

REVISION OF THE CRINOID FAMILY COMASTERIDÆ,  
WITH DESCRIPTIONS OF NEW GENERA AND SPECIES.

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The work of the steamer *Albatross*, of the United States Bureau of Fisheries, especially within the last two years, has resulted in the accumulation of a magnificent collection of comasterid material, practically every known and numerous heretofore unknown species being represented. This has been studied in connection with the remarkably comprehensive collection belonging to the zoological museum of the University of Copenhagen (previously studied by Drs. C. F. Lütken and P. H. Carpenter), for the privilege of examining which I am indebted to the generosity of my friend, Dr. Th. Mortensen; with the very fine collection of Japanese comasterids deposited in the U. S. National Museum by Mr. Frank Springer; with the collection made by the German steamer *Gazelle* in Australia, sent to me for study through the kindness of Drs. W. Weltner and R. Hartmeyer, and with the collections of a number of American museums. Still other collections have been examined at different times, and the notes made on them have proved of considerable value, the most important of these being the collection at the Museum of Comparative Zoology, which contains specimens identified by Carpenter, and that of the Boston Society of Natural History.

After the completion of the work on this "revision," the authorities of the Indian Museum at Calcutta, through the superintendent, Dr. N. Annandale, sent me the specimens collected by the steamer *Investigator*, which proved to be a collection of more than usual interest. It was with considerable gratification that I found, after a critical study of the *Investigator* material, no changes of any kind were necessary, and I was thereby induced to publish the "revision" in its present form, believing that, if such a large collection as that of the *Investigator* did not alter in any way the general scheme, there was a reasonable hope of at least as long a life as is enjoyed by most "revisions."

The history of the family Comasteridæ may be said to date from that most excellent memoir of Dr. P. H. Carpenter on the genus *Actinometra*. In this memoir he gives a detailed account of the systematic treatment of the various species of the genus by previous authors, and ably reduces to order a systematic chaos scarcely surpassed in the whole subject of zoology; for even so great a zoologist as Prof. Johannes Müller, in the only monograph then published on the unstalked crinoids, had placed a single species (under four different specific names) under the subgenus *Actinometra* among the exocyclic forms (twice); under the subgenus *Alecto* among the endocyclic forms, and again under the subgenerically *incertæ sedis*, in the heterogeneous group *Comatula*.

Since 1879 the genus *Actinometra* has been accepted in the sense in which it was used by Carpenter. Nine years afterwards he split it up into eight specific groups, distributing these among four "series," and this arrangement has been used ever since. Shortly afterwards the genus was raised to family rank, on a par with the family "Antedonidæ," covering the genus "*Antedon*" of Doctor Carpenter. This I have recently shown to be an unnatural division. In the course of my work I found the genus *Actinometra* becoming somewhat unwieldy, and I accordingly split it in two sections, one small and one large; but with the accession of new material the large division proved not to be natural, and I split that into two parts. Enormous collections from the Philippine Islands having been received, a still further change was seen to be necessary, and the last of the divisions created was shattered into three fragments. I discarded the appropriate and euphonious name *Actinometra* proposed by Professor Müller in favor of *Comatula* of Lamarek, of which it is a pure synonym, with the same type. While the name Comatulidæ was first employed to cover the family in place of Actinometridæ (not available because of the disuse of *Actinometra*), I soon found that confusion with the Comatuladæ of Fleming (1828) and Comatulidæ of d'Orbigny (1852) and succeeding authors, with a more or less comprehensive range of meaning, but never so restricted as to cover the "Actinometridæ" alone, made a change desirable, and I therefore substituted "Comasteridæ," the name being derived from that of the next oldest genus.

The most important discovery made in regard to the Comasteridæ since the publication of Carpenter's memoir in 1879 is that of Mr. Frank Springer, who in 1903 described and figured a strongly developed ambulacral plating on the arms and pinnules of a new species from the Tortugas. I have since found these plates to be universally present in the species of the "Fimbriata group" from the West Indies, well developed even in "*Actinometra*" *lineata*, in which I detected it in some of the *Challenger* specimens previously examined by

Carpenter. These plates appear to represent the side plates of the Pentacrinitidæ, Tropiometridæ, Thalassometridæ, Antedonidæ, etc., although performing the function of both side and covering plates. The latter are phylogenetically more advanced structures; whereas side plates are phylogenetically the thin produced ventrolateral border of the pinnulars and brachials which has become separated from the parent ossicle by suture, so covering plates are the produced inner distal angles of the side plates which have become secondarily separated off.

## KEY TO THE GENERA OF THE COMASTERIDÆ.

- a*<sup>1</sup>. Six pinnules following the first pair absent; mouth always central. (1) COMATILIA.
- a*<sup>2</sup>. All pinnules present; mouth usually more or less eccentric.
- b*<sup>1</sup>. IBr<sub>1</sub> and <sub>2</sub> and first two joints after each axillary united by syzygy. (2) COMATULA.
- b*<sup>2</sup>. IBr<sub>1</sub> and <sub>2</sub> and first two joints after the first axillary united by synarthry.
- c*<sup>1</sup>. Cirri present.
- d*<sup>1</sup>. Cirri without dorsal spines (ten arms).
- e*<sup>1</sup>. First two pinnules much stouter than the succeeding; cirri long, slender, and numerous (XI)----- (3) COMINIA.
- e*<sup>2</sup>. First two pinnules more slender than the succeeding; cirri short and stout, few in number (to XXVII)----- (4) COMACTINIA.
- d*<sup>2</sup>. Cirri with dorsal spines or projections (ten or more arms).
- e*<sup>1</sup>. Distal pinnules exceedingly slender with greatly elongated joints which have expanded articulations; ten arms. (5) LEPTONEMASTER.
- e*<sup>2</sup>. Distal pinnules comparatively stout, the joints rarely over twice as long as broad, the articulations not expanded.
- f*<sup>1</sup>. Ten arms; synarthrial tubercles prominent; pinnule joints with the distal ventro-lateral angle produced----- (6) COMISSIA.
- f*<sup>2</sup>. More than ten arms; synarthrial tubercles not developed; no production of the distal ventro-lateral angles of the pinnule joints.
- g*<sup>1</sup>. First brachial bearing a pinnule on arms arising from a IBr or subsequent axillary; a syzygy between the second and third brachials.
- h*<sup>1</sup>. Brachials in distal half of arm exceedingly short, almost discoidal; ambulacra naked----- (7) CAPILLASTER.
- h*<sup>2</sup>. Brachials in distal half of arm triangular or very obliquely wedge-shaped, nearly or quite as long as broad; pinnule ambulacra with large side plates----- (8) NEMASTER.
- g*<sup>2</sup>. First brachial never bearing a pinnule.
- h*<sup>1</sup>. All division series 2; a syzygy between the first two brachials----- (9) COMATELLA.
- h*<sup>2</sup>. Several or all of the division series 4 (3+4).
- i*<sup>1</sup>. Proximal pinnules more slender than the succeeding; combs occur at intervals on the distal pinnules. (10) COMASTER.
- i*<sup>2</sup>. Proximal pinnules stouter than the succeeding; no combs on the distal pinnules----- (11) COMANTHUS.
- e*<sup>2</sup>. Cirri absent; centro-dorsal a thin pentagonal or stellate plate.
- d*<sup>1</sup>. First brachial bearing a pinnule; first syzygy between the first two brachials----- (7) CAPILLASTER.

*d*<sup>2</sup>. First brachial never bearing a pinnule.

*e*<sup>1</sup>. Proximal pinnules more slender than the succeeding; terminal comb short, with long curved teeth, appearing at intervals along the distal pinnules.....(10) COMASTER.

*c*<sup>2</sup>. Proximal pinnules stouter than the succeeding; terminal comb long with short rounded teeth, confined to the proximal pinnules.

(11) COMANTHUS.

SUPPLEMENTARY KEY TO GENERA CONTAINING SPECIES WITH TEN ARMS ONLY.

*a*<sup>1</sup>. Six pinnules following the first pair absent; large side plates developed along the pinnule ambulacra; opposing spine forked or branched.

(1) COMATILIA.

*a*<sup>2</sup>. All pinnules present; no ambulacral plating; opposing spine single.

*b*<sup>1</sup>.  $1BR_1$  and  $_2$  and first two brachials united by syzygy.....(2) COMATULA.

*b*<sup>2</sup>.  $1BR_1$  and  $_2$  and first two brachials united by synarthry.

*c*<sup>1</sup>. Cirri without dorsal spines or projections.

*d*<sup>1</sup>. First two pinnules much stouter than the succeeding; cirri long, slender, and numerous (XL).....(3) COMINIA.

*d*<sup>2</sup>. First two pinnules more slender than the succeeding; cirri short and stout, few in number (to XXVII).....(4) COMACTINIA.

*c*<sup>2</sup>. Cirri with dorsal spines or projections.

*d*<sup>1</sup>. Distal cirrus joints (except the penultimate) considerably longer than broad; synarthrial tubercles not developed; distal pinnules exceedingly slender, with greatly elongated joints which have expanded articulations.....(5) LEPTONEMASTER.

*d*<sup>2</sup>. Distal cirrus joints considerably broader than long; synarthrial tubercles prominent; distal pinnules comparatively stout, the joints rarely over twice as long as broad, the articulations not expanded.....(6) COMISSIA.

SUPPLEMENTARY KEY TO GENERA CONTAINING MULTIBRACHIATE SPECIES.

*a*<sup>1</sup>.  $1BR_1$  and  $_2$  and first two joints beyond each axillary united by syzygy.

(2) COMATULA.

*a*<sup>2</sup>.  $1BR_1$  and  $_2$  and first two joints beyond the first axillary united by synarthry.

*b*<sup>1</sup>. First brachial bearing a pinnule; first brachial syzygy between the second and third brachials.

*c*<sup>1</sup>. Brachials in distal half of arm exceedingly short, almost discoidal; ambulacra naked.....(7) CAPILLASTER.

*c*<sup>2</sup>. Brachials in distal half of arm triangular or very obliquely wedge-shaped, nearly or quite as long as broad; pinnule ambulacra with large side plates.....(8) NEMASTER.

*b*<sup>2</sup>. First brachial never bearing a pinnule.

*c*<sup>1</sup>. Division series all 2; first brachial syzygy between the first two brachials on all but the outermost arms.....(9) COMATELLA.

*c*<sup>2</sup>. Several or all of the division series 4 (3+4).

*d*<sup>1</sup>. Proximal pinnules more slender than the succeeding; combs occur at intervals along the distal pinnules.....(10) COMASTER.

*d*<sup>2</sup>. Proximal pinnules stouter than the succeeding; no combs on the distal pinnules.....(11) COMANTHUS.

## 1. Genus COMATILIA A. H. Clark.

1909. *Comatilia* A. H. CLARK, Proc. U. S. Nat. Mus., XXXVI, p. 365.

*Genotype*.—*Comatilia iridometrififormis* A. H. Clark (new species).

*Distribution*.—Only known from between the Bahama Islands and Cape Fear, North Carolina.

*Depth*.—Two hundred and eighty fathoms.

## 2. Genus COMATULA Lamarck (emended).

1758. *Asterias* (part) LINNÆUS, Syst. Nat., 10th ed., II, p. 663.

1772. *Asteria* (part) BRÜNNICH, Zoölogia fundamenta, p. 230 (emendation).

[1812. *Comatule* (part) LAMARCK, Extrait du cours de zoölogie du mus. d'hist. nat. sur les animaux sans vertèbres, p. 35 (no definition)].

1816. *Comatula* LAMARCK, Hist. nat. des animaux sans vertèbres, II, p. 530, emended 1908—A. H. CLARK, Proc. U. S. Nat. Mus., XXXIII, p. 685.

1841. *Actinometra* J. MÜLLER, Archiv für Naturgesch., 1841, I, p. 140.

*Genotype*.—*Comatula solaris* Lamarck (new species).

*Distribution*.—Northern Australia to the Mergui Archipelago, China, and the Philippine Islands, ? Madagascar, ? Society Islands.

*Depth*.—Littoral and sublittoral.

## 3. COMINIA, new genus.

1908. *Comanthus* (part) A. H. CLARK, Proc. Biol. Soc. Washington, XXI, p. 220.

*Genotype*.—*Comanthus decameros* A. H. Clark, 1908.

*Description*.—Centro-dorsal discoidal, bearing numerous marginal cirri in roughly three irregular and crowded more or less alternating rows.

Cirri XL, 16–17; first joint very short, second slightly longer than broad to about twice as long as broad, third–sixth two and one-half to three times as long as broad, the following decreasing in length, the last two being squarish; opposing spine represented by a low tubercle; no dorsal spines or projections; terminal claw about as long as the penultimate joint, moderately stout and moderately curved.

Ends of the basal rays very prominent in the angles of the calyx; radials concealed;  $IBr_1$  short, oblong, widely separated laterally;  $IBr_2$  (ax) broadly pentagonal, about twice as broad as long.

Ten arms; first seven or eight brachials slightly wedge-shaped, then triangular about as broad as long. Arms rugged and tubercular basally, but not enlarged or swollen.

$P_1$  long, stout basally but becoming slender and flagellate distally;  $P_2$  slightly smaller and slightly less stout basally; following pinnules shorter and more slender, the distal pinnules increasing to about the length of  $P_1$ ; comb confined to  $PP_{1, 2}$  and  $3$ .

*Distribution*.—Only known from the Korean Straits.

*Depth*.—One hundred and seventy fathoms.

## 4. COMACTINIA, new genus.

1840. *Comatula* (part) J. MÜLLER, Archiv für Naturgesch., 1840, I, p. 311.  
 1841. *Alceto* (part) J. MÜLLER, Archiv für Naturgesch., 1841, I, p. 143.  
 1849. *Comatula* (*Alceto*) J. MÜLLER, Abhandl. d. k. preuss. Akad., 1847, p. 250.  
 1878. *Antedon* (part) POURTALES, Bull. Mus. Comp. Zool., V, p. 214.  
 1881. *Actinometra* (part) P. H. CARPENTER, Bull. Mus. Comp. Zool., IX, No. 4, p. 154.  
 1908. *Comaster* (part) A. H. CLARK, Proc. U. S. Nat. Mus., XXXIII, p. 685.  
 1908. *Phanogenia* (part) A. H. CLARK, Proc. U. S. Nat. Mus., XXXV, p. 124.

*Genotype*.—*Alceto echinoptera* J. Müller, 1841.

*Description*.—Centro-dorsal rather large, discoidal, the cirri arranged in a single marginal row.

Cirri short and stout, IX–XXVII, 8–12; basal joints short, then two or three half again to twice as long as broad, the following decreasing in length, being about as long as broad distally; opposing spine, small, erect, median in position; no dorsal spines or projections; terminal claw about as long as the antepenultimate joint (which is longer than the penultimate) stout and strongly curved basally, becoming slender and nearly straight distally.

Ends of the basal rays visible in the interradial angles; radials concealed;  $IBr_1$  very short and band-like, closely united laterally;  $IBr_2$  (ax) triangular, usually about twice as broad as long;  $IBr_1$  and first two brachials in lateral contact, though not laterally flattened.

Ten arms; proximal brachials discoidal, or oblong, then becoming triangular, at first broader than long, later about as long as broad, and wedge-shaped terminally.

Oral pinnules longer than, but not quite so stout as, those succeeding; middle pinnules with more or less developed spinous edges and dorsal processes on the joints.

*Distribution*.—Caribbean Sea, northward to South Carolina and southward to Brazil.

*Depth*.—Sublittoral, and down to 262 fathoms.

## 5. LEPTONEMASTER, new genus.

*Genotype*.—*Leptonemaster venustus*, new species.

*Description*.—Centro-dorsal a thin flat disk; cirrus sockets in a single marginal row.

Cirri XV–XX, 12–15, long and slender; first joint short, second half again as broad as long to nearly square, third about twice as long as its terminal diameter, fourth the longest, two and one-half to three times as long as its proximal diameter, fifth a transition joint, not quite so long as the fourth, with a dark band about its center; following joints gradually decreasing in length, the antepenultimate being very slightly longer than broad, or squarish, and the

penultimate squarish or not quite so long as broad; second to sixth joints slender, moderately constricted centrally ("dice-box shaped"), with prominent articulations, rounded in cross-section, then becoming rather strongly compressed laterally (the distal portion of the cirrus therefore becoming broader in lateral view) and less and less "dice-box shaped;" transition and following joints with a small, though prominent, sharp subterminal dorsal spine; opposing spine slightly marked, median, arising from the entire dorsal surface of the penultimate joint; terminal claw somewhat longer than the penultimate joint (about as long as the antepenultimate), moderately stout, and moderately curved, the curvature being strongest in the basal portion.

Ends of the basal rays visible as rather prominent tubercles in the angles of the calyx; radials entirely hidden or slightly visible over the ends of the basal rays, separated distally;  $IBr_1$  short, nearly four times as broad as long, the proximal edge convex, not in contact basally, rounded and widely free laterally, the sides of adjacent  $IBr_1$  making with each other an angle of about  $90^\circ$ ;  $IBr_2$  (ax) triangular, the anterior angle somewhat produced, about one and one-half times as broad as long, the very short lateral edges making an obtuse angle with those of the  $IBr_1$ .

Ten arms; first seven brachials approximately oblong, then becoming obliquely wedge-shaped, and after the tenth triangular, about as long as broad, and terminally obliquely wedge-shaped and longer than broad, with somewhat expanded articulations; after about the sixth the brachials develop strongly produced and overlapping distal ends. Syzygies occur between the third and fourth brachials, again between the tenth and eleventh to twelfth and thirteenth, and distally at intervals of three oblique muscular articulations.

Disk naked; mouth and anal tube about equally eccentric.

$P_1$  the stoutest, and much the longest, evenly tapering to a flagellate tip;  $P_2$  considerably shorter and much more slender than  $P_2$ ;  $P_3$  not much more than one-third,  $P_4$  one-third the length of  $P_1$ ; following pinnules increasing slowly in length, the distal being nearly as long as  $P_1$ , with elongated joints which have expanded articulations, and spinous distal ends.

*Distribution.*—Caribbean coast of Central America, Gulf of Mexico, and northern coast of Cuba.

*Depth.*—Forty-two to 163 fathoms.

LEPTONEMASTER VENUSTUS, new species.

Centro-dorsal a thin flat disk, the small cirrus sockets arranged in a single crowded marginal row, usually five to each radial area.

Cirri XV–XX, 12–15 (most commonly 13 or 14) 10 mm. long, as described above.

IBr series and calyx elements as described.

Ten arms 70 mm. to 90 mm. long; first brachial short, slightly wedge-shaped, about three times as broad as the exterior length, entirely separated interiorly by the anterior apex of the IBr<sub>2</sub>, the interior edges diverging at an angle of approximately 90° or slightly less; second brachial irregularly quadrate, slightly larger than the first; third and fourth brachials (syzygial pair) oblong, about half again as broad as long; next three brachials approximately oblong, about twice as broad as long, then becoming obliquely wedge-shaped, and after about the tenth triangular, about as long as broad, further out on the arm becoming very obliquely wedge-shaped (almost triangular) about as long as broad, and in the terminal portion longer than broad. After about the sixth the brachials develop strongly produced and overlapping distal ends.

P<sub>1</sub> 10 mm. long, with about thirty-five joints, moderately stout basally and evenly tapering; terminal comb with 13 to 15 teeth, preceded by two or three more or less rudimentary; teeth spade-shaped or triangular, longer than broad, slightly longer than the lateral diameter of the joint which bears them, well separated, and incurved; basal joints of the pinnule broader than long, the proportionate length gradually increasing, so that the joints from the middle onward are approximately squarish; the joints have prominent dorsal projections with the apex at the distal end, and strongly produced distal edges, these characters dying gradually away after about the middle of the pinnule; P<sub>2</sub> much more slender than P<sub>1</sub>, 7 mm. long, the joints after the fifth squarish; first two joints with strong dorsal processes or broad carinations, that of the second the stronger; following joints with rounded dorsal processes and prominent distal edges; terminal comb rather long with sixteen fully developed and five or six smaller and more rounded teeth; teeth proportionately slightly longer and better developed than the teeth of P<sub>1</sub>; P<sub>3</sub> about 4 mm. long, slender and delicate, the first two joints disproportionately large, about half again as broad as long, the second with a much produced distal dorsal angle or even distal half of the dorsal side; third joint squarish; following joints slightly longer than broad; third and following joints as far as the comb, as in P<sub>2</sub>, with strongly produced coarsely spinous distal ends; comb as in P<sub>2</sub>; P<sub>4</sub> 3.5 mm. long, slightly more delicate than P<sub>3</sub>, with no enlargement of the two basal joints and no comb; first two joints short, third longer than broad, the following increasing slightly in length, being about half again as long as broad distally; third and following joints with produced and coarsely spinous distal edges; P<sub>5</sub> similar to P<sub>4</sub>, 4 mm. long, with sixteen joints, but slightly stouter; following pinnules similar to P<sub>5</sub>, increasing very gradually in length; distal pinnules 8 mm. to 9 mm. long, slender, with about 21 joints, the first two not so long as

broad, the third slightly longer than broad, the remainder becoming elongated and about three or four times as long as broad distally; third and following joints with expanded articulations and coarsely spinous distal ends.

*Color* (in spirits).—Brownish white, the perisome dark brown.

*Type*.—Cat. No. 25457, U.S.N.M., from *Grampus* station 5104, off the west coast of Florida; 51 fathoms.

### 6. COMISSIA, new genus.

1908. *Comaster* (part) A. H. CLARK, Smiths. Miscell. Coll. (Quarterly Issue), I.II, p. 202.

*Genotype*.—*Comissia lütkeni*, new species.

*Description*.—Centro-dorsal discoidal, the bare polar area broad and flat, the cirrus sockets arranged in two closely crowded alternating rows.

Cirri XV–XXV, 16–24, resembling those of *Capillaster*; the fourth is a transition joint.

Ends of the basal rays visible as prominent tubercles in the angles of the calyx; radials very slightly visible over the ends of the basal rays, or quite concealed;  $IBr_1$  short and broad, closely united laterally, more or less concealed by the centro-dorsal;  $IBr_2$  (ax) triangular, about twice as broad as long, free laterally; synarthrial tubercles prominent.

Ten arms; first brachial short, slightly wedge-shaped, between three and four times as broad as long exteriorly, interiorly united; second brachial larger and much more obliquely wedge-shaped; third and fourth (syzygial pair) somewhat longer interiorly than exteriorly, about twice as broad as the interior length; following one or two brachials almost oblong, about three times as broad as long, then becoming triangular, about twice as broad as long, in the terminal part of the arm becoming very obliquely wedge-shaped, about as long as broad; brachials after the second with prominent and finely spinous distal ends and a very finely tubercular or spinous dorsal surface which in the terminal portion gradually become obsolete, so that the ends of the arms are practically smooth. Syzygies occur between the third and fourth brachials, again between the eleventh and twelfth to fourteenth and fifteenth, and distally at intervals of three oblique muscular articulations.

Disk naked, or with small scattered calcareous granules; mouth subcentral; anal tube small and marginal.

$P_1$  the longest; following pinnules decreasing gradually in length and slightly in stoutness to  $P_4$ , which is less than half as long as  $P_1$ , with somewhat less than half as many joints; following pinnules remaining similar for some time, then gradually becoming more slender and increasing in length to about the length of  $P_3$  distally;

the joints of the middle and distal pinnules are slightly "dicebox-shaped," with a finely spinous surface and with the distal ends produced ventrally into two long sharp spines, one on each side of the perisome; this modification of the joints in the more proximal of the pinnules affects only the distal portion, but later encroaches more and more upon the proximal part, soon involving almost all of the joints.

COMISSIA LUTKENI, new species.

1908. *Comaster coppingeri* (part) A. H. CLARK, Smiths. Miscell. Coll. (Quarterly Issue), LII, p. 202 (ten-armed specimens).

Centro-dorsal discoidal, the bare polar area broad and flat, 4 mm. or 5 mm. in diameter; cirrus sockets arranged in two closely crowded alternating rows.

Cirri XV-XXV, 16-24 (usually 18-21) 7 mm. to 17 mm. long, comparatively small and rather stout; first joint over twice as broad as long, second and third nearly or quite as broad as long, fourth half again to nearly twice as long as broad, a transition joint, usually rather darker than the preceding, but light colored and with a polished surface in the distal fourth; following joints decreasing in length, after the eighth being about twice as broad as long; occasionally the fifth is a transition joint instead of the fourth, in which case the two are about of the same size: fourth and following joints with the dorsal and dorso-lateral distal edge everted and finely spinous; this eversion of the distal edge of the joints gradually narrows anteriorly, on the last two or three joints becoming merely a single blunt spine or tubercle; concurrently with its shortening, it gradually attains a crescentic form, so that in lateral view the joints from the fourth onward appear to be furnished with low dorsal spines which arise gradually from the whole dorsal surface, at first terminal, gradually becoming subterminal in position, and on the antepenultimate joint almost median: opposing spine median, arising from the entire dorsal surface of the penultimate joint, short and blunt, reaching not more than one-third the distal diameter of that joint in height; terminal claw about as long as the penultimate joint, stout, and moderately curved.

Post-radial elements as given in the generic description; the arms are 70 mm. to 75 mm. long.

P<sub>1</sub> 12 mm. to 15 mm. long, slightly stouter than the succeeding, though not especially large, with about thirty-five joints, at first about twice as broad as long, very gradually becoming longer and about as long as broad after the twelfth or fifteenth; terminal comb prominent, arising abruptly, with sixteen teeth, bluntly triangular, nearly twice as long as broad at the base, basally in apposition, about as high as the transverse diameter of the joints which bear them, rather strongly recurved; P<sub>2</sub> similar, 10 mm. to 12 mm. long; P<sub>3</sub>

similar, 8 mm. to 10 mm. long;  $P_4$  6 mm. long;  $P_5$  and following pinnules 6 mm. long without combs, composed of sixteen joints, the first three not so long as broad, the remainder about as long as broad; distally the pinnules gradually increase in length and become more slender, being distally 8 mm. long with twenty-three to twenty-five joints, the first two short, the third and following longer than broad, becoming about twice as long as broad in the outer portion. The lower pinnules have the corners of the joints considerably cut away as in *Heliometra*; the joints of the middle and distal pinnules are slightly "dice-box shaped" with a finely spinous surface, and with the distal ends produced ventrally into two long, sharp spines, one on each side of the perisome; this modification of the joints in the more proximal of the middle pinnules affects only the distal portion, but later encroaches more and more upon the proximal part of the pinnules, soon involving almost all of the joints.

*Color* (in spirits).—Bright yellow, the skeleton lighter.

*Type*.—Cat. No. 25513, U.S.N.M., from *Albatross* station 5153; east of Port Dos Amigos, Tawi Tawi; 49 fathoms.

#### 7. Genus CAPILLASTER A. H. Clark.

1758. *Asterias* (part) LINNÆUS, Syst. Nat., 10th ed., II, p. 663.

1772. *Asteria* (part) BRÜNNICH, Zoölogia fundamenta, p. 230 (emendation).

1816. *Comatula* (part) LAMARCK, Hist. nat. des animaux sans vertèbres, II, p. 530.

1836. *Comaster* (part) L. AGASSIZ, Mém. Soc. de sci. nat. de Neuchâtel, I, p. 193.

1841. *Actinometra* (part) J. MÜLLER, Archiv für Naturgesch., 1841, I, p. 140.

1849. *Comatula* (*Actinometra*) (part) J. MÜLLER, Abhandl. d. k. preuss. Akad., 1847, p. 246.

1849. *Comatula* (*Alecto*) (part) J. MÜLLER, Abhandl. d. k. preuss. Akad., 1847, p. 258.

1909. *Capillaster* A. H. CLARK, Proc. Biol. Soc. Washington, XXII, p. 87.

*Genotype*.—*Actinometra sentosa* P. H. Carpenter, 1888.

*Distribution*.—Madagascar to northern Australia, the Philippines, and Japan.

*Depth*.—Littoral and sub-littoral; rarely down to 160 fathoms.

#### 8. NEMASTER, new genus.

1879. *Antedon* (part) RATHBUN, Trans. Conn. Acad. Sci., V, p. 157.

1880. *Actinometra* (part) P. H. CARPENTER, Journ. Linn. Soc. (Zool.), XV, p. 213.

1908. *Comaster* (part) A. H. CLARK, Proc. U. S. Nat. Mus., XXXIII, p. 685.

*Genotype*.—*Nemaster grandis*, new species.

*Distribution*.—Caribbean Sea and Atlantic coast of South America south to Bahia.

*Depth*.—Littoral, and down to 194 fathoms.

*Diagnosis*.—In general same as *Capillaster*; IIBr 4 (3+4); IIIBr 3 (2+3), or irregular; brachials at first oblong, then triangular, about as long as broad, wedge shaped and longer terminally; terminal comb usually repeated on inner side of proximal pinnules; side plates developed along the ambulacra.

NEMASTER GRANDIS, new species.

Centro-dorsal thick-discoidal, the polar area 5 mm. in diameter, deeply concave; cirrus sockets marginal, arranged in three closely crowded alternating rows.

Cirri XXV-XXX, 30-35, about 40 mm. long, large and stout; first joint short, about three times as broad as long; following joints gradually increasing in length to the sixth or eighth, which, with the three following, is squarish, then gradually decreasing, the joints from the twelfth or fifteenth onward being about twice as broad as long, but the last two are almost square again; a transition joint occurs between the seventh and the twelfth, proximal to which the joints have a dull, finely pitted surface, distally a highly polished surface, the pits widely scattered or absent, and dorsal projections; transition joint not especially marked; joints proximal to the transition joint with practically straight sides and no modification of the dorsal distal edge; transition and following joints with the distal dorsal edge projecting as a transverse ridge, coarsely dentate (usually tridentate), the ridge being equal in length (transversely) to about half the diameter of the joints; distally the ridge gradually narrows, becoming bidentate, and in the terminal four to seven joints resolves itself into a single spine, which on the antepenultimate becomes subterminal in position; all the transverse ridges appear as rather prominent spines in lateral view; opposing spine prominent, though short, rather stout, arising from the whole dorsal surface of the penultimate joint, about equal in length to one-third the diameter of that joint, the apex subterminal or submedian, the distal edge usually making much less of an angle with the transverse diameter of the joint than the proximal, giving the spine the appearance of leaning forward; terminal claw considerably longer than the penultimate joint, stout basally, slender distally, strongly curved proximally, but becoming nearly straight in the distal portion.

Ends of the basal rays visible as low tubercles in the angles of the calyx, but with difficulty differentiated from the adjacent parts; radials concealed in the median line, but visible as a rather prominent triangle in the angles of the calyx, the apex of which separates the lower corners of the IBr<sub>1</sub>; IBr<sub>1</sub> oblong, rounded dorsally and laterally, about three times as broad as long, widely separated laterally; IBr<sub>2</sub> (ax) pentagonal, one-third to one-half again as broad as long, the

lateral edges diverging distally and about equal in length to those of the IBr<sub>1</sub>; IIBr 4 (3+4); IIIBr 3 (2+3), the division series being separated by a distance about equal to the breadth of the IIBr series; if the full IIIBr series is not present, those on the exterior sides of the IBr series are most frequently absent, so that there is an approximation to a 1, 2, 2, 1 arrangement.

Twenty-four to thirty-one arms, about 200 mm. long; first brachial wedge-shaped, rather large, not quite half again as broad as the exterior length, almost entirely united interiorly; second and third brachials (syzygial pair) not quite so long as broad; next four brachials oblong, about twice as broad as long, then wedge-shaped, and after three or four triangular, about as long as broad; in the terminal portion of the arms the brachials become wedge-shaped, nearly or quite twice as long as broad. The distal edges of the brachials project slightly and are beset with fine spines. Syzygies occur between the second and third brachials, again between the fourteenth and fifteenth to twenty-second and twenty-third (usually in the vicinity of the eighteenth) and distally at intervals of three oblique muscular articulations.

Mouth marginal and radial; anus central; disk naked, about 30 mm. in diameter; side plates developed along the brachial and pinnule ambulacra.

P<sub>D</sub> 30 mm. to 35 mm. long, stout, much stouter than the succeeding pinnules, but tapering evenly to a slender and flagellate tip, with forty to forty-five joints, all of which are approximately squarish; a slight prominence is visible on the dorsal side of the distal edge of the second joint, which rapidly becomes larger and increases in width on the succeeding joints, after about the seventh taking the form of a strong coarsely spinous eversion of the dorsal edge of the joints; this disappears near the proximal part of the distal comb; comb composed of fourteen teeth, arising abruptly; first tooth low and triangular; second oblong or slightly trapezoidal, usually slightly broader basally than high, the following becoming more obliquely trapezoidal and relatively somewhat higher, the terminal teeth being truncated-triangular; the more proximal teeth are not equal in height to more than three quarters of the lateral diameter of the joints which bear them, but the later teeth, owing to the distal tapering of the pinnule, become about equal to the lateral diameter; P<sub>F</sub> about 25 mm. long, considerably less stout than P<sub>D</sub>, but otherwise similar to it; P<sub>1</sub> about 20 mm. long, much less stout than P<sub>F</sub>, similar to it; P<sub>2</sub> and following pinnules slender and delicate, about 10 mm. long; P<sub>2</sub> bears a comb distally, but the following pinnules are without combs; PP<sub>2, 3, 4</sub>, and 'a, b, c' have the first two joints disproportionately large and produced dorsally into large carinate processes; distal pinnules slender, about 12 mm. long, with about twenty-five

joints, the first over twice as broad as long, the second about as long as broad, the third longer than broad, the remainder about half again as long as broad. The distal ends of the joints are slightly everted and finely spinous; the dorsal surface is beset with fine spines, and the last four joints bear long recurved spines.

*Type*.—Cat. No. 25459, U.S.N.M., from *Albatross* station 2146; off Colon; 34 fathoms.

#### 9. Genus COMATELLA A. H. Clark.

1874. *Actinometra* (part) LÜTKEN, Mus. Godefr. Cat., V, p. 190.

1908. *Comaster* (part) A. H. CLARK, Proc. U. S. Nat. Mus., XXXIII, p. 685.

1908. *Phanogenia* (part) A. H. CLARK, Proc. U. S. Nat. Mus., XXXV, p. 124.

1908. *Comatella* A. H. CLARK, Smiths. Miscell. Coll. (Quarterly Issue), LII, p. 207.

*Genotype*.—*Actinometra nigra* P. H. Carpenter, 1888.

*Distribution*.—Ceylon to Fiji, Tonga, Samoa, and Japan; West Indies, St. Paul's Rocks, Atlantic coasts of southern Europe and northwestern Africa.

*Depth*.—In the Indian and Pacific oceans, littoral, and down to 140 fathoms; in the Atlantic 73–830 fathoms.

#### 10. Genus COMASTER L. Agassiz.

1816. *Comatula* (part) LAMARCK, Hist. nat. des animaux sans vertèbres, II, p. 530.

1836. *Comaster* L. AGASSIZ, Mém. Soc. de Sci. nat. de Neuchâtel, I, p. 193.

1841. *Alecto* (part) J. MÜLLER, Archiv für Naturgesch., 1841, I, p. 147.

1849. *Comatula* (part) J. MÜLLER, Abhandl. d. k. preuss. Akad., 1847, p. 262.

1866. *Phanogenia* LOVÉN, Öfversigt k. Vetensk.-Akad. Förhandl., 1866, No. 9, p. 231.

1879. *Actinometra* (part) P. H. CARPENTER, Proc. Roy. Soc., XXVIII, p. 386.

*Genotype*.—*Comatula multiradiata* Lamarck, 1816 (not *Asterias multiradiata* Linnaeus) = *Alecto multifida* J. Müller, 1841.<sup>a</sup>

*Distribution*.—Northern Australia to Luzon and the Mergui Archipelago.

*Depth*.—Littoral and sublittoral.

#### 11. Genus COMANTHUS A. H. Clark.

1816. *Comatula* (part) LAMARCK, Hist. nat. des animaux sans vertèbres, II, p. 530.

1841. *Actinometra* (part) J. MÜLLER, Archiv für Naturgesch., 1841, I, p. 140.

1841. *Comaster* (part) J. MÜLLER, Archiv für Naturgesch., 1841, I, p. 140.

1841. *Alecto* (part) J. MÜLLER, Archiv für Naturgesch., 1841, I, p. 144.

1849. *Comatula* (*Actinometra*) (part) J. MÜLLER, Abhandl. d. k. preuss. Akad., 1847, p. 256.

<sup>a</sup> Cf. Proc. Biol. Soc. Washington, XXII, p. 87.

1849. *Comatula (Alceto)* (part) J. MÜLLER, Abhandl. d. k. preuss. Akad., 1847, p. 260.

1891. *Goldfussia* (not of de Casteleau, 1843) NORMAN, Ann. and Mag. Nat. Hist., [6] VII, p. 387.

1908. *Phanogenia* (part) A. H. CLARK, Proc. U. S. Nat. Mus., XXXV, p. 124.

1908. *Comanthus* A. H. CLARK, Proc. Biol. Soc., Washington, XXI, p. 220.

*Genotype*.—*Comanthus intricata* A. H. Clark, 1908.

*Distribution*.—South Africa westward and northwestward, along the southern coast of Asia and the entire coast of Australia, throughout the East Indies, to southern Japan, the Kingsmill (Gilbert) Islands, Fiji, and Samoa.<sup>a</sup>

*Depth*.—Littoral and sublittoral.

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<sup>a</sup> Carpenter records *C. rotalaria* ("*Actinometra parvicirra*") from Peru, in South America, and others have since accepted this record. This Peru is, however, undoubtedly Peru or Francis Island, situated approximately in lat. 1° 30' S., long. 176° 00' E., in the Gilbert group, north of Fiji.