

NEW GENERA OF RECENT FREE CRINOIDS

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Since the publication of Dr. P. H. Carpenter's great monograph on the recent unstalked crinoids in 1888, the group has received very little attention from systematists, probably because of the rarity of most of the species and the difficulty in getting together representative material of even the more common ones. Dr. Carpenter included in the family Comatulidæ the genera *Thaumatocrinus*, *Eudiocrinus*, *Promachocrinus* (including the subsequently differentiated *Decame-trocrinus*), *Atelecrinus*, *Antedon*, *Comatula* (= *Actinometra*), and *Thiolliericrinus*. All of these, with the exception of *Antedon* and *Comatula*, are comparatively small, strictly homogeneous genera; with them, however, the case is quite different. The genus *Antedon* was divided by Dr. Carpenter into four "series," and all but the first series into two or more "groups," the characters used in the differentiation of the groups and series being (1) the character of the joint between the costals, (2) the number of arms, (3) the number of the distichals, (4) the character of the lower pinnules, (5) the development or absence of covering plates on the ambulacra, and (6) the rounded or "wall-sided" character of the costals and lower brachials. Of all these characters, the first alone is the only one not common to two or more of his series or groups, as diagnosed by him. Taking No. 2, for instance, five of his groups and also several unassigned species are ten-armed; all the rest have more than ten arms. A number of single species have both ten and more than ten arms, as a result of purely individual variation. No. 3 is equally unreliable; some species are both ten-armed and multibrachiate, the latter varieties having the distichals either 2 or 4 (3 + 4); other species, very difficult to differentiate in the ten-armed varieties, become one "bidistichate" and another "tridistichate," according to species in their multibrachiate forms. In regard to No. 4, the lower pinnules of the "Basicurva group" are identical in character with those of the "Spinifera" and "Granulifera" groups, and those of certain of his heterogeneous "Milberti group" with species of the "Pal-mata" and "Savignii" groups. Taking No. 5, we find covering plates developed in the "Acœla" and "Basicurva" groups among the ten-armed forms, and in the "Spinifera" and "Granulifera" groups among the multibrachiate species; as for No. 6, "wall-sidedness" of

the costals and lower brachials, characteristic of the "Basiçurva," "Spinifera," and "Granulifera" groups, is equally well marked in species of the "Milberti," "Tenella," and "Palmata" groups, and in species closely allied to *Antedon balanoides*. Since the publication of the *Challenger* report, the family Comatulidæ, as understood by Dr. Carpenter, has been broken up into the families Thaumatrocrinidæ (*Thaumatrocrinus*), Antedonidæ (including *Eudiocrinus*, *Antedon*, and *Thiolliericrinus*), Atelecrinidæ (*Atelecrinus*), Actinometridæ (*Comatula*), and Decametrocrinidæ (*Promachocrinus* and *Decametrocrinus*). The family Decametrocrinidæ appears to be somewhat unnatural. *Decametrocrinus* is most nearly related to *Eudiocrinus*, and it is doubtful if single arms from species of the two genera could be differentiated; *Decametrocrinus* is clearly a meristic variation from a *Eudiocrinus* type. The two genera agree in having the disk black, the perisome extending far up on the arms, in having single undivided arms, and perfectly smooth cirri with elongated segments; the first two characters do not occur in any other genera of free crinoids, while a detailed study of the cirri will probably prove them to be quite as characteristic. Another point is that the ambulacra in *Eudiocrinus* and *Decametrocrinus* do not divide upon the disk; in the former there are five ambulacra running from the mouth to the arms, and in the latter ten, arranged in five pairs. Taking these points into consideration, it appears most logical to unite *Decametrocrinus* and *Eudiocrinus*, making of them the family Eudiocrinidæ, from which combination *Promachocrinus* is omitted. I only know *Promachocrinus* from what has been written of the genus, having had no opportunity of examining specimens; and it therefore seems best not to say anything about it for the present, more particularly as we shall soon hear something in regard to it from one of the foremost authorities on the recent crinoids. Attention should here be called to the researches of Mr. Frank Springer on *Uintacrinus* and its probable relationship with the genus *Comatula*.

Turning our attention again to the genus *Antedon*, we find that it has been revised by Hartlaub in 1895, and by Minckert in 1905. The former divided *Antedon* into groups with, and without, plated ambulacra, but otherwise followed Carpenter. Minckert, in his instructive work on the arm regeneration in the comatulids, uses Carpenter's groups, but proposes another group, the "Brevipinna group," for species with plated ambulacra, and variable (2 or 4 (3 + 4) or both) distichal series. Both authors take Carpenter's groups as homogeneous units, which in many cases they are not;

for instance, the "Basicurva group" contains species both with and without plated ambulacra; the "Milberti group" contains two species really belonging to the "Tenella group," and others only remotely related to *Antedon milberti*, etc. The genera here proposed are capable of exact and diagnostic definition, and occupy definite and characteristic geographical areas, as well as bathymetrical and thermal altitudes, which is the case with but one or two of the units heretofore used in the classification of the finer divisions of the old genus *Antedon*.

No attempt is made in this paper to discuss the relationships of the fossil Antedonidæ and Actinometridæ, a study of these forms having been rendered impossible through lack of material; I hope, however, to be able to consider them later. In the list of species at the end of each genus names of species which have not been described accurately enough to admit of generic determination, or names regarded as synonyms, are omitted; but a synonymy of all the species has been worked out, and will probably be published in the near future.

KEY TO THE GENERA DESCRIBED

- A. Pinnule ambulacra without covering plates.
- a. Costals united by syzygy.....(1) *Zygometra*
 aa. Costals united by bifascial articulation.
- b. A pinnule on the 4th (epizygal) brachial.
- c. Lower pinnules stout and prismatic, subequal in length; costals and lower brachials sharply "wall-sided."
- d. First pinnule as large as or larger than the second or third; brachials long, triangular or quadrate; first two brachials not enlarged; always light yellow in color.
 (2) *Nanometra*
- dd. First pinnule smaller than those following; brachials very short, discoidal; first two brachials much enlarged; deep purple or reddish brown in color, usually blotched with yellow.....(3) *Tropiometra*
- cc. Lower pinnules greatly elongated, slender, and flagellate, the first with very numerous short and broad joints; costals rounded, well separated.
- d. All the greatly elongated lower pinnules are composed of short and broad joints, and are more or less serrate toward the tip; centrodorsal hemispherical with very numerous cirri; cirri long, the proximal segments elongate, the distal short, sharply carinate or spiny always with an opposing spine; terminal claw curved. moderate in length or short; brachials quadrate or triangular: yellow(4) *Heliometra*
- dd. All but the first of the elongated lower pinnules are composed of greatly elongated joints and are smooth

- distally; centro-dorsal discoidal with numerous cirri, which are composed of greatly elongated smooth joints; terminal claw very long and nearly straight; no opposing spine; middle and distal arm joints discoidal; brown or grayish.....(5) *Thysanometra*
- ccc. One or more of the lower pinnules elongated; but all the lower pinnules are slender and have elongated, smooth, cylindrical joints.
- d. The first joint of the elongated proximal pinnules is always short; distal pinnules cylindrical, very slender, not elongated; centro-dorsal hemispherical or discoidal, the cirri without definite arrangement; some or all of the cirrus segments markedly "dice-box shaped."
- (6) *Antedon* de Fréminville
- dd. All the pinnules greatly elongated, the first joint as well as the others very long; centro-dorsal conical or long columnar, divided by five broad interradianal ridges or planes into areas, each with definite vertical rows of cirrus sockets; cirrus segments cylindrical or flattened, never "dice-box shaped."
- e. Costals and lower brachials smooth, well-separated, and rounded; cirri smooth with all the joints elongated, arranged in 3, 4 or 5 rows in each radial area.
- (7) *Psathyrometra*
- ee. Costals and lower brachials spiny, sharply "wall-sided;" cirri with much elongated joints proximally, very short and spiny joints distally, arranged in 2 rows in each radial area.....(8) *Zenometra*
- cccc. Lower pinnules cylindrical, one or more enlarged, very stout, styliform, or more or less flagellate.
- d. Cirri without definite arrangement; centro-dorsal discoidal.
- e. Cirri long with 50-70 short segments, bearing dorsal spines distally; pinnule of second brachial greatly elongated and flagellate, the following pinnules very short; costals widely free laterally, and rounded.
- (9) *Pontiometra*
- ee. Cirri moderate or short, with not more than 40 segments; one or more of the lower pinnules very stout, stiff, elongate, styliform or more or less flagellate, with cylindrical segments; following pinnules decrease gradually in length; outer surface of costals (also distichals and palmars when present) and lower brachials rounded, never carinate, convex dorso-ventrally, imparting a swollen appearance to the segments, usually more or less tubercular.
- (10) *Himerometra*
- dd. Cirri in 10 vertical rows, on a long conical centro-dorsal.
- (18) *Adelometra*
- bb. No pinnule on the 4th (epizygal) brachial.
- c. Centro-dorsal discoidal, the short cirri in two or three irregular marginal rows; costals and lower brachials not

tubercular, the former well-separated laterally.

(11) *Cyllometra*

cc. Centro-dorsal conical, the elongate and slender cirri in more or less definite vertical rows; costals and lower brachials strongly tubercular, in close apposition, and sharply "wall-sided." (12) *Perometra*

AA. Pinnule ambulacra plated.

a. Pinnules stout and prismatic, closely set; costals (also distichals and palmars when present) and lower brachials sharply "wall-sided."

b. Distal pinnules extend several millimeters beyond tip of arm, which is sharply recurved; first pinnule of the same character as the following, but much smaller; cirri very long with 80 to 130 segments..... (13) *Ptilometra*

bb. Distal pinnules very short, not extending beyond tip of arm, which is not incurved.

c. First pinnule much enlarged, composed of a few large, stout segments; genital pinnules not differentiated; cirri long, slender, with 25 to 90 segments, the distal always spiny (14) *Thalassometra*

cc. First pinnule more slender than the following, longer, composed of a large number of small joints; genital pinnules more or less expanded; cirri short and stout, with less than 30 segments without dorsal spines.

(15) *Charitometra*

aa. Pinnules prismatic; costals deep, with concave sides and a prominent latero-posterior thin flange-like margin; genital pinnules much expanded; cirri short, stout, and smooth.

(16) *Pacilometra*

aaa. Pinnules slender and cylindrical, well separated and thorn-like; costals rounded; cirri distally spiny... (17) *Calometra*

1. ZYGOMETRA, gen. nov.

Centro-dorsal discoidal, bearing one to three rows of marginal cirri; cirri very variable, but always stout, with 15 to 50 segments, with or without dorsal spines; the segments are, however, always short (almost always broader than long), and very uniform in size; disk always plated, but pinnule ambulacra naked; costals united by syzygy, always well rounded, well separated laterally, never carinate; ten to ninety or more arms, distichals 4 (3 + 4) (almost never 2), the subsequent series either 2 or 4 (3 + 4); lower pinnules more or less elongate (but not markedly so), the basal segments often somewhat carinate; distal edges of costals and brachials often everted or overlapping; brachials always wider than long.

Color in life yellow, brown, purple, or red, usually more or less definitely banded.

Type of the genus.—*Antedon microdiscus* Bell, 1884.

Zygometra corresponds to Dr. Carpenter's "Elegans group" or series 1 of *Antedon*, and is composed of species occurring from Australia northward to southern Japan. In regard to this genus the question at once arises as to whether the generic name *Hyponome*, proposed by Lovén, should not be used. *Hyponome* was founded on a detached visceral mass, probably of *Antedon microdiscus*, which was considered by Professor Lovén to be a recent cystidean, and described as such. Now the characters given for *Hyponome sarsii* do not permit us to refer it to any species of *Zygometra* with any degree of certainty; in other words, *Hyponome* is a genus with a non-recognizable type, and therefore has no standing.

The following described species are referable to *Zygometra*; I have examined an additional species from Japan:

<i>Zygometra elegans</i> (Bell)	<i>Zygometra microdiscus</i> (Bell)
" <i>hartlaubi</i> (A. H. Clark)	" <i>multiradiata</i> (P. H. Carpenter)
" <i>kahleri</i> A. H. Clark	" <i>rubroflava</i> (A. H. Clark)

2. NANOMETRA, gen. nov.

Centro-dorsal hemispherical, bearing 15 to 25 rather slender cirri with 25 to 30 segments, very uniform, never much longer than wide, the distal sometimes more or less carinate; disk and pinnule ambulacra not plated; costals united by bifascial articulation, short and broad, in lateral apposition, with sharply flattened sides (*i. e.*, "wall-sided"); the first two or three brachials also have sharply flattened sides; ten arms, the brachials quadrate, sometimes elongate; the third and fourth brachials united by syzygy (usually); a second syzygy occurs between brachials 9 and 10 to brachials 13 and 14, and syzygia occur distally with 2 to 8 bifascial articulations intervening; lower pinnules stout, more or less carinate and prismatic, but not elongate; middle and distal pinnules slender, more or less carinate or prismatic, the first two segments short, more or less expanded, the others elongate.

Color in life, yellow.

Type of the genus.—*Antedon minor* A. H. Clark, 1907.

Nanometra includes those species of Dr. Carpenter's "Basicurva group" which differ markedly from all the others in entirely lacking the characteristic plating of the disk and ambulacra. They are all small species, inhabiting warm and comparatively shallow water, and are found from the Arafura and Australian seas northward to southern Japan.

The following are the described species of the genus:

<i>Nanometra denticulata</i> (P. H. Carpenter)	<i>Nanometra pusilla</i> (P. H. Carpenter)
“ <i>minckerti</i> A. H. Clark ¹	“ <i>wilsoni</i> (Bell)

3. TROPIOMETRA, gen. nov.

Centro-dorsal discoidal, bearing 20 to 30 marginal cirri in one more or less irregular row; cirri stout, short, with 20 to 35 segments, all wider than long, perfectly smooth, the opposing spine on the penultimate absent or but faintly indicated; terminal claw small and short; disk and ambulacra naked; costals broad and nearly flat, united by bifascial articulation, in close apposition laterally, and more or less “wall-sided;” always ten arms; first brachial oblong, and rather disproportionately large; second brachial wedge-shaped, rather larger than the first; first two brachials in close lateral contact with those on adjacent rays, and more or less flattened laterally; following brachials very short, oblong, discoidal, or very slightly quadrate, the arms with or without a median keel; third and fourth brachials united by syzygy; other syzygies usually between the ninth and tenth and fourteenth and fifteenth, or approximately in those positions; distally syzygia occur with intervals of from 2 to 9 bifascial articulations; lower pinnules subequal, stout, prismatic, sharply carinate, with 20 to 25 short segments, mostly broader than long, flattened externally; distal pinnules very slender, elongate, usually non-carinate.

Color (in spirits) purple or purple-brown, often more or less spotted or blotched with yellow; sometimes yellow, or reddish purple and yellow; rarely white.

Type of the genus.—*Comatula carinata* Lamarck, 1816.

This genus is equivalent to a part of Dr. Carpenter’s “Milberti group,” and contains four species, their united ranges including, so far as can be judged, all tropical seas, the Red Sea, northward to Japan, and southward to Chile and the Cape of Good Hope.

The known species referable to this genus are:

<i>Tropiometra afra</i> (Hartlaub)	<i>Tropiometra braziliensis</i> (Rathbun)
“ <i>carinata</i> (Lamarck) ²	“ <i>macrodiscus</i> (Hara)

¹*Nanometra minckerti*, new name for *Antedon minor* A. H. Clark, preoccupied. I take great pleasure in dedicating this interesting species to Mr. Wilhelm Minckert, in recognition of his excellent work on the unstalked crinoids.

²*Antedon capensis* Bell, described in the “Basicurva group,” is a synonym of this species. I have compared specimens identified by Professor Bell with others from Zanzibar and find them identical.

4. HELIOMETRA, gen. nov.

Centro-dorsal hemispherical, bearing very numerous cirri without definite arrangement, well distributed over the surface, but the pole always free; cirri long, moderately stout, with numerous (30 to 80, usually 40 to 60) segments, the proximal somewhat longer than wide, the distal short, and provided with more or less prominent dorsal spines; disk and ambulacra unplated; costals united by bifascial articulation, rounded, never carinate, usually well separated; arms always ten in number; brachials very numerous, always triangular or more or less quadrate, more or less overlapping, never carinate nor laterally compressed; syzygial joints between brachials 3 and 4, 9 and 10, and 14 and 15, or 16 and 17 (irregularly between 15 and 16); distally 2 to 6 bifascially articulated joints (most commonly 3 or 4) intervene between successive syzygia; proximal pinnules greatly elongated and flagellate, the first and second always, and usually the third and fourth, composed of very numerous joints which are wider than long, at least in the basal half; the distal portion of the lower pinnules is always more or less serrate or combed; distal pinnules slender and elongate, set closely together, the first two joints expanded and trapezoidal, the others elongated.

Color in life yellow, in one species more or less blotched with white.

Type of the genus.—*Alecto eschrichtii* J. Müller, 1841.

This genus corresponds to the "Eschrichti group" of Dr. Carpenter, and contains at present eighteen described species. In addition to these I have examined some undescribed forms from the neighborhood of Shanghai. The distribution as at present known is: Arctic and Antarctic seas, northern and southern Atlantic, entire American coast of the Pacific, Bering Sea, Sea of Okhotsk, Sea of Japan, and the coasts of the western Pacific, south at least to Shanghai.

The species of *Heliopecten*, taken as a whole, form a remarkably homogeneous aggregation, the differential specific characters being, when compared with those of the other genera of recent free crinoids, very slight; for instance, most of the well-known species of *Himeropecten*, to say nothing of the extraordinary *Cylopecten manca*, exhibit more individual than *Heliopecten* does generic variation. The regular distribution of the syzygia is noteworthy, forming as it does in several species a reliable specific character. No other genus has the syzygia thus regularly placed, although an approach to it is noticeable in *Antedon*.

The following are the described species of the genus:

<i>Helio метра antarctica</i> (P. H. Carpenter)	<i>Helio метра magellanica</i> (Bell)
" <i>asperrima</i> (A. H. Clark)	" <i>mariae</i> (A. H. Clark)
" <i>brachymetra</i> (A. H. Clark)	" <i>maxima</i> (A. H. Clark)
" <i>clio</i> (A. H. Clark)	" <i>perplexa</i> (A. H. Clark)
" <i>eschrichtii</i> (J. Müller)	" <i>quadrata</i> (P. H. Carpenter)
" <i>glabra</i> (A. H. Clark) ¹	" <i>rathbuni</i> (A. H. Clark)
" <i>hondocensis</i> (A. H. Clark)	" <i>rhomboidea</i> (P. H. Carpenter)
" <i>inexpectata</i> (A. H. Clark)	" <i>serraticissima</i> (A. H. Clark)
" <i>juvenalis</i> A. H. Clark	" <i>tanneri</i> (Hartlaub)
" <i>laodice</i> (A. H. Clark)	

5. THYSANOMETRA, gen. nov.

Centro-dorsal discoidal, bearing 50 to 70 marginal cirri in several marginal rows; cirri slender and very smooth, with 15 to 20 greatly elongated segments; no trace of dorsal spines; no opposing spine; terminal claw very long and nearly straight; disk and ambulacra naked; costals rounded, well separated, never carinate; ten arms, the brachials mostly oblong, but sometimes slightly quadrate in the anterior third of the arm; third and fourth, ninth and tenth, and fourteenth and fifteenth brachials united by syzygy; syzygia distally with usually 3 bifascial articulations intervening; lower pinnules greatly elongate and flagellate, the first composed of very numerous short and broad segments, the others of segments all but the basal 3 or 4 of which are greatly elongated; distal pinnules very slender, with greatly elongated segments.

Color in life grayish brown, the skeleton and cirri nearly white.

Type of the genus.—*Antedon tenelloides* A. H. Clark, 1907.

This genus contains a single peculiar species, known only from southern Japan. It is:

Thysanometra tenelloides (A. H. Clark)

6. ANTEDON de Fréminville 1811

Centro-dorsal hemispherical, rarely more or less discoidal, bearing from 10 to 15 to nearly 60 cirri, the pole always free; cirri of variable length, composed of from 10 to 50 segments, all of which are usually longer than wide (frequently very much so); although the last few are sometimes comparatively short, there is never any great difference between the longest and the shortest segments; cirrus segments

¹ *Helio метра glabra*, new name for *Antedon australis* P. H. Carpenter, 1888; not *Antedon australis* P. H. Carpenter, 1882.

always more or less constricted centrally, the articulations expanded (*i. e.*, "dice-box shaped"), at least in the proximal half of the cirri; cirri smooth, or with more or less developed dorsal spines; terminal claw (on penultimate segment) always prominent, at least on some of the cirri; disk and ambulacra naked, rarely with small scattered calcareous granules on the former; costals united by bifascial articulation, thin, broad, not very convex, often carinate, normally in apposition laterally when the arms are closed, sometimes distinctly "wall-sided" (by individual, not specific, variation); ten arms—abnormal specimens of certain species occasionally have more, in which case the distichals are 2 or 4 (3 + 4)—long and slender, evenly tapering, the brachials triangular, almost always longer than wide (after the third syzygial joint), becoming greatly elongated and often "dice-box shaped" distally; brachials rounded, never carinate nor overlapping, but the distal edge is sometimes fringed with spines; surface of costals and lower brachials sometimes more or less covered with closely set spines; syzygia between brachials 3 and 4, 9 and 10, and usually 14 and 15, the last somewhat variable, and distally at intervals of 2 to 6 (usually 2 to 4) articulations; the syzygia, as a rule, regularly distributed in each species; pinnules with smooth segments, one or more of the proximal pinnules always elongated and flagellate, composed of elongated segments, but the first segment always short; distal pinnules with the first segment very short, the others greatly elongated, more or less swollen at the joints.

Color in life variable, purple, rose, red, orange, yellow, green or brown, usually more or less mottled or banded.

Type of the genus.—*Antedon gorgonia* de Fréminville, 1811 = *Asterias bifida* Pennant, 1777 = *Comatula mediterranea* Lamarck, 1816 = *Comatula fimbriata* Miller, 1821, etc.

The genus *Antedon*, as here restricted, is practically equivalent to the "Tenella group" of Dr. Carpenter. Two species, *Antedon pumila* Bell and *Antedon parvicirra*, obviously belong with the *Antedon bifida* type, and it is difficult to see why Dr. Carpenter placed them, as he did, with *Himerometra milberti*. The shape and proportions of the brachials, cirri, and pinnules, and the regular disposition of the syzygia at once proclaim their relationship with the small tropical forms of the genus *Antedon*, such as *Antedon nana*, *A. briseis*, and *A. minuta*. *Antedon* is practically cosmopolitan, and occurs from the littoral region down at least to 2,900 fathoms. The species of this genus are peculiarly difficult of determination, as they are the most brittle of all the Antedonidæ, and it is very hard to secure them in recognizable shape; thus it is that, although I have examined

many specimens from the American shores of the Pacific, and a number from the Bering Sea and Asiatic coasts, only a few are in a condition admitting of more than a generic diagnosis.

The following species are referable to *Antedon* as here restricted:

<i>Antedon abyssicola</i> P. H. Carpenter	<i>Antedon japonica</i> Hartlaub
" <i>abyssorum</i> P. H. Carpenter	" <i>lævis</i> P. H. Carpenter
" <i>adeona</i> (Lamarck)	" <i>longipinna</i> P. H. Carpenter
" <i>adrestine</i> A. H. Clark	" <i>minuta</i> A. H. Clark
" <i>alternata</i> P. H. Carpenter	" <i>nana</i> Hartlaub
" <i>angustipinna</i> P. H. Carpenter	" <i>orientalis</i> A. H. Clark
" <i>arctica</i> A. H. Clark	" <i>parvicirra</i> P. H. Carpenter
" <i>bifida</i> (Pennant)	" <i>parvula</i> Hartlaub
" <i>briseis</i> A. H. Clark	" <i>phalangium</i> (J. Müller)
" <i>carpenteri</i> Bell	" <i>prolixa</i> Sladen
" <i>challengeri</i> A. H. Clark ¹	" <i>psyche</i> A. H. Clark
" <i>ciliata</i> A. H. Clark	" <i>pumila</i> Bell
" <i>dentata</i> (Say)	" <i>remota</i> P. H. Carpenter
" <i>dübeneri</i> Böhlische	" <i>serrata</i> A. H. Clark
" <i>exigua</i> P. H. Carpenter	" <i>serripinna</i> P. H. Carpenter
" <i>hirsuta</i> P. H. Carpenter	" <i>stella</i> ² A. H. Clark
" <i>hupferi</i> Hartlaub	" <i>tenella</i> (Retzius)
" <i>isis</i> A. H. Clark	" <i>tenuicirra</i> P. H. Carpenter

7. PSATHYROMETRA, gen. nov.

Centro-dorsal long and conical, divided by five interradiial ridges into areas containing 3 to 5 parallel vertical rows of cirrus sockets; cirri with 30 to 40 elongated, compressed, smooth segments, the longest three or four times as long as wide, gradually decreasing in length distally; terminal spines very small; disk and ambulacra naked; costals well separated, always rounded; ten arms, strongly convex dorsally, deep, but not carinate nor compressed; pinnules all much elongated, the first joint as well as the others greatly elongated.

Color in life light pinkish to deep purple.

Type of the genus.—*Antedon fragilis* A. H. Clark, 1907.

This genus occurs in the north Pacific Ocean, from Panama northward, and in the Sea of Japan and the Bering Sea. None of the three species were known to Dr. Carpenter. The species included in this genus are:

Psathyrometra bigradata (Hartlaub) *Psathyrometra erythrizon* (A. H. Clark)
Psathyrometra fragilis (A. H. Clark)

¹*Antedon challengeri*, new name for *Antedon lineata* P. H. Carpenter, 1888; not *Antedon lineatus* Pomel, 1887.

²*Antedon stella*, new name for *Antedon tenuis* A. H. Clark, 1907; not *Antedon tenuis* P. H. Carpenter, 1887.

8. ZENOMETRA, gen. nov.

Centro-dorsal long, conical or columnar, divided by five inter-radial ridges, often very high, each radial area containing two vertical rows of cirrus sockets; cirri long, with about 50 segments, the basal half of which are greatly elongated, the distal very short, bearing prominent dorsal spines; disk and ambulacra naked; ten arms; costals and lower brachials in close apposition and strongly "wall-sided," more or less covered with small spines; pinnules all much elongated, the first joint, as well as the others, greatly elongated.

Color in life not recorded; in spirits, pinkish.

Type of the genus.—*Antedon columnaris* P. H. Carpenter, 1881.

Zenometra is most closely related to the Pacific *Psathyrometra*, which it represents in the Caribbean Sea. One species only has been described, but I have examined specimens of one or two others from the West Indies. The only described species of the genus is:

Zenometra columnaris (P. H. Carpenter)

9. PONTIOMETRA, gen. nov.

Centro-dorsal discoidal, bearing about 40 cirri in two or three marginal rows; cirri long, with 50 to 70 very uniform short segments, the distal half of which bear dorsal spines; disk and ambulacra unplatelated; radials much wider than the costals, which are rounded and widely separated, not united syzygially; fifty to nearly one hundred arms, all the divisions of two articulated segments; lower brachials discoidal, soon becoming quadrate (wider than long); usually a syzygy between the third and fourth brachial, and others distally at intervals of 6 to 14 bifascial articulations; first brachial pinnule greatly elongated, slender, tapering, and flagellate, with about 40 somewhat elongated segments; following pinnules extremely short, with only 6 to 8 segments, increasing slowly in length distally, but never becoming very long.

Color deep purple or nearly black.

Type of the genus.—*Antedon andersoni* P. H. Carpenter, 1889.

Pontiometra is most closely related to *Himerometra*, but presents several characteristic features of considerable interest; the excessively elongated first pinnule, contrasting sharply with those following, the comparative slenderness and consequent wide separation of the costals, the greatly elongated cirri, with very numerous segments, and the comparatively great length of the brachials, the lower of which, together with the palmars, distichals, and costals, entirely lack the peculiar swollen appearance of those of *Himerometra*, seem to

unquestionably warrant generic separation. This genus is as yet only known from the Mergui and Pelew Islands, and from Amboina; the only described species is:

Pontiometra andersoni (P. H. Carpenter)

10. **HIMEROMETRA**, gen. nov.

Centro-dorsal discoidal, bearing 20 to 40 (usually about 30) cirri in one or two (sometimes three) marginal rows; cirri with 20-40 segments, which are very uniform in size, rarely longer than wide (never much so), medium in length or rather short, moderately stout and smooth, or with small dorsal spines; costals short, united by bifascial articulation, always rounded (never carinate), more or less convex longitudinally, which gives them a characteristic swollen appearance, and usually more or less tubercular at the joint; they may or may not be in apposition, and are sometimes strongly "wall-sided;" distichals and palmars either 2, or 4 (3 + 4) or both; arms ten to about fifty in number, the brachials always much wider than long, with more or less prominent and overlapping distal edges, quadrate or oblong, never triangular; always rounded, and never carinate; disk and ambulacra naked, but the former may have a few small scattered calcareous granules; syzygia irregular, but the third and fourth brachials usually joined by syzygy, and other syzygia at more or less frequent intervals throughout the arms; one or more of the proximal pinnules greatly enlarged, stout, styliform (or more or less recurved), with cylindrical segments, tapering gradually from the base to the slender tip; rarely the distal segments are disproportionately small; distal pinnules slender, the proximal segments not specially marked, the distal not specially elongate.

Color in life purple or reddish purple, the skeleton lighter, often more or less blotched or streaked; sometimes very dark brown or nearly black, but this appears to be a more or less local variation.

Type of the genus.—*Antedon crassipinna* Hartlaub, 1890.

Himerometra includes parts of Dr. Carpenter's "Milberti," "Pal-mata," and "Savignii" groups, and a close examination will show it to be a very well defined and homogeneous genus, presenting, as a whole, a number of interesting characters not found in any other. The peculiar swollen appearance of the costals, and usually also of the distichals, palmars, and lower brachials, which are often or usually more or less tubercular, is very characteristic. The costals and lower brachials, with the intervening distichal and palmar series (when present), are always smooth, and never overlap. *Antedon crassipinna* has been chosen as the type first, because it is a distinctly

typical species, which *A. milberti* is not, as it never has more than ten arms, and second because it is very common and easily obtainable. *Himerometra* ranges from the Red Sea and east African coast eastward through the East Indies to Japan and the Hawaiian Islands.

The described species referable to the genus *Himerometra* are:

<i>Himerometra abboti</i> (A. H. Clark)	<i>Himerometra marginata</i> (P. H. Carpenter)
" <i>affinis</i> (Hartlaub)	" <i>martensi</i> (Hartlaub)
" <i>anceps</i> (P. H. Carpenter)	" <i>milberti</i> (J. Müller)
" <i>articulata</i> (J. Müller)	" <i>monocantha</i> (Hartlaub)
" <i>bella</i> (Hartlaub)	" <i>nematodon</i> (Hartlaub)
" <i>bengalensis</i> (Hartlaub)	" <i>occulta</i> (P. H. Carpenter)
" <i>bidens</i> (Bell)	" <i>okelli</i> (Chadwick)
" <i>bimaculata</i> (P. H. Carpenter)	" <i>oryzanthia</i> (Hartlaub)
" <i>brevicuneata</i> (P. H. Carpenter)	" <i>palmata</i> (J. Müller)
" <i>brockii</i> (Hartlaub)	" <i>persica</i> A. H. Clark
" <i>clcmens</i> (P. H. Carpenter)	" <i>philiberti</i> (J. Müller)
" <i>crassipinna</i> (Hartlaub)	" <i>regalis</i> (P. H. Carpenter)
" <i>delicatissima</i> (A. H. Clark)	" <i>reginae</i> (Bell)
" <i>döderleini</i> (de Loriol)	" <i>quinduplicava</i> (P. H. Carpenter)
" <i>elongata</i> (J. Müller)	" <i>reynaudi</i> (J. Müller)
" <i>emendatrix</i> (Bell)	" <i>savignii</i> (J. Müller)
" <i>erinacca</i> (Hartlaub)	" <i>spicata</i> (P. H. Carpenter)
" <i>finshii</i> (Hartlaub)	" <i>spinipinna</i> (Hartlaub)
" <i>flagellata</i> (J. Müller)	" <i>stylifer</i> (A. H. Clark)
" <i>gyges</i> (Bell)	" <i>subtilis</i> (Hartlaub)
" <i>helianthus</i> A. H. Clark	" <i>tenera</i> (Hartlaub)
" <i>imparipinna</i> (P. H. Carpenter)	" <i>tenuipinna</i> (Hartlaub)
" <i>indica</i> (Smith)	" <i>tessellata</i> (J. Müller)
" <i>klunzingeri</i> (Hartlaub)	" <i>tuberculata</i> (P. H. Carpenter)
" <i>kraepelini</i> (Hartlaub)	" <i>variipinna</i> (P. H. Carpenter)
" <i>lavicirra</i> (P. H. Carpenter)	
" <i>ludovici</i> (P. H. Carpenter)	

11. CYLLOMETRA, gen. nov.

Centro-dorsal discoidal, bearing 15 to 25 marginal cirri more or less regularly arranged in one or two rows; cirri with 15 to 30 segments, very uniform in size and proportions, usually about as long as wide, smooth, or bearing single or paired dorsal spines or a transverse dorsal ridge distally; disk naked or with fine calcareous granules, often segregated in the interambulacral areas; pinnule ambu-

lacra naked; costals rounded, free laterally; ten to thirty arms, the distichals usually (the palmars always) 2, rarely 4 (3 + 4); first few brachials discoidal, then quadrate about as long as wide (or slightly wider than long), becoming elongate distally and more or less "dice-box shaped" at the ends of the arms; distribution of the syzygies irregular; but there is usually one between the third and fourth, second and third, or first and second brachials; one or more of the lower pinnules usually much enlarged, stout, and stiff, the segments with more or less raised and denticulate distal ends; distal pinnules moderate, the first two joints short, the others elongate; normally no pinnule on the fourth (*i. e.*, "third") brachial.

Color in life yellow or white, more or less banded or blotched with purple or red brown; red-brown; rarely red, the pinnules yellow, or entirely red.

Type of the genus.—*Antedon manca* P. H. Carpenter, 1888.

This genus includes seven small but very interesting species, most of which appear to be rather rare or local in their distribution. Dr. Carpenter placed one species near *Antedon milberti* (overlooking the absence of a pinnule on the fourth brachial), two at the end of the "Milberti group," one (under two specific names) in the "Palmata group," and one in the unassigned list at the end of the ten-armed forms. The known species of *Cyllometra* are:

<i>Cyllometra impinnata</i> (P. H. Carpenter)	<i>Cyllometra manca</i> (P. H. Carpenter)
" <i>informis</i> (P. H. Carpenter)	" <i>perspinosa</i> (P. H. Carpenter)
" <i>belli</i> (A. H. Clark) ¹	" <i>ruber</i> (A. H. Clark)
	<i>Cyllometra tigrina</i> (A. H. Clark)

12. PEROMETRA, gen. nov.

Centro-dorsal conical or hemispherical, usually more or less elongate, the cirrus sockets in usually definite vertical rows; cirri slender, long, composed of 35 to 60 segments, the first few short, then elongate until about the middle of the cirrus (or rather beyond), then squarish; the distal segments bear small dorsal spines; disk and ambulacra naked; rays in close apposition, the costals and lower brachials more or less "wall-sided;" costals united by bifascial articulation; large, often extravagantly elongated tubercles on the junction of the costals, and of the first two brachials; always ten arms, the brachials after the fourth quadrate (sometimes triangular),

¹*Cyllometra belli*, new name for *Antedon loveni* Bell, 1884, not *Antedon loveni* Bell, 1882.

slightly wider than long in the basal half of the arms, becoming elongate distally; third and fourth brachials usually united by syzygy; a second syzygy between the ninth and tenth, or thirteenth and fourteenth (or at some intermediate point), and others distally with 3 to 8 (usually 4) bifascial articulations intervening; lower pinnules smooth, slender, regularly tapering, flattened exteriorly, the segments longer than wide; distal pinnules long, the first segment very short, the second rather stout and trapezoidal, the others long-cylindrical; the fourth (*i. e.*, "third") brachial always, and the second sometimes, lacks a pinnule.

Color in life reddish purple and white in varying proportions.

Type of the genus.—*Antedon diomedea* A. H. Clark, 1907.

Perometra is only known from the Philippine Islands and southern Japan. The two species belonging to the genus are:

Perometra balanoides (P. H. Carpenter) *Perometra diomedea* (A. H. Clark)

13. PTILOMETRA, gen. nov.

Centro-dorsal conical, columnar, or thick-discoidal, the cirri usually in ten definite vertical rows or in five well-separated double rows, occasionally without definite arrangement; cirri very long, rather slender, with 80 to 130 segments, few of which are longer than wide, the distal bearing dorsal spines; disk and ambulacra plated, but sometimes the former nearly naked; costals broad, united by bifascial articulation, in apposition laterally and strongly "wall-sided," not very convex, usually bluntly carinate; ten to thirty arms; distichals and palmars (when present) two, united by bifascial articulation; palmars only developed on outer side of rays; arms rounded at the base, but becoming narrow and compressed distally, where the brachials develop overlapping spines; brachials short-triangular or short-quadrate, the last few terminal joints abruptly turned inward between the distal pinnules, which reach for several millimeters beyond the end of the arms; first pinnule about half (rarely more) as large as the following pinnules; pinnules stout, stiff, strongly prismatic (especially the lower), the first joint short, the rest medium, but little longer than wide.

Color purple, dull yellowish white, or mottled.

Type of the genus.—*Alecto macronema* J. Müller, 1841.

Ptilometra ranges from Australia northward to southern Japan. I had at first isolated *Alecto macronema*, making it the type of *Ptilometra*, and including the other species in the genus *Asterometra* with *Antedon macropoda* as the type, but further study has led me

to combine the two, at least for the present. The known species of *Ptilometra* are:

<i>Ptilometra anthus</i> (A. H. Clark)	<i>Ptilometra macronema</i> (J. Müller)
“ <i>longicirra</i> (P. H. Carpenter)	“ <i>macropoda</i> (A. H. Clark)

14. THALASSOMETRA, gen. nov.

Centro-dorsal more or less conical or columnar, the cirri in 10 or 15 vertical rows (rarely without definite arrangement), often in pairs or groups of three, separated from each other by ridges; cirri long and slender, with 25 to 90 segments, the lower longer than wide, the distal short and bearing strong dorsal spines; disk always well plated, ambulacra well plated; costals united by bifascial articulation, deep, strongly “wall-sided;” ten to thirty arms, long, more or less (often much) compressed and carinate, at least distally, the terminal segments not incurved; distichal and palmar series usually 2, rarely 4 (3 + 4); first syzygy usually between the third and fourth brachials (except when the arm springs from an axillary united to the preceding segment by syzygy, in which case it is between the first and second); other syzygies distributed more or less irregularly; first pinnule the largest, long and stout, often greatly enlarged, composed of rather short, but not numerous, segments; other pinnules of moderate length, or rather short, stiff, rather stout, prismatic, the segments moderately elongate, the first two more or less laterally expanded and trapezoidal; terminal pinnules small, becoming gradually very short at the tip of the arm, beyond which they do not extend; the genital pinnules are rarely (? never) specially differentiated.

Color in life bright yellow or yellow and white, sometimes the calyx, rarely the whole animal, dull greenish or brownish.

Type of the genus.—*Antedon villosa* A. H. Clark, 1907.

This genus includes the larger part of Dr. Carpenter’s “Basicurva group,” together with part of the “Spinifera group,” and one species placed by him in the “Granulifera group” (in addition to being in the “Basicurva group”). Several additional species have been described since the *Challenger* report was written, and I have also examined a few others as yet undescribed. *Thalassometra* has a very wide distribution, occurring pretty generally throughout the tropics, and north to Bering Sea and the coast of Portugal, south to Australia and South Africa. The following described species belong to this genus:

<i>Thalassometra acutiradia</i> (P. H. Carpenter)	<i>Thalassometra latipinna</i> (P. H. Carpenter)
" <i>agassizi</i> (Hartlaub)	" <i>lusitanica</i> (P. H. Carpenter)
" <i>alboflava</i> (A. H. Clark)	" <i>multispina</i> (P. H. Carpenter)
" <i>aster</i> (A. H. Clark)	" <i>pergracilis</i> (A. H. Clark) ¹
" <i>bispinosa</i> (P. H. Carpenter)	" <i>pubescens</i> (A. H. Clark)
" <i>breviradia</i> (P. H. Carpenter)	" <i>quinquecostata</i> (P. H. Carpenter)
" <i>diadema</i> (A. H. Clark)	" <i>spinicirra</i> (P. H. Carpenter)
" <i>duplex</i> (P. H. Carpenter)	" <i>spinifera</i> (P. H. Carpenter)
" <i>echinata</i> (P. H. Carpenter)	" <i>valida</i> (P. H. Carpenter)
" <i>hana</i> (A. H. Clark)	" <i>villosa</i> (A. H. Clark)
" <i>hawaiiensis</i> (A. H. Clark)	" <i>wood-masoni</i> (Bell)
" <i>incerta</i> (P. H. Carpenter)	

15. CHARITOMETRA, gen. nov.

Centro-dorsal usually discoidal, rather thick, rarely low-conical or low-hemispherical, the comparatively few cirri usually without definite arrangement; cirri short and stout, with less than 30 segments, very uniform in length, about as long as or slightly longer than wide, not bearing dorsal spines, although the later joints are sometimes tubercular dorsally; an opposing spine always present; disk well, or at least moderately, plated, the ambulacra always well plated; costals and lower brachials strongly flattened against each other laterally, sharply "wall-sided;" distichals and palmars either 2 or 4 (3 + 4), the latter often 2 (1 + 2); ten to about fifty arms, long, always more or less (often much) compressed, at least in the outer half, and carinate; first syzygy between the third and fourth brachial in arms springing direct from the costal axillary, or from an axillary joined to the preceding segment by bifascial articulation, but between the first and second in arms arising from an axillary joined to the preceding segment by syzygy; distal syzygia irregularly distributed; first pinnule (which in *Thalassometra* is much stouter and larger, with larger joints than its successors) rather slender, often more or less flagellate, always less stout than its successors, and composed of more numerous and shorter joints; genital pinnules always have one or more of the joints more or less expanded, protecting the

¹*Antedon pergracilis*; new name for *Antedon gracilis* P. H. Carpenter, 1888, preoccupied (*cf.* *Antedon gracilis* de Loriol, 1886).

genital glands; distal pinnules (as well as, to a greater degree, the proximal) stout, prismatic, the segments but little longer than wide; terminal pinnules short, not extending beyond the tip of the arm, which is not incurved.

Color in life yellow or brownish yellow, sometimes more or less marked with white, rarely grayish brown, or gray with the tips of the arms yellow.

Type of the genus.—*Antedon incisa* P. H. Carpenter, 1888.

Charitometra is composed of most of the species included by Dr. Carpenter in the "Basicurva," "Spinifera," and "Granulifera" groups, not falling in the genus *Thalassometra*, with a few others subsequently described, and a number of as yet undescribed forms which I have examined, mostly from the Caribbean Sea. The genus is mainly tropical, but occurs southward to South Africa and the Australian seas, and northward to southern Japan. The following described species are included in the genus:

<i>Charitometra aculeata</i> (P. H. Carpenter)	<i>Charitometra hepburniana</i> (A. H. Clark)
" <i>angusticalyx</i> (P. H. Carpenter)	" <i>inaequalis</i> (P. H. Carpenter)
" <i>basicurva</i> (P. H. Carpenter)	" <i>incisa</i> (P. H. Carpenter)
" <i>brevipinna</i> (Pourtalès)	" <i>lata</i> (A. H. Clark)
" <i>compressa</i> (P. H. Carpenter)	" <i>orion</i> (A. H. Clark)
" <i>distincta</i> (P. H. Carpenter)	" <i>parvipinna</i> (P. H. Carpenter)
" <i>flexilis</i> (P. H. Carpenter)	" <i>patula</i> (P. H. Carpenter)
" <i>garrettiana</i> (A. H. Clark)	" <i>pourtalesi</i> (P. H. Carpenter)
" <i>granulifera</i> (Pourtalès)	" <i>robusta</i> (P. H. Carpenter)
	" <i>tuberosa</i> (P. H. Carpenter)

16. PÆCILOMETRA, gen. nov.

Centro-dorsal hemispherical, subconical, or columnar, bearing 20 to 30 cirri; cirri with 15 to 18 smooth segments, nearly all of which are longer than wide; no opposing spine; terminal claw small and sharp; disk completely plated; ambulacra plated; radials quite concealed in the adult; costals with a thin projecting latero-posterior border, causing them to appear scale-like; costals and lower brachials sharply flattened laterally, the former more or less concave, but not in apposition; ten arms, the brachials as long as or longer than wide, triangular, becoming quadrate distally; first pinnule with 20 to 30

short joints, slender, tapering, and almost flagellate; following pinnules with 3 to 5 of the joints much expanded laterally, enclosing the genital glands, which are covered with strong protecting plates; remaining pinnules prismatic; all the pinnules, especially the lower, have the first joint much wider than its successors.

Color in life, yellow when young, becoming when adult dull yellow-brown or dark gray-brown.

Type of the genus.—*Antedon acala* P. H. Carpenter, 1888.

Pacilometra is closely related to *Charitometra*, but it appears to be an invariably ten-armed type. The costals are peculiar in possessing a thin border, continuous laterally and posteriorly, and in having the sides more or less strongly concave, characters which appear to warrant generic differentiation. The range of *Pacilometra* is from the Meangis Islands north to southern Japan. Two species are known, but the differences between them are not great, and it may be found necessary to unite them at some future time. The later species was wrongly described as belonging to Dr. Carpenter's "Basicurva group," the author having been misled by the association in the same group of *Pacilometra acala* and *Calometra discoidea*, two widely different forms. The error is, however, quite inexcusable. The two species of this genus are:

Pacilometra acala (P. H. Carpenter)

Pacilometra scalaris (A. H. Clark)

17. CALOMETRA, gen. nov.

Centro-dorsal discoidal, bearing 15 to 20 cirri in a single, or partially double or triple, more or less definite marginal row; cirri rather stout, with 20 to 50 segments, the more proximal more or less elongated (but never very much so), the distal very short, usually with small, blunt dorsal spines; disk completely covered with calcareous plates; pinnule and brachial ambulacra well plated; costals rounded, widely free laterally, or furnished with lateral (but not posterior) marginal flanges meeting the flanges on the adjacent rays; distichals (when present) two; palmars two (rarely one), usually articulated, but sometimes united by syzygy; ten to fifty arms of moderate length, rather stout, evenly tapering, the brachials triangular or very obliquely quadrangle, almost always longer than wide, convex on the longer edge, becoming shorter distally; position of syzygia irregular; lower pinnules with the first two joints (especially the first) greatly expanded, this character most marked on the first pinnule, which is always small and weak, with small, squar-

ish joints; the second or third pinnules (or both) may be elongated and styliform; pinnules cylindrical, evenly tapering, slender, very stiff and spine-like, the distal with the first two joints short and squarish or trapezoidal, the others greatly elongated.

Color in life very varied; lavender and yellow; red-brown and yellow; red-brown, purple, yellow, and white; yellow, orange, white, or purple and white, the cirri almost invariably more or less banded with purple and white or yellow.

Type of the genus.—*Antedon callista* A. H. Clark, 1907.

This well marked and handsome genus is found from the Ki Islands northward to southern Japan, where it occurs in great abundance. The only species known to Dr. Carpenter was *Calometra discoidea*, which he placed in his "Acœla group," together with *Pæcilometra acœla*. The next species known was described by Professor Bell under the name of *Antedon bassett-smithi*, in 1894. It was placed by him in the "Spinifera group." The other species have all been recently discovered in the seas about southern Japan. The species of the genus at present known are:

<i>Calometra bassett-smithi</i> (Bell)	<i>Calometra multicolor</i> (A. H. Clark)
" <i>callista</i> (A. H. Clark)	" <i>propinqua</i> (A. H. Clark)
" <i>discoidea</i> (P. H. Carpenter)	" <i>separata</i> (A. H. Clark)
" <i>flavopurpurea</i> (A. H. Clark)	" <i>thetis</i> (A. H. Clark)
<i>Calometra versicolor</i> (A. H. Clark)	

18. ADELOMETRA, gen. nov.

Centro-dorsal columnar, bearing ten vertical rows of cirrus-sockets; cirri long and slender, with 60 or 70 segments little, if any, longer than wide, quite uniform in length, the distal third becoming short and developing spines; disk and ambulacra naked; costals comparatively narrow, well separated, the intercostal articulation rising into a tubercle; ten to fifteen (?) arms, distichals 2 or 4 (3 + 4), the brachials all long (all but a very few in the proximal part of the arms longer than wide) and discoidal, squarish, or more or less quadrate; third and fourth brachials united by syzygy, a second syzygy between the thirteenth and fourteenth or sixteenth and seventeenth (or at some intermediate point), and others distally at intervals of from two to seven (usually five or six) bifascial articulations; first pinnule much the longest, with elongated segments; following pinnules much shorter and less stout, becoming longer again and more slender distally.

Color (in spirits): "The skeleton a very light brown, and the perisome darker."

Type of the genus.—*Antedon angustiradia* P. H. Carpenter, 1888.

This genus includes a single species which was placed by Dr. Carpenter in the "Savignii group," but which differs markedly from all the others placed by him in that group. It is:

Adelometra angustiradia (P. H. Carpenter)