pacific Islands with less than 20 species (Messing 1998; Kirkendale and Messing 2003). Regarding species richness, the Ashizuri-Uwakai Sea is comparable to the marginal areas of the Indo-Malayan region: close to southern Vietnam with 31 species (Mekhova and Britayev 2012; updated according to recent taxonomic criteria), and Singapore with 39 species (Messing and Tai 2016).

In the shallow waters of the Ashizuri-Uwakai Sea, the family Comatulidae is dominant and comprises 57% of the species listed here, followed by Colobometridae with 17% (Table 1). In shallow waters of the Indo-western Pacific, Comatulidae is the most common family, accounting for more than half of species in each local area [see comparative data in Kogo and Fujita (2005: 320)]. The most species-rich families after Comatulidae are the Himerometridae, Mariametridae, or Colobometridae, although numbers vary among local areas. The family Mariametridae has the second dominant family in the central East Indian Archipelago (Messing 1998), continental coasts of the South China Sea (Mekhova and Britayev 2012), the Pacific Islands (Zmarzly 1985; Messing 2007) and southern Japan (Kogo and Fujita 2005, 2014). In the Ashizuri-Uwakai Sea, however, only a single species of Mariametridae was found, despite intensive sampling for more than three years. The present research could not provide a reason for the general lack of Mariametridae in the study areas. Nevertheless, it is possible that two mariametrid species, *Liparometra grandis* (A. H. Clark, 1908) and *Mariametra subcarinata* (A. H. Clark, 1908), are distributed in the Ashizuri-Uwakai Sea, as they have been recorded in shallow waters of neighbor areas, Kyushu and Sagami Bay, west and northeast of the Ashizuri-Uwakai Sea, respectively (Kogo and Fujita 2005, 2014).

The present result shows a dominance of tropical species in the shallow waters of the Ashizuri-Uwakai Sea. Among the species listed here, 75% are tropical species with their distributional range extending southward to at least the Philippines, and the remaining 25% are temperate species endemic to Japan and the East China Sea (Table 1; excluding newly described species, *Comanthus scintillus* and *Belonometra kogoi*, due to a paucity of information). No cold-water species distributed from northward Japan were found. These results strongly suggest the influence of the Kuroshio Current that flows along the Pacific coast of southern Japan. Kogo and Fujita (2005) recognized a faunal boundary of crinoids between Kyushu and the Ryukyu Islands. As to the shallow-water comatulid fauna, the Ashizuri-Uwakai Sea is more similar to the Ryukyu Islands compared to the neighboring Kyushu area, sharing 70% and 43% of species, respectively (Kogo and Fujita 2005). The Kuroshio current can promote the linkage of marine biota between tropical waters and the Pacific coast of southern Japan, as seen here with links between the Ryukyu Islands and the Ashizuri-Uwakai Sea. At the same time, there could be some kind of distributional boundary preventing the spread of pelagic larvae, which would cause the faunal differences between Ashizuri-Uwakai Sea and Kyushu area.

Although the field survey for this study continued for more than three years, some species commonly found in shallow waters of southern Japan were not recorded. *Comanthus imbricatus* (A. H. Clark, 1908) (Comatulidae) and *Cyllometra manca* (Carpenter, 1888) (Colobometridae), in addition to the two mariametrid species mentioned above, are highly likely to be distributed in the Ashizuri-Uwakai Sea (see Kogo 1998; Kogo and Fujita 2005, 2014). Additionally, in this research, some forms of Comatulidae that could not be assigned to any given species were discovered (see remarks under *Comanthus parvicirrus* and *C. suavia*). They are likely to be undescribed, and need further detailed investigation. Further efforts in sampling and taxonomic study could possibly add at least five species to the present species list.

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Appendix

Specimens collected in the Ashizuri-Uwakai Sea. Specimens without collector's name are collected by the author. Comparative materials are collected in the area other than the Ashizuri-Uwakai Sea. The body size of the specimen is indicated by R, the length from the center of the centrodorsal to the arm tip, measured to the nearest 5 mm (longest, or longest–shortest).

Comatella stelligera. BIK-EC-CR0005, R 210 mm, Komame, 4.1 m depth, 20 September 2013.

Phanogenia distincta. BIK-EC-CR0006, R 200 mm, Tsutomezaki, 34.0 m depth, 29 September 2014; BIK-EC-CR0007, R 135 mm, same data as BIK-EC-CR0006.

Comaster nobilis. BIK-EC-CR0008, R 160 mm, Nishidomari, 5.7 m depth, 8 June 2011; BIK-EC-CR0009, R 135 mm, Nishidomari, 3.0 m depth, 31 January 2015.

Comanthus parvicirrus. BIK-EC-CR0080, R 145–70 mm, Nishidomari, 5.0 m depth, 8 June 2011; BIK-EC-CR0081, R 160–75 mm, Nishidomari, 3.0 m depth, 21 July 2012; BIK-EC-CR0082, R 195–95 mm, Nishidomari, 5.0 m depth, 3 April 2013; BIK-EC-CR0083, R 160–80 mm, Nishidomari, 7.0 m depth, 26 September 2014; BIK-EC-CR0084, R 185–85 mm, same data as BIK-EC-CR0083 except depth, 7.8 m.

Comanthus gisleni. BIK-EC-CR0099, R 145–65 mm, Nishidomari, 5.7 m depth, 8 June 2011; BIK-EC-CR0100, R 140–70 mm, Nishidomari, 7.0 m depth, night, 16 May 2014; BIK-EC-CR0101, R 140–75 mm, Nishidomari, 5.0 m depth, night, 18 January 2015; BIK-EC-CR0102, R 155–80 mm, Nishidomari, 3.0 m depth, night, 29 January 2015; BIK-EC-CR0103, R 165–75 mm, same data as BIK-EC-0102.

Comanthus scintillus. BIK-EC-CR0089, BIK-EC-CR0091–0093, BIK-EC-CR0095, OMNH-Iv6230–6235, detailed data shown in Obuchi and Fujita (2017).

Comanthus suavia. BIK-EC-CR0096, R 175–95 mm, Nishidomari, 4.6 m depth, 4 May 2013; BIK-EC-CR0097, R 225–95 mm, Komame, 9.2 m depth, 20 September 2013; BIK-EC-CR0098, R 65–35 mm (juvenile), Nishidomari, 5.9 m depth, night, 20 June 2014.

Comanthus wahlbergii. BIK-EC-CR0010, R unknown, Nishidomari, 2.5 m depth, 10 June 2011; BIK-EC-CR0011, R 105–65 mm, Nishidomari, 7.6 m depth, 1 May 2014; BIK-EC-CR0012, R 115–80 mm, same data as BIK-EC-CR0011; BIK-EC-CR0013, R 125–65 mm, Nishidomari, 5.6 m depth, night, 23 May 2014; BIK-EC-CR0014, R 125–65 mm, Nishidomari, 2.5 m depth, night, 7 June 2014; BIK-EC-CR0015, R 110–65 mm, Nishidomari, 3.0 m depth, night, 18 January 2015.

Anneissia intermedia. BIK-EC-CR0026, R 255 mm, Tachibanaura, 25.1 m depth, 18 June 2014; BIK-EC-CR0027, R 205 mm, Tachibanaura, 12.2 m depth, 12 August 2014.

Anneissia japonica. BIK-EC-CR0016, R 150 mm, Amaji, 12.3 m depth, 29 September 2014; BIK-EC-CR0017, R 145 mm, Tatsukushi, 7.2 m depth, 2 October 2014.

Anneissia solaster. BIK-EC-CR0018, R 150 mm, off Nishidomari, 16.3 m depth, 1 November 2013; BIK-EC-CR0019, R 120 mm, same data as BIK-EC-CR0018 except depth, 15.0 m depth; BIK-EC-CR0020, R 135 mm, Nishidomari, 4.3 m depth, night, 1 June 2014; BIK-EC-CR0021, R 95 mm, Nishidomari, 3.0 m depth, night, 7 June 2014; BIK-EC-CR0022, R 120 mm, Nishidomari, 6.3 m depth, night, 28 July 2014; BIK-EC-CR0023, R 100 mm, Nishidomari, 5.4 m depth, night, 14 August 2014; BIK-EC-CR0024, R 115 mm, Nishidomari, 3.0 m depth, night, 18 January 2015; BIK-EC-CR0025, R 95 mm, Nishidomari, 5.0 m depth, night, 29 January 2015.

Clarkcomanthus albinotus. BIK-EC-CR0051, R 180–100 mm, Nishidomari, 5.7 m depth, 8 June 2011; BIK-EC-CR0052, R 115–75 mm, Nishidomari, 2.3 m depth, 17 March 2013; BIK-EC-CR0053, R 120–80 mm, Nishidomari, 4.3 m depth, 25 March 2013.

Clarkcomanthus comanthipinna. BIK-EC-CR0037, R 180–105 mm, Nishidomari, 4.5 m depth, 8 June 2011; BIK-EC-CR0038, R 170–90 mm, Nishidomari, 4.3 m depth, 21 March 2013; BIK-EC-CR0039, R 135–75 mm, Nishidomari, 4.9 m depth, 9 April 2014; BIK-EC-CR0040, R 175–85 mm, same data as BIK-EC-CR0039 except depth, 5.6 m; BIK-EC-CR0041, R 220–115 mm, Nishidomari, 1.5 m depth, night, 23 May 2014; BIK-EC-CR0042, R 170–90 mm, Nishidomari, 5.0 m depth, night, 18 January 2015; BIK-EC-CR0043, R 140–85 mm, Nishidomari, 5.0 m depth, night, 18 January 2015; BIK-EC-CR0044, R 150–90 mm, Nishidomari, 3.0 m depth, 29 January 2015.

Clarkcomanthus exilis. BIK-EC-CR0045, R unknown, Nishidomari, 4.2 m depth, 8 June 2011; BIK-EC-CR0046, R 85 mm, same data as BIK-EC-CR0045 except depth, 4.0 m; BIK-EC-CR0047, R 95–65 mm, Nishidomari, 4.4 m depth, night, 17 February 2017; BIK-EC-CR0048, R 80–45 mm, Nishidomari, 3.6 m depth, night, 28 March 2013; BIK-EC-CR0049, R 90 mm, Nishidomari, 3.0 m depth, night, 18 January 2015; BIK-EC-CR0050, R 95 mm, same data as BIK-EC-CR-0049.

Clarkcomanthus littoralis. BIK-EC-CR0028, R 135 mm, Nishidomari, 5.0 m depth, 8 June 2011; BIK-EC-CR0029, R unknown, Nishidomari, approximately 5 m depth, night, 26 July 2012; BIK-EC-CR0030, R 170 mm, Nishidomari, 5.0 m depth, night, 2 March 2013; BIK-EC-CR0031, R 80 mm, Nishidomari, 7.3 m depth, night, 7 August 2013; BIK-EC-CR0032, R 115 mm, Nishidomari, 3.0 m depth, night, 29 January 2015; BIK-EC-CR0033, R 130 mm, Nishidomari, 3.0 m depth, 31 January 2015; [comparative material] BIK-EC-CR107, R 115 mm, Miyagi, Chatan, Okinawa Island, Ryukyu Islands, Japan, 8.4 m depth, 11 March 2014.

Clarkcomanthus mirabilis. BIK-EC-CR0034, R 150 mm, Torinokubi, Okinoshima Island, 14.6 m depth, 6 November 2013; [comparative material] OMNH-Iv6236, R 135 mm, Horseshoe Cliff, Onna, Okinawa Island, Ryukyu Islands, Japan, approximately 20 m depth, 12 April 2013.

Clarkcomanthus mirus. BIK-EC-CR0036, R 310–155 mm, Yokoshima Island, 13.6 m depth, 8 November 2013; OMNH-Iv6237, R 245–125 mm, same data as BIK-EC-CR0036 except depth, 14.6 m depth.

Catoptometra magnifica. BIK-EC-CR0054, R 130 mm, Tachibanaura, 18.9 m depth, 18 June 2014.

Catoptometra rubroflova. BIK-EC-CR0055, R 185 mm, Akasaki-2, Okinoshima Island, 26.7 m depth, 5 June 2014; [comparative material] BIK-EC-CR0108, R unknown, Northeast of Okogashima Island, Kagoshima Bay, Kyushu Island, Japan, 30.4 m depth, 8 June 2010.

Himerometra magnipinna. BIK-EC-CR0002 [same as BIK-EC-501 in Obuchi (2013)], OMNH-Iv5402 and OMNH-Iv5403, detail data shown in Obuchi (2013: 19); BIK-EC-CR0056, R 175 mm, Niguro, Okinoshima Island, 17.3 m depth, 30 July 2014; BIK-EC-CR0105, R 110 mm, Himeshima Island, 16.0 m depth, 14 July 2016.

Lamprometra palmata. BIK-EC-CR0057, R 145 mm, Nishidomari, 2.0 m depth, 8 June 2011; BIK-EC-CR0058, R 140 mm, Tatsukusi, 6.0 m depth, 23 November 2013; BIK-EC-CR0059, R 105 mm, Nishidomari, 1.1 m depth, night, 23 May 2014.

Pontiometra andersoni. BIK-EC-CR0060, R 165 mm, Tachibanaura, 15.0 m depth, 12 June 2011.

Basilometra boschmai. BIK-EC-CR0061, R 90 mm, Issai,

15.0 m depth, 11 June 2011; BIK-EC-CR0062, R 170 mm, Tachibanaura, 13.0 m depth, 2 October 2013; BIK-EC-CR0063, R 175 mm, Akasaki-2, Okinoshima Island, 21.4 m depth, 27 September 2014.

Cenometra bella. BIK-EC-CR0104, R 130 mm, Himeshima Island, 16.0 m depth, 14 July 2016.

Alisometra owstoni. BIK-EC-CR0064, R 120 mm, Akasaki-2, Okinoshima Island, 27.6 m depth, 5 June 2014; BIK-EC-CR0065, R 60 mm, Torinokubi, Okinoshima Island, 18.6 m depth, 25 October 2014.

Iconometra japonica. BIK-EC-CR0066, R 105 mm, Tatsukushi, 15.7 m depth, 2 December 2013; BIK-EC-CR0067, R 80 mm, same data as BIK-EC-CR0066; BIK-EC-CR0068, R 90 mm, same data as BIK-EC-CR0066; BIK-EC-CR0106, 3 specimens, R 50–55 mm, Himeshima Island, 12.0 m depth, 14 July 2016.

Tropiometra afra macrodiscus. BIK-EC-CR0069, R 220 mm, Akadomari, 1.5 m depth, 30 May 2014; BIK-EC-CR0070, R 65 mm, juvenile, Nishidomari, 4.7 m depth, night, 21 June 2014.

Dorometra parvicirra. BIK-EC-CR0071, R 100 mm, Shirigai, 10.0 m depth, 1 October 2013; BIK-EC-CR0072, R 110 mm, same data as BIK-EC-CR0071; BIK-EC-CR0073, R 110 mm, same data as BIK-EC-CR0071; BIK-EC-CR0074, R 90 mm, same data as BIK-EC-CR0071; BIK-EC-CR0075, R unknown, Tatsukushi, 7.2 m depth, 23 November 2013.

Antedon serrata. BIK-EC-CR0076, R 30 mm, Kosaizuno, 6.0 m depth, 6 May 2013; BIK-EC-CR0077, R 40 mm, Torinokubi, Okinoshima Island, 17.4 m depth, 5 June 2014; BIK-EC-CR0078, R 45 mm, Tsutomezaki, 5.8 m depth, 23 November 2014.

Belonometra kogoi. OMNH-Iv5432–5435, detailed data shown in Obuchi and Omori (2015: 444); BIK-EC-CR0079, R unknown, Akasaki-2, Okinoshima Island, 33.7 m depth, 30 July 2014.