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THE RECENT CRINOIDS OF AUSTRALIA.

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BY AUSTIN HOBART CLARK.

INTRODUCTION.

The Trustees of the Australian Museum have done me the honour of entrusting to me for study their entire collection of Australian Crinoids.

The Crinoid fauna of the Australian coasts is of the greatest interest, not alone from the abundance and variety of its component species, but from its similarity in certain ways to that of the Jurassic and later horizons of Europe. Previous to the receipt of this collection I had only been able to examine occasional specimens, representing, however, numerous species, from Australia, mostly from Sydney, together with the collection made by the German ship "Gazelle" at various points on the west and north-west coasts. It was therefore with the greatest anticipation that I undertook the study of the collections of the Australian Museum, a study which has assisted in elucidating a number of hitherto obscure points and in giving me a much clearer idea of the Crinoid fauna of Australia as a whole.

I wish to record my appreciation of the kindness shown me by the Trustees of the Australian Museum and by the Curator, Mr. R. Etheridge, Junr., and to thank these gentlemen for the privilege I have enjoyed in being permitted to examine their very extensive and valuable collections.

At the time this collection was received I had at hand the Crinoids belonging to the University of Copenhagen, those of the Berlin Museum, including several of Professor Johannes Müller's types, those of the Indian Museum, the specimens collected by the German steamer "Gazelle," and by the Indian steamers "Investigator" and "Golden Crown." In addition the enormous collections of the United States National Museum were under my care, as well as the large mass of material brought together by the United States Fisheries steamer "Albatross," when working among the Philippine Islands. Altogether the available material comprised some dozens of Australian specimens, and some hundreds of specimens of species occurring in Australia, so that I had ample facilities for making comparisons between the individuals in the Australian Museum collection and valuable material belonging to other institutions.

I happened to be in Cambridge, Massachusetts, at the time that my friend, Dr. Hubert Lyman Clark, was studying the

Echinoderms collected by the "Thetis" and, with his usual kindness, he permitted me to take one from the Crinoids which were among them, and I shall take the opportunity of including it in the present paper.

While this paper was in press I visited all the Museums of Europe which I had reason to think contained Australian Crinoids. In London, thanks to the courtesy of Professor F. Jeffrey Bell, I was permitted to examine the collections upon which his list of the Crinoids of North-western Australia was based, the historic "Alert" collections, and a considerable amount of unrecorded material. At Paris, thanks to the kindness of MM. E. Perrier and L. Joubin, I was enabled to examine the Australian specimens—all in a wonderfully perfect state of preservation—described nearly one hundred years ago by Lamarck, as well as those described at a later date by Johannes Müller. Drs. F. A. Jentink and R. Horst, at Leyden, most generously allowed me to study the historic specimens under their care, while Professors K. Kraepelin and G. Pfeffer extended similar courtesies to me at Hamburg.

Upon my return to the United States, Professor W. Michaelsen, of Hamburg, sent to me the Crinoids which he, together with Dr. R. Hartmeyer, of Berlin, had collected on the west coast of Australia. Though a large collection, it does not alter the generalizations herein expressed to any appreciable degree.

Thus in the preparation of this Report I have personally examined the type specimen of every species of Crinoid recorded from Australia, and also practically every specimen which, so far as can be ascertained, has ever been sent abroad from that country.

In certain cases the examination of the types has shown that the present conception of the species is entirely erroneous, and it has frequently happened that species have been recorded under incorrect names. The rectification of these errors has necessitated a somewhat extensive revision of the proof, and for the trouble caused thereby I offer to the Editor of these Memoirs a sincere apology.

Among the Crinoids sent to me were a few from the Solomon Islands, taken mostly at Ugi. I have thought it best to consider these apart from those from the Australian coasts, as the faunal relations of the Solomons are somewhat different from those of Australia. These are therefore treated in a paper which will appear in a forthcoming number of the Museum "Records," and, though short, represents the sum of our knowledge regarding the Crinoid fauna of those Islands, and is accompanied by a bibliography which includes all the papers I have been able to find where Solomon Island Crinoids are mentioned.

A few other specimens are from scattered localities ; but some of these are of very exceptional interest, and cannot justly be omitted from consideration. They are therefore included with the above.

From a palæontological point of view the study of the recent Crinoids is of more importance than that of any other animals so far as the marine deposits are concerned. There are three reasons for this :—

(1). The Crinoids are animals of the greatest antiquity and their palæontological record therefore shows a succession of forms none of which depart very widely from the general type ; developmentally speaking the lapse of time since the first vestiges of crinoidal remains is infinitesimal, and the Crinoids of the several past horizons can only logically be considered as constituting so many separate zoögeographic areas, all of equal value, and all equal in terms of phylogenetic development to the zoögeographic areas of to-day. In fact one is almost justified in stating that the phylogenetic perfection of the Crinoids is in inverse proportion to their age as we know it from their position in the rocks, so great has been their specialization in the past, and a phylogenetic tree beginning with the Crinoids of the present day and ending with those of the Cambrian would have just as much to recommend it as one following the so-called development of the class from Cambrian times to the recent epoch. Thus, the past history of the Crinoids may be said to be a radial, instead of a linear, succession of types, each one of which takes a position on or near the circumference of a circle, and all of which are nearly equidistant from the two or three indicated primitive types which occupy its centre.

(2). The Crinoids are securely attached by a stem and root, and thus immovably fixed, or attach themselves to various objects by means of their cirri, remaining as a rule stationary for life ; the young are always fixed. As we know it, the free larval existence is passed chiefly within the vitelline membrane attached to the pinnules of the parent, the actual free swimming stage not being of more than forty-eight hours' duration. Thus, of all marine animals the Crinoids are the most nearly strictly sessile. This renders them most valuable aids in tracing out the fundamental facts of the distribution of marine animals, both past and present, for it reduces to a minimum the effect of ocean currents upon them, and, since individual species are strictly limited in their thermal and bathymetric range (especially in the former), it results in the interposition of certain barriers to their distribution more or less inoperative in the case of other animals, including the other Echinoderms. Chief among these barriers are deep channels of considerable width which the littoral and

sublittoral species cannot cross as their larvæ develop the normal impulse for fixation in a shorter time than that required to drift to the other side, and thus fall into deep water amidst a cold and unnatural environment, and perish. Rivers of considerable volume and depth act in exactly the same way; the larvæ, on account of their short duration of existence as larvæ, cannot pass around the fatal fresh water, nor, if the river be very deep, can they pass beneath it.

(3). The Crinoids are the most highly calcified of organisms, and the most uniformly calcified as a class, exhibiting, so far as we know, but very slight variation. The smallest Comatulids, with arms scarcely half an inch long, probably never have less than 20,000 distinct skeletal elements, while it has been estimated that the large Pentacrinites possess 5,000,000; personally I think the latter estimate slightly too conservative as it takes no account of the visceral skeleton. Thus, the Crinoids are peculiarly susceptible of preservation, and hence their excellent palæontological record, surpassing even that of the molluscs.

As subjects for study in all lines the Crinoids offer wonderful possibilities, and in no place can their study be prosecuted to such advantage as in Australia where the multitude of forms easily available occur largely within easy reach of important scientific centres. It is mainly to Australia, therefore, that the world must look for the solution of the problems dealing with these animals, and the Australian naturalists will be the ones to whom the naturalists of other lands must look for guidance.

Only a very feeble beginning has been made in the study of the recent Crinoids, even from a systematic standpoint. The proportion of known to unknown forms is still very small, as is graphically brought out by the study of any large collection, and remarkable new genera are being brought to light with increasing frequency.

The anatomy of two species of *Antedon*, *A. bifida* and *A. mediterranea*, has been studied by Ludwig, Perrier, Hamann, and the two Carpenters, who also discussed in more or less detail that of *Heliometra glacialis* and a few other species such as *Comanthus parvicirra*, *Neocomatella alata*, and *Comatella nigra*; but the refinement of technique and especially of methods of fixation since their work was done—work which was almost wholly based upon more or less poorly preserved alcoholic material—have made the field one of very great promise, entirely untouched so far as Australian species are concerned.

Dendy's studies on the regeneration of the disk, and Minckert's, Perrier's, and Przibram's on the regeneration of the disk and arms have indicated most interesting lines of work, and pointed

out some very remarkable facts, but can scarcely be said to have done more; Reichensperger's investigation of the glands and their secretions have opened up interesting questions of physiology.

The work of Wyville Thomson, W. B. Carpenter, Perrier, and especially of Barrois, Bury, and Seeliger has laid a foundation, though one with many weak spots, upon which to build up the study of the comparative embryology of the Crinoids; but no one up to this time has attempted any embryological investigation outside of the genus *Antedon*, Thomson, Carpenter, and Perrier treating of *Antedon bifida*, Barrois and Bury of *A. mediterranea*, and Seeliger of *A. adriatica*. Great results from this study are assured in Australia where the genus *Antedon* does not occur, it being here replaced by many other genera, some of them much more favourable for study in the young stages, and others about whose development nothing whatever is known.

The composition of the Crinoid skeleton offers an interesting field for investigation. An analysis of the pinnulate arms of a specimen of *Metacrinus rotundus* from Japan showed 11% of $MgCO_3$. Fearing from the very high percentage of $MgCO_3$ that some mistake might have been made in the analysis, I had analyses made of another specimen of *Metacrinus rotundus* from Japan, and of a specimen of *Heliometra maxima* from very cold water in the Sea of Okhotsk; the former showed 10.29% of $MgCO_3$, and the latter 7%.

It has been noticed that the littoral Crinoids are more or less limited in their distribution to coast lines well supplied with fresh water, either from rain or shallow rivers; a careful statistical study of the effect of river water and rain water, especially the toxic effect of the dissolved oxygen in the latter, upon the small organisms which serve as Crinoid food, as well as a detailed study of the comparative growth of the Crinoids in areas exposed to and protected from rain, would be certain to yield results of great value. Not only on this point but on all others has the general natural history of the Crinoids been sadly neglected. We are ignorant of the limitations of their chemical, physical, and biological environment and of its influence on their size, colour, development, and local distribution; no detailed analyses have been made of the stomach contents; we do not know whether they select their food, whether each species eats the same things, or whether the food is uniform or varied or its supply intermittent or constant. The Comasterids have many-coiled intestines whereby we infer they ingest a large proportion of indigestible inorganic matter along with their food, though we do not know anything about it. Since the numerous coils are not found until late in post-pentacrinoid life, we assume that when young their habits resemble those of the endocyclic forms, but here again we have only a theoretical basis for our belief.

The gregarious habits of certain forms and the solitary habits of others have been explained theoretically but never studied in the field, nor is anything known about their adolescent autotomy or their relations to light, salinity, temperature, or mechanical disturbances, such as wave motion. The physiological processes, such as the digestive action, the breaking apart of the syzygies, and the significance of the water vascular system are as yet practically unstudied, as are the curious pigments, antedonin and others, and their varied and beautiful manifestations under different conditions.

In short, though the study of no group of animals gives promise of such important results, especially from a palæontological standpoint, there is no group of animals about which we know so little, and it is greatly to be hoped that the near future will see an awakening of interest which will place our knowledge of the recent Crinoids on a par with our knowledge of other recent animals, as their great importance, particularly in linking the present with the past, deserves.

HISTORY OF THE SUBJECT.

The history of the study of the Crinoidea inhabiting the coasts of Australia is, considering the great importance of the region, surprisingly short. The literature dealing with the subject is all included in less than forty papers contributed by only fourteen authors; most of these papers mention Australian species only incidentally, while a few are local lists, based on small collections from single localities or from limited areas; no comprehensive work has yet appeared. Such a state of affairs necessitates a very considerable amount of labour for anyone who wishes to acquire a general idea of the subject, for all these papers must be read and a general idea formed by piecing together the more or less fragmentary bits of information gleaned from each.

Lamarck was the first author to mention any Australian Crinoid, over one hundred years after the first announcement of their occurrence in China had been made. In 1816 he described four new species, which had been obtained in Australia by Péron and Le Sueur on their memorable voyage in 1803, under the names of *Comatula aëonæ*, *C. fimbriata*, *C. solaris*, and *C. rotalaria*. The second of these is the same form which was described from China by Petiver, in 1711, as *Stella chinensis perlegens*, a reference cited by Linnæus under his *Asterias pectinata*, and is also identical with the species represented by the type specimen of Linnæus' second species, *Asterias multiradiata*, which had come from the Indian Ocean. At the same time Lamarck described his *Comatula brachiolata*, for which the habitat "Atlantic Ocean" was given, though it has since been found to be an Australian species.

Professor Johannes Müller next took up the comprehensive study of the recent Crinoids, and in 1841 published an excellent treatise on the genera and species of the Comatulids. In this five new species are described which occur on the Australian coasts, though, so far as known, none of the type specimens were actually obtained there. The first of these species, *Actinometra imperialis*, of unknown habitat, was made the type of a new genus, *Actinometra*; but later Müller discovered that it was identical with Lamarck's *Comatula solaris*, described twenty-five years before. One of the four other species is also a synonym of a form previously described by Lamarck, *Alecto rosea* being the same as *Comatula brachiolata*, and *A. timorensis* is identical with the *Alecto parvicirra* described by Müller in the same paper. *Alecto timorensis* came from Timor, but the origin of the others was unknown.

On examining the literature, Müller found two forms designated by the name *multiradiata*, supposed by their authors to be referable to the Linnæan *Asterias multiradiata*. One was the *Comatula multiradiata* of Lamarck, briefly and inadequately diagnosed in 1816, and the other the *Comatula multiradiata* of Goldfuss, well described and beautifully figured in 1832. Müller took the ground that the name must hold for the form which was recognizable from the description, that described by Goldfuss, and he redescribed one of Lamarck's original specimens under the name of *multifida*, which name he intended as a substitute for *multiradiata*, Lamarck. The *multiradiata* of Lamarck was a composite species, composed of three elements now distributed in two different genera; but its exact interpretation is a matter of very considerable importance, for it was made the type of the genus *Comaster* by L. Agassiz, in 1836. This action by Müller technically identifies the *multiradiata* of Lamarck, and gives us a definite type, *multifida*, for the genus *Comaster*. Although not originally described from Australia, *multifida* is an Australian species.

In 1843 Müller described *Alecto purpurea* from a specimen which was obtained by Preiss in Australia. This species has been commonly considered identical with the Linnæan *Asterias pectinata*, but in reality it is perfectly distinct. The type is in the Berlin Museum, and the authorities of that institution have been so kind as to allow me to borrow it, whereby I have been enabled to compare it side by side with similar specimens in the Australian Museum, and thus definitely to establish its identity and individuality.

On the 13th August, 1845, there appeared the following notice in "L'Institut," p. 292:—

"Une espèce nouvelle d'Encrine vivante a été découverte par le reverend C. Pleydell, à Newcastle, sur la rivière Hunter,

dans la Nouvelle-Hollande; l'auteur propose de lui donner le nom d'*Encrinus australis*. Elle n'a pas de colonne vertébrale, mais le corps de l'animal a environ un cinquième de pouce de long, et est terminé dans cette direction par une base circulaire. A l'extrémité opposée du corps sont attachés cinq appendices claviculaires, etc. M. Pleydell a essayé souvent de recueillir avec beaucoup de soin des échantillons complets de cet animal pour les envoyer en Europe; mais, après sa mort, les articulations ne tardent pas à s'en disjoindre et à tomber en pièces. La découverte de M. Pleydell est d'autant plus intéressante que jusqu'à présent on n'a encore rencontré que très rarement des échantillons en entier de *Encrines* vivants, et encore le nombre des espèces en est-il très limité. On sait d'autre part combien sont nombreux ces animaux à l'état fossile dans presque toute la série des terrains stratifiés, jusque peut-être dans les terrains tertiaire, si l'on ajoute foi aux dernières découvertes faites à ce sujet dans les terrains subalpains."

This organism could not have been a Crinoid; what it was has remained, so far as literature is concerned, a mystery.

In 1846 Müller described two species which had been brought from King George Sound in South-western Australia by MM. Quoy and Gaimard. These were *Comatula macronema* and *C. trichoptera*, which have since proved to be the most characteristic of all the Australian species, and, with the addition of another related to the first, the only ones confined to the more southern part of the Continent.

Sir Richard Owen in 1862 described, but did not name, an "encrinite" which was dredged by Mr. J. S. Poore in eight fathoms in King George Sound; it was about six inches long, with arms one and one-half inches long, and was coloured a beautiful rose or pink, fading to white. Dr. P. H. Carpenter suggested that it was possibly a pentacrinoid larva, though of most unusual size. It seems most probable, however, that this was really a small Umbellularian; one of Kölliker's figures of the young of *Umbellularia carpenteri*, taken by the "Challenger" in the seas south-west of Australia, shows an animal sufficiently like a Crinoid to deceive even a fairly skilled zoölogist, and of the size described by Owen. The colour as given is certainly suggestive of an Umbellularian, and, moreover, does not occur in any of the small stalked Crinoids, nor in any pentacrinoid larvæ.

Six years later Professor Sven Lovén announced the discovery of a recent Cystidean—a group previously supposed to be exclusively Palæozoic—at Cape York; but this was soon shown to be merely the detached visceral mass of some Comatulid having a strongly plated perisome, and later it was referred by P. H. Carpenter to *Zygometa multiradiata* which is common in that region.

In 1877 Professor E. P. Wright wrote a paper on a new genus and species of sponge, *Kallispongia archeri*, from Australia, which Ridley, then recorder for the "Zoological Record," at once suspected to be the stalked larva of some Comatulid. Wright figures two species which are probably the larvæ of *Compsometra loveni* and *Ptilometra mulleri*; he distinguishes the latter as a variety.

Dr. P. H. Carpenter two years later published his able monograph on the genus *Actinometra*, and the preliminary report on the Comatulidæ collected by the "Challenger" Expedition. The former contained nothing new in regard to Australian forms, although for the most part based upon a species which is common on the northern coast; the latter will be considered in connection with his completed monograph.

In 1881 he discussed a few Australian species, but without bringing forward any new facts in regard to the fauna of the region. At the same time he described *Antedon pinniformis* and *A. perspinosa* from New Guinea, both species which have more recently been reported from Queensland. During the following year he gave a short account of a specimen at Copenhagen which was the basis of Lütken's MS. name *Antedon australis*. This magnificent example of *Craspedometra acuticirra* had been taken at Sydney, and it remains to-day the only specimen of the species from any locality south of the Andamans and Singapore. In the same paper he described *Actinometra robusta* (Lütken MS.) and *Actinometra meyeri*, both from Australia. The former was soon recognised as the same as the Lamarckian *Comatula solaris*, while the latter he later erroneously placed in the synonymy of Müller's *Actinometra parvicirra*.

In the year 1882 Professor F. Jeffrey Bell proposed a scheme for the graphic representation of the various species of Comatulids by means of formulæ, and published a list giving most of the described forms with their appropriate formulæ. In this list he included certain MS. names of his own, in anticipation of the "Alert" Report, among them *Antedon loveni* and *Antedon insignis*, which he changed two years later to *Antedon pumila* and *Antedon loveni* for no apparent reason, greatly to the confusion of nomenclature. In addition he described as new *Actinometra annulata*, from Cape York, which was wrongly considered by Carpenter as the same as Müller's *Alecto parvicirra*.

The "Report upon the Zoological Collections made in the Indo-Pacific Ocean during the Cruise of H.M.S. 'Alert' in the years 1881-2," published in 1884, is the first paper of any length dealing mainly with Australian species. It was written by Professor F. Jeffrey Bell, but Carpenter assisted in many of the identifications. Twenty-eight species from Australian waters

are mentioned, all with definite localities; fifteen of these are described as new. Certain species described many years before by Lamarck and Müller are listed, but not redescribed, although the original descriptions are quite inadequate. The species mentioned, with their identification as now understood, (those designated by an asterisk are here described for the first time) are:—

<i>Antedon aedeone</i>	...	...	<i>Tropiometra</i> , sp. nov.
			<i>Oligometra aedeone</i> .
<i>Antedon milberti</i>	...	...	<i>Amphimetra milberti</i> .
			<i>Amphimetra discoidea</i> .
			<i>Oligometra carpenteri</i> .
<i>Antedon pinniformis</i>	...	...	<i>Oligometra aedeone</i> .
* <i>Antedon carpenteri</i>	...	...	<i>Oligometra carpenteri</i> .
* <i>Antedon pumila</i>	...	...	<i>Compsometra loveni</i> .
* <i>Antedon bideus</i>	...	...	<i>Oligometra aedeone</i> .
* <i>Antedon loveni</i>	...	...	<i>Colobometra perspinosa</i> .
* <i>Antedon decipiens</i>	...	...	<i>Amphimetra varipinna</i> .
* <i>Antedon reginae</i>	...	...	<i>Dichrometra reginae</i> .
<i>Antedon articulata</i>	...	...	<i>Dichrometra articulata</i> .
<i>Antedon gyges</i>	...	...	<i>Dichrometra gyges</i> .
* <i>Antedon irregularis</i>	...	...	<i>Amphimetra varipinna</i> .
* <i>Antedon elegans</i>	...	...	<i>Zygotetra elegans</i> .
* <i>Antedon briareus</i>	...	...	<i>Comantheria briareus</i> .
* <i>Antedon microdiscus</i>	...	...	<i>Zygotetra microdiscus</i> .
<i>Actinometra solaris</i>	...	...	<i>Comatula solaris</i> .
<i>Actinometra albonotata</i>	...	...	<i>Comatula solaris</i> .
* <i>Actinometra intermedia</i>	...	...	<i>Comatula solaris</i> .
<i>Actinometra robusta</i>	...	...	<i>Comatula solaris</i> .
* <i>Actinometra strotta</i> (nomen nudum).	...	...	<i>Comatula solaris</i> .
<i>Actinometra cumingii</i>	...	...	<i>Comanthus parvicirra</i> .
* <i>Actinometra coppingeri</i>	...	...	<i>Capillaster multiradiata</i> .
<i>Actinometra jukesi</i>	...	...	<i>Comatula rotalaria</i> .
<i>Actinometra parvicirra</i>	...	...	<i>Comanthus parvicirra</i> .
<i>Actinometra alternans</i>	...	...	<i>Comantheria alternans</i> .
* <i>Actinometra paucicirra</i>	...	...	<i>Comatula rotalaria</i> .
<i>Actinometra multifida</i>	...	...	<i>Comaster typica</i> .
			<i>Comanthina schlegelii</i> .
* <i>Actinometra variabilis</i>	...	...	<i>Comaster typica</i> .
			<i>Comaster multifida</i> .
? <i>Actinometra purpurea</i>	...	...	<i>Comatula pectinata</i> .

Several other species were collected by the "Alert," but were not determined, mostly from having being overlooked; they are chiefly represented by small specimens. While going over the "Alert" material in London, I took the opportunity of identifying these, and they are included in the systematic portion of the

present paper. It has not seemed advisable to burden the above list with references to them, as they obviously were not considered in the preparation of the report, though they are all in jars which bear on the outside a specific name.

So much has been written concerning the errors in identification and description of the various species included in this report by all subsequent authors who have had occasion to treat of Australian Crinoids that it seems unnecessary to recapitulate them here. Systematically, the chief point of interest lies in the inclusion of the first two known recent species of *Zygometra*, which, with the *Eudiocrinus indivisus* described by Semper in 1868 from the Philippine Islands, make three recent species of a family peculiarly characteristic of the Jurassic rocks of Europe.

Early in 1885 Professor Bell published a short paper on a collection of Echinoderms which had been brought from Australia to London in connection with the International Fisheries Exhibition held in that city in 1883. Among them were five species of Crinoids, together with two more from the Solomon Islands; these are, with their present status:—

<i>Antedon milberti</i> ...	...	<i>Amphimetra discoidea</i>
<i>Antedon macronema</i> ...	...	<i>Ptilometra mulleri</i>
<i>Antedon pumila</i> ...	...	<i>Compsometra loveni</i>
<i>Actinometra solaris</i> ...	...	<i>Comatula solaris</i>
<i>Actinometra intermedia</i> ...	...	<i>Comatula solaris</i>
<i>Actinometra jukesi</i> ...	...	<i>Comatula jukesi</i>

In addition there were "several species of *Antedon*, hitherto undescribed, but here unfortunately represented by single, nor always perfect specimens."

Three years later Professor Bell reported upon a collection of Echinoderms made by Mr. J. Bracebridge Wilson at Port Philip. Among these were three Crinoids, two of which he described as new. One of these, *Antedon wilsoni*, is undoubtedly the young of *Ptilometra mulleri* or of *Pt. macronema*, and the other, *Antedon incommoda*, Professor Bell himself pronounced in the following year to be the same as his earlier species *Antedon loveni* (= *Antedon pumila*), though I found, upon examining the types at London, that it is really a valid form. The remaining species was *Comanthus trichoptera*.

In the same year the "Challenger Report on the Crinoidea, Part ii. Comatulæ" was published. Although only species obtained by the "Challenger" were treated in detail, all the known Comatulids are mentioned and their habitat given.

The "Challenger" occupied five stations on the eastern and north-eastern coasts of Australia, where Crinoids were found,

securing in all thirteen species of which three were described as new(*) ; these are :—

<i>Actinometra multiradiata</i> ...	<i>Capillaster multiradiata</i>
<i>Actinometra maculata</i> ...	<i>Comatella maculata</i>
<i>Actinometra paucicirra</i> ...	<i>Comatula cotalaria</i>
<i>Actinometra solaris</i> ...	<i>Comatula solaris</i>
<i>Actinometra pectinata</i> ...	<i>Comatula pectinata</i>
* <i>Actinometra belli</i> ...	<i>Comantheria belli</i>
<i>Actinometra trichoptera</i> ...	<i>Comanthus trichoptera</i>
* <i>Actinometra valida</i> ...	<i>Comanthus annulata</i>
<i>Actinometra parvicirra</i> ...	<i>Comanthus parvicirra</i>
* <i>Antedon multiradiata</i> ...	<i>Zygometa multiradiata</i>
<i>Antedon microdiscus</i> ...	<i>Zygometa microdiscus</i>
<i>Antedon variipinna</i> ...	<i>Amphimetra variipinna</i>
<i>Antedon macronema</i> ...	<i>Ptilometra mulleri</i>

Thirty-one species were credited to Australia by Carpenter ; these are :—

<i>Antedon elegans</i>	<i>Actinometra brachiolata</i>
<i>Antedon microdiscus</i>	<i>Actinometra pectinata</i> ⁷
<i>Antedon multiradiata</i>	<i>Actinometra solaris</i>
<i>Antedon carpenteri</i>	<i>Actinometra paucicirra</i> ⁸
<i>Antedon loveni</i> ¹	<i>Actinometra cumingi</i> ⁹
<i>Antedon milberti</i> ²	<i>Actinometra maculata</i>
<i>Antedon pinniformis</i> ³	<i>Actinometra rotalaria</i> ¹⁰
<i>Antedon pumila</i> ⁴	<i>Actinometra valida</i> ¹¹
<i>Antedon variipinna</i>	<i>Actinometra coppingeri</i> ¹²
<i>Antedon adeonæ</i>	<i>Actinometra multiradiata</i>
<i>Antedon bidens</i> ⁵	<i>Actinometra alternans</i>
<i>Antedon macronema</i> ⁶	<i>Actinometra belli</i>
<i>Antedon articulata</i>	<i>Actinometra briareus</i>
<i>Antedon gyges</i>	<i>Actinometra multifida</i> ¹³
<i>Antedon reginæ</i>	<i>Actinometra parvicirra</i> ¹⁴
<i>Actinometra trichoptera</i>	<i>Actinometra variabilis</i> ¹⁵

1. A synonym of *Antedon perspinosa*, P. H. Carpenter, 1881, and of *Antedon insignis*, Bell, 1882.

2. In reality *discoidea*.

3. Based on the "Alert" Report ; in reality *Comatula adeonæ*, Lamarck, 1816, misidentified.

4. A synonym of *Antedon loveni*, Bell, 1882.

5. A synonym of *Comatula adeonæ*, Lamarck, 1816.

6. Includes also *Ptilometra mulleri*.

7. Includes also *Alecto purpurea*, J. Müller, 1843.

8. A synonym of *Comatula rotalaria*, Lamarck, 1816.

9. Based on the "Alert" Report; in reality the *Alecto parvicirra* of J. Müller, 1841.

10. Not the *Comatula rotalaria* of Lamarck, 1816, but the *Alecto parvicirra* of J. Müller, 1841, to which species Carpenter inadvertently shifted Lamarck's name.

11. A synonym of *Actinometra annulata*, Bell, 1882, and of *Actinometra meyeri*. Carpenter, 1882.

12. A synonym of *Asterias multiradiata*, Linnæus, 1758.

13. Based on the "Alert" Report; under this name are included *Phanogenia typica*, Lovén, 1866, and *Actinometra schlegelii*, P. H. Carpenter, 1881.

14. Includes also *Actinometra annulata*, Bell, 1882.

15. Based on the "Alert" Report; under this name are included *Alecto multifida*, J. Müller, 1841, and *Phanogenia typica*, Lovén, 1866.

A careful analysis of Carpenter's Australian species, based on a review of his entire material, gives us the following thirty forms known to him as inhabitants of the coasts of Australia:—

<i>Capillaster multiradiata</i>	<i>Comanthus parvicirra</i>
<i>Comatella maculata</i>	<i>Zygometa microdiscus</i>
<i>Comatula rotalaria</i>	<i>Zygometa multiradiata</i>
<i>Comatula brachiolata</i>	<i>Zygometa elegans</i>
<i>Comatula solaris</i>	<i>Amphimetra milberti</i>
<i>Comatula purpurea</i>	<i>Amphimetra discoidea</i>
<i>Comatula pectinata</i>	<i>Dichometra articulata</i>
<i>Comaster typica</i>	<i>Dichrometra reginæ</i>
<i>Comaster multifida</i>	<i>Dichrometra gyges</i>
<i>Comantheria briareus</i>	<i>Colobometra perspinosa</i>
<i>Comantheria alternans</i>	<i>Oligometra adeona</i>
<i>Comanthina belli</i>	<i>Oligometra carpenteri</i>
<i>Comanthina schlegelii</i>	<i>Ptilometra macronema</i>
<i>Comanthus trichoptera</i>	<i>Ptilometra mulleri</i>
<i>Comanthus annulata</i>	<i>Compsometra loveni</i>

Of these, sixteen, or more than one half, belong to the Comasteridæ, three each to the Zygometridæ, Mariametridæ and Colobometridæ, two each to the Himerometridæ and Thalassometridæ, and one to the Antedonidæ; there are twenty-nine representatives of the great suborder Oligophreata, while only one is found of the Macrophreata.

In 1889 Mr. Thomas Whitelegge published a most excellent "List of the Marine and Fresh-water Invertebrate Fauna of Port Jackson and Neighbourhood," and in this list he included five species of Crinoids, all of them previously known from the region. He was able to add original notes in regard to three

of these species, *Compsometra loveni*, *Ptilometra mulleri*, and *Comanthus trichoptera*, the other two being included on the basis of the "Challenger" Report, they having been dredged by that ship at Station No. 164 off Port Jackson.

Mr. Whitelegge's list is of interest as being the first contribution to the study of the Australian Crinoids, by one who was actually acquainted with them in life; and also as giving the first definite data in regard to their breeding season.

In 1890 Dr. P. H. Carpenter identified for the Port Philip Biological Survey Committee some twenty-nine specimens of Comatulids which had been dredged by Mr. J. Bracebridge Wilson in the outer harbour at Port Phillip, and outside the Heads in the summer of 1887-8. There were five species in this collection, the most numerous being the little *Compsometra loveni*, *Comanthus trichoptera*, and *Ptilometra mulleri* were also included, while "*Antedon wilsoni*," the young of this last, and a new species of "*Antedon*" were recorded. Of this new species Dr. Carpenter remarks that, though he believes it to be a new species, "it may turn out to be only a strongly marked variety of *A. pumila*" (i.e., *Compsometra loveni*). This new species is without doubt the *Compsometra lacertosa* described herein.

In 1890 Dr. E. P. Ramsay recorded some specimens of *Antedon pumila* (*Compsometra loveni*) which he obtained by dredging in Port Jackson.

The year 1891 was marked by the appearance of Dr. Clemens Hartlaub's excellent Monograph upon the Comatulid fauna of the Indian Archipelago, a preliminary notice of it having appeared in 1890, primarily a report upon the magnificent collections made by Dr. J. Brock at Amboina, but including all the known Crinoids of the Indian Ocean. In addition to *Ptilometra mulleri* from Sydney, seven Australian Comatulids are considered, four of which are here described for the first time, while one of the remaining three is new to Australia; these species are:—

<i>Antedon nematodon</i> (n.sp.)	...	<i>Heterometra nematodon</i>
<i>Antedon monacantha</i> (n.sp.)	...	<i>Stephanometra monacantha</i>
<i>Antedon tenera</i> (n.sp.)	...	<i>Dichrometra tenera</i>
<i>Antedon afra</i> (n.sp.)	...	<i>Tropiometra afra</i>
<i>Actinometra pectinata</i>	...	? <i>Comatula purpurea</i>
<i>Actinometra brachiolata</i>	...	<i>Comatula brachiolata</i>
<i>Actinometra bennetti</i> †	...	<i>Comanthus bennetti</i>

These four new species were all obtained many years before by the ships belonging to the Godeffroys of Hamburg, and deposited in their private museum. Here they had been examined by Professor C. F. Lütken, who had bestowed MS. names upon them, but had never published any diagnoses of his new forms. After

the dissolution of the Godeffroy Company the museum was broken up and its contents scattered, mostly, however, going to various German institutions, where the specimens were accessible to Hartlaub. Lütken had negotiated many exchanges, and had sent out many specimens under the MS. names which he had applied to the various species. Hartlaub is therefore to be commended for retaining Lütken's original names when describing the species, and thereby enabling those who have received specimens determined by Lütken to know what species they represent, as well as making clear the identification of the numerous *nomina nuda* occurring in the catalogues of the Godeffroy Museum.

In addition to describing and recording these various species from Australia, Hartlaub discovered that the species called by Bell in 1882 *Antedon insignis*, which name he changed in 1884 to *Antedon loveni*, is in reality the same as the form described by Carpenter in 1881 as *Antedon perspinosa*.

Professor Bell three years later published a list of the Echinoderms of North-west Australia, including eleven species of Crinoids. No definite localities are given, but he states that "the chief localities are Holothuria Bank, Magnetic Shoal, Cossack Island, and Baudin Island (14° 08' S. lat., 125° 36' E. long.)."

The depth alone is recorded with the various species, and the list as given is:—

<i>Antedon milberti</i> ...	... 8-15 fms.	{ <i>Amphimetra discoidea</i>
		{ <i>Oligometra carpenteri</i>
<i>Antedon serripinna</i> ...	... 24-39 "	{ <i>Oligometra carpenteri</i>
<i>Antedon variipinna</i> ...	... 9-38 "	{ <i>Amphimetra variipinna</i>
<i>Antedon</i> , sp. (near <i>macronema</i>) ?		{ <i>Cenometra cornuta</i>
<i>Actinometra pectinata</i> ...	... 20-36 "	{ <i>Comatula pectinata</i>
		{ <i>Comatula purpurea</i>
<i>Actinometra nobilis</i> ...	... 65 "	{ <i>Comanthina belli</i>
<i>Actinometra paucicirra</i> ...	... 8-15 "	{ <i>Comatula rotalaria</i>
<i>Actinometra parvicirra</i> ...	... 9 "	{ <i>Comatula pectinata</i>
		{ <i>Comantheria briareus</i>
<i>Actinometra variabilis</i> ...	... 9-38 "	{ <i>Comanthus parvicirra</i>
<i>Actinometra multifida</i> ...	... ?	{ <i>Comaster typica</i>
		{ <i>Comanthina belli</i>
<i>Actinometra multiradiata</i> ...	... ?	{ <i>Capillaster multiradiata</i>

It is impossible to question the accuracy of a list of this nature no matter how suspicious one may be of some of the records; but fortunately I was able to review Professor Bell's material during my visit to London, and to reidentify all of the specimens.

In 1898 Professor Ludwig Döderlein published an account of a collection of Crinoids from Amboina and Thursday Island; the species recorded by him, with their present identification are:—

<i>Antedon elegans</i>	...	...	<i>Zygometra elegans</i>
<i>Antedon microdiscus</i>	...	...	<i>Zygometra microdiscus</i>
<i>Antedon bidens</i>	...	...	<i>Oligometra adeonæ</i>
<i>Antedon ludovici</i>	...	...	<i>Craspedometra acuticirra</i>
<i>Antedon imparipinna</i>	...	...	<i>Dichrometra protectus</i>
<i>Actinometra pectinata</i>	...	...	<i>Comatula pectinata</i>
<i>Actinometra solaris</i>	...	...	<i>Comatula solaris</i>
<i>Actinometra paucicirra</i>	...	...	<i>Comatula rotalaria</i>
<i>Actinometra belli</i>	...	...	{ <i>Comaster multifida</i>
			{ <i>Comanthina belli</i>
<i>Actinometra parvicirra</i>	...	...	{ <i>Comanthus annulata</i>
			{ <i>Comanthus parvicirra</i>
<i>Actinometra regalis</i>			<i>Comanthina schlegelii</i>

THE AUSTRALIAN CRINOID FAUNA.

As known to-day the Crinoid fauna of the littoral and sublittoral zones about the continent of Australia (including Tasmania) is composed of forty-six species, included in nineteen genera and nine families; eight of these families, including eighteen of the nineteen genera, belong to the suborder Oligophreata. Twenty of the species and one of the genera are only known from Australia; but the latter is closely allied to two other genera characteristic of the East Indian region.

The proportionate frequency of the genera and species in the several families is entirely different from what is found in other parts of the world. The Comasteridæ are represented by five genera and nineteen species, five of which have not been found elsewhere; the Zygometridæ, though represented by only one of the three genera, include three species, all peculiar to Australia; only two other recent species of this genus are known; the Himerometridæ are represented by three genera, while the families Mariametridæ and Stephanometridæ have one each; all of the four genera of Colobometridæ inhabit Australia, one of the genera including three Australian species. There are two Australian genera of Tropiometridæ, one of which is not known elsewhere; the great family Thalassometridæ, which includes sixteen genera and very numerous species, is represented by three species; and the very large cosmopolitan family Antedonidæ, containing nearly twenty-five genera, includes but a single genus in Australian waters, with two species, neither of them known elsewhere.

The great majority of the Australian Crinoids are tropical species which have extended their range southward from the East Indian region, and they are therefore limited to the coast of

Queensland on the east, and the coast north of Dirk Hartog Island on the west. The southern coasts are tenanted by seven species peculiar to Australia, but belonging to one endemic and four tropical genera, which lend to that region an aspect very characteristic, and yet at the same time without any especial zoögeographic significance.

The extent of the intrusion of the various tropical species into Australian territory varies greatly, though possibly much of this apparent variability is due to the present lack of accurate knowledge.

On the eastern coast the following species are not known to occur except at Cape York, or in the immediate vicinity of that peninsula :—

Comaster multifida
Comanthina belli
 „ *schlegelii*
Zygometra multiradiata
Stephanometra monacantha
Dichrometra gyges.

Flinders Island is the southern limit of :—

Capillaster multiradiata.

Port Denison represents the furthest south attained by :—

Comatula purpurea
Comantheria briareus
Comanthus bennetti
Stiremetra arachnoides.

Bowen limits the range of :—

Comatella maculata
Comanthus valida
Heterometra nematodon
Dichrometra tenera
Tropiometra afra.

South of Port Molle the following are not found :—

Comanthus parvicirra
Comatula rotalaria
Comaster typica
Comantheria alternans
Zygometra microdiscus
Amphimetra discoidea
 „ *milberti*
Dichrometra articulata
 „ *reginæ.*

The following are not known south of Port Curtis :—

Comatula solaris
Zygometra elegans
Amphimetra varipinna
Heterometra bengalensis
Oligometra carpenteri
 „ *adeonæ*.

The tropical species extending to Port Jackson, or to Sydney are :—

Comatella stelligera
Comatula pectinata
Colobometra perspinosa
Craspedometra acuticirra.

There are seven species confined to the southern part of Australia, all peculiar to the region ; these are :—

Comanthus trichoptera
Comatula brachiolata
Ptilometra macronema
 „ *mulleri*
Compsometra loveni
 „ *incommoda*
Oligometra thetidis.

And they have the following distribution :—

Comatula brachiolata :—King George Sound east to Port Phillip.

Comanthus trichoptera :—Tasmania ; King George Sound east to Port Jackson.

Ptilometra macronema :—Dirk Hartog Island to King George Sound, and east to Kangaroo Island, and to Port Phillip.

Ptilometra mulleri :—Port Phillip to Newcastle and Port Stephens.

Compsometra loveni :—Port Phillip, north to Claremont Island, Queensland.

Compsometra incommoda :—Port Phillip to Port Jackson.

Nothing whatever is known of the Australian range of the following species :—

Tropiometra encrinus.

The data in regard to the range of the species inhabiting the west coast of Australia are so unsatisfactory as scarcely to warrant recapitulation. The following are recorded from North-western Australia :—

Capillaster multiradiata
Comaster typica

Comaster multifida
Comatula rotalaria
 „ *pectinata*
Comanthina belli
Comanthus parvicirra
Amphimetra variipinna
 „ *discoidea*
Oligometra carpenteri
 „ *adeonæ.*

From Nicol Bay we know :—
Zygometra microdiscus.

From Mermaid, etc. :—
Comantheria belli
Zygometra microdiscus
 „ *elegans.*

From off Port Walcott :—
Comaster typica
Comantheria briareus.

From Dundas Strait :—
Comatula pectinata
Oligometra adeonæ.

From Holothuria Bank :—
Comatula rotalaria
 „ *etheridgei*, sp. nov.
Heterometra bengalensis.

From Baudin Island :—
Comatula etheridgei, sp. nov.
 „ *pectinata*
Comanthus parvicirra
Zygometra elegans
Amphimetra variipinna
Cenometra cornuta, sp. nov.
Oligometra carpenteri
 „ *adeonæ.*

From Fremantle :—
Comanthus parvicirra.

From Shark Bay :—
Comatula pectinata
 „ *purpurea.*

And from Turtle Bay, Dirk Hartog Island:—

Capillaster multiradiata
Decametra studeri
Ptilometra macronema.

In short it may be said that from the point of view of the Crinoids the coasts of Australia form an integral part of the great Indo-Pacific-Japanese faunal region. With its area of maximum intensity lying within a triangle whose apices are roughly Luzon, Borneo, and New Guinea, this faunal region extends southward, embracing the northern coasts of Australia, and down either side of that Continent, becoming progressively more and more attenuated as one proceeds southward, reaching Shark Bay on the west and Sydney on the east coast. At these points it undergoes a transformation, and a fauna is evolved which, while strictly East Indian, is at the same time characteristically Australian, so that the southern coasts of Australia north to Shark Bay and Sydney may be said to constitute a *South Australian* subregion, characterized by one peculiar genus (closely related, however, to two East Indian genera) and seven peculiar species distributed among five genera, the one just mentioned (*Ptilometra*) and four others, all of which extend northward to China or Japan.

I have said that the fauna of the Australian coasts north of Sydney and Shark Bay belongs to the Indo-Pacific-Japanese region; that is, it is made up entirely of Indo-Pacific-Japanese genera and species. It has, however, a curious entity of its own, a composition which at once distinguishes it from the fauna of any other district, and renders it possible to recognize a collection of Crinoids from any part of the region at once as being Australian.

Among the Comasteridæ there are four species peculiar to North Australia; these are:—

Comatula rotalaria
Comatula etheridgei
Comatula purpurea
Comanthina belli

And, strangely enough, they all represent extreme types.

The genus *Zygometra* includes in this region three peculiar species:—

Zygometra microdiscus
Zygometra multiradiata
Zygometra elegans

And, most singularly, these are the three most specialized species, with the largest number of arms in the genus.

The genus *Oligometra* here, from the widely spread *serripinna* stock, produces an entirely distinct species, *O. carpenteri*, which, again, is the extreme form of the genus, and from a somewhat different branch (from which *O. thetidis* is also derived), *O. adeonæ*.

But perhaps as significant as the occurrence of all these extreme forms is the absence of many genera which we are accustomed to consider as an integral part of the fauna of the Indo-Pacific-Japanese region. In the Comasteridæ, *Cominia* and *Comissia* are lacking; in the Zygometridæ *Eudiocrinus* and *Catoptometra* are not found; the families Pontiométridæ and Calométridæ are absent; in the family Himerométridæ we fail to find *Himerometra*; in the Mariamétridæ, *Mariametra* and *Selenemtra*; in the Stephanométridæ, *Oxymetra*; in the Colobométridæ, *Cyllo-metra*; in the Thalassométridæ *Asterometra* or *Pterometra*; in the Antedoninæ, *Mastigometra* or *Iridometra*; the subfamilies Perometriniæ, Zenometriniæ, Heliometriniæ, and Thysanometriniæ are not represented at all, though they include seven genera abundantly represented in the shallow waters of the East Indies.

While undoubtedly further investigation will fill some of these gaps, still there are so many of them that their significance cannot be denied; the rich East Indian fauna in spreading southward has been modified, first by a selective weeding out of its component genera and species, which has been in part compensated by a development into extreme species of genera from other stock.

This process has given the North Australian fauna as compared with the parent East Indian stock a curiously unbalanced aspect; the Comasteridæ and Zygometridæ are over-developed to the great detriment of the other groups, especially of the Macrophreata; and on the whole this change has been sufficient to entitle the Australian coasts from Shark Bay and Sydney northward to rank as a separate subregion of the general Indo-Pacific-Japanese region which may be called the *North Australian Subregion*, to which the South Australian Subregion must be subordinated as a daughter division.

The North Australian Subregion is the equivalent of the Japanese, the South-east African, and the North-east African Subregions, and, like them, is the result of an adaptation to diverse environments of a common stock, the component species of which have in each case been sifted out and modified in a different way.

But there is this important difference in respect to the Crinoids of the Australian Subregion as compared with the other subregions of the great Indo-Pacific area; the peculiar species are always differentiated by an exaggeration of the specific characters. A fauna in its infancy is characterized by an enormous diversity

among the individuals of all the component species, such a state of affairs as we find to-day in the Behring Sea ; at maturity we find that the fauna has crystallized into definite fixed and stable (usually new) species, some of which generally indicate new generic types showing obvious relationships with the genera of other regions. In senescence there occurs what has aptly been termed an "explosion" of specific characters which is more or less general among the component species regardless of the groups to which they may belong, and may result in the sudden origin of erratic generic types. Speaking in terms of faunistic ontogeny, the Crinoid fauna of Australia is a Crinoid fauna in senescence, the oldest Crinoid fauna to be found in the recent seas. It came originally from the northward, from the region of the great East India islands ; but the fauna of these islands has been at various times rejuvenated, probably through geological processes resulting in changes in the land and water distribution, while that of Australia has been allowed to pass peacefully into old age. The past European fauna (or more exactly that part of it which is comparable to the existing faunas) was senescent, like the present fauna of Australia ; the fauna of Eastern Africa is approximately at maturity ; that of the West Indies and the north-western coast of Africa is young, not having reached maturity, while that of southern Japan is younger still. The Arctic Crinoids indicate a fauna at maturity, composed of definite fixed types ; but the Antarctic fauna is not so old, and the Antarctic extension northward to the Behring Sea presents, at least north of the tropics, all the evidences of youth.

One cannot consider the recent Crinoids of Australia without speculating upon the possible evidence afforded in regard to the past distribution of land and sea. It is not the place here to enter into a detailed discussion of the East Indian and Indian Ocean Crinoid fauna, but a study of that fauna brings out many points of the greatest interest to the Palæontologist. What was essentially the North Australian fauna existed in Europe ; it reached Europe by passage from the northern part of the Bay of Bengal north of what is now India. Geological changes have turned the sea between the Bay of Bengal and the Atlantic into land, resulting in the extirpation of all but two of the genera, *Antedon* and *Leptometra*, which have been able to survive, and flourish to-day on the east Atlantic shores and the Mediterranean, the only living survivors of the rich fauna that reached Europe by the ancient inland sea. It is most extraordinary that these two genera should have undergone so little change as to make them barely separable from the far distant *Mastigometra* and *Psathyrometra* from which they have been derived.

At the time when the various tropical Australian genera reached Europe, other genera, more hardy, pushed northward

from the main line across Russia, gradually adapting themselves to the conditions obtaining in the comparatively rigorous north; with the closing of the sea connection behind them these genera, *Heliometra* and *Hathrometra*—at the present time still closely related to their parent East Indian genera *Cyclometra* and *Trichometra*—became fixed as an Arctic fauna, and as such survive to-day.

Besides this open sea connection with Europe and with the Arctic Ocean, certain land connections (not necessarily above the surface of the sea) are unmistakably indicated by the recent Crinoids.

The adaptable genus *Cyclometra*, in addition to sending a branch to the northward, sent one southward from Australia which became acclimated and took on much the same characters as the northern branch, differing in almost the same way from the parent stock. This formed what I have previously considered as the Antarctic species group of *Heliometra*, but which I now think it would be better to recognize as a separate genus under the name of *Solanometra* (with the genotype *Antedon antarctica*, P. H. C.), and also, by a meristic variation resulting in the doubling of all the radials and the consequent possession of twenty instead of ten arms, *Promachocrinus*. At this time southern South America was connected with the Antarctic land, and thus *Solanometra* obtained a foothold on the western coast of that continent. Finding no barriers to its dispersal, it spread rapidly northward, dipping downward when passing under the tropics (not here recorded from water shallower than 286 fathoms) and reaching the Aleutian Islands, Kamchatka, and North-eastern Japan.

There was also a land stretching from southern India southwestward to Madagascar by which the Crinoids reached South-eastern Africa; there was no southern portion of Africa, but the Crinoids followed the southern boundary of a land which reached, in a general way, from southern British East Africa to Morocco (or some point in northern West Africa) and thence to and including the West Indies, the coast highlands of Venezuela and Columbia, southern Central America, and possibly the Galapagos Islands.

A few innovations in classification have been incorporated in this Report which seem to be called for by recent accessions to our knowledge. The family Tropiometridæ, including the genera *Tropiometra*, *Calometra*, *Ptilometra*, *Pterometra*, and *Asterometra*, has proved to be quite artificial. It is true that the species of all these genera agree in having the muscles very greatly reduced and the arms ending very abruptly as if broken off, but I find

upon close study that the muscles have been reduced from three distinct original types, while the abbreviated arm tips occur in one of the genera of the Thalassometridæ. I have therefore retained the family Tropiometridæ as covering *Tropiometra* only, a curious genus with no very close affinities, created a new family Calometridæ containing four new genera for the numerous species which I formerly placed in *Calometra*, and placed *Ptilometra*, *Pterometra*, and *Asterometra* in the Thalassometridæ where they undoubtedly belong. The Charitometridæ I have made a family instead of a subfamily, of equal rank with the family Thalassometridæ (formerly the subfamily Thalassometriniæ).

Recent discoveries have shown that the Zygometridæ are not nearly so sharply differentiated from the so-called Himorometridæ as was previously supposed, and it has seemed best to discard the latter family altogether, raising the three subfamilies previously included within it to family rank.

EXPLANATION OF TERMS.

In the description of a Comatulid the number of the cirri is expressed by Roman numerals, and the number of their component segments by Arabic; thus "cirri XVII, 25" means that the animal has seventeen cirri, each with twenty-five segments.

The division series are indicated by the letters "Br" preceded by the number of the series, expressed in Roman numerals; thus "IBr" signifies the first division series following the radials, the "costals" of P. H. Carpenter's terminology in his later works, and the "second and third radials" of the "Challenger" Reports; "IIBr" is equivalent to "distichal series," "IIIBr" to "palmar series," "IVBr" to "post-palmar series," etc. The individual elements of the division series are indicated by so-called inferior numbers; thus IIBr2 means the "second distichal" or the second ossicle of the second division series.

The presence of a syzygy is indicated by the use of the symbol "+"; thus "IIBr4(3+4)" means that the second division series is composed of four ossicles, of which the third and fourth are united by syzygy.

The outer pinnules of an arm are numbered in regular sequence, P₁, P₂, P₃, etc.; the inner pinnules are lettered Pa, Pb, Pc, etc. The IBr or "costal pinnule" (only found in the genus *Eudiocrinus*) is distinguished as Pc, the IIBr or "distichal pinnule" as Pd, the IIIBr or "palmar pinnule" as Pr, the use of these inferior capitals serving to differentiate these pinnules from those of the inner side of the arm.

KEYS TO THE FAMILIES, GENERA, AND SPECIES OF AUSTRALIAN
CRINOIDS.

The following keys have been arranged so as to make as easy as possible the work of identifying Australian Crinoids. The most obvious and most readily comprehended differential characters have been employed, regardless of their systematic value. Besides general keys, I have included keys based upon the extent and character of the arm division which, although purely a matter of secondary significance, offers possibly the best criteria to those not especially familiar with these animals for the identification of the various genera and species.

It must be borne in mind that the young of all multibrachiata Comatulids have ten arms only, and that, therefore, these keys are not adapted to them. In general there will be no difficulty in identifying the young by comparison with adult specimens of the species inhabiting the localities where they are found; but in the Tropiometridæ and Thalassometridæ the young differ widely from the fully grown, and great caution must be used in their determination.

KEY TO THE FAMILIES AND SUBFAMILIES OF CRINOIDS INHABITING THE
COASTS OF AUSTRALIA.

- a¹. Proximal pinnules furnished with a terminal comb; mouth usually marginal or submarginal, anal tube central (10-160 arms)..... *Comasteridæ*.
- a². Proximal pinnules without terminal comb; mouth central, anal tube marginal.
- b¹. I Br united by pseudo-syzygy (5-100 arms)..... *Zygometridæ*.
- b². I Br united by synarthy.
- c¹. Pa absent (10-30 arms)..... *Colobometridæ*.
- c². Pa present.
- d¹. All the pinnules cylindrical and very slender; P₁ twice as long as the next following pinnules; all the pinnules are composed of much elongated segments (10 arms)..... *Antedonidæ*.
- d². Some of the lower, or all the pinnules prismatic, or some of the lower pinnules enlarged and stout; P₁ smaller than P₂; or, if larger, strongly prismatic.
- e¹. The pinnules, at least those in the lower portion of arm, triangular.
- f¹. All the pinnules strongly prismatic; cirri very long, the outer segments short and bearing dorsal spines; P₁ similar to P₂ but smaller, or much enlarged and strongly prismatic (10-30 arms)..... *Thalassometridæ*.
- f². The distal pinnules slender and cylindrical, shorter than the triangular middle pinnules; cirri short and stout, the distal segments without dorsal processes; P₁ similar to P₂, but slightly shorter and more delicate (10 arms)..... *Tropiometridæ*.

- e*². All the pinnules cylindrical.
- f*¹. Brachials in distal part of arm exceedingly short and discoidal (10-40 arms).....*Himerometridæ*.
- f*². Brachials in distal part of arm wedge-shaped and not particularly short.
- g*¹. The outer cirrus segments bear dorsally paired dorsal spines, or one or two denticulate transverse ridges (10-40 arms).....*Colobometridæ*.
- g*². The outer cirrus segments are longitudinally carinate dorsally, or bear single median dorsal spines.
- h*¹. II Br 4 (3+4).....*Himerometridæ*.
- h*². II Br 2.
- i*¹. P₂ very stiff and spine like, with eighteen or fewer segments.....*Stephanometridæ*.
- i*². P₂ flagellate distally, with more than twenty segments.....*Mariametridæ*.

KEY TO THE GENERA OF THE COMASTERIDÆ.

- a*¹. Combs not confined to the proximal pinnules, but occurring at intervals all along the arm; proximal pinnules slender; mouth but slightly excentric.....*Comaster*.
- a*². Combs confined to the proximal pinnules; proximal pinnules stouter than those succeeding.
- b*¹. II Br 4 (3+4); always more than 10 arms... ..*Comanthus*.
- b*². II Br 2, or lacking; 10 or more arms.
- c*¹. Middle pinnules stout, with segments which are very much broader than long; I Br apparently united by syzygy; if more than ten arms, cirri are absent.....*Comatula*.
- c*². Middle pinnules not enlarged, composed of approximately squarish segments; I Br united by synarthry; twenty or more arms; cirri well developed.....*Comatella*.

KEY TO THE GENERA OF THE COLOBOMETRIDÆ.

- a*¹. P_a absent.
- b*¹. All the pinnules very stiff, with very spinous distal ends to the segments; all the lower pinnules enlarged; cirrus segments, or P₂ and P₃, with very spiny ends, forty or more in number.....*Colobometra*.
- b*². P₂ only enlarged and stiffened; cirrus segments with smooth ends, less than twenty in number.
- c*¹. More than ten arms.....*Cyllometra*.
- c*². Ten arms.....*Decametra*.
- a*². P_a present.
- b*¹. Ten arms; 20 or less cirrus segments, the outer with dorsal transverse ridges.....*Oligometra*.
- b*². More than twenty arms; more than 30 cirrus segments, the outer with paired dorsal spines.*Cenometra*.

KEY TO THE GENERA OF THE THALASSOMETRIDÆ.

- a*¹. Ten arms; cirri arranged in ten columns on a rather small columnar centrodorsal; P₁ larger and stouter than P₂...*Stiremetra*

- a*². More than ten (usually 15-20) arms; cirri irregularly arranged, or arranged in fifteen closely crowded columns, on a large columnar centrodorsal; *P*₁ smaller than *P*₂.....*Ptilometra*.

KEY TO THE GENERA OF THE HIMEROMETRIDÆ.

- a*¹. Distal brachials exceedingly short and discoidal; arm bases very rugged.....*Amphimetra*.
*a*². Distal brachials wedge-shaped and not especially short; arm bases smooth.
*b*¹. II Br 4 (3 + 4).
*c*¹. Cirri long, stout basally but gradually tapering to a point distally.....*Craspedometra*.
*c*². Cirri moderate, not tapering distally.....*Heterometra*.

THE FOLLOWING FAMILIES ARE REPRESENTED IN AUSTRALIAN SEAS BY BUT A SINGLE GENUS EACH.

Zygometridæ; Tropiometridæ; Stephanometrindæ; Mariametrindæ; and Antedonidæ.

KEY TO THE GENERA OF AUSTRALIAN CRINOIDS CONTAINING SPECIES WITH TEN ARMS ONLY.

- a*¹. Lower pinnules provided with a terminal comb; mouth excentric, anus central or nearly so.....*Comatula*.
*a*². Lower pinnules without terminal combs; mouth central, arms marginal.
*b*¹. *Pa* absent.
*c*¹. All the pinnules very stiff; cirri long, with more than forty segments.....*Colobometra*.
*c*². Only *P*₂ stiffened; cirri short, with less than twenty segments.....*Decametra*.
*b*². *Pa* present.
*c*¹. All the pinnules sharply triangular, the first much enlarged.....*Stiremetra*.
*c*². All, or at least the distal pinnules, cylindrical.
*d*¹. *P*₁ twice as long as *P*₂.....*Compsometra*.
*d*². *P*₁ shorter than *P*₂.
*e*¹. The lower pinnules bear stout processes on the segments.....*Oligometra*.
*e*². The lower pinnules do not bear processes on the segments.
*f*¹. Cirri slightly tapering distally, rather slender, with processes on the dorsal side of the distal segments.....*Amphimetra*.
*f*². Cirri stout and smooth, not tapering distally.....*Tropiometra*.

KEY TO THE GENERA OF AUSTRALIAN CRINOIDS CONTAINING SPECIES WITH MORE THAN TEN ARMS, WHOSE DIVISION SERIES ARE ALL OF TWO OSSICLES EACH.

- a*¹. The proximal pinnules bear terminal combs; mouth marginal or submarginal; anus more or less central.
*b*¹. Cirri absent; elements of division series apparently united by syzygy.....*Comatula*.

- b*². Cirri present; elements of division series united by synarthry
..... *Comatella*.
- a*². The proximal pinnules do not bear terminal combs; mouth central; anal tube marginal.
- b*¹. Pinnules triangular..... *Ptilometra*.
- b*². Pinnules cylindrical.
- c*¹. *P*₂ much enlarged, abruptly larger than *P*₁ or *P*₃, which latter resemble *P*₄, stiff and spinelike; the division series are well separated, and their component ossicles have broad ventrolateral processes.
- d*¹. Cirrus segments subequal, all much broader than long, the outer with paired dorsal spines..... *Cenometra*.
- d*². Earlier cirrus segments (except the basal) longer than broad, but becoming shorter distally; outer cirrus segments without dorsal processes..... *Stephanometra*.
- c*². *P*₂ not greatly, if at all, larger than *P*₃, which latter is considerably larger than *P*₄; enlarged proximal pinnules flagellate, with very numerous segments; division series in close lateral apposition, and usually laterally flattened, without ventrolateral processes on the component segments..... *Dichrometra*.

KEY TO THE GENERA OF AUSTRALIAN CRINOIDS CONTAINING SPECIES WITH MORE THAN TEN ARMS WHOSE II BR SERIES ARE 4 (3+4).

- a*¹. The proximal pinnules bear terminal combs; mouth more or less excentric, anus more or less central.
- b*¹. Combs occur at intervals along the distal pinnules; proximal pinnules slender; mouth nearly central..... *Comaster*.
- b*². Combs confined to the proximal pinnules, which are stouter than those succeeding; arms nearly or quite central..... *Comanthus*.
- a*². Proximal pinnules without terminal combs; mouth central, anus marginal.
- b*¹. I Br united by pseudosyzygy; disk completely plated... *Zygometra*.
- b*². I Br united by synarthry; disk unplated.
- c*¹. Distal brachials exceedingly short and discoidal; arm bases rugged and tubercular; lateral processes on the segments of the proximal pinnules..... *Amphimetra*.
- c*². Distal brachials wedge-shaped, not especially short; arm bases smooth; no lateral processes on the lower pinnules.
- d*¹. Cirri long and smooth, stout basally and tapering evenly to a point..... *Craspedometra*.
- d*². Cirri shorter, not tapering distally, the outer segments strongly carinate or spinous dorsally..... *Heterometra*.

KEY TO THE AUSTRALIAN SPECIES OF THE GENUS COMATELLA.

- a*¹. About twenty arms; cirri small, with 15-20 segments (*Queensland*)..... *C. maculata*.
- a*². About thirty arms; cirri well developed; with 20-26 segments (*Queensland*; *New South Wales*)..... *C. stelligera*.

KEY TO THE AUSTRALIAN SPECIES OF THE GENUS COMATULA.

- a*¹. Twenty arms; cirri absent.
- b*¹. All the arms of equal length (*N. and N. W. Australia*)... *C. rotalaria*.

- b*². The outer arms on each radius averaging only half as long as the inner arms (*N. W. Australia*).....*C. etheridgei*, sp. nov.
- a*². Ten arms ; cirri present.
- b*¹. Thirty or more very short cirrus segments (*Southern Australia*).....*C. brachiolata*.
- b*². Less than twenty-five cirrus segments, which are of moderate length.
- c*¹. Eighteen or more cirrus segments (*Queensland* and *N. W. Australia*).....*C. solaris*.
- c*². Fifteen or less cirrus segments.
- d*¹. Cirri occurring all round the periphery of the centro-dorsal (*Queensland* and *N. W. Australia*).....*C. pectinata*.
- d*². One or two cirri in each interradial angle (*Queensland* and *N. W. Australia*).....*C. purpurea*.

KEY TO THE AUSTRALIAN SPECIES OF THE GENUS COMASTER.

- a*¹. Less than fifty arms (*Queensland* and *N. W. Australia*).....*C. multifida*.
- a*². Usually eighty or more arms (*Queensland* and *N. W. Australia*).....*C. typica*.

KEY TO THE SUBGENERA OF THE GENUS COMANTHUS.

- a*¹. III Br 2, rarely 4 (3+4).....*Comantheria*.
- a*². III Br 2 externally, 4 (3+4) internally.....*Comanthina*.
- a*³. III Br 4 (3+4), rarely 2.....*Comanthus*.

KEY TO THE AUSTRALIAN SPECIES OF THE SUBGENUS COMANTHERIA.

- a*¹. IV Br and following series 4 (3+4) (*Queensland*; *N. W. Australia*).....*C. briareus*.
- a*². IV Br series 4 (3+4), V Br series 2, VI Br series 4 (3+4) (*Queensland*).....*C. alternans*.

KEY TO THE AUSTRALIAN SPECIES OF THE SUBGENUS COMANTHINA.

- a*¹. IV Br and following series 4 (3+4) ; the proximal pinnule segments do not bear dorsal processes (*Queensland*).....*C. schlegelii*.
- a*². IV Br and following series 2 ; the proximal pinnule segments have strong dorsal processes (*Queensland* and *N. W. Australia*).....*C. belli*.

KEY TO THE AUSTRALIAN SPECIES OF THE SUBGENUS COMANTHUS.

- a*¹. Cirri long and stout, the segments thirty or more in number, subequal, the distal without dorsal processes ; eighty to one hundred and twenty arms (*Queensland*).....*C. bennetti*.
- a*². Cirri short and slender with less than twenty-five segments, of which the proximal are more or less elongated and the distal short, or absent ; not more than sixty arms.
- b*¹. Forty or more arms ; cirri absent (*Queensland* and *N. W. Australia*).....*C. annulata*.
- b*². Less than thirty arms ; cirri present.
- c*¹. Twenty to thirty very slender cirri with nearly twenty segments ; anterior angles of axillaries produced (*N. S. Wales* and *S. Australia*).....*C. trichoptera*.
- c*². Less than fifteen cirri, which are not especially slender, with less than fourteen segments ; anterior angles of axillaries not especially produced (*Queensland* and *N. W. Australia*).....*C. parvicirra*.

KEY TO THE AUSTRALIAN SPECIES OF THE GENUS ZYGOMETRA.

- a*¹. III Br series mostly, or entirely, 2.
- b*¹. 2 III Br series developed on each post-radial series, internally ; thirty arms ; thirty-five or fewer cirrus segments (? *N. Australia*).....*Z. comata*.
- b*². Numerous III Br series developed on each post-radial series, externally as well as internally ; forty or more arms ; forty or more cirrus segments (*N. Australia*).....*Z. elegans*.
- a*². III Br series mostly, or entirely, 4 (3+4).
- b*². 4 division series ; proximal pinnules very large and stout (*N. Australia*).....*Z. microdiscus*.
- b*². 3 division series ; proximal pinnules slender (*N. Australia*).....*Z. multiradiata*.

KEY TO THE AUSTRALIAN SPECIES OF THE GENUS AMPHIMETRA.

- a*¹. More than ten arms ; the proximal pinnules with strong lateral processes on thesegments (*Queensland* ; *N. W. Australia*)...*A. variipinna*.
- a*². Ten arms ; the proximal pinnules smooth.
- b*¹. Cirri very stout, all the segments much broader than long, subequal (*N. W. Australia*).....*A. milberti*.
- b*². Cirri moderately slender, at least the proximal segments longer than broad (*Queensland*).....*A. discoidea*.

KEY TO THE AUSTRALIAN SPECIES OF THE GENUS HETEROMETRA.

- a*¹. 35-55 cirrus segments, the outer half with moderately developed spines ; lower pinnules not carinate ; thirty-eight arms (*Queensland*).....*H. nematodon*.
- a*². 20-25 cirrus segments, the outer with long sharp spines ; lower pinnules strongly carinate ; eighteen or less arms (*Queensland*).....*H. bengalensis*.

KEY TO THE AUSTRALIAN SPECIES OF THE GENUS DICHROMETRA.

- a*¹. Lower pinnules considerably larger on the outer arms of each post-radial series than on the inner, and very slender ; 20-30 cirrus segments, the outer with small spines ; 32-43 arms (*Queensland*).....*D. tenera*.
- a*². Lower pinnules approximately of equal size on all the arms.
- b*¹. *P*₂ longer than *P*₃.
- c*¹. *P*₂ not greatly larger than *P*₃ ; thirty-eight arms (*Queensland*).....*D. reginae*.
- c*². *P*₃ not much longer than *P*₁ ; forty-one arms (*Thursday Island*).....*D. gyges*.
- b*². *P*₂ and *P*₃ about equal in length ; 35-40 cirrus segments, the outer spiny (*Queensland*).....*D. articulata*.

KEY TO THE AUSTRALIAN SPECIES OF THE GENUS OLIGOMETRA.

- a*¹. *P*₃ much the largest pinnule on the arm ; the whole animal delicate and slender. *P*₂ with large processes on the lower segments (*Queensland* and *N. W. Australia*).....*O. carpenteri*.
- a*². *P*¹ the longest pinnule ; the whole animal is stout.
- b*¹. Cirri XX, 20 ; two dorsal transverse ridges on each cirrus segment ; genital pinnules not expanded (*N. W. Australia*, *Thursday Island*, *Queensland*).....*O. adeonæ*.

- b*². Cirri XV-XX, 15; a median transverse ridge on the dorsal side of each cirrus segment) genital pinnules expanded (*New South Wales*). *O. thetidis*.

KEY TO THE SPECIES OF THE GENUS PTILOMETRA.

- a*¹. Proximal cirrus segments as long as or longer than broad; cirrus sockets in more or less definite columns; middle segments of proximal pinnules half again to twice as long as broad; distal pinnules with the third and following segments longer than broad (*W. and S. Australia*) *P. macronema*.
- a*². Proximal cirrus segments twice as broad as long; cirrus sockets irregularly arranged; middle segments of proximal pinnules not so long as broad; distal pinnules with the segments broader than long until the distal third (*S. E. Australia*) *P. mulleri*.

KEY TO THE AUSTRALIAN SPECIES OF THE GENUS TROPIOMETRA.

- a*¹. 30 or more cirrus segments; arms perfectly smooth and evenly rounded dorsally, usually about 200 mm. long; deep violet or bright yellow (*Queensland*) *T. afra*.
- a*². 25 or less cirrus segments; arms with a narrow median dorsal keel, 135 mm. or less in length; mottled violet and white, or purple and yellow (*Queensland*) *T. encrinus*.

KEY TO THE AUSTRALIAN SPECIES OF THE GENUS COMPSOMETRA.

- a*¹. Cirri slender and delicate, the segments preceding the penultimate being at least half again as long as broad. *C. loveni*.
- a*². Cirri comparatively stout, the three or four segments preceding the penultimate being broader than long. *C. incommoda*.

THE FOLLOWING GENERA ARE REPRESENTED IN AUSTRALIAN SEAS BY A SINGLE SPECIES EACH:—

Capillaster; *Craspedometra*; *Stephanometra*; *Cenometra*; *Colobometra*; *Decametra*; *Stiremetra*.

LIST OF THE CRINOIDS OF AUSTRALIA.

In the annotated synonymy the localities printed in heavy faced type are the type localities; those in italics are the places from which the species are reported other than the place of origin of the type-specimen.

In cases where the first reference to a species is accompanied merely by a more or less enigmatic "specific formula," or is merely a *nomen nudum*, it is omitted, and the reference substituted where the species was first adequately described. Information in regard to the early history of all the names may be found in my paper on the "Nomenclature of the Recent Crinoids,"¹ and it seems superfluous to repeat the data there given.

In the case of families and higher groups it has not seemed worth while to burden the text with references to the original place of publication, as in most cases these works are of no interest other than purely systematic. Where such references

¹Proc. U.S. Nat. Mus., vol. 34, No. 1623, pp. 435-542.

are not given I have, however, appended the name of the student who first proposed the group name as a guide to anyone who may be interested in looking up the matter further.

Phylum **ECHINODERMATA**, *Klein*.

Subphylum **Echinodermata Heteroradiata**, *A. H. Clark*.

Class **PELMATOZOA**, *Leuckart*.

Subclass **CRINOIDEA**, *Müller*.

Order **COMATULIDA**, *A. H. Clark*.

Suborder **OLIGOPHREATA**, *A. H. Clark*.

Family **COMASTERIDÆ**, *A. H. Clark*.

Subfamily **CAPILLASTERINÆ**, *A. H. Clark*.

Genus **CAPILLASTER**, *A. H. Clark*.

Capillaster, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 87 (*Actinometra sentosa*, P. H. Carpenter, 1888).

Differential Characters.—The genus *Capillaster* is a very easy one to recognize, for it is the only Comatulid genus in which a pinnule is borne on the first brachial of the free arm; if III Br and subsequent series are present, these are always composed of three ossicles, the two outer united by syzygy, and the first bearing a pinnule.

Range.—*Capillaster* ranges from South-eastern Africa to Ceylon, and thence eastward and north-eastward to Northern Australia, the Philippine Islands, the Carolines, and Southern Japan.

A closely allied genus, *Nemaster*, represents it in the Caribbean Sea and on the coast of Brazil.

CAPILLASTER MULTIRADIATA (*Linnaeus*).

Stella chinensis perlegens, 1711, Petiver, Gazophylacium, pl. 4, fig. 6 (*China*).

Asterias pectinata (part), 1758, Linnaeus, Syst. Nat., ed. x., p. 663 (reference to Petiver, but not other references or the type specimen).

Asterias multiradiata, 1758, Linnaeus, *tom. cit.*, p. 663 (type specimen at Lund., but not references cited) (**INDIAN OCEAN**).

- Comatula fimbriata*, 1816, Lamarck, Hist. Nat. des animaux sans vertèbres, vol. 2, p. 535 (AUSTRALIA).
- Comatula coccodistoma*, 1862, Dujardin and Hupé, Hist. Nat. des zoophytes, Echinodermes, p. 208 (*nomen nudum*) (Madagascar).
- Comatula (Actinometra) borneensis*, 1875, Grube, Jahresber. schles. Ges. vaterl. Cultur, 1875, p. 75 (NORTH BORNEO).
- Actinometra coppengeri*, 1882, Bell, Proc. Zool. Soc., 1882, p. 535 (FLINDERS, CLAIRMONT); 1884, Report Zool. Coll. H.M.S. "Alert," p. 168, pl. xvi, fig. B. (*idem*).
- Actinometra multiradiata*, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 322 (*Prince of Wales Channel, 8 fms.*); 1889, Studer, Die Forschungsreise S.M.S. "Gazelle," iii, Thiel, Zool. u. Geol., p. 195 (*19° 42' S. lat., 116° 49' E. long., 91.5 meters*); 1894, Bell, Proc. Zool. Soc., 1894, p. 394 (*N.W. Australia*).
- Capillaster multiradiata*, 1909, A. H. Clark, Zoologische Anzeiger, vol. 34, p. 364 (*Dirk Hartog I., 7 fms.*); Vidensk. Meddel fra den Naturhist. Forening i København, 1909, p. 134 (discussion).
- Actinometra multifida*, Brit. Mus., MS.
- Antedon anceps*, Brit. Mus., MS.

Differential Characters.—This species usually has between fifteen and twenty-five arms. It is the only Australian Comatulid in which the first brachial of the free arm bears a pinnule, and is therefore easily recognised.

Australian Records.—Known since 1816 from "Australia," it is only within comparatively recent years that exact records of locality touching the occurrence of this species in Australia have been published. The "Gazelle" obtained it in 7 fathoms at Turtle Bay, Dirk Hartog Island, West Australia, and in 19° 42' S. lat., 116° 49' E. long. (off West Australia) in 91.5 meters (about 51 fathoms); Bell records it from "North-west Australia"; the "Alert" dredged it at Flinders Island, Claremont, in 11 fathoms; and the "Challenger" dredged it in Prince of Wales Channel (10° 30' S. lat., 142° 18' E. long.) in 8 fathoms.

Distribution.—*Capillaster multiradiata* is found at Madagascar and Mauritius, and ranges from Ceylon eastward along the shores of the Indian Ocean, including the more northern coasts of Australia, occurring abundantly about all the East Indian Islands, and reaching as far as Kogoshima, Japan, and the Caroline Islands.²

² The form occurring on the south-eastern coast of Africa, and at Madagascar and Mauritius, differs slightly from the typical East Indian variety, and has been differentiated under the subspecific name of *C. m. coccodistoma* cf. Proc. U.S. Nat. Mus., vol. 40, p. 16).

Genus COMATELLA, A. H. Clark.

Comatella, 1908, A. H. Clark, Smiths. Miscell. Coll. (Quarterly Issue), vol. 52, p. 207 (*Actinometra nigra*, P. H. Carpenter 1888).

Differential Characters.—In the genus *Comatella* the division series are all of two segments each, and the first two brachials of the free undivided arm are united by a true or a pseudo-syzygy; the cirri are always present and well developed. There is never a pinnule on the first brachial.

Range.—This genus ranges from South-eastern Africa, the Maldives and Laccadive Islands to Southern Japan, the Philippines, Tonga, Samoa, Fiji, and Northern and Eastern Australia.

A very similar genus, *Neocomatella*, replaces it in the Caribbean Sea and on the Atlantic Coasts of Southern Europe and North-western Africa.

COMATELLA STELLIGERA (P. H. C.).

Antedon (Actinometra) tenax, Lütken, MS.

Actinometra stelligera, 1880, P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 15, p. 198, pl. xii., fig. 26 (near KANDAVU, FIJI).

Actinometra notata, 1889, P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 21, p. 312, pl. xxvii. (KING ISLAND, MERGUI ARCHIPELAGO).

Antedon bassett-smithi, 1894, Bell, Proc. Zool. Soc., 1894, p. 399, pl. xxiv. (MACCLESFIELD BANK, 13-36 fms.).

Comatella stelligera, 1909, A. H. Clark, Vidensk. Medd. fra den Naturhist. Forening i København, 1909, p. 136.

Differential Characters.—This and the following are the only Australian Comasterids in which all the division series are composed of two ossicles united by a readily discernible synarthry. The cirri are always functional and numerous. *Comatella stelligera* is easily distinguished from *C. maculata* by its more numerous (about thirty) arms and longer and stouter cirri, which have more than, instead of less than, eighteen segments.

Specimen in the Australian Museum.—The collection submitted to me included a single specimen of this species from Port Jackson, New South Wales, the first known from Australia. It is of medium size and has thirty-six arms which were originally about 90 mm. long; the cirri are xxii, 18-20, 20 mm. long. The eversion of the distal edge of the brachials is especially well marked, and there is an indication of an eversion of the distal edges of the elements of the division series.

Range.—*Comatella stelligera* is found from Port Jackson, N.S. Wales, to Samoa, Fiji, Tonga, the Philippine Islands and Macclesfield Bank, the Mergui Archipelago, and Ceylon.

COMATELLA MACULATA (*P. H. C.*).

Actinometra fusca, 1877, Lütken, Mus. Godeffr. Cat., vol. 5, p. 100 (*nomen nudum*), (*Bowen*). 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, pp. 306, 307 (*nomen nudum*), (*Bowen*).

Actinometra maculata, 1888, P. H. Carpenter, *tom. cit.*, p. 307, pl. lv., fig. 2 (PRINCE OF WALES CHANNEL, near CAPE YORK, 8 fms.).

Comatella maculata, 1909, A. H. Clark, Vidensk. Meddel. fra den Naturhist. Forening i København, 1909, p. 138 (*Bowen*).

Differential Characters.—*Comatella maculata* is a small species with twenty arms, or somewhat fewer, about 80 mm. to 100 mm. long; the cirri are small, though numerous, and possess not more than twenty segments.

Australian Record.—Bowen.

Range.—Northern Australia to the Maldive and Laccadive Islands, and South-eastern Africa.

Remarks.—The type specimen, which I examined while in London, resembles very closely the specimen from Bowen in the collection of the Zoölogical Museum at Copenhagen, described in my report on that collection.

Subfamily COMACTINIINÆ.

Genus COMATULA, *Lamarck*.

Comatula, 1816, Lamarck, Hist. nat. des animaux sans vertèbres vol. 2, p. 530 (*Comatula solaris*, sp. nov.).

Differential Characters.—In *Comatula* the elements of the IB series and the following division series (when present) and the first two brachials are united by what appears to be a true syzygy, though in reality it is a modified form of the more common synarthry or bifascial articulation. There are ten arms, except in three species, two of which have twenty and the third usually ten, but sometimes eleven or twelve. The cirri, which are often absent in the adults, are perfectly smooth dorsally without dorsal spines or ridges. The segments of the genital pinnules are short and very broad.

Range.—*Comatula* ranges from the Andaman Islands, Java and Singapore, including the whole of Australia, to Celebes, the Philippine Islands and Hong Kong.

A closely allied genus, *Comactinia*, represents it in the Caribbean Sea.

COMATULA ROTALARIA (*Lamarck*).

Comatula rotalaria, Hist. nat. des animaux sans vertèbres, vol. 2, p. 534 (Australia).

Actinometra jukesii, 1879, P. H. Carpenter, Proc. Roy. Soc., vol. 28, p. 390 (NORTH-EAST COAST OF AUSTRALIA).

Actinometra jukesii, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 168 (*Albany Island; Prince of Wales Channel*); 1885, Proc. Linn. Soc. N. S. Wales, vol. 9, p. 498 (*Port Molle*).

Actinometra paucicirra, 1884, Bell, *tom. cit.*, p. 169, pl. xvii., figs. A, Aa (PRINCE OF WALES CHANNEL; THURSDAY ISLAND); 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 291.—1898, Döderlein, Denkschr. Ges. Jena, vol. viii., p. 479 (*Thursday Island*).

Differential Characters.—This species always has almost or quite exactly twenty arms and division series of two ossicles each, united by a pseudo-syzygy which appears exactly like a syzygy externally. When adult there are no cirri; the cirri of the young are always perfectly smooth dorsally.

Specimens in the Australian Museum Collection.—*Albany Passage*:—Two fine examples, one with nineteen, the other with twenty arms. *Port Molle, Queensland*:—Two specimens; one is a fine large individual with twenty arms 120 mm. long, the other a young example with twenty arms 60 mm. long, and cirri vii, 15, 11 mm. long. This specimen represents the stage figured by Bell in the "Alert" Report (pl. xvii., A); the seven cirri are confined to the interradial angles of the centrodorsal; three are single, the remaining four in two pairs; they are moderately slender; the first segment is very short, the second not quite so long as broad, the third slightly longer than broad, the fourth and following approximately equal in size, about half again as long as broad except the penultimate, which is about as long as broad; the more proximal segments are slightly constricted centrally, and the penultimate bears a small and short sub-terminal opposing spine; the terminal claw is half again as long as the penultimate segment, moderately and evenly curved.

The study of these specimens has shown that in this species, as in the genus *Comatella*, arm division is of the so-called "compound" type, and in *Comatula pectinata* also when a II Br series occurs the first true syzygy on the inner arm is between the first and second brachials, on the outer between the third and fourth. The very characteristic cirri, identical in small specimens of *rotalaria* and in specimens of the other species of the genus at comparable stages, which never show any trace of dorsal processes on the outer segments, and which have all the segments except the basal subequal with no transition segments, as well as the invariably ten-armed condition of all but three of the species, one of which is almost invariably ten-armed, show that *Comatula*

must be placed with *Comactinia* and *Cominia*, and that, in spite of its compound division when more than ten arms are present, it cannot be at all closely related to *Comatella*.

The occurrence of compound division both in *Comatula* and *Comatella* is comparable to the occurrence of interpolated division series consisting of two segments each in such different groups as the Pontiométridæ, Stephanométridæ, and Mariamétridæ among the Comatulids and in *Endoxocrinus* among the Pentacrinites, and of extraneous division of the same type in the Comatulid genus *Capillaster* and the Pentacrinite genus *Hypalocrinus*.

Additional Australian Records.—Professor J. Bete Jukes found this species abundant on the North-east Coast of Australia; the "Alert" dredged it at Albany Island, in 3-4 fathoms, at Thursday Island, and in the Prince of Wales Channel, in 7 fathoms, and in 5-7 fathoms, as well as in Torres Strait, in 4 fathoms; Professor F. J. Bell has reported it from Port Molle, and the "Challenger" found it between Albany and Somerset Islands, off Booby Island (10° 36' S. lat., 14° 55' E. long.), in 6 fathoms, as well as at Cape York and the Aru Islands south of the western end of New Guinea. There are some specimens in the British Museum from Holothuria Bank, 34 fathoms.

Range.—The Aru Islands and the Northern Coast of Australia, south in Queensland to Port Molle.

Remarks.—Basing my conclusions upon the data and the figures given by P. H. Carpenter in the "Challenger" Report, I have previously used the name *rotalaria* for the species called by Müller *Alecto parvicirra*; I was therefore somewhat surprised, when studying the collections of the Paris Museum, to find that Lamarck's original material consisted of two beautiful specimens of the form called *jukesii* by Carpenter and *paucicirra* by Bell, a very different thing from the *rotalaria* of the "Challenger" Report.

COMATULA ETHERIDGEI, *sp. nov.*

Description.—In general resembling *C. pectinata*; there are no cirri, but the centrodorsal is somewhat raised above the dorsal surface of the radial pentagon.

P_1 is replaced on each arm by two brachials terminating in an axillary (morphologically an exteriorly developed IIBr series) from which springs interiorly (*i.e.*, on the side toward the original arm) a small arm two-thirds the length of a normal P_1 , and externally a normal P_1 .

In the type specimen the small supernumerary arms are usually about two-thirds the length of the normal P_1 , but they may be as long as three-fourths of the length of that pinnule; another

specimen is similar, but the supernumerary arms are rather smaller; a third specimen is similar, but the supernumerary arms are longer, reaching 20 mm., and there are a few small, slender and weak cirri, each with 12 segments.

The arm length is 70 mm.

Localities.—Holothuria Bank, 38 fathoms:—Three specimens. Baudin Island, North-western Australia:—One specimen, resembling the third mentioned above from Holothuria Bank. All the specimens are in the British Museum, and are described herein with the kind consent of Professor F. J. Bell.

Remarks.—This is a most extraordinary species, appearing partially to bridge the gap between the ten-armed forms, *Comatula pectinata*, *C. solaris*, *C. purpurea*, and *C. micraster*, and the twenty-armed *C. rotalaria*.

Some time ago, basing my conclusions upon a study of the arm structure, I ventured the remark that in compound arm division the inner arms are phylogenetically the oldest; the truth of this statement is strikingly illustrated by the present species in which we find the original arms of the ten-armed stage, next to them young arms less than half as large, and exteriorly pinnules which have not yet become replaced by arms.

COMATULA BRACHIOLATA (Lamarck).

Comatula brachiolata, 1816, Lamarck, Hist. nat. des animaux sans vertèbres, vol. 2, p. 535 (? ATLANTIC OCEAN).

Alecto rosea, 1841, J. Müller, Archiv. für Naturgesch., 1841, i., p. 143 (UNKNOWN LOCALITY).

Actinometra brachiolata, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 380 (*Australia*). 1891, Hartlaub, Nova Acta Acad. vol. 58, No. 1, p. 107 (*Australia*).

Differential Characters.—This is an exceptionally rugged species with a large broad centrodorsal and short stout tuberculous arms. The very numerous cirrus segments, all of which are subequal and much broader than long, serve to distinguish it at once from all the other species of the genus.

Nothing is known in regard to its distribution; the two specimens upon which Müller's *Alecto rosea* is based, and which are now before me, are supposed to have come from Australia.

Remarks.—I have examined the types both of Lamarck's *Comatula brachiolata* (at Paris), and of Müller's *Alecto rosea* (sent to me from Berlin), and I find them to be specimens of the same species. A beautiful specimen in the British Museum was taken at Port Phillip, and I have seen others from the vicinity of King George Sound. It is evident, therefore, that this is a South Australian species like *Comanthus trichoptera*.

COMATULA SOLARIS (*Lamarck.*)

- Comatula solaris*, 1816, Lamarck, Hist. nat. des animaux sans vertèbres, vol. 2, p. 533 (AUSTRALIA).
- Actinometra imperialis*, 1841, J. Müller, Archiv. für Naturgesch., 1841, i., p. 140 (UNKNOWN LOCALITY).
- Actinometra robusta*, 1879, P. H. Carpenter, Trans. Linn. Soc. (Zool.), [2] ii., p. 86, pl. v., figs. 10-15 (AUSTRALIA); 1882, Journ. Linn. Soc. (Zool.), vol. 16, p. 517 (*Australia*); 1884, Bell, Report Zool. Coll. H.M.S. "Alert," p. 167 (*Port Curtis; Sta. 144* ["probably *Thursday Island.*"]).
- Actinometra albonotata*, 1882, Bell, Proc. Zool. Soc. 1882, p. 535 (ALBANY ISLAND).
- Actinometra solaris*, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 164 (*Warrior Reef; Prince of Wales Channel; Port Curtis; Torres Strait; Thursday Island; Albany Island*); 1885, Bell, Proc. Linn. Soc. N.S. Wales, vol. 9, p. 498 (*Port Molle*); 1888, P. H. Carpenter, "Challenger" Report, Zool., vol. 26, p. 288 (*Channel between Albany Island and Somerset, 8-12 fathoms; off Booby Island, 6 fathoms*).—1898, Döderlein, Denkschr. Ges. Jena, vol. viii., p. 478 (*Thursday Island*).
- Actinometra solaris*, var. *albonotata*, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 164 (*Albany Island*).
- Actinometra intermedia*, 1884, Bell, *tom. cit.*, p. 166; (ALBANY ISLAND); 1885, Bell, Proc. Linn. Soc. N.S. Wales, vol. 9, p. 498 (*Port Molle*).
- Actinometra strotta*, 1884, Bell, *tom. cit.*, p. 167 (*nomen nudum*), (*Port Molle*); 1884, P. H. Carpenter, "Challenger" Reports, Zool. vol. 11, p. 67 (CAPE YORK).

Differential Characters.—*Comatula solaris* is a large and handsome species with especially broad, short jointed genital pinnules, and rather stout cirri which have from sixteen to twenty-five segments. As a rule it may be at once distinguished from *C. pectinata* by its superior size and more robust build as well as by the more numerous cirrus segments, but occasionally the two species approach each other so closely that the identification of a given specimen is more or less arbitrary.

Specimens in the Australian Museum Collection.—Port Molle, Queensland, 14 fathoms—Three specimens. Port Molle—One specimen. Masthead Island Lagoon—One specimen. No locality—Ten specimens.

Additional Australian Records.—Port Curtis, in 5-11 fathoms; Holothuria Bank; Thursday Island; Fitzroy Island; Albany Island, in 3-4 fathoms; Warrior Reef; Prince of Wales Channel,

in 5-7 fathoms; Torres Strait, littoral, and in 10 fathoms; Cape York; Port Molle, in 12 fathoms; Port Denison; channel between Albany and Somerset Islands, in 8-12 fathoms; off Booby Island (10° 36' S. lat., 14° 55' E. long.), in 6 fathoms.

Range.—Hong Kong, Singapore, and the Philippine Islands southward to Northern Australia, on the north-east coast extending south to Port Curtis.

Remarks.—It is very curious that this species does not occur in the broad armed and generally robust phase except along the Australian coast; specimens from Singapore and Hong Kong always, so far as known, have narrow slender arms, which are well rounded dorsally. On the other hand, the robust phase of *C. pectinata* is common throughout its range. It is not uncommon to find specimens of *C. pectinata* with three or four robust arms, the remainder being slender, and much longer, but I never saw this variation in *C. solaris*.

Lamarck's original material consisted of six fine specimens.

The fine specimen taken by the "Alert" at Port Molle has no cirri; the centrodorsal is reduced to a pentagonal plate which is not quite sunk to the level of the dorsal surface of the radials.

COMATULA PECTINATA (Linnaeus).

Asterias pectinata, 1758, Linnaeus, Syst. Nat., ed. x., p. 663 (type specimen, but not citations) (INDIAN SEAS).

Comatula cumingii, 1894, J. Müller, Abhandl. d. k. preuss. Akad. d. wiss., 1847, p. 255 (MALACCA).

Actinometra affinis, 1882, P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, p. 517 (JAVA).

Actinometra pectinata, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 165 (*Dundas Strait*).—1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 284 (*Channel between Albany Island and Somerset, 8-12 fathoms*).—1891, Hartlaub, Nova Acta Acad., vol. 58, No. 1, p. 107 (*Cooktown*).—1898, Döderlein, Denkschr. Ges. Jena, vol. viii., p. 478 (*Thursday Island*).

Actinometra solaris, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 164 (*Arafura Sea*).

?*Actinometra purpurea*, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 170 (*Dundas Strait*).

Actinometra echinoptera, Brit. Mus., MS.

Comatula rosularis, Brit. Mus., MS.

Actinometra parvicirra, Brit. Mus., MS.

Antedon irregularis, Brit. Mus., MS.

Differential Characters.—This is a more slender and usually smaller species than *C. solaris*, and the cirri rarely have more than fifteen segments, those of *C. solaris* possessing eighteen or over. The arms may taper evenly from the base to the tip, or they may be somewhat swollen proximally, this, however, rarely being carried to the extreme commonly seen in *C. solaris*. The segments of the genital pinnules of *C. pectinata* are longer and less broadened than those of *C. solaris*.

The ossicles of the I Br series and the first two brachials in *C. solaris* are always, so far as I have seen, united by a peculiar articulation which very closely resembles a syzygy, but which is derived from a synarthry; it is called a pseudosyzygy. These segments in *C. pectinata* may be united either by pseudosyzygy or by a more or less unmodified synarthry.

The difference in length between the grooved anterior and the ungrooved posterior arms reaches a maximum in this species, the latter being sometimes scarcely one-third the length of the former. The restriction of the ambulacra also is sometimes carried to an extreme as in the much smaller *C. micraster*, four arms being grooved and six ungrooved.

Comatula pectinata frequently occurs with eleven arms, sometimes with twelve; *C. solaris*, *C. purpurea*, and *C. micraster* have never been found with more than ten.

Specimens in the Australian Museum Collection.—Albany Passage—One fine specimen with cirri xix, 14-15, 10-12 mm. long. Port Molle—One small specimen. Port Jackson—One specimen with arms 100 mm. long, somewhat swollen basally, and cirri xvi, 11-13, 10 mm. long. No locality—Three large specimens.

Additional Australian Records.—Thursday Island, littoral, and in 4-6 fathoms; Arafura Sea; Warrior Reef, Torres Strait; Basset-Smith Bank, in 9 fathoms; Prince of Wales Channel, in 7 fathoms; Port Curtis, littoral, and down to 11 fathoms; Port Molle, in 14 fathoms; Dundas Strait, in 17 fathoms; North-western Australia; Cape York; between Albany and Somerset Islands; Fitzroy Island; Cooktown; Holothuria Bank, in 24-34 fathoms; northern side of Holothuria Bank, in 36 fathoms; near Cape Voltaire (14° 50' S. lat., 125° 40' E. long.); Baudin Island, littoral, and in 8-15 fathoms.

Range.—Singapore and the Philippine Islands southward to Australia, reaching on the east coast, Port Jackson, N. S. Wales.

Remarks.—At Singapore it is not uncommon to find specimens of this species with eleven arms, and a few have even been recorded with twelve; two of the specimens from Holothuria Bank also have eleven arms, but no other examples are known from Australia with more than ten. There are never more than ten arms in the stout phase.

An examination of the type of Müller's *Comatula cumingii* has shown it to be a young specimen of this species.

COMATULA PURPUREA (J. Müller).

Alecto purpurea, 1843, J. Müller, Archiv für Naturgesch., 1843, i., p. 132 (AUSTRALIA); 1910, A. H. Clark, Proc. Biol. Soc. Washington, vol. 23, pp. 95-98 (fig.) (detailed description of the type specimen).

Actinometra pectinata (part), 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 165.—1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 284, pl. liii., fig. 15.

Differential Characters.—This species is very like *C. pectinata*, but may be at once distinguished by the curious arrangement of the cirri; these are segregated in the interradian angles where they occur singly or in pairs, so that they are from five to ten in number. The size of *C. purpurea* is usually much less than that of *C. pectinata*.

Through the kindness of the authorities of the Berlin Museum I was enabled to compare the specimens recorded below directly with Professor Müller's original type.

Specimens in the Australian Museum Collection.—Murray Island, Torres Strait—Thirteen specimens; the cirri are v-x (usually nearer the latter), 9-12 (usually 11-12), 6 mm. long; as in *C. pectinata* they are of two types which are quite distinct, a primitive type in which the segments, except the basal two, are subequal in length and the distal are not compressed laterally, and a more advanced type in which the distal segments are shorter than the proximal, and are laterally compressed; the arms are from 40 mm. to 50 mm. long; the median dorsal surface from the sixth brachial outward is occupied by a delicate narrow rounded ridge, more prominent than the similar ridge often seen in *C. pectinata*. Port Denison—On specimen with arms 80 mm. long and cirri viii., 10-12, 8 mm. to 10 mm. long. No locality—One fine large specimen with arms 120 mm. long and cirri vii., 14-15, 9 mm. to 11 mm. long.

Additional Australian Records.—This species was not differentiated from *C. pectinata* either by Bell or by Carpenter. At the British Museum I examined specimens from Dundas Strait, in 17 fathoms; from Torres Strait; and from Dimes Island, New Guinea. It is abundant at Shark Bay.

Subfamily COMASTERINÆ, A. H. Clark.

Genus COMASTER, L. Agassiz.

Comaster, 1836, L. Agassiz, Mém. Soc. sci. nat. Neuchatel, vol. 1, p. 193. (*Comatula multiradiata*, Lamarek, 1816 [not *Asterias multiradiata*, Linnæus, 1758]=*Alecto multifida*, J. Müller, 1841).

Differential Characters.—The various species of *Comaster* are most readily recognised by their peculiar type of arm division. The II Br series are 4 (3 + 4), but the following series are all 2, usually appearing as if united by syzygy; III Br series are internal in their appearance, so that, if only II Br series and III Br series are present, the thirty arms will be arranged in 1, 2, 2, 1 order; the following division series follow the internal III Br series and are developed on either side alternately, so that each I Br series appears to give off two stout trunks giving off undivided arms on alternate segments, and finally terminating in a pair of undivided arms. The presence of forty arms due to the presence of all the II Br and all the III Br series is rare, but occasionally is found; species possessing such an arm arrangement are easily recognised by the II Br 4 (3 + 4) and the III Br 2 series.

The presence of terminal combs at intervals on the outer pinnules also distinguishes the genus *Comaster* from all the other genera of the Comasteridæ.

Range.—Maldive Islands to Northern Australia, Fiji, the Philippines, and the Gilbert (Kingsmill) Islands.

COMASTER TYPICA (Lovén.)

Antedon stellatus, Lütken, MS.

Phanogenia typica, 1866, Lovén, Öfv. k. Vetensk. Akad. Förhandl., 1866, No 9, p. 231, fig. on p. 230, a-h (NEW HARBOUR, near Singapore).

Actinometra multifida (part), 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 169 (*Prince of Wales Channel; Thursday Island; Torres Strait*).

Actinometra variabilis, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 169, pl. xvii., figs. B, Ba (THURSDAY ISLAND); 1894, Proc. Zool. Soc. 1894, p. 394 (*N.W. Australia, 9-38 fms.*).

Actinometra typica, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 296, pl. lvii., fig. 1.

Comaster typica, 1909, A. H. Clark, Zool. Anzeiger, vol. 34, p. 365 (*off Port Walcott*); Vidensk. Medd. fra den naturhist. Forening i København, 1909, p. 139.

The systematic position of the *Actinometra variabilis* described and figured by Professor Bell in the Report upon the "Alert" Collections has puzzled me considerably. Carpenter placed it in the "Parvicirra group" of "*Actinometra*," all but one of the other species of which fall into the genus *Comanthus* as now understood; but the branching of the arms as shown in Bell's figure is of a curious type exclusively confined to the genus *Comaster*. The general appearance, too, of the specimen figured by Bell is that of a species of *Comaster*.

Carpenter placed the species *typica*, *distincta*, *multibrachiata* and *novæguineæ* in his "Typica group" composed of species in which the first two post-radial ossicles ("two outer radials") are supposedly united by syzygy instead of by the usual synarthry, and the same is true of the division series, which are typically composed of two segments each. Now the occurrence of a true syzygy in these places is theoretically impossible, and I therefore seized the first opportunity of examining into the matter. I find that the union between these ossicles is in reality a modification of the primitive synarthry in the direction of the syzygy, though the dorso-ventral bar across the joint face is never entirely obliterated. All grades of perfection of this "pseudo-syzygy" may be traced, from the perfect synarthry of *Comaster multijida* to the nearly perfect syzygy of *C. typica*. The "Typica group," then, is shown to be non-existent as a natural unit. But the members of the "Typica group" all agree in their peculiar combs on the proximal pinnules; these combs are short with very long teeth, and are abruptly bent so that they do not lie in the general line of the pinnule; moreover, the combs are not confined to the proximal pinnules, but occur at intervals all along the arm to the tip, a condition quite unknown in other Comasterids. Also, the proximal pinnules are very slender instead of being long and stout. In these characters Müller's *Alecto multijida* agrees with the species in Carpenter's "Typica group," and must therefore be placed with them, together with several curious species recently described by Dr. Hartlaub and by myself; all these forms I have united under the generic name *Comaster*.

The determination of *variabilis* as a *Comaster* at once brought out the fact that there is absolutely nothing in Bell's description or figure whereby this species may be differentiated from the *Actinometra multibrachiata* described four years later by Carpenter, of which I have numerous specimens from the Philippine Islands. The chief character of the latter is the large and robust cirri, but Bell says nothing whatever about the size of the cirri of *variabilis*, and they are not shown in his figure.

I requested Professor Bell to compare the types of these two species, both of which are in the British Museum, and to inform me whether or not my suspicions as to their identity were well founded. He very courteously replied that the figures given of them appear to him "to be quite satisfactory and to show the complete difference between them. In *A. multibrachiata* the arms are free and the cirri are stout and well pronounced, while in *A. variabilis* the arms are united for a considerable distance and the cirri are either completely absent or very delicate." The figure of *variabilis*, however, shows the arms to be "free," exactly as in *multibrachiata*, and, in fact, in all the species of the genus.

The character of the cirri as given by Professor Bell, however, while it shows that *variabilis* cannot be the same as *multibrachata*, removes all possibility of distinguishing the supposed species from *typica*, a form already known from North-western Australia, and represented in the collection of the Australian Museum from Port Molle, Queensland. From the original description and the figure, supplemented by the data which Professor Bell was so kind as to send me in correspondence, it is evident that the only course open to us is to place *Actinometra variabilis* in the synonymy of *Phanogenia typica*, of which species it is merely a slightly immature stage.

Differential Characters.—*Comaster typica* when fully grown has no cirri. The arms, which are from sixty to nearly two hundred in number, arise by a curious method of branching analagous to that found in certain fossil Crinoids; the I Br axillaries give rise to two division series; these II Br 4 (3 + 4) division series bear outwardly undivided arms, and inwardly a division series of 2, which, in turn give off inwardly undivided arms and outwardly a IV Br series, and so on. The general appearance is that of two stout arm trunks arising from each II Br axillary, each of these trunks giving off undivided arms on either side alternately, finally terminating in a pair of arms. No other Australian Crinoid except the following possesses this scheme of arm division. The occurrence of terminal combs at intervals all along the arm and the slenderness of the proximal pinnules, as well as the apparent syzygy between the two elements of each division series, also assist in identifying the form. Taken altogether, this is much the easiest of all the Australian Comasterids to recognize.

Specimens in the Australian Museum Collection.—Port Molle, Queensland—One small immature specimen with about fifty arms. The centrodorsal has a row of twelve cirrus sockets which in life bore functional cirri; one cirrus stump of two segments remains. The interradiolateral portion of the disk is completely plated, a character not previously reported in this species (though sometimes occurring in *C. multifida*) and possibly only found in the young, as in the young of *Comactinia meridionalis*.

Additional Australian Records.—The "Gazelle" dredged a single specimen of this species in 19° 42.1' S. lat., 116° 49.8' E. long. (north of Port Walcott, Western Australia), in 50 fathoms. The "Alert" dredged a specimen in Prince of Wales Channel, Torres Strait, in 5-7 fathoms, and obtained four others at Thursday Island. It has been reported by Bell from North-western Australia in from 9 to 38 fathoms.

Range.—*Comaster typica* is found from Singapore to the Philippines and Fiji, and the Gilbert (Kingsmill) Islands, and southward to Northern Australia.

COMASTER MULTIFIDA (*J. Müller*).

- Comatula multiradiata* (part) (not of Linnæus), 1816, Lamarck, Hist. nat. des animaux sans vertèbres, vol. 2, p. 533.
- Alecto multifida*, 1841, J. Müller, Archiv. für Naturgesch., 1841, i., p. 147 (based on preceding).
- Actinometra multifida*, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 169 (*Percy Island*; *Albany Island*; *Prince of Wales Channel*); 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 29, p. 383 (*Queensland*; *Torres Strait*); 1894, Bell, Proc. Zool. Soc., 1894, p. 394 (*N.W. Australia*).
- Actinometra variabilis* (part), 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 169 (but not reference to plate). (*Thursday Island*).
- Actinometra belli*, 1898, Döderlein, Denk. Ges. Jena, vol. viii., p. 479 (part), plate, fig. 4 (but not 4a).
- Comaster carpenteri*, 1908, A. H. Clark, Proc. U. S. Nat. Mus., vol. 33, p. 686.

Differential Characters.—*Comaster multifida* usually has about forty arms, the II Br series being 4(3 + 4) and the III Br series 2. This arm structure, combined with the characteristic cirri and the occurrence of terminal combs at intervals on the outer pinnules to the arm tips, make the species an easy one to recognise.

Australian Records.—This species has been reported from North-western Australia, and from Percy and Albany Islands, and Prince of Wales Channel.

Distribution.—This form ranges from Northern Australia northward to the Moluccas.

Professor Döderlein in his paper upon a collection of Comatulids from Amboina and Thursday Island has confused this species with *Comantheria belli*; in his figures, supposedly of that species, fig. 4 obviously represents *Comaster multifida*; this explains why it has not developed the characteristic carination of the pinnule segments.

In the type of *Alecto multifida*, which I examined while at Paris, there are forty-five arms; the typical scheme of arm division is as follows:—There are two IIBr 4(3 + 4) series; each of these gives off one III Br 2 series externally; the latter bear outwardly an undivided arm, and inwardly a IV Br 2 series. The elements of the III Br series are united apparently by a close synarthry which has not become metamorphosed into a pseudosyzygy as is the case in *Comaster typica*. This is probably what misled Carpenter and caused him to place this species in the "Parvicirra group" instead of next to its closest relative, *C. typica*.

In the type specimen one of the III Br series is 4 (3 + 4); there are eight IV Br 2 series, all internal; there is one V Br series. The rays are broad, and the interradial areas are heavily plated. There were about fifteen cirri present in life, the stumps remaining showing that the cirri were stout.

Comaster multifida is a curious local derivative from the comparatively wide spread *C. typica* type.

Genus COMANTHUS, *A. H. Clark.*

Comanthus, 1908, *A. H. Clark*, Proc. Biol. Soc. Washington, vol. 21, p. 220; Smiths. Miscell. Coll. (Quarterly Issue), vol. 52, p. 203 (*COMANTHUS INTRICATA*, *sp. nov.*).

Subgenus COMANTHERIA, *A. H. Clark.*

Comantheria, 1909, *A. H. Clark*, Vidensk. Medd. fra den Naturhist. Forening i København, 1909, p. 142 (*Antedon briareus*, Bell, 1884).

Differential Characters.—The subgenus *Comantheria* has the II Br series 4 (3 + 4), the III Br series 2, and some or all of the succeeding division series 4 (3 + 4). The species are all large, with very numerous arms, and usually no cirri.

Range.—The species of *Comantheria* range from Northern Australia northward to Canton, China, and Southern Japan; they are abundant in the Philippine Islands.

COMANTHERIA ALTERNANS (*P. H. C.*).

Actinometra alternans, 1881, *P. H. Carpenter*, Notes from the Leyden Museum, vol. 3, p. 208 (UNKNOWN LOCALITY); 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 169 (*Port Molle*).

Differential Characters.—This species has no cirri, the II Br series are 4 (3 + 4), the III Br series 2, and the more distal series evenly divided between 4 (3 + 4) and 2, the two types more or less regularly alternating.

Australian Record—Port Molle, Queensland.

Distribution.—Philippine Islands south to Queensland, in 12-20 fathoms.

Remarks.—The type, which I examined at Leyden, has about ninety arms; the division series are regularly alternating, the II Br series being 4 (3 + 4), the III Br series 2, the IV Br series 4 (3 + 4), the V Br series 2, etc.; there are almost no exceptions to this regular alternation. The centrodorsal is in shape like an *Hippasteria*, not yet having become stellate.

COMANTHERIA BRIAREUS (*Bell*).

Antedon briareus, 1884, *Bell*, Rep. Zool. Coll. H.M.S. "Alert," p. 163, pl. xiv. (PORT DENISON).

Actinometra divaricata, 1888, P. H. Carpenter, "Challenger" Reports, Zool. vol. 26, p. 332, pl. lxxiii., figs. 6-8 (BANDA).

Actinometra parvicirra (part), 1894, *Bell*, Proc. Zool. Soc., 1894, p. 394 (*N.W. Australia*).

Comanthus briareus, 1909, A. H. Clark, Zool. Anzeiger, vol. 34, p. 365 (off *Port Walcott*).

Differential Characters.—This species is readily distinguished from all the other Australian members of the genus. The absence of cirri and the very great number of arms give it a superficial similarity to *Comanthina belli* and to *Comantheria alternans*; but it differs from the former in having the III Br series all 2 and in lacking the prominent carination of the proximal pinnule segments, and from the latter in the absence or at least rarity of division series of 2 after the III Br series.

Australian Records.—*Comantheria briareus* was obtained by Dr. R. W. Coppinger of the "Alert" at Port Denison, Queensland, in 3-4 fathoms, and was dredged by the German ship "Gazelle" in 19° 42' 1" S. lat., 116° 49' 8" E. long. (north of Port Walcott, Western Australia), in 50 fathoms. There is a specimen in the British Museum with between seventy-five and eighty arms which was dredged at Baudin Island, in 8-15 fathoms.

Range.—Philippine Islands and Moluccas, south to northern Australia.

Subgenus COMANTHINA, *A. H. Clark*.

Comanthina, 1909, A. H. Clark, Vidensk. Medd. fra den naturhist. Forening i København, 1909, p. 142 (*Actinometra nobilis*, P. H. Carpenter, 1884).

Differential Characters.—In *Comanthina* the III Br series are 4 (3+4), and the III Br series are 2 externally and 4 (3+4) internally; the species are all large, with very numerous arms, and usually few or no cirri when adult.

Range.—The species of the subgenus *Comanthina* range from northern Australia to Ceylon and the Philippine Islands.

COMANTHINA BELLI (*P. H. C.*).

Actinometra belli, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 334, pl. lxiv., figs. 1, 2 (PRINCE OF WALES CHANNEL).—1898, Döderlein, Denk. Ges. Jena, vol. viii., p. 479, plate, fig. 4a (but not fig. 4), (*Thursday Island*).

Actinometra nobilis, 1894, Bell, Proc. Zool. Soc., 1894, p. 394 (North-west Australia).

Actinometra multifida, 1894, Bell, *loc. cit.*, p. 394 (North-western Australia).

Differential Characters.—*Comanthina belli*, like *Comantheria alternans* and *C. briareus*, has a very large number of arms and a rudimentary centrodorsal usually devoid of cirri; the III Br series, however, are 2 on the outer side of the rays and 4 (3 + 4) on the inner side; the subsequent divisions are usually 2; and this, taken in connection with the very prominent carination of the segments in the proximal half of the pinnules, distinguishes it at once from all other Australian Comatulids.

Australian Records.—The "Challenger" dredged this species in 10° 30' S. lat., 142° 18' E. long. (Prince of Wales Channel, near Cape York) in 8 fathoms. There are specimens in the British Museum from Western and from North-western Australia. There are also two unrecorded specimens from Torres Strait in the U. S. National Museum, and one in the Berlin Museum collected at Mermaid by the "Gazelle." This interesting form is not otherwise known.

COMANTHINA SCHLEGELII (*P. H. C.*).

Actinometra schlegelii, 1881, P. H. Carpenter, Notes from the Leyden Museum, vol. iii., p. 210 (? EAST INDIES).

Actinometra multifida (part), 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 169 (*Percy Island*).

Actinometra dissimilis, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 337 (*ZAMBOANGA*).

Actinometra nobilis, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 336, pl. lxv. (*PHILIPPINE ISLANDS*, 18 FMS.).

Actinometra regalis, 1888, P. H. Carpenter, *tom. cit.*, p. 347, pl. lxviii. (*BANDA*, 17 FMS.).

Comanthus (Comanthina) nobilis, 1909, A. H. Clark, Vidensk. Medd. fra den Naturhist. Forening i Köbenhavn, 1909, p. 143.

Differential Characters.—Like *C. belli*, this species has the III Br series 2 externally and 4 (3 + 4) internally; it differs, however, in lacking the strong carination of the earlier pinnule segments and in having the IV Br and further division series 4 (3 + 4).

Australian Record.—The "Alert" obtained this species at Percy Island, Queensland; it is not otherwise known from Australia.

Range.—Maldive to the Philippine, Caroline and Solomon Islands, south to Northern Australia.

Remarks.—An examination of the type of Carpenter's *Actinometra schlegelii* at Leyden has shown me that it is the same thing as his *A. nobilis* and *A. regalis* described seven years later. Carpenter overlooked the curious characteristic arm structure in the Leyden specimen, just as he did in the type of *A. regalis*, though it is clearly depicted in his figure of the latter. I studied the types of *A. nobilis*, *A. regalis* and *A. dissimilis* at London, and find that they are identical with *A. schlegelii* and with *A. nobilis*.

Subgenus COMANTHUS, *A. H. Clark*.

Comanthus, 1908, A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, p. 220; Smiths. Miscell. Coll. (Quarterly Issue), vol. 52, p. 203; 1909, Vidensk., Medd. fra den naturhist. Forening i København, 1909, p. 142 (COMANTHUS INTRICATA, A. H. Clark, 1908).

Specific group BENNETTIA, *A. H. Clark*.

Bennettia, 1909, A. H. Clark, Vidensk. Medd. fra den naturhist. Forening i København, 1909, p. 142 (ALECTO BENNETTI, J. Müller, 1841).

Differential Characters.—The cirri are always present and numerous, compressed distally, and usually stout, and the division series are, almost invariably, all 4 (3 + 4).

Range.—South-east Africa to Samoa, including the whole of Australia and Tasmania, and northward to Japan.

COMANTHUS (BENNETTIA) BENNETTI (*J. Müller*).

Alecto bennetti, 1841, J. Müller, Archiv. für Naturgesch., 1841, i., p. 146 (UNKNOWN).

Actinometra brachymera, 1877, Lütken, Cat. Mus. Godeffroy, vol. v., p. 100 (*Port Denison*; *Pelew Islands*).

Actinometra peronii, 1881, P. H. Carpenter, Notes from the Leyden Museum, vol. iii., p. 214 (CERAM).

Actinometra bennetti, 1891, Hartlaub, Nova Acta Acad., vol. 58, No. 1, p. 107 (*Port Denison*).

Comanthus (Comanthus) bennetti, 1909, A. H. Clark, Vidensk. Medd. fra den Naturhist. Forening i København, 1909, p. 147.

Differential Characters.—This species is at once known by its very large number of arms, all the division series being 4 (3 + 4),

and its large centrodorsal which bears numerous long and stout cirri with thirty or more segments which are all practically of the same size and do not develop dorsal spines or ridges.

Australian Record.—Hartlaub has examined a specimen of this magnificent species from Port Denison, which was originally in the Godeffroy Museum where it had received the MS. name *brachymera* from Professor Lütken.

Distribution.—*Comanthus bennetti* ranges from the Bay of Bengal eastward to the Pelew Islands, and south to Queensland.

Remarks.—Carpenter's *Actinometra peronii*, the type of which I examined at Leyden, is identical with Müller's *Alecto bennetti*, of which the type is in the same museum.

Professor Köhler records *Actinometra robustipinna* from Amboina, but, judging from his description, his specimen was undoubtedly an example of this species. The type of Carpenter's *Actinometra robustipinna*, which I examined at Leyden, is a much mutilated example of some species of *Himerometra*, possibly *H. crassipinna*, and is not an "*Actinometra*" at all.

COMANTHUS (BENNETTIA) TRICHOPTERA (*J. Müller*).

Comatula trichoptera, 1846, *J. Müller*, Monatsber. k. preuss. Akad., 1846, p. 178 (KING GEORGE SOUND).

Actinometra trichoptera, 1888, Bell, Ann. and Mag. Nat. Hist., [6] vol. 2, p. 402 (*Port Phillip*); 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, pp. 345, 383 (*Port Jackson*; *Port Phillip*; *King George Sound*); 1889, Proc. Roy. Soc. Vict., vol. 2 (n.s.), p. 135 (*Port Phillip*); 1889, Whitelegge, Journ. Roy. Soc. N.S. Wales, vol. 23, p. 198 (*Port Jackson*).

Differential Characters.—This interesting species cannot well be mistaken for any other. The division series are almost invariably 4 (3+4); the axillaries have a curiously produced distal angle; the arms vary from twenty to thirty-five in number; the cirri are very numerous, confined to the margin of a thin and broad centrodorsal, and are typically very slender, with about twenty segments.

Comanthus trichoptera is the southernmost representative of an otherwise tropical family, and is exclusively confined to the eastern and southern coast of Australia and the coast of Tasmania. It is most nearly related to *C. samoana* which, however, has fewer, much shorter and stouter cirri which have fewer segments and are strongly compressed laterally toward the tip.

Specimens in the Australian Museum Collection.—Broughton Island, N.S. Wales.—Five specimens; one of these has twenty

arms 90 mm. long and cirri xxvi., 19-21, 12 mm. long; two of the others are similar with twenty-four and twenty-eight arms, another is small with sixteen arms 35 mm. long, and the last is also small. Port Jackson—Seven specimens; a typical example has twenty arms 100 mm. long and cirri xxxii., 10 mm. to 14 mm. long; three of the specimens are peculiar in having the centrodorsal very small with the dorsal pole only 2 mm. in diameter, though bearing the usual number of cirri. Watson's Bay, Port Jackson—Five specimens; one has twenty-two arms 110 mm. long and cirri xix., 18-20, 12 mm. long; another has thirty-one arms and cirri xlvi., 14 mm. long, and a third has twenty-eight arms and cirri xlii. Cape Hawke, 25-28 fathoms—Two specimens. Bottle and Glass Rocks, Port Jackson—Two specimens with the centrodorsal very small as in the three described from Port Jackson. Australia—One small specimen. Tasmania—Two specimens. No locality—One fine specimen with twenty-five arms 130 mm. long.

Additional Australian Records.—King George Sound; Port Phillip; Port Jackson; Watson's Bay, Port Jackson, "common under stones at low water."

Distribution.—Confined to Southern Australia; King George Sound eastward along the southern coast of Australia, including Tasmania, and northward on the east coast to Port Jackson.

Remarks.—It would seem as if this species offered an exceptional opportunity for some one interested in embryology and comparative development who wishes to open up a new field. No question in the whole Echinoderm subject is of such interest as the comparative development of the Crinoids, and in this line of work no study is more important than a detailed investigation of the life history of some one of the Comasteridæ. We have learned a great deal from the study of the development of *Antedon*, but there is much that we do not know yet and many of our ideas based upon that genus undoubtedly need a thorough revision in the light of new data acquired from a study of some other forms.

The type specimen of this species, preserved in the Paris Museum, is a small, but characteristic one.

Specific Group VANIA, *nov.*

Validia, 1909, A. H. Clark, Vidensk. Medd. fra den naturhist. Forening i København, 1909, p. 142 (*Comatula rotalaria*, Lamarck, 1816).

Differential Characters.—The cirri are few, small and weak, irregularly disposed, or entirely absent; some or all of the II Br series are 2; the remaining division series have a majority of 4 (3 + 4), a minority 2, the two types being irregular in the manner of their occurrence.

Range.—Beluchistan to northern Australia, Fiji, Tonga, and the Gilbert Islands, and northward to southern Japan.

Type Species.—*Alecto parvicirra*, J. Müller, 1841.

Remarks.—The specific group *Vania* covers exactly the same ground as was intended by the specific group *Validia* established by myself in 1909. The type of *Validia* is *Comatula rotalaria*, Lamarck, 1816, chosen on the basis of the description given by Carpenter in the "Challenger" Report. Examination of the types of *Comatula rotalaria* at Paris, however, has shown that this species is the same as the *Actinometra jukesii* and *Actinometra paucicirra* described many years later by Carpenter and Bell; therefore the name *Validia* lapses into the synonymy of *Comatula*, though it will become available if it should ever be thought advisable to separate the twenty-armed from the ten-armed species assigned to that genus.

COMANTHUS (VANIA) ANNULATA (Bell).

Actinometra intricata, Lütken, MS. (part), (Bowen).

Actinometra intricata (part), 1874, Lütken, Cat. Mus. Godeffroy, vol. v., p. 190 (Bowen).

Actinometra annulata, 1882, Bell., Proc. Zool. Soc., 1882, p. 535, pl. xxxv. (CAPE YORK).

Actinometra meyeri, 1882, P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, p. 525 (AUSTRALIA).

Actinometra valida, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 314, pl. lix., fig. 3 (PRINCE OF WALES CHANNEL).

Actinometra littoralis, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 346, pl. lxvii., figs. 1, 2 (BANDA).

Comanthus intricata, 1908, A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, p. 220 (BOWEN).

Comanthus (Comanthus) valida, 1909, A. H. Clark, Vidensk. Medd. fra den naturhist. Forening i København, 1909, p. 143 (Bowen).

Differential Characters.—This species rarely has more than one or two cirri, and usually has none; if present, they are larger and stouter than those of *C. parvicirra*, with a few more segments; they are shorter and stouter than those of *C. trichoptera* with proportionately much shorter segments. The arms are usually between forty and sixty in number; the division series are almost all 4 (3 + 4), but some are always to be found of 2, especially in the II Br series.

Specimens in the Australian Museum Collection.—Port Denison, Queensland—Two immature specimens; one has nineteen arms about 100 mm. long, the other twenty-four arms about 120 mm. long. The centrodorsal is much reduced in size.

Additional Australian Records.—The "Challenger" dredged this species in 10° 30' S. lat., 142° 18' E. long. (Prince of Wales Channel), in 8 fathoms, and I have recorded a specimen from Bowen, Queensland, which is in the collection of the University of Copenhagen, having been originally obtained from the Godeffroy Museum. There are two unrecorded specimens from Torres Strait in the U. S. National Museum. At the British Museum I examined specimens from Cape York, from Torres Strait, from North-eastern Australia, and from Holothuria Bank, in 34 fathoms.

Distribution.—*Comanthus valida* ranges from northern Australia northward to the Philippine Islands, eastward to the Solomon, Fiji, and Tonga Islands, and westward to Ceylon.

Remarks.—An examination of the types of Bell's *Actinometra annulata* (at London) and of Carpenter's *Actinometra meyeri* (at Hamburg) has shown that they are identical with the *Actinometra valida* described in the "Challenger" Report, and with the *Comanthus intricata* which I described in 1908. The occurrence of rather more II Br 2 series than usual in the type of *Actinometra valida* prevented Carpenter from discovering its affinities with *A. meyeri* and *A. annulata*.

COMANTHUS (VANIA) PARVICIRRA (*J. Müller*).

Alecto parvicirra, 1841, J. Müller, *Archiv. für Naturgesch.*, 1841, I, p. 145 (UNKNOWN).

Alecto timorensis, 1841, J. Müller, *tom. cit.*, p. 145 (TIMOR).

Comatula brevicirra, 1862, Dujardin and Hupé, *Hist. nat. des. Zoophytes, Echinodermes*, p. 208.

Comatula simplex, 1862, Dujardin and Hupé, *loc. cit. (Australia)*.

Actinometra trachygaster (part), 1869, Lütken, *Mus. Godeffr. Cat.*, vol. 4, p. 125.

Actinometra intricata (part), 1874, Lütken, *idem*, vol. 5, p. 190.

Comatula mertensi, 1875, Grube, *Jahresber. schls. Gesellsch. für vaterl. Cultur*, 1875, p. 74 (NORTH BORNEO).

Actinometra armata, 1876, W. B. Carpenter, *Proc. Roy. Soc.* vol. 24, p. 451 (PHILIPPINE ISLANDS).

Actinometra polymorpha, 1877, P. H. Carpenter, *Journ. Linn. Soc. (Zool.)*, vol. 13, p. 440 (PHILIPPINE ISLANDS).

- Actinometra mutabilis*, 1884, von Graff, "Challenger" Reports, Zool., vol. 10, p. 13.
- Actinometra cumingii*, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 167 (*Port Molle*).
- Actinometra elongata*, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 311, pl. lvii., figs. 2-4 (BANDA).
- Actinometra simplex*, 1888, P. H. Carpenter, *tom. cit.*, p. 311, pl. lix., fig. 1 (ADMIRALTY ISLANDS, 16-25 fms.)
- Actinometra rotalaria*, 1888, P. H. Carpenter, *tom. cit.*, vol. 26, p. 313, pl. lix., fig. 2.
- Actinometra quadrata*, 1888, P. H. Carpenter, *tom. cit.*, p. 331, pl. lxii., fig. 1 (TONGATABU REEFS, TONGA ISLANDS).
- Actinometra guttata*, 1891, Hartlaub, Nova Acta Acad., vol. 58, No. 1, p. 96 (in synonymy).
- Actinometra variabilis* (part), 1894, Bell, Proc. Zool. Soc., 1894, p. 394 (*North-west Australia*).
- Comatula orientalis*, 1907, A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, p. 155 (new name for *Actinometra simplex*, preoccupied).
- Comatula helianthus*, 1908, A. H. Clark, *idem*, vol. 34, p. 440 (new name for *Actinometra elongata*, preoccupied).
- Comanthus (Comanthus) rotalaria*, 1909, A. H. Clark, Vidensk. Medd. fra. den naturhist. Forening i København, 1909, p. 144 (*Australia*).

Differential Characters.—*Comanthus parvicirra* usually has from five to fifteen cirri which are small and weak, and more or less irregularly spaced about the margin of the centrodorsal. They consist of from twelve to fifteen segments. The arms are from fifteen to forty in number, most commonly between twenty and thirty. The division series are 4 (3 + 4), but a few can always be found, usually among the II Br series, of 2. The arms rarely exceed 100 mm. in length.

Specimens in the Australian Museum Collection.—Port Molle, Queensland—Two small specimens with fifteen and seventeen arms.

There is also a typical specimen which was collected at the New Hebrides, whence the species had not previously been reported.

Additional Australian Records.—Torres Strait; Warrior Reef, Torres Strait; Port Molle, Queensland; Prince of Wales Channel (10° 30' S. lat., 142° 18' E. long.), in 8 fathoms; Bassett-Smith Bank, in 9 fathoms; Cape Baudin; Fremantle, West Australia.

Distribution.—*Comanthus parvicirra* ranges from Beluchistan and the Seychelles eastward along the shores of the Indian

Ocean, including the north coast of Australia, and thence to the Gilbert Islands and Southern Japan.

Remarks.—*Comatula rotalaria*, Lamarck, 1816, must be eliminated from the synonymy of this species, an examination of the types at Paris having shown it to be identical with Bell's *Actinometra paucicirra*; the *Alecto wahlbergii*, J. Müller, 1841, from South Africa, formerly considered the same as this species, is in reality very distinct, being much more like *C. trichoptera*; *Actinometra meyeri* and *A. annulata*, placed in the synonymy of this species by Carpenter, are in reality the same as his *Actinometra valida*.

Family ZYGOMETRIDÆ, A. H. Clark.

Genus ZYGOMETRA, A. H. Clark.

Zygometa, 1907, A. H. Clark, Smiths. Miscell. Coll. (Quarterly Issue), vol. 50, p. 347 (ANTEDON MICRODISCUS, Bell, 1884).

Differential Characters.—The species of the genus *Zygometa* have the elements of the I Br series united by what appears to be a perfect syzygy, though in reality it is a curious modification of a synarthry which has taken on all the characters of the syzygy. The II Br series, when present, are 4 (3 + 4). The Australian species have numerous arms, but the East Indian species have only from ten to thirty arms. The lower pinnules are enlarged and stout, but taper to a more or less flagellate tip. The cirri are long, with numerous segments of which the outer bear long dorsal spines.

Range.—Northern Australia to the Mergui Archipelago, Singapore, Hong Kong, and the Philippine Islands.

ZYGOMETRA MICRODISCUS (Bell).

Antedon microdiscus, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 163, pl. xv. (PORT MOLLE, 12 fms.; *Nicol Bay, N.W. Australia*).—1888, P. H. Carpenter, "Challenger" Reports, Zool. vol. 26, p. 97, pl. xxxvii., figs. 4-6 (*Prince of Wales Channel, 8 fms.*).—1898, Döderlein, Denkschr. Ges. Jena, vol. viii., p. 476, pl. xxxvi., figs. 2, 2a (*Thursday Island*).

Zygometa microdiscus, 1909, A. H. Clark, Zool. Anzeiger, vol. 34, p. 367 (*Mermaid Strait, N.W. Australia*).

Differential Characters.—*Zygometa microdiscus* may be at once distinguished from all the other species of the genus by the almost or quite exclusive presence of division series of 4 (3 + 4), and the occurrence of at least four axillaries beyond that

of the I Br series. The enormously long lower pinnules and cirri, the latter reaching 40 mm.-45 mm. in the type, are characteristic features of this species. The proximal pinnules remind one very strongly of those of certain species of *Himerometra*, as for instance *H. bartschi*, and the arm structure not infrequently also approaches that characteristic of *Himerometra*, so that some care must be used in identification. The heavily plated disk and the presence of a pseudosyzygy between the elements of the I Br series are, however, ample to differentiate this species from any of the superficially similar forms among the Himerometridæ.

Australian Records.—Port Molle, Queensland, in 12 fathoms; Mermaid Strait, in the north-western part of Western Australia; Torres Strait, in 10 fathoms; Prince of Wales Channel, in 8 fathoms; Cape York; Thursday Island; Holothuria Bank; Lewis Island, Dampier Archipelago; Nicol Bay, North-western Australia.

Distribution.—This species is only known from the coasts of northern Australia.

Remarks.—In the type specimen the disk has been lost, and is just beginning to regenerate; this was mistaken for a normally small disk, the error being responsible for the specific name.

ZYGOMETRA MULTIRADIATA (P. H. C.).

? *Hyponome sarsii*, 1868, Lovén, Forhandl. Skand. Naturf. Christiania, vol. 10, p. liv. (CAPE YORK).

Antedon multiradiata, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 96, pl. ix. (OFF BOOBY ISLAND, TORRES STRAIT, 6 FMS.)

Differential Characters.—This species is essentially like the preceding, but it only has three axillaries above that of the I Br series, and the proximal pinnules are much less stout.

Australian Record.—This form was dredged by the "Challenger" in 10° 36' S. lat., 14° 55' E. long. (off Booby Island, Torres Strait), in 6 fathoms; in the British Museum I found some specimens from North-western Australia, and from Lewis Island in the Dampier Archipelago, as well as one collected by the "Alert" in Somerset Passage, near Albany Island, in 5-9 fathoms.

It is probably a detached visceral mass of this species which was described by Professor Sven Lovén as *Hyponome sarsii* from Cape York.

Range.—Northern Australia.

ZYGOMETRA ELEGANS (Bell).

Antedon elegans, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 162, pl. xiii., figs. B, Ba (PORT MOLLE; *Thursday Island*).

Antedon fluctuans, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 94, pl. viii. (8° 56' S. LAT., 136° 05' E. LONG.).—1898, Döderlein, Denkschr. Ges. Jena, vol. viii., p. 475, pl. xxxvi., fig. 1 (*Thursday Island*).

Zygometa elegans, 1909, A. H. Clark, Zool. Anzeiger, vol. 34, p. 367 (*Mermaid Strait, N.W. Australia*).

Differential Characters.—In *Zygometa elegans* the II Br series are 4 (3 + 4), but the succeeding division series are entirely or mostly 2; the occurrence of the III Br series is not confined to the inner branch from the II Br series³.

Specimens in the Australian Museum Collection.—Mast Head, Island—One specimen with about sixty arms each about 70 mm. long; slightly more division series of 4 (3 + 4) are present than usual. Lagoon, Mast Head Island—One specimen with forty arms; the single remaining entire cirrus has fifty-six segments. Port Denison—Two specimens; one is a fine example with sixty arms about 100 mm. long and cirri xix., 45-48, 35-40 mm. long; the II Br series are 4 (3 + 4), the remaining series 2 rarely, on the exterior of the rays, 4 (3 + 4); this specimen agrees with four others at hand from Mermaid Strait, North-western Australia, collected by the German ship "Gazelle"; the other specimen is considerably smaller with twenty-nine arms 65 mm. long, the II Br series being 4 (3 + 4) and the III Br series 2; the cirri are xx., 35-39. Port Molle—One small specimen with eighteen arms about 50 mm. long and cirri xviii., 22-24, together with arm fragments from a larger individual. Port Curtis—Three specimens; one has the centrodorsal large, thick-discoidal, with the

³ In working over the magnificent collection of Comatulids made at Singapore by Mr. Svend Gad, I found that the common *Zygometa* occurring there and in the Mergui Archipelago is not the same as that called *elegans* by Bell though it had been united with that species by Carpenter. It is a twenty to thirty armed form, and the III Br series, which are always 2, are only developed interiorly in 1, 2, 2, 1 order. I thought at the time that the name *fluctuans* covered this species, but I now find that *fluctuans* is in reality only small *elegans*, and that the name is not available for the Singapore species at all. I therefore propose that it be called *Zygometa comata*, sp. nov., reinstating a *nomen nudum* long ago applied to it in MS. by Carpenter. A satisfactory description of *Zygometa comata* will be found in Vidensk. Medd. fra den Naturhist. Forening i København, 1909, p. 151 ("*Zygometa fluctuans*"); it occurs in the Mergui Archipelago, at Singapore, and among the Philippine Islands.

Small specimens of this species are readily distinguished from small specimens of *Z. elegans* by the regularity in the development of the III Br series, these in *comata* appearing only internally, two to each ray.

dorsal pole very slightly concave, 5 mm. in diameter; the cirri are xv., 50-53, 35 mm. to 38 mm. long; there are thirty-five arms 80 mm. long; the III Br series are 4 (3+4) exteriorly and 2 interiorly as in the genus *Himerometra*; another has the centrodorsal discoidal about 4 mm. in diameter at the dorsal pole, nearly flat; the cirri are xxxv., 46-48, 35 mm. to 40 mm. long; 4 (3+4) series are slightly more numerous than usual; the third example is small with twenty arms 60 mm. long (all the II Br series being present); the dorsal pole of the centrodorsal is flat, 2.5 mm. in diameter; the cirri are xxiii., 20-22, 13 mm. long.

Additional Australian Records.—Port Molle, in 12-20 fathoms; Thursday Island; Arafura Sea (8° 56' S. lat., 136° 05' E. long.), 49 fathoms; Torres Strait, in 10 fathoms; Prince of Wales Channel, in 7 fathoms; Mermaid Strait, North-western Australia; Baudin Island, in 8-15 fathoms.

Range.—Northern Coast of Australia from Mermaid Strait, eastward and southward to Port Curtis, Queensland.

Family HIMEROMETRIDÆ, A. H. Clark.

Genus CRASPEDOMETRA, A. H. Clark.

Craspedometra, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 8 (*Antedon acuticirra*, P. H. Carpenter, 1882).

Differential Characters.—*Craspedometra* in Australia is most easily identified by its cirri; these are very long, smooth dorsally, very stout basally, but tapering gradually to a sharp point. The arms are from twenty-five to forty or more in number, the II Br series being 4 (3+4) and the III Br series 2, developed irregularly.

Range.—East Africa (Madagascar to the Red Sea) to Australia, and thence northward to Hong Kong and the Philippine Islands.

CRASPEDOMETRA ACUTICIRRA (P. H. C.).

Antedon acuticirra, 1882, P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, p. 509 (UNKNOWN).

Antedon australis, 1882, P. H. Carpenter, *tom. cit.*, p. 510 (SYDNEY).

Antedon ludovici, 1882, P. H. Carpenter, *tom. cit.*, p. 510 (HONG KONG).

Antedon bipartipinna, 1882, P. H. Carpenter, *tom. cit.*, p. 512 (HONG KONG).

Craspedometra acuticirra, 1909, A. H. Clark, Vidensk. Medd. fra den Naturhist. Forening i København, 1909, p. 159 (Sydney).

Differential Characters.—The long cirri, which are very stout at the base but gradually taper to a point, distinguish this species at once from all other Comatulids. It has usually about thirty arms in the vicinity of 125-150 mm. in length; the cirri are about 45 mm. long.

Australian Record.—The Copenhagen Museum possesses a fine specimen of this species which was collected at Sydney, New South Wales, many years ago. Professor Lütken labelled it *Antedon australis*, but he never described it; Dr. Carpenter examined it during his visit to Copenhagen, and mentioned some of its characters in discussing the type specimen of *C. acuticirra*. More recently I have examined it and published a detailed description and figure.

Range.—*Craspedometra acuticirra* ranges from the Mergui Archipelago and the Andaman Islands to Hongkong, and southward to Sydney, New South Wales.

Genus AMPHIMETRA, A. H. Clark.

Amphimetra, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 6 (COMATULA [ALECTO] MILBERTI, J. Müller, 1846).

Differential Characters.—The species of *Amphimetra* are remarkable for the excessive shortness of the outer brachials. The elements of the division series and the proximal brachials are more or less swollen. In the ten-armed species the lower pinnules are all subequal, but in the multibrachiate forms they are, some of them (though never the first), enlarged, with more or less delicate tips, and often bear in the distal part of each segment strong lateral processes, resembling those characteristic of *Oligometra serripinna*.

Range.—*Amphimetra* is found from south-eastern Africa to Australia, the Philippine Islands, and southern Japan; the ten armed species are found from Queensland to Singapore and the Philippine Islands.

AMPHIMETRA VARIIPINNA (P. H. C.).

Antedon variipinna, 1882, P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, p. 506 (CANTON, CHINA).—1888, "Challenger" Reports, Zool., vol. 26, p. 256 (*Prince of Wales Channel*, 8 fms).—1894, Bell, Proc. Zool. Soc., 1894, p. 394 (*N.W. Australia*, 9-38 fms).

Antedon crenulata, 1882, P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, p. 507 (BORNEO).

Antedon decipiens, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 159, pl. xi., figs. B, Ba (ARAFURA SEA, 32-36 FMS.).

Antedon irregularis, 1884, Bell, *tom. cit.*, p. 161, pl. xiii., figs. A, Aa-c (PRINCE OF WALES CHANNEL; TORRES STRAIT).

Differential Characters.—*Amphimetra variipinna* is easily distinguished from all other Australian Comatulids; it always has more than ten arms, usually from fifteen to twenty, with short discoidal brachials distally; the division series and arm bases are rugged and tuberculous; the long lower pinnules have segments with the distal corners produced into broad rounded processes so that the outline of the pinnules is strongly serrate.

Specimen in the Australian Museum Collection.—Mast Head Island—One fine twenty-two armed specimen. Ten miles south-west of Mapoon, 10 fathoms—Three fine specimens; one has nineteen arms 150 mm. long and cirri xvi., 41-43, 25 mm. to 30 mm. long; another has twenty-one arms 150 mm. long and cirri 30 mm. long with 40-42 segments; the third has seventeen arms 130 mm. long and cirri xxiii., 41-44, 30 mm. long. In these specimens the processes on the segments of the lower pinnules are strongly developed and typical; the cirri are more or less carinate distally, and the synarthrial tubercles are prominent so that the animals are characteristically rugose. Port Curtis—Two specimens; one has fourteen arms 80 mm. long and cirri xxiii., 35-40, 30 mm. long; the other has twenty-six arms 100 mm. long and cirri xxix., 35-45 (usually 40-41) 30 mm long; the centrodorsal is 5 mm. in diameter at the dorsal pole; the arm bases are exceptionally rugged with the synarthrial tubercles large, prominent, and bluntly conical; the lower brachials are very short but much swollen with strongly projecting distal edges; the division series are just in opposition laterally; the distal cirrus segments are very strongly and sharply carinate, this carination standing out as a broad spine of which the outer edge is almost or quite parallel to the longitudinal axes of the segments.

Additional Australian Records.—Prince of Wales Channel, in 7 fathoms, in 8 fathoms, and in 7-9 fathoms; Torres Strait, in 5-7 fathoms, and in 10 fathoms; Holothuria Bank, in 24, and in 38 fathoms; North-east of Holothuria Bank, in 15-20 fathoms; Dundas Strait, in 17 fathoms; Baudin Island.

Distribution.—Mergui Archipelago, Singapore, Canton, and the Philippine Islands southward to Australia, reaching, on the east coast, Port Curtis, Queensland.⁴

⁴ Mr. H. C. Chadwick has recorded this species from Ceylon, but such of his specimens as I have examined prove to be *Heterometra reynaudii*.

AMPHIMETRA DISCOIDEA (*A. H. Clark*).

Comatula dibrachiata, 1862, Dujardin and Hupe, Hist. nat. des zoophytes, Echinoderms, p. 208 (*nomen nudum*).

Antedon milberti, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 156 (*Port Molle*; *Port Denison*; *Prince of Wales Channel*; *Torres Strait*).—1885, Proc. Linn. Soc. N.S. Wales., vol. 9 (1884), p. 497 (*Port Denison*; *Port Molle*).—1894, Proc. Zool. Soc., 1894, p. 394 (*N.W. Australia*, 8-15 fms.).

Himerometra discoidea, 1908, A. H. Clark, Smiths. Miscell. Coll. (Quarterly Issue), vol. 52, part 2, p. 215 (PORT DENISON).

Amphimetra formosa, 1909, A. H. Clark, Proc. U.S. Nat. Mus., vol. 37, p. 32 (*Philippines*; *nomen nudum*).—Vidensk. Medd. fra den Naturhist. Forening i København, 1909, p. 157 (SINGAPORE; PHILIPPINES).

Differential Characters.—So far as known this species never has more than ten arms; the lower pinnules are subequal in length, and all rather short; the cirri are slender, the segments, at least in the proximal half, being somewhat longer than broad. *A. milberti*, which also occurs in Australia, has very stout cirri with all the segments much broader than long and subequal.

Specimens in the Australian Museum Collection.—Port Denison—Twelve specimens; one of these has cirri xxii., 46, 30 mm. long; another xx., 36-49, 30 mm. long; a third xxiii., 43, 40 mm. long, a fourth xxii., 42-45, 30 mm. long; these and five other similar examples exactly resemble the type, which also came from Port Denison; there is no tendency toward the curiously abrupt type of synarthrial tubercle nor the short segmented proximal pinnules characteristic of the form which I have called *formosa*, from Singapore and the Philippine Islands; three other large and well developed specimens with cirri about xx., 46-51 (maximum) 30 mm. to 37 mm. long, however, exhibit the synarthrial tubercles and lower pinnules of the type found in *A. formosa* more or less perfected, and I therefore find myself obliged to consider the two supposed species as only a single form, "*formosa*," representing merely a more developed stage than typical *discoidea*. Port Molle—Two specimens with cirri about xx., 39-42, 30 mm. long; both of these have synarthrial tubercles resembling those of the type of *A. formosa*.

Additional Australian Records.—Torres Strait, in 10 fathoms; Prince of Wales Channel, in 7-9 fathoms; Holothuria Bank, in 15 fathoms; Port Molle, in 12-20 fathoms; Port Denison, in 3 fathoms; North-western Australia, in 8-15 fathoms; West Australia.

Range.—Singapore and the Philippine Islands southward to Australia, reaching Port Molle on the eastern coast.

There is a specimen of *Amphimetra discoidea* in the Paris Museum labelled by P. H. Carpenter "*Comatula (Antedon) milberti*, var. *dibrachiata*, which closely resembles the type in the United States National Museum; it has 26 or 27 cirrus segments. It appears to have been the specimen from which the drawing of "*Comatula carinata*" in Guérin-Ménéville's "Iconographie du regne animal" (Plate 1, fig. 2a) was made.

AMPHIMETRA MILBERTI (*J. Müller*).

Comatula (Alecto) milberti, 1846, J. Müller, Monatsber. preuss. Akad., 1846, p. 178 ("NORTH AMERICA").

Comatula jacquinoti, 1846, J. Müller, *loc. cit.* (CERAM).

Comatula laevisima (part), 1875, Grube, Jahresber. d. schles. Ges. für vaterl. Cultur, 1875, p. 74 (NORTH BORNEO).

Antedon milberti (part), 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 156 (*Port Molle*).

Amphimetra milberti, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 7.

Differential Characters.—This species is easily distinguished from the preceding by its very stout cirri, all of the segments in which are twice as broad as long.

Australian Record.—The "Alert" obtained a single specimen of this species at Port Molle; all the other specimens listed in the "Alert" Report from Port Molle belong to the preceding form.

Range.—Mergui Archipelago to Borneo and the Philippine Islands, and south to northern Australia.

Genus HETERO METRA, *A. H. Clark*.

Heterometra, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 11 (ANTEDON QUINDUPLICAVA, P. H. Carpenter, 1888).

Differential Characters.—The II Br series of *Heterometra* are 4 (3 + 4) and the succeeding division series, which are irregularly developed, are 2. In general the arm number is from fifteen to thirty. The proximal pinnules, usually excepting P₁, are enlarged, but are always slender and flagellate distally; the outer brachials are distinctly wedge-shaped and of moderate length.

Range.—*Heterometra* is found from East Africa eastward to northern Australia and the Philippine Islands.

HETEROMETRA NEMATODON (*Hartlaub*).

Antedon milberti (part), 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 156 (*Port Molle*).

Antedon nematodon, 1890, Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 185 (BOWEN).—1891, Nova Acta Acad., vol. 58, No. 1, p. 27, pl. i., fig. 9 (*Bowen*).

Differential Characters.—This is easily distinguished from the only other Australian species of the genus by its numerous arms (thirty-eight) and cirrus segments (40-50); the arms are over 80 mm. long.

Australian Records.—The type specimen of this species was obtained many years ago by the Godeffroy Company, and received the MS. name of *nematodon* from Professor Lütken while in the Godeffroy Museum. It was found at Bowen, Queensland; a second smaller specimen was obtained by the "Alert" at Port Molle.

HETEROMETRA BENGALENSIS (*Hartlaub*).

Antedon bengalensis, 1890, Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 182 (BAY OF BENGAL).—1891, Nova Acta Acad., vol. 58, No. 1, p. 19, pl. i., fig. 2, pl. ii., fig. 16 (*Bay of Bengal*).

Antedon anceps, 1904, Chadwick, Rep. Ceylon Pearl Oyster Fisheries, Part II, Supplementary Report, xi., p. 157.

Heterometra bengalensis, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 11.

Differential Characters.—*Heterometra bengalensis* is readily distinguished from *H. nematodon*, the only other Australian species, by its short cirri with few (14-24) segments, the outer with long spines, and by the small number (eleven or twelve) of its arms.

Specimens in the Australian Museum Collection.—Port Curtis—Three small specimens, one with twelve and two with eleven arms 25 mm. to 33 mm. long; the cirri of the largest are xv, 14-18 (usually 15); except for the characters incident to immaturity, these specimens agree well with numerous others at hand from India. A specimen in the British Museum was taken on Holothuria Bank, in 15 fathoms. There are no previous Australian records.

Range.—Ceylon to the Philippine Islands, and southward to Australia, reaching, on the east coast, Port Curtis.

Family STEPHANOMETRIDÆ, *A. H. Clark.*Genus STEPHANOMETRA, *A. H. Clark.*

Stephanometra, 1909, *A. H. Clark*, Proc. Biol. Soc. Washington, vol. 22, p. 9 (*ANTEDON MONACANTHA*, Hartlaub, 1890).

Differential Characters.—In the genus *Stephanometra* the pinnules of one or more of the lower pinnule pairs are enlarged, with less than eighteen segments, greatly stiffened, and very sharply pointed, becoming spine-like in character. The division series are all 2, each of their component ossicles with a rounded ventro-lateral process supporting the visceral mass.

Range.—*Stephanometra* ranges from Mauritius and the Red Sea to northern Australia, Fiji, Tonga, and the Philippine Islands.

It is represented in the Caribbean Sea by *Analcidometra*.

STEPHANOMETRA MONACANTHA (*Hartlaub*).

Antedon monacantha, 1890, Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 179 (MORTLOCK ISLAND; TORRES STRAIT).—1891, Nova Acta Acad., vol. 58, No. 1, p. 59, pl. 3, figs. 33, 38 (*Mortlock Island; Torres Strait*).

Differential Characters.—*Stephanometra monacantha* usually has from twenty to thirty arms; the cirri are without dorsal spines, and the second pinnule, in abrupt contrast to the others, is much enlarged, stiff and spine-like, with 12-14 (rarely as many as 20) segments, of which the outer are very long.

Australian Record.—This form was recorded at the time of its description from Torres Strait.

Distribution.—This well marked species occurs from the Nicobar Islands and Singapore to the Philippines, the Carolines, and the Tonga Islands, and on the northern coast of Australia.

Family MARIAMETRIDÆ, *A. H. Clark.*Genus DICHROMETRA, *A. H. Clark.*

Dichrometra, 1909, *A. H. Clark*, Proc. Biol. Soc. Washington, vol. 22, p. 12 (*Alecto flagellata*, *J. Müller*, 1841).

Differential Characters.—The proximal pinnules of *Dichrometra*, though enlarged, are slender and flagellate distally and are composed of more than twenty-four segments; the division series are all 2, and are in lateral apposition, sometimes being considerably flattened against each other.

Range.—*Dichrometra* is found from East Africa eastward to Fiji, Tonga, the Marshall Islands, and the Philippines, and from northern Australia to southern Japan.

DICHROMETRA ARTICULATA (*J. Müller*).

Comatula (Alecto) articulata, 1849, *J. Müller*, *Abhandl. k. preuss. Akad.*, 1847, p. 263 (MOLUCCAS).

Antedon articulata, 1884, *Bell*, *Rep. Zool. Coll. H.M.S. "Alert,"* p. 160 (*Port Molle*).—1888, *P. H. Carpenter*, "*Challenger*" Reports, *Zool.*, vol. 26, p. 379.

Dichrometra articulata, 1909, *A. H. Clark*, *Proc. Biol. Soc. Washington*, vol. 22, p. 13.

Differential Characters.—This species is readily distinguished from the other Australian species of the genus by having P_2 and P_3 slender and flagellate, about equal in length, and by having cirri with more than thirty-five segments, of which the outer bear prominent spines.

Dichrometra articulata was originally described from the Moluccas, and has since been recorded by *Bell* from Port Molle, Queensland, where it was dredged by the "Alert" in 12-20 fathoms.

DICHROMETRA REGINÆ (*Bell*).

Antedon reginæ, 1884, *Bell*, *Rep. Zool. Coll. H.M.S. "Alert,"* p. 160, pl. xii., figs. A, Aa (PORT MOLLE).

Dichrometra reginæ, 1909, *A. H. Clark*, *Proc. Biol. Soc. Washington*, vol. 22, p. 13.

Differential Characters.—This species has cirri with about thirty segments, of which the outer are strongly carinate dorsally; P_2 is not greatly larger than P_3 . It is not clear from the original description just how it differs from *D. gyges* nor how either of them differ from *D. tenera* or *D. protectus*. A redescription of this species with adequate figures is much to be desired.

Dichrometra reginæ is only known from a single specimen which was collected by the "Alert" at Port Molle, Queensland, in 12-20 fathoms.

Remarks.—The type and only known specimen of this species, which I examined in London, has the cirri xxv, 29-34; the longest cirrus segment is about as long as broad; the distal segments are about one-third broader than long; dorsal spines are developed from the thirteenth or fifteenth segment onward; as a whole the cirri are moderately stout, but not especially long.

There are thirty-eight arms about 100 mm. long.

P_2 is about 22 mm. long, very slender and delicate, flagellate, soft, with forty-three segments which are only slightly longer than broad; P_3 is similar to P_2 , but the following pinnules are shorter; P_1 is 14 mm. and P_4 10 mm. in length; there is but a slight difference in basal stoutness between the earlier pinnules, but P_2 and P_3 taper much less rapidly than the others.

This species is very close to *D. articulata*, and further investigation may show that the two are really identical.

DICHROMETRA GYGES (Bell).

Antedon gygès, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 160, pl. xii, figs. B, Ba, b (THURSDAY ISLAND).

Dichrometra gyges, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 13.

Differential Characters.—*Dichrometra gyges* has P_2 not much longer than P_1 ; the cirri resemble those of *D. reginæ*, but have a slightly greater number of segments. There is a possibility that it is the same thing as the species known as *Dichrometra tenera*. Like *D. reginæ* this species is badly in need of redescription.

The only known specimen of *Dichrometra gyges* was collected by the "Alert" at Thursday Island, in 3-4 fathoms.

Remarks.—In the type of this species, which I examined at London, the cirri are xxxv, 24-29 (usually 28), 20 mm. to 25 mm. long; from the eleventh onward the segments are strongly carinate, or are supplied with broadly rounded dorsal spines.

There are forty-one (thirty-seven, plus four lacking) arms 80 mm. long.

P_2 is the longest, but is slender, resembling P_1 ; P_3 is slender and weak, not nearly so large as P_1 ; the basal segments of the earlier pinnules are more or less carinate.

This species is nearly related to *D. tenera*, of which it may eventually prove to be a synonym.

DICHROMETRA TENERA (Hartlaub).

Antedon tener, 1877, Lütken, Mus. Godefr. Cat., vol. 5, p. 100.

Antedon tenera, 1890, Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 180 (QUEENSLAND; TORRES STRAIT).—1891, Nova Acta Acad., German, vol. 58, No. 1, p. 66 (Queensland; Port Denison; Torres Strait).

Dichrometra tenera, 1909, A. H. Clark, Vidensk. Medd. fra den Naturhist. Foren. i København, 1909, p. 173 (Bowen).

Differential Characters.—This species is readily distinguished from *D. articulata* by its fewer cirrus segments which are strongly carinate instead of spiny distally, by having P_2 considerably longer than P_3 , and the proximal pinnules on the outer side of the outer arms of each post-radial series markedly larger than those on the inner side of the outer arms or on the inner arms.

Australian Records.—Torres Strait; Queensland; Bowen and Port Denison, Queensland. There is a dry specimen in the British Museum (labelled *Antedon articulata*) from Port Essington, Queensland, and there is a specimen in the Paris Museum from Thursday Island.

Distribution.—Marshall Islands to northern Australia, south on the east coast to Port Denison, Queensland.

Family COLOBOMETRIDÆ, A. H. Clark.

Genus CENOMETRA, A. H. Clark.

Cenometra, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 8 (HIMEROMETRA UNICORNIS, A. H. Clark, 1908).

Differential Characters.—The cirri of the species of *Cenometra* are composed of very short subequal segments, of which those in the outer portion bear two dorsal tubercles or spines each, placed side by side: P_2 is greatly enlarged, abruptly larger than any of the other pinnules, and is strongly curved outward in the direction of the arm tip.

Range.—Mauritius and Ceylon to northern Australia, thence northward to the Philippine Islands and the Gulf of Tonkin.

CENOMETRA CORNUTA, *sp. nov.*

Antedon, *sp.* (near *macronema*), 1894, Bell, Proc. Zool. Soc., 1894, p. 394 (*North-west Australia*).

Description.—Cirri XIV, 35-37, about 20 mm. long; the cirri are rather slender, and are composed of short segments, none of which are less than twice as broad as long; the proximal segments are flattened dorsally; in the outer half of the cirri the segments bear dorsally a pair of tubercles with their apices well separated.

There are, in the type, twenty-six arms about 110 mm. long; the lateral processes on the division series are broad with truncated or roundedly incised outer margins.

P_2 is very stout and very strongly curved, with 11-14 (usually 12) segments, most of which are about as long as broad; on the distal side the distal ends of the segments are strongly everted and serrate; this eversion is well marked even on the second

segment; the first, second, and third segments of the earlier pinnules are slightly carinate, the carination being sharply truncated distally so that the outer profile is straight and not convex as in *C. emendatrix*.

The colour is white and purple, in bands of about one quarter of an inch in width; the cirri are brown.

Localities.—Adele Island, North Australia (type locality); Baudin Island.

The type specimen is in the British Museum.

Genus COLOBOMETRA, A. H. Clark.

Colobometra, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 5 (ANTEDON PERSPINOSA, P. H. Carpenter, 1881).

Differential Characters.—The genus *Colobometra* lacks the first inner pinnule (P_a). All of the species have ten arms, the brachials with exceedingly spiny distal ends. The cirri are long with numerous segments, the outer bearing paired dorsal spines, the proximal with produced and very spinous edges. Some or all of the lower pinnules are much enlarged and their component segments have very stiff with very spinous distal ends; the middle and outer pinnules also have segments with very spinous distal ends.

Range.—*Colobometra* is found from the Red Sea eastward to northern and eastern Australia, Lord Howe Island, the Solomon Islands, the Philippines, and Singapore.

COLOBOMETRA PERSPINOSA (P. H. C.).

Antedon perspinosa, 1881, P. H. Carpenter, Notes from the Leyden Museum, vol. 3, p. 178 (JOBIE).

Antedon insignis, 1882, Bell, Proc. Zool. Soc., 1882, p. 534 (PORT DENISON).

Antedon loveni, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 158, pl. x., figs. B, *Ca-e* (not *Aa-e* as given in the reference to the plate) (PORT DENISON; this and the preceding species are founded on the same specimen).

Colobometra perspinosa, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 6.

Differential Characters.—*Colobometra perspinosa* lacks the first inner pinnule (that on the first syzygial pair) on each arm; the long cirri have about sixty segments, comparatively long proximally, short distally, the longer proximal segments with the distal ends produced into an overlapping border of long spines; the shorter distal segments bear paired spines dorsally; the lower

pinnules, except P_1 , are very long and greatly stiffened, with long spines about the distal ends of each segment; the outer pinnules have spinous segments, and the brachials are bordered distally with long spines.

Specimens in the Australian Museum Collection.—Port Jackson—A small arm fragment. Lord Howe Island—One specimen, without cirri; the very stiff lower pinnules reach a length of 23 mm. (P_2); the arms were probably about 120 mm. long; there were xviii. cirri arranged in one and a partial second irregular marginal row; the dorsal pole of the centrodorsal is deeply concave; the synarthrial tubercles are but slightly marked; in the proximal portion of the arms there is a faint low rounded median carination; P_1 , which is not stiffened like the succeeding, is only half as long as P_2 .

Additional Australian Record.—Port Denison, Queensland., in 3-4 fathoms.

Range.—*Colobometra perspinosa* is known from Port Jackson and Port Denison, Australia, from Lord Howe Island, and from the Island of Jobie in Geelvink Bay, New Guinea.

Genus DECAMETRA, A. H. Clark.

Decametra, 1910, A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, p. 31 (DECAMETRA MOBIUSI, *sp. nov.*).

Differential Characters.—The species of the genus *Decametra* have ten arms and lack the first inner pinnule (Pa) like those of *Colobometra*; but only P_2 is enlarged, and that is not greatly different from the following pinnules; its component segments are not especially long, and their distal ends are but slightly when at all prominent, and the pinnule is slender and flagellate distally. The cirri are short, and are composed of subequal segments (instead of long proximal and short distal segments as in *Colobometra*), the outer bearing a more or less denticulate transverse ridge, or sometimes a pair of small tubercles.

Range.—*Decametra* occurs from South-eastern Africa and Mauritius to Ceylon and North-western Australia, Singapore, and the Philippine Islands.

DECAMETRA STUDERI (A. H. Clark).

Oligometra studeri, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 41 (DIRK HARTOG ISLAND, 7 FMS.).

Cyllometra studeri, 1909, A. H. Clark, *tom. cit.*, p. 88.—Zool. Anzeiger, vol. 34, p. 368.

Differential Characters.—*Cyllometra studeri* is most closely related to *C. informis*, which was dredged by the "Challenger" among the Philippine Islands. It differs from that species most obviously in its smooth pinnules, the lower and middle pinnules in the latter having slightly overlapping and spinous ends to the segments, and in the much greater length and slenderness of P_2 which is twice as long as P_3 with eighteen segments most of which are elongated, instead of only slightly when at all longer than P_3 , with twelve segments, most of which are squarish. Both species are readily distinguished from all the others of the genus by the small number of cirrus segments.

Australian Record.—The type and only known specimen of this species was collected by the naturalists of the German steamer "Gazelle," at Turtle Bay Anchorage, Dirk Hartog Island, in 7 fathoms.

Genus OLIGOMETRA, A. H. Clark.

Oligometra, 1908, A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, p. 216 (ANTEDON SERRIPINNA, P. H. Carpenter, 1881).

Differential Characters.—The species of *Oligometra* are all small; they possess ten arms as in *Decametra*, but the first inner pinnule (Pa) is always present. The cirri are short, rarely with more than twenty-five segments almost all of which are about as long as broad and bear across the middle of the dorsal side a serrate transverse ridge which appears as a small median spine in lateral view; the opposing spine is small, but prominent, median and erect. One or more of the lower pinnules (usually P_1 or P_2) is enlarged, and its segments may bear lateral processes.

Range.—*Oligometra* occurs from South-eastern Africa to Ceylon and northern and eastern Australia, the Tonga Islands and the Philippines, and northward to Japan.

OLIGOMETRA CARPENTERI (Bell).

Antedon carpenteri, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 157, pl. x., figs. Aa-c (PORT CURTIS).

Antedon milberti (part), 1894, Bell, Proc. Zool. Soc., 1894, p. 394 (*North-western Australia*).

Antedon serripinna, 1894, Bell, *loc. cit.*

Oligometra carpenteri, 1908, A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, p. 126.

Differential Characters.—This is a slender and delicate little species, much resembling *O. serripinna*; P_1 is small, and P_2 greatly enlarged with long lateral processes on the segments.

Specimens in the Australian Museum Collection.—Port Curtis, Queensland—Three specimens.

Additional Australian Records.—Port Curtis, in 7 fathoms, and in 11 fathoms; Prince of Wales Channel, in 7-9 fathoms; Bassett-Smith Bank, in 9 fathoms; Holothuria Bank, in 39 fathoms; Baudin Island, in 8-15 fathoms.

OLIGOMETRA ADEONÆ (*Lamarck*).

Comatula adeonæ, 1816, Lamarck, Hist. Nat. des animaux sans vertèbres, vol. 2, p. 535 (AUSTRALIA).

Antedon adeonæ (part), 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 156 (*Port Curtis; Port Denison*).

Antedon pinniformis, 1884, Bell, *loc. cit.* (*Dundas Strait*).

Antedon bidens, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 158, pl. xi., figs. Aa-c (TORRES STRAIT).—1898, Döderlein, Denkschr. Ges. Jena, vol. 8, p. 476, pl. 36, figs 3-3d (*Thursday Island*).

Oligometra bidens, 1908, A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, p. 126.—1909, A. H. Clark, Zool. Anzeiger, vol. 34, p. 368 (*N.W. Australia*).

Oligometra adeonæ, 1908, A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, p. 126.

Differential Characters.—This species is related to *O. thetidis*, and these two are easily distinguished from the other Australian species of the genus by the large size of P_1 and the comparatively small size and smoothness of P_2 , as well as by their stout, robust build. The cirrus segments of *O. bidens* bear dorsally double transverse ridges instead of a single transverse ridge as in *O. thetidis*, and are more numerous; the genital pinnules of *O. bidens* do not appear to be expanded laterally as in *O. thetidis*.

Australian Records.—"Australia"; Torres Strait, in 10 fathoms; Thursday Island; Port Curtis; Port Denison; Dundas Strait; Baudin Island, in 8-15 fathoms; North-western Australia.

Remarks.—At Paris I examined the types of this species, which were obtained in Australia by MM. Péron and Le Sueur in 1803; the cirri are about xxx, 17-20 (most commonly 19), very stout; the first segment is very short, the following gradually increasing in length and becoming nearly as long as broad on the sixth and following; the fourth and following have on the dorsal surface two transverse ridges which appear as two small spines in lateral view.

The rays and first three brachials resemble those of the species of *Tropiometra* in being very broad and sharply flattened against

their neighbours laterally; there is considerably more flattening than in the species of *Tropiometra*, as the plates are deeper dorso-ventrally; the four brachials following the first syzygial pair are oblong and very short; the following are triangular, soon becoming about as long as broad.

The proximal pinnules are large and strongly prismatic; P_1 is the largest and longest, and is composed of from eight to ten segments, of which the third and fourth are the largest and longest; the size, stoutness, and length of the pinnules gradually decreases to P_5 or P_6 ; the distal pinnules are not much longer than P_6 .

Bell's *Antedon bidens* is the same thing as Lamarck's *Comatula adeonæ*; in the best specimen obtained by the "Alert" the cirri are about xx, 21; the bidentate appearance is caused by the moving back of the transverse ridge so far that it is near the proximal end of the segments, while the distal dorsal edge of the segments has become prominent, so that there are in effect two transverse ridges, appearing as two small spines in lateral view.

P_1 is the longest, considerably stiffened; P_2 is similar, but slightly shorter; P_3 is similar, but slightly shorter than P_2 ; the distal ends of the segments of these lower pinnules tend to become slightly prominent.

The figure of this species given in the "Alert" Report is very misleading, but a good (photographic) illustration of it is given by Döderlein in the reference cited.

OLIGOMETRA THETIDIS (H. L. Clark).

Oligometra thetidis, 1909, H. L. Clark, Mem. Aust. Mus., vol. 4, Part 11, p. 522, pl. xlvii., figs. 1-3 (OFF WOLLONGONG, 55-56 FMS.).

Description.--I happened to be in Cambridge, Massachusetts, when Dr. H. L. Clark received the collection of Echinoderms brought together by H.M.C.S. "Thetis," and he most courteously permitted me to examine the specimens of Crinoids therein contained. This new *Oligometra* is a form of rather exceptional interest, and I availed myself of the opportunity of drawing up a careful description of it. This description is somewhat more detailed than that published by Dr. Clark, and follows more closely the terminology and form in present use, so that it may not be out of place to incorporate it here.

Centrodorsal low-hemispherical, a rather large polar area bare; the cirrus sockets arranged in two irregular closely crowded rows.

Cirri xv-xx, 15 (rarely 14, 16, or 17), short and stout; first segment very short, second somewhat longer, becoming on the

fourth and following about as long as broad; fourth and following segments with a median transverse dorsal ridge, appearing like a small spine in lateral view; at first the apex of this ridge is practically a straight line, but later it becomes gradually more and more convex and at the same time narrower, so that on the terminal segments it resolves itself into a laterally elongated centrally arched tubercle; opposing spine short but prominent; median, erect, equal in height to about one-fourth the lateral diameter of the penultimate segment; terminal claw slightly shorter than the penultimate segment, stout and rather abruptly curved proximally, becoming slender and nearly straight distally.

Radials plainly visible, between two and three times as broad as long; IBr_1 trapezoidal, about twice as broad as long, basally in lateral apposition, gradually separating distally; IBr_2 broadly pentagonal, about one and one-half times as broad as long.

Ten arms about 25 mm. long; first brachial wedge-shaped, interiorly united for almost its entire length; second brachial similar, but proportionately longer; third and fourth brachials (syzygial pair) about as long as broad, oblong; following brachials to the eighth oblong, about twice as broad as long, then becoming triangular and about as long as broad, and wedge-shaped and longer than broad distally; synarthrial tubercles more or less, but never strongly, developed.

Syzygies occur between the third and fourth and seventh and eighth brachials, thence at intervals of from three to five (usually four) oblique muscular articulations.

P_1 comparatively long and stout, tapering uniformly from the base to the tip, with twelve segments, the first about as long as broad, the second half again as long as broad, the third and following about twice as long as broad (slightly more proximally, slightly less distally); P_2 similar, but considerably shorter with eight segments, the first squarish or not quite so long as broad, the second about half again as long as broad; the remainder about twice as long as broad; P_3 shorter than P_2 with about twelve segments, the first not so long as broad, the second to the fifth about as long as broad and rather stout, the remainder longer than broad; P_4 similar, but the third and fourth segments are slightly broader; following pinnules with the third and fourth segments laterally expanded forming a roof over the genital glands; the fifth segment is expanded proximally but tapers distally, and the remaining segments are slender. This swollen and expanded condition of the pinnule segments persists practically unchanged to P_{15} , at which point the arms of the specimens examined are all broken off.

The colour (in spirits) is yellowish-white, transversely banded on each segment with purple, rarely entirely yellowish-white or entirely purple.

The preceding description was drawn up from an examination of nineteen specimens, all from the type locality.

Differential Characters.—The only species with which this needs comparison is *O. adeonæ*, with which it agrees in the general stoutness of its build and in the larger size of P_1 over P_2 . It is smaller and has fewer cirrus segments than that species, however, and they lack the curious bidentate structure dorsally; as a whole, also, the cirri are considerably stouter than those of *O. adeonæ*. There is no swelling of the genital pinnules in *O. adeonæ*.

There can be no confusion between these two forms and *O. carpenteri* and *O. serripinna*, as the latter are slender and delicate creatures with a small and delicate P_1 and much enlarged and stiffened P_2 , the latter having stout lateral processes on its segments.

Specimens Examined.—Off Wollongong, 55-56 fathoms—Nineteen specimens.

These are the original specimens upon which the species was founded.

Remarks.—I cannot see any grounds for believing that this form may eventually turn out to be Lamarck's *adeonæ* as suggested by Dr. Clark; it is much smaller than that species, and the pinnules could not possibly be described as long, nor are the three or four first the longest. In general appearance it is curiously similar to *Analcidometra caribbea*⁵ from the Carribean Sea; it is about the same size, the lower pinnules are more or less similar in shape and proportions, and the genital pinnules are similarly expanded.

Family TROPIONOMETRIDÆ, A. H. Clark.

Genus TROPIONOMETRA, A. H. Clark.

Tropionometra, 1907, A. H. Clark, Smiths. Miscell. Coll. (Quarterly Issue), vol. 50, p. 349 (COMATULA CARINATA, Lamarck, 1816).

Differential Characters.—In the genus *Tropionometra* the I Br series and the first two brachials are large and broad, in lateral apposition, and somewhat flattened laterally, but the remaining brachials are exceedingly short; the dorsal surface of the arm may be smooth, or there may be a tubercle developed in the middle of the dorsal side of each brachial, which sometimes rises into a very high carination. The cirri are stout with from

⁵ *Oligometra caribbea*, 1908, A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, No. 1608, p. 238.

twenty to forty subequal segments, and perfectly smooth dorsally. The ambulacra are without ambulacral plating. The centrodorsal is discoidal, thick and broad. The pinnules are long and moderately stout in the earlier part of the arm, where they tend to be prismatic, but become shorter and more slender distally; the proximal pinnules are not essentially different from those following.

Range.—Carribean Sea to southern Brazil; St. Helena; West Africa; Cape Colony to Suez, and eastward to Australia, the South Sea Islands, and southern Japan.

TROPIOMETRA AFRA (*Hartlaub*).

Antedon afra, 1890, Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 172 (BOWEN).

Tropiometra afra, 1908, A. H. Clark, Proc. U.S. Nat. Mus., vol. 36, p. 315 (*Misaki, Japan; South Pacific*).—1909, A. H. Clark, Vidensk. Medd. fra den Naturhist. Forening i København, 1909, p. 184 (*Bowen; Korean Straits*).

Differential Characters.—This is a large and stout species with arms usually somewhat over 200 mm. long, which are rounded and perfectly smooth dorsally, and stout cirri with usually from 30-35 or more segments. So far as known the colour is always either entirely yellow or entirely violet, never mottled.

Australian Records.—Bowen; I have also examined a specimen labeled "South Pacific" which probably came from Australia. Only three Australian specimens are known, two having come from Bowen.

Distribution.—From Queensland this species ranges northward to southern Japan where it is common in the Korean Straits and abundant at Misaki.

TROPIOMETRA ENCRINUS, *A. H. Clark*.

Tropiometra encrinus, 1911, A. H. Clark, Proc. U.S. Nat. Mus., vol. 40, p. 36 (EAST INDIES).

Differential Characters.—This is a smaller form than the preceding, the arms being rarely more than 120 mm. in length; each brachial after those just at the base of the arms bears a pronounced median tubercle or keel in its distal portion; the cirri have between twenty and twenty-five segments. The colour is mottled yellow and purple.

Australian Records.—There are no definite Australian records, but I have examined a number of specimens labeled "South Pacific" which possibly came from there. The species occurs at Norfolk Island, and apparently in the Marshall Group.

Family THALASSOMETRID Æ, A. H. Clark.

Genus PTILOMETRA, A. H. Clark.

Ptilometra, 1907, A. H. Clark, Smiths. Miscell. Coll. (Quarterly Issue), vol. 50, p. 358 (COMATULA MACRONEMA, J. Müller, 1846).

Differential Characters.—The pinnules of *Ptilometra* are strongly pismatic, stiffened, and all are approximately similar; P_1 is smaller than the succeeding pinnules; at the arm tip the pinnules decrease in length very abruptly and the very short crescentic brachials curve inward between the outermost pinnules, so that the arm tip at first sight always appears to be broken off. The arms are stout and dorsally rounded basally, becoming laterally flattened and strongly carinate distally, each brachial with a long overlapping spine; the division series are always 2, and the lower part of the animal is compressed so that the division series and arm bases are flattened against each other; the cirri are stout basally, but taper distally; they are exceedingly long, and may be longer than the arms though usually they are about three-fourths of the arm length. The arms are from twelve to thirty in number in fully grown individuals. The centrodorsal is large and more or less columnar, and the cirrus sockets are closely crowded and more or less irregularly arranged.

This genus is nearly related to *Pterometra* of the East Indies, but in that genus the cirrus sockets are arranged in ten columns on a more or less conical centrodorsal, and the proximal cirrus segments bear long slender ventral overlapping spines.

Range.—Southern Australia, north to Dirk Hartog Island on the west and Port Stephens on the east.

PTILOMETRA MACRONEMA (*J. Müller*).

Comatula macronema, 1846, J. Müller, Monatsber. k. preuss. Akad., 1846, p. 179 (KING GEORGE SOUND).

?*Antedon wilsoni*, 1888, Bell, Ann. Mag. Nat. Hist. [6], vol. 2 pp. 402, 403 (PORT PHILLIP).—1890, P. H. Carpenter, Proc. Roy. Soc. Vict. (N.S.), vol. 2, p. 135 (*Port Phillip*).

Antedon macronema, 1889, Studer, Die Forschungsreise S.M.S. "Gazelle," iii. Thiel, p. 185 (*Dirk Hartog Island*).

Ptilometra dorcadis, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 39 (DIRK HARTOG ISLAND, 7 FMS.).

Ptilometra macronema, 1907, A. H. Clark, Smiths. Miscell. Coll. (Quarterly Issue), vol. 50, p. 358.

Differential Characters—In its general appearance this species is more robust than *P. mulleri* from New South Wales; the centrodorsal is thicker and more columnar, the cirri are longer and stouter, and therefore not so slender distally, while in the basal portion of the fully developed cirri the segments are as long as or slightly longer than broad instead of, as in *mulleri*, about twice as broad as long; the proximal pinnules are more enlarged and longer than in *mulleri*, with considerably longer segments of which the central are half again to twice as long as broad instead of not so long as broad as in *P. mulleri*; in the middle pinnules of *mulleri* the segments do not become longer than broad until the distal quarter is reached, while in the present species the third and following are always longer than broad, and the distal are considerably elongated. In *macronema* there is a strong tendency for the cirrus sockets to be arranged in columns, about four in each radial area, a tendency seldom indicated in *mulleri*.

Specimens in the Australian Museum Collection.—Kangaroo Island, South Australia—Two fine specimens; one has thirty-two arms 55 mm. to 60 mm. long, and cirri about l. 82-88, 65 mm. long; the centrodorsal is 6 mm. high and 8 mm. in diameter; the III Br series are developed externally in 2, 1, 1, 2 order as is always the case in this group; the lower pinnules are large and long.

The other is six-rayed with twenty-six arms, five, four, three, four, six, and four to a post-radial series; the cirri are about l.; the centrodorsal is 5 mm. high and 8 mm. in diameter.

In both of the specimens most of the cirri are comparatively small and undeveloped.

Additional Australian Records.—King George Sound; Dirk Hartog Island, 7 fathoms; Port Phillip.

Both this and the succeeding species occur at Port Phillip, according to the labels on the specimens at the British Museum; this form, however, appears to be much more common, for, while it is represented by thirteen specimens from that locality, *Pt. mulleri* is only represented by one.

Remarks.—This species was first described from King George Sound in South-western Australia, from specimens brought back to Paris by MM. Quoy and Gaimard, and was subsequently reported as common on the coast of New South Wales. In studying the collections accumulated by the German ship "Gazelle" I found that the species of *Ptilometra* occurring at Dirk Hartog Island was different from that occurring at Sydney, and I accordingly called it *Ptilometra dorcadis*. It now became a question whether this species or the one I considered for the time *macronema* (the one occurring at Sydney) was the true *macronema*.

found at King George Sound. Suspecting that *dorcadis* might eventually prove to be true *macronema*, I suggest that, in this case, the species occurring at Sydney may bear the name *mulleri*.

My *Ptilometra dorcadis* was a well marked form, and in examining the collection of the Australian Museum I at once recognised it in two beautiful specimens from Kangaroo Island, near Adelaide. As it occurs both at Dirk Hartog Island and at Kangaroo Island it is safe to say that it also inhabits the intervening territory, including King George Sound, and, therefore, is a synonym of Müller's *Comatula macronema*.

As a necessary consequence the name *macronema* must be restricted to the species occurring from Dirk Hartog Island southward and eastward to Kangaroo Island, while the species occurring at Port Phillip and thence eastward and northward must drop the name *macronema* and adopt that of *mulleri*.

While at Paris I examined the four specimens upon which Müller based his *Comatula macronema*. These are of about the same size as the type of my *Ptilometra dorcadis* from Dirk Hartog Island, and agree with it in all respects. The more proximal segments of the larger cirri (which are disproportionately large) are slightly longer than broad instead of twice as broad as long as in the species from the south-eastern coast (*mulleri*).

PTILOMETRA MULLERI, A. H. Clark.

- Kallispongia archeri*, var., 1877, Wright, Proc. Roy. Irish Acad., [2], vol. 2, p. 754, pl. xl., fig. 3 (*Australia*).
- Antedon mauonema*, 1885, Bell, Proc. Linn. Soc. N. S. Wales, vol. 9 (1884), p. 497 (*Port Stephens*).
- ? *Antedon wilsoni*, 1888, Bell, Ann. and Mag. Nat. Hist., [6], vol. 2, pp. 402, 403 (PORT PHILLIP).—1890, P. H. Carpenter, Proc. Roy. Soc. Vict. (N.S.), vol. 2, p. 135 (*Port Phillip*).
- Antedon macronema*, 1888, Carpenter, "Challenger" Reports, Zool., vol. 26, p. 212 (*Port Stephens; Port Jackson, 30-35 fms*).—1889, Whitelegge, Journ. Roy. Soc. N. S. Wales, vol. 23, p. 198 (*near Sow and Pigs Reef, Port Jackson*).—? 1890, P. H. Carpenter, Proc. Roy. Soc. Vict. [N.S.], vol. 2, p. 135 (*Port Phillip*).—1891, Hartlaub, Nova Acta Acad., German., vol. 58, No. 1, p. 75 (*Sydney*).
- Ptilometra mulleri*, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 41 (SYDNEY).
- Ptilometra macronema*, 1909, H. L. Clark, Mem. Austr. Mus., iv., p. 527 (*off Broken Head, 28 fms.; off Cape Three Points, 23-24 fms.; off Manning River, 22 fms.*).

Himerometra pædophora, 1909, H. L. Clark, Mem. Austr. Mus., iv., p. 524, pl. xlvii, figs. 4-10 (off Manning River, 22 fms.).

Differential Characters.—This species is more delicate and slender than *P. macronema*; the centrodorsal is less thickened and columnar, with the cirrus sockets less regularly arranged; the cirri are shorter and more slender, especially distally, with short proximal segments; the proximal pinnules are more slender and shorter, and all the pinnules have proportionately considerably shorter segments.

Specimens in the Australian Museum Collections.—Port Stephens.—Eighty-four specimens; a moderate sized specimen has nineteen arms 55 mm. long and the longest cirri 50 mm. long with 94 segments; the others are of medium size and have between fifteen and twenty arms.

Nelson's Bay, Port Stephens.—Three medium sized specimens.

Newcastle, 42-78 fathoms.—One specimen with nineteen arms 55 mm. long; two II Br series are lacking, and one III Br series is developed (externally).

Newcastle Bight.—Six medium sized specimens.

Broken Bay.—One medium sized specimen.

Broughton Island.—Two small specimens.

Off Barranjoey.—One stout medium sized specimen with eighteen arms.

Off Port Halliday.—One small ten-armed specimen; the arms are 20 mm. long and the cirri about xv., 47-49, 17 mm. long. This specimen is intermediate between the adult form and the ten-armed young called by Dr. H. L. Clark "*Himerometra pædophora*"; the smaller cirri are of the undeveloped type characteristic of "*pædophora*," but the longer have distally taken on the characters of those of the adult; the cirrus sockets are arranged in two columns in each radial area with a more or less marked midradial space between them as in *Pterometra* and in many of the *Thalassometridæ*.

Cape Hawke.—Four medium sized specimens with twelve, fourteen, seventeen and eighteen arms; the largest has arms 50 mm. and cirri 40 mm. long.

Port Jackson.—Eleven specimens; one fine large example has nineteen arms 75 mm. long and cirri about l. 84-90, 60 mm. to 65 mm. long; the centrodorsal is 4 mm. high and 6 mm. broad; another large specimen has twenty-three arms 70 mm. long and cirri 50 to 55 mm. long; the smallest specimen has twelve arms 30 mm. long. One very curious individual has twenty-three arms about 65 mm. long, all the II Br and three III Br series being developed; the arms resemble those of ordinary specimens from

the same locality, but the cirri are most extraordinary; there are about fifty of them; at the base they resemble normal cirri, but most of them rapidly taper to a fine point, being only about 7 mm. or 8 mm. long; they appear as if they had all been simultaneously broken off and regenerated, though they are thicker at the base than regenerated cirri; a few, which are broken distally, are rather longer than the majority, though much smaller than usual; the longest stump is 15 mm. long. The colour of the specimen is a uniform slightly pinkish white. The remaining specimens offer no points of especial interest.

Off Manning River, 22 fathoms.—Twenty-three very young ten-armed specimens and twenty-six larger specimens.

Off Broken Head, 28 fathoms.—Four specimens.

Off Cape Three Points, 23-34 fathoms.—Fourteen specimens.

Port Phillip.—One small specimen (see below).

“Australia.”—One specimen.

No locality.—Twelve specimens.

Additional Australian Records.—Port Stephens in 6-8 fathoms; Sydney; Port Jackson, 30-35 fathoms; near Sow and Pigs Reef, Port Jackson; Port Phillip.

Remarks.—This species has hitherto always been confused with *P. macronema*, originally described by Müller from King George Sound, from which it is quite distinct.

One of the figures given by Wright in illustrating *Kallispongia archeri*, supposed by him to be a new sponge, probably represents this form, but as the figure is said to represent a varietal form no nomenclatural confusion can result.

In 1888 Professor Bell described his *Antedon wilsoni* from Port Phillip which, so far as I can see, is nothing but the young of the present species, though it was adopted as valid two years later by P. H. Carpenter. More recently Dr. H. L. Clark has again described the young of this species, this time under the name of *Himerometra pædophora*.

The specimens upon which Dr. Clark founded his *Himerometra pædophora* are obviously young, representing a stage just subsequent to the first appearance of P_2 . The cirri are only just beginning to become carinate toward the tip, and the distal segments are as yet comparatively long. The sacculi are “abundant and large, especially in distal pinnules” as in the adult, and the disk already “shows many small calcareous plates, largest and most conspicuous around the base of the anal tube.” Side and covering plates have not as yet made their appearance.

A specimen from Port Phillip, Victoria, is certainly referable to “*Antedon wilsoni*,” and “*Himerometra pædophora*,” and no

less certainly to either *Ptilometra mulleri* or *P. macronema*, but which of the two it is impossible to say with accuracy.

The stage represented is somewhat in advance of that described as "*pædophora*," more nearly coinciding with "*wilsoni*."

The ten arms are 25 mm. long, and the cirri, which are xi, two to each radial area excepting one which has three, are 28 mm. to 33 mm. long; the first cirrus segment is short, the second nearly or quite as long as broad, the third slightly longer, the fourth nearly or quite half again as long as broad; the following five or six segments are similar, the succeeding then gradually decreasing in length so that the outer segments are about as long as broad; these shorter distal segments are bluntly carinate; one of the cirri has the tip broken and regenerating as often seen in this species.

The elements of the I Br series have already taken on the characters found in the adult; the I Br₁ is oblong, two and one-half times as broad as long, the I Br₂ broadly pentagonal with the lateral edges about half the length of those of the I Br₁; the elements of the I Br series and the first two brachials have the lateral edges perfectly straight and somewhat produced into a narrow flange-like border by which they are in lateral apposition; a broad synarthrial tubercle is just beginning to develop.

The arms are rounded dorsally with as yet no trace of carination; the pinnules are rounded and not prismatic, though the larger show traces of a prismatic condition in the basal segments; the marginal lappets of the pinnule ambulacra are calcified, but side plates have not yet become differentiated. Syzygies occur between the third and fourth and seventh and eighth brachials, and distally at intervals of two oblique muscular articulations.

While at Cambridge, Massachusetts, in the summer of 1908, I was enabled, thanks to the kindness of Dr. H. L. Clark, to examine some very young specimens, three in number, of *Ptilometra mulleri*; these present many points of difference from the adults, and may be described as follows:—

Centrodorsal thick-discoidal, bearing vii-ix cirri in a single marginal row; these have 25-30 segments of which the two first are about twice as broad as long, the third somewhat longer, the fourth and following about as long as broad; the segments in the outer half of the cirri have the proximal edge of the dorsal half cut away, and are somewhat compressed dorsally, being almost carinate on some of the cirri; penultimate segment with a prominent opposing spine which is terminally situated and reaches in height about one-half the lateral diameter of the segment bearing it; the cirri are comparatively thick at the base and decrease gradually in diameter until about the fourth segment after which they remain of the same diameter.

Ends of the basal rays visible as slight tubercles in the angles of the calyx; radials prominent, strongly concave anteriorly, and somewhat produced in the interradial angles; I Br₁ oblong, twice as broad as long, the lateral edges straight; I Br₂ broadly pentagonal, about half again as long as the I Br₁, the anterior angle rounded, the lateral edges straight continuing anteriorly the lateral edges of the I Br₁; in life the I Br series are probably just in apposition, but the component segments are sharp, not as yet having become flattened against each other.

Ten arms about 20 mm. long; the brachials are mostly wedge-shaped and about as long as broad; the first two are slightly larger than the others; the brachials are all rounded dorsally, with no trace of carination.

Syzygies occur between the third and fourth, seventh and eighth, and usually the eleventh and twelfth (sometimes the ninth and tenth or tenth and eleventh) brachials, and distally at intervals of usually two oblique muscular articulations, though frequently one syzygial pair immediately follows another.

PP_{1, 2, and 3} are small and weak, very short, equal in length to a syzygial pair and one other brachial, composed of five segments, the first about as long as broad, the remainder rather longer than broad; these pinnules taper gradually from the base to the tip; P₄ and the following pinnules are about half again as long and much stouter, composed of about seven ossicles, the first two short, the remainder rather longer than broad; the first three segments are stout, the pinnule thence tapering rather sharply to the tip; the segments are rounded dorsally, but are rather sharply convex, foreshadowing their ultimate prismatic shape.

Sacculi are large and closely set along the ambulacra.

The colour is light purple, the perisome deep purple.

There is as yet no trace of any ambulacral skeleton.

Dr. H. L. Clark described these young specimens (with others somewhat more advanced) as a new species in the genus *Himerometra*. The straight sides of the elements of the I Br series, the tapering cirri, and the uniformity of the proximal pinnules, together with the perisomic plating, especially on the pinnules, seen in the larger specimens, the distribution of the syzygies, and the abundance and large size of the sacculi, as well as the very characteristic musculature show conclusively that these specimens cannot be any species of *Himerometra*, young or old, but that they must belong to the genus *Ptilometra*; in fact if one can for the moment overlook the obsolescence or absence of carination on the outer part of the arms and on the pinnules—a character always late in making its appearance—the relationship is at once evident. Dr. Clark says,—“Fortunately, however, there are

young specimens of *Ptilometra* in the collection as small as the larger specimens of *pædophora*, and it is possible, therefore, to show that the two are not even nearly allied forms; the conical centrodorsal, the long cirri and the crowded prismatic pinnules distinguish the *Ptilometras* at a glance. Moreover, it should be noted that pentacrinoid larvæ were not present on the pinnules of any undoubted *Pt. macronema* [*i.e., mulleri*]. It is difficult for me to believe that the smallest *Ptilometras*, too young to have assumed any of their characteristic generic or specific features,⁶ should be the only ones which are breeding."

Answering the last statement first, I some time ago⁶ showed that it is rarely the adults of any species which bear Pentacrinoid young upon their pinnules or cirri, but usually young ones; the free swimming young always drift to leeward of the parents before settling down; at the next breeding season another brood drifts over to the place occupied by the brood of the preceding season and settles down upon it. Thus it is that while young Comatulids often bear Pentacrinoids they are very rarely found on the fully grown. There are some nice examples of this in the Museum at Cambridge, where the cirri of some young specimens of *Comactinia meridionalis* are preserved bearing Pentacrinoids upon them, and I have seen some scores of additional cases of the same thing.

The Comatulids change from their comparatively undeveloped post-Pentacrinoid condition to the perfect form very quickly; this is accompanied by a rapid development of P_2 and the immediately succeeding pinnules, a great increase in the width of the pinnulars and the brachials which make the pinnules appear much closer together and the brachials shorter, and, in species with long cirri, by a rapid (distal) addition to the cirrus segments, the added segments as they appear becoming progressively more and more developed. In the *Thalassometridæ* and in the *Tropiometridæ* the carination of the brachials and pinnules is never present in the very young, but is rather suddenly assumed at an early stage; a graphic recapitulation of this may be observed in any regenerating specimen.

Dr. Clark has failed to mention a single character by which his *pædophora* can be distinguished from the young of *Ptilometra mulleri* as predicated from the facts known in regard to the young of related species and, as we have now been able to study a specimen exactly intermediate between the *pædophora* stage and the adult condition, there seems to be no escape from the conclusion I had arrived at, and communicated to him, when Dr.

⁶ Vidensk. Medd. fra den Naturhist. Forening i Kjobenhavn, 1909, p. 120.

Clark first showed me his *pædophora*, namely, that *pædophora* is nothing but the young of *Ptilometra mulleri*, the sacculi, the broad I Br series and first two brachials, the syzygies, and the ambulacral plating of the larger specimens preventing its reference to any species outside of that genus.

Genus STIREMETRA, A. H. Clark.

Stiremetra, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 15 (ANTEDON ACUTIRADIA, P. H. Carpenter, 1888).

Differential Characters.—In *Stiremetra* as in *Ptilometra* the pinnules are prismatic and stout, with the ambulacral grooves bordered by side and covering plates; these are much better developed than in *Ptilometra*, however, and P₁, instead of being smaller and shorter than P₂ as in *Ptilometra*, is much enlarged and much longer than the following pinnules. The centrodorsal is hemispherical or bluntly conical, with the cirrus sockets arranged in ten columns of usually two sockets each. The lower part of the animal is compressed, so that the elements of the I Br series and the lower brachials are sharply flattened against each other laterally. There are only ten arms.

Range.—Kermadec Islands and Port Jackson to Fiji and the Philippines; mostly in deep water, but one species is littoral.

STIREMETRA ARACHNOIDES (A. H. Clark).

Stenometra arachnoides, 1909, A. H. Clark, Proc. U.S. Nat. Mus., vol. 36, p. 402 (OFF TAWI TAWI, PHILIPPINES, 12 FMS.; Port Denison).

A specimen of this species was found in the jar containing the type specimen of *Amphimetra discoidea*. The U.S. National Museum received these Crinoids many years ago in exchange from the Australian Museum. They were collected at Port Denison, Queensland.

This specimen and the type, which was obtained by the "Albatross" in the Philippine Islands, are the only examples of this interesting form so far known.

Suborder MACROPHREATA, A. H. Clark.

Family ANTEDONIDÆ, Norman

Subfamily ANTEDONINÆ, A. H. Clark.

Genus COMPSOMETRA, A. H. Clark.

Compsometra, 1908, A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, p. 131 (ANTEDON LOVENI, Bell, 1882, = *Antedon pumila*, Bell, 1884).

Differential Characters.—The species of *Compsometra* are readily distinguished from those of any other Australian genus by their very small size, the very long P_1 , which is slender and composed of elongated segments, the delicate cirri which have less than fifteen segments, long and "dice-box shaped," at least in the proximal half, and the regularity in the distribution of the syzygies.

Range.—*Compsometra* ranges from Southern Australia to Southern Japan and the Hawaiian Islands.

COMPSOMETRA LOVENI (Bell).

? *Kallispongia archeri*, 1877, Wright, Proc. Roy. Irish Acad., [2], vol. 2, p. 754 (AUSTRALIA).

Antedon loveni, 1882, Bell, Proc. Zool. Soc., 1882, p. 534 (PORT JACKSON, 0.5 fms.).—1908, A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, p. 481.

Antedon pumila, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 157, pl. x., figs. B, Ba, b (based on the same specimens as the preceding).—1885, Proc. Linn. Soc. N.S. Wales, vol. 9 (1884), p. 497 (*Nelson's Bay, Port Stephens*).—1889, Ann. and Mag. Nat. Hist., [6], vol. 3, p. 292.—1889, Whitelegge, Journ. Roy. Soc. N.S. Wales, vol. 23, p. 197 (*Port Jackson, deep water; Taylor Bay; Watson's Bay*).—1890, P. H. Carpenter, Proc. Roy. Soc. Vict., (N.S.), vol. 2, p. 135 (*Port Phillip*).—1890, Ramsay, Rec. Austr. Mus., vol. 1, p. 84 (*Port Jackson*).

Differential Characters.—This delicate little species may readily be distinguished from *C. lacertosa* by its much more slender cirri in which the segments preceding the penultimate are at least half again as long as broad.

Specimens in the Australian Museum Collection.—Claremont Island, 11 fathoms—One typical specimen.

Nelson's Bay, Port Stephens—Forty-three specimens; six of these are deep purple, the remainder being dull greyish-yellow more or less tinged with brown.

Port Halliday.—Fragments.

Broughton Island.—Eight specimens; four are yellow, three brown, and one deep purple with each segment of the arms, pinnules, and cirri bordered with white.

Bottle and Glass Rocks, Port Jackson.—Thirty-four specimens.

Port Jackson.—Six hundred and forty-six specimens.

This magnificent series shows that when adult this species ordinarily possesses an arm length of 30 mm. to 35 mm., the cirri being xv-xxx, 12-14, 7 mm. to 8 mm. long; occasionally larger individuals occur, the largest having an arm length of 70 mm. while one is bearing eggs which has arms only 20 mm. long.

In colour the great majority (587) are dull greyish-yellow tinged with brown, the cirri and the proximal portions of the arms being lighter than the rest; fifty-two of them are a rather dark brown or purple with light yellowish cirri and arm bases; seven have each segment of the arms, pinnules, and cirri deep purple in the centre, the borders being white, this giving them a beautiful and striking "pepper and salt" appearance.

This lot also included four Pentacrinoid young attached to seaweeds.

"Australia."—Twenty-eight specimens.

Additional Australian Records.—Port Jackson, 0-5 fathoms; Nelson's Bay, Port Stephens; Port Phillip.

Remarks.—It is probable that this is the species upon which Wright's *Kallispongia archeri* was mainly founded, though no definite assertion to that effect can be made. In 1882 Bell listed this species with a so-called specific formula which he evidently believed to be diagnostic, thus technically naming it; two years later, however, he chose a new name for it under which it appears in the "Alert" Report, the original name having been shifted to a species which he at first had called "*insignis*." Bell described P_1 as shorter than P_2 , and so, when he received some additional specimens from Port Phillip he failed to recognise his species, and bestowed a third name upon it. Whitelegge, who was familiar with the animal in life, had discovered the error in Bell's description as given in the "Alert" Report, and rectified it just as Bell himself discovered it and published a short note to that effect. By a curious circumstance it happened that, though Whitelegge was right in his statement in regard to this form, Bell was in error; for the specimens upon which Bell had founded his *Antedon incommoda* do not belong to this species at all, but are representatives of the species which has recently been called *lacertosa*.

Whitelegge, in his list of the Crinoids of Port Jackson, says:—"In the description of this species the first pinnules are said to be the shortest; this is incorrect, the first pinnules are the longest. Very common in deep water, occasionally found under stones; Taylor Bay; Watson's Bay. The stalked or larval form is often found attached to seaweeds. August-September."

It is interesting to find that this species, like the European *Antedon*, breeds in the early spring, apparently as early in the season as the conditions will permit.

COMPOMETRA INCOMMODA (Bell).

- Antedon*, sp. nov., 1889, P. H. Carpenter, Proc. Roy. Soc. Vict., (N.S.), vol. 1, p. 135 (*Port Phillip*).
- Antedon incommoda*, 1888, Bell, Ann. and Mag. Nat. Hist. (6), vol. 2, p. 404 (PORT PHILLIP).—1889, Bell, *idem*, vol. 3, p. 292 (*supposed identity with A. pumila*).
- Compsometra lacertosa*, 1910, A. H. Clark, Proc. U.S. Nat. Mus., vol. 38, p. 275 (PORT JACKSON).

Differential Characters.—*Compsometra incommoda* is a somewhat stouter species than *C. loveni*, the cirri especially being stouter, with the three or four segments preceding the penultimate broader than long.

Description.—Centrodorsal discoidal, rather thin, with a broad flat polar area nearly or quite 2 mm. in diameter; cirrus sockets arranged in two very closely crowded more or less irregular marginal rows.

Cirri xxxiv-xxxvi, 9-12 (usually 10) 7 mm. long, the extreme flatness of the centrodorsal which, however, bears very numerous cirri very closely crowded and almost in the same plane, short, and rather strongly decurved distally, gives the dorsal part of the animal a striking resemblance to certain species of *Catoptometra* or *Oligometra*, and renders it very unlike that of any other macrophreathe form. First cirrus segment very short, second nearly or quite as long as broad, fourth and fifth the longest, about half again as long as the median diameter; following segments gradually decreasing in length so that the last two are about as long as broad; opposing spine minute, slender, subterminal, directed slightly forward; terminal claw long, nearly twice as long as the penultimate segment, evenly tapering and moderately and evenly curved. The second and following segments are slightly constricted centrally, this character gradually disappearing distally as the segments become shorter; the longer proximal segments are rounded in cross section and comparatively narrow in lateral view, but the segments become laterally flattened distally and appear laterally broader, like the cirri of *Antedon petasus*.

Disk as in *Compsometra loveni*; sacculi rather small but very numerous along the ambulacra of the disk, arms, and pinnules.

In good specimens the division series are entirely hidden by the dense circle of cirri; radials even with the edge of the centrodorsal; the I Br series extend outward horizontally as in *Comatula* so that the entire animal is flat as in the ten-armed Comasterids; I Br₁ very short, slightly trapezoidal, about four times as broad as long; I Br₂ almost triangular, the lateral edges, which are slightly shorter than those of the I Br₁, making with

the sides of that ossicle almost a right-angle, about as broad as long, the distal angle considerably produced.

Ten arms 60 mm. to 65 mm. long, rather stout in the basal third but becoming exceedingly slender distally; first brachial short, almost oblong, two to two and one-half times as broad as long in the median line, barely in contact basally interiorly, the diverging interior edges making a very broadly obtuse angle; second brachial much larger, almost triangular, about as broad as the greatest length; third and fourth brachials (syzygial pair) wedge-shaped, twice as long interiorly as exteriorly, about as broad as the interior length; following three brachials about twice as broad as the median length, slightly wedge-shaped, then becoming very obliquely wedge-shaped, almost triangular, about as broad as long, further out on the arm less oblique, and in the terminal portion much elongated and centrally constricted, twice as long as broad or even longer; fifth and following brachials with rather strongly overlapping spinous distal edges, this character becoming less marked in the outer portion of the arm.

Syzygies occur between the third and fourth brachials, again between the ninth and tenth and fourteenth and fifteenth, and distally at intervals of three oblique muscular articulations.

P_1 11 mm. long, slender and flagellate, with thirty to thirty-two segments; first segment short, following three or four about as long as broad, then rapidly becoming elongated and after three or four more about twice as long as broad, somewhat longer distally; second and two or three following segments with the distal edges strongly produced, overlapping, and finely spinous, but this gradually dies away as the segments become elongated so that most of the pinnule is smooth; the elongated segments have slightly expanded ends; P_2 5 mm. long, slightly less stout basally than P_1 , with sixteen to twenty segments, the first exceedingly short, the next two about as long as broad, the following becoming elongated and about twice as long as broad distally; second, third and fourth with strongly overlapping distal dorsal ends, this feature dying away on the three or four following segments; P_3 about 5 mm. long resembling P_2 with about fifteen segments, of which the proximal have much more strongly produced and overlapping distal ends, and this character is prominent on all the segments almost to the tip of the pinnule; the third-twelfth segments bear a large rounded genital gland; following pinnules similar to P_3 but slightly longer (5.5 mm.) with somewhat larger genital glands; after P_{10} the genital glands slowly decrease in size and finally disappear on P_{16} ; distal pinnules exceedingly slender, about 4 mm. long, with large and thickly set sacculi.

The colour is a dull greenish grey.

Specimens in the Australian Museum Collection.—Port Jackson.—Five specimens.

Additional Australian Record.—Port Phillip.

Remarks.—In examining the Comatulids in the British Museum I was greatly surprised to find that the types of Bell's *Antedon incommoda* consist of two specimens of the form which I had called *Compsometra lacertosa*, and one young *Ptilometra*; Bell himself placed *incommoda* unhesitatingly in the synonymy of his previously described *loveni* or *pumila*.

CRINOIDS KNOWN FROM THE DEEP WATER ABOUT AUSTRALIA.

While the present Memoir is concerned only with the littoral and sublittoral Crinoids of Australia, some mention should be made of such species as are known to occur in the deep sea surrounding that continent. While on her epoch-making voyage around the world, the "Challenger" made three hauls off the Australian coast at which Crinoids were obtained in depths varying from 950 to 2,600 fathoms; a number of years afterwards Capt. F. Worsley, of the cable-repair ship "Sherard Osburn," while working on the Sahul Bank, secured several very interesting species which were reported upon, after the death of Dr. P. H. Carpenter, to whom they were originally sent, by Prof. F. J. Bell. Thanks to the kindness of Dr. Nelson Annandale, of the Indian Museum, Calcutta, the specimens collected by Capt. Worsley belonging to that institution are now before me. The species obtained on the Sahul Bank are comparatively shallow water forms, and probably came from near the 100 fathoms line—at least most of them. They include the only stalked Crinoid so far known from the vicinity of Australia.

I. COMATULIDS.

Suborder OLIGOPHREATA, *A. H. Clark*.

Family THALASSOMETRIDÆ, *A. H. Clark*.

Genus ASTEROMETRA, *A. H. Clark*.

ASTEROMETRA MIRIFICA, *A. H. Clark*.

Antedon longicirra (part) (not of Carpenter), 1893, Bell, Journ. Linn. Soc. (Zool.), vol. 24, p. 339.

Asterometra mirifica, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 146.

Sahul Bank (10° 30' S. lat., 125° E. long.).

ASTEROMETRA ACERBA, *A. H. Clark.*

Antedon longicirra (part) (not of Carpenter), 1893, Bell, Journ. Linn. Soc. (Zool.), vol. 24, p. 339.

Asterometra acerba, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 147.

Sahul Bank.

Genus COSMIOMETRA, *A. H. Clark.*COSMIOMETRA WOODMASONI (*Bell.*).

Antedon woodmasoni, 1893, Bell, Journ. Linn. Soc. (Zool.), vol. 24, p. 340, pl. xxiii, pl. xxiv., fig. 1.

Cosmiometra woodmasoni, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 17.

Sahul Bank.

Genus STIREMETRA, *A. H. Clark.*STIREMETRA SPINICIRRA (*P. H. C.*).

Antedon spinicirra, 1888, P. H. Carpenter, "Challenger" Report, Zool., vol. 26, p. 112, pl. xi, figs. 1, 2.—1889, Whitelegge, Journ. Roy. Soc. N.S. Wales, vol. 23, p. 198.

Stiremetra spinicirra, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 15.

Off Port Jackson (34° 08' S. lat., 152° 00' E. long.), 950 fathoms.

Family CHARITOMETRIDÆ, *A. H. Clark.*Genus PACHYLOMETRA, *A. H. Clark.*PACHYLOMETRA PATULA (*P. H. C.*).

Antedon patula, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 219, pl. xliii.—1893, Bell, Journ. Linn. Soc. (Zool.), vol. 24, p. 341, pl. xxiv., figs. 2-6.

Pachylometra patula, 1909, A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 21.

Sahul Bank.

Suborder MACROPHREATA, *A. H. Clark.*

Family ANTEDONIDÆ, *Norman.*

Subfamily BATHYMETRINÆ, *A. H. Clark.*

Genus BATHYMETRA, *A. H. Clark.*

BATHYMETRA CARPENTERI, *A. H. Clark.*

Antedon abyssicola, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 191 (part), pl. xxxiii., fig. 2.

Bathymetra carpenteri, 1908, A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, p. 235.

South-west of Melbourne (42° 42' S. lat., 134° 10' E.), 2,600 fathoms.

Family PENTAMETROCRINIDÆ, *A. H. Clark.*

Genus DECAMETROCRINUS, *Minckert.*

DECAMETROCRINUS ABYSSORUM (*P. H. C.*).

Fromachocrinus abyssorum, 1888, P. H. Carpenter, "Challenger" Reports, Zool., vol. 26, p. 351, pl. i., figs. 4, 5, pl. lxxix., figs. 5-7.

Decametrocrinus abyssorum, 1905, Minckert, Zool. Anzeiger, vol. 28, p. 494.

South-west of Melbourne (50° 01' S. lat., 123° 04' E. long.), 1,800 fathoms.

Genus PENTAMETROCRINUS, *A. H. Clark.*

PENTAMETROCRINUS SEMPERI (*P. H. C.*).

Eudiocrinus semperi, 1882, P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, p. 497.—1888, "Challenger" Reports, Zool., vol. 26, p. 82, pl. iii., fig. 7, pl. vi., figs. 1-3.—1889, Whitelegge, Journ. Roy. Soc. N.S. Wales., vol. 23, p. 197.

Pentametrocrinus semperi, 1908, A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, p. 135.

Off Port Jackson (34° 08' S. lat., 152° 00' E. long.), 950 fathoms.

PENTAMETROCRINUS, *sp.*

Thaumatoocrinus renovatus, 1884, P. H. Carpenter, Phil. Trans. Roy. Soc., 1883, p. 919.

South-west of Melbourne (50° 01' S. lat., 123° 04' E. long.), 1,800 fathoms.

II. STALKED CRINOIDS.

Family PENTACRINITIDÆ, Gray.

Genus METACRINUS (*P. H. C.*).METACRINUS INTERRUPTUS (*P. H. C.*).

Metacrinus interruptus, 1884, P. H. Carpenter, "Challenger" Reports, Zool., vol. 11, p. 367, pl. lii.—1893, Bell, Journ. Linn. Soc. (Zool.), vol. 24, p. 339.
Sahul Bank.

UNIDENTIFIABLE LIST.

ENCRINUS AUSTRALIS, Pleydell.

Encrinus australis, 1845, Pleydell, L'Institut, 13 août, 1845, p. 292 (see p. 711).

ENCRINITE.

Encrinite, 1862, Owen, Ann. and Mag. Nat. Hist., (3), vol. 9, p. 486 (see p. 712).

ANTEDON, *sp.*

Antedon, *sp.* (near "*macronema*"), 1894, Bell, Proc. Zool. Soc. 1894, p. 394 (*N. W. Australia, ? fms.*).

While in London I examined the specimen upon which this record is based, and found it to be an example of the *Cenometra cornuta* described herein (p. 772).

ANTEDON ADEONÆ.

Antedon adeonæ, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 156 (part).

Among the "Alert" collections at London there are some curious Comatulids from Port Molle (12-20 fathoms) and from "Alert" Station No. 87, recorded under the name of "*Antedon adeonæ*," which represent a very distinct new species, possibly belonging to the genus *Tropiometra*. I was not able while in London to spare the time to work this species out satisfactorily.

COMPSOMETRA, *sp.*

In the British Museum there are eleven specimens of a species of *Compsometra* from Lewis Island in the Dampier Archipelago; I was not able to determine them specifically while visiting that institution because of lack of time.

ANTEDON, *sp.*

Antedon, *sp.*, 1885, Bell, Proc. Linn. Soc. N.S. Wales, vol. 9 (1884), p. 498.

Professor Bell gives a nominal list of Crinoids included in a collection from New South Wales placed in his hands for determination; in addition there were "several species of *Antedon*, hitherto undescribed, but here unfortunately represented by single, not always perfect, specimens."

ANTEDON, *sp.*

Antedon, *sp.*, 1889, Studer, Die Forschungsreise S.M.S. "Gazelle," iii. Thiel, Zool. und Geol., p. 184.

Professor Studer records an undetermined species which he referred to this genus which was taken in 25° 50·8' S. lat., 112° 36·8' E. long. (off Dirk Hartog Island), two sea miles from land, in 45-60 fathoms, with a bottom temperature of 21° C. The specimen was of a deep violet colour in life.

COMATULA, *sp.*

Comatula, *sp.*, 1889, Studer, Die Forschungsreise S.M.S. "Gazelle," iii. Thiel, Zool. und Geol., p. 195.

Two ten-armed Comatulids are recorded from 19° 41·1' S. lat., 116° 49·8' E. long., off the west coast of Australia, in 91·5 meters, with a bottom temperature of 14·7° C. The colour of one is recorded as purple, of the other as pale yellow; the latter is probably a *Thalassometrid*.

ANTEDON, *sp.*

Antedon, 1893, Kent, The Great Barrier Reef of Australia; its Products and Potentialities, p. 43, pl. xi., figs. 7, 7a.

"Two other members of the same echinodermatous, or sea-urchin and starfish, class, observed on the Palm Island reefs, are depicted in the same coloured plate. These are the two Feather-starfish, *Antedon* *sp.*, represented by Figs. 7 and 7a, clinging to the corallum of the *Gorgonia* in the right hand upper corner. In general form they resemble the English Feather-star, *Comatula rosacea* [*i.e.*, *Antedon bifida*]; but they possess about forty, in place of the ten, pinnate arms of the European type. The variety of hues exhibited by this Barrier Reef species are legion, running through every gradation of tint from pale yellow to rose-pink, deep crimson and black, and including every conceivable intermixture of these colours. One especially handsome racial variety of this Feather-star, obtained at Thursday Island,

had its fern-like arms resplendent with shades of old-gold and bronze-green."

ACTINOMETRA, *sp.*

Actinometra, 1894, Walther, Einleitung in die Geologie als historische Wissenschaft, p. 298.

Walther records an undetermined species of "*Actinometra*" as very common at Somerset, Queensland, in 15-22 meters. Probably this is *Comatula solaris* or *C. rotalaria*.

ACTINOMETRA CUMINGII, *Bell.*

Actinometra cumingii, 1884, Bell, Rep. Zool. Coll. H.M.S. "Alert," p. 167.

Port Molle.—"A delicate specimen with 10 cirri, the cirri having about 12 joints and no penultimate spine, and most of the joints being a little longer than broad, is referred to this species. Two of the arms which have undergone injury are now giving rise to four and three arms respectively."

If this description is accurate, this can only be a specimen of *Comatula rotalaria* which is just undergoing adolescent autotomy; this is the only multibrachiate Australian Comasterid with no dorsal processes on the cirri and with "most of the [cirrus] joints a little longer than broad."

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EDITORIAL NOTE.—At p. 711 Mr. Clark refers to a notice in "L'Institut" of 1845, p. 292, of the discovery of a new Encrinite at Newcastle, N.S. Wales, by the Rev. "C. Pleydell." Whilst reading the proofs of this Memoir, I felt convinced I had, in previous years, somewhere seen another reference to this "Encrinite," but could not, for the time being, remember where. By pure accident, on looking through some old memoranda, I came upon the original reference. The clergyman referred to was the Rev. "C. Pleydell N. Wilton," of Newcastle, and his paper, under the title of—"On a New Species of Encrinite (Encrinus Australis)," and of which the notice in "L'Institut" is clearly an extract, was published in the "Tasmanian Journal of Natural Science," 1843, ii., No. vii., pp. 118-120.

It is quite evident from the tenor of his paper Mr. Wilton had many specimens. They were only found on the beach or in rock-pools, adhering to sea-weed, after gales. Examples of this

organism were sent to Oxford previous to 1841, and presented to the Ashmolean Society. The following is Mr. Wilton's description verbatim :—

"The *Encrinus Australis* has no vertebral column, but its body, which is about $\frac{1}{5}$ th of an inch in length, is terminated in that direction by a circular base ; the circumference of the body being indented by three rows of irregularly shaped hollow sections, each furnished with a circular orifice, to which the several tentacula of about 80 joints, and curving inwards towards their extremities, are appended, and by which the animal attaches itself to the sea-weed, which adheres to the bottom of the water-hole in the rock. To the opposite extremity of its body, which is always uppermost in the water, are attached five clavicles. Upon removing these from the body, its inferior surface presents a star of five points, each point being set in the angle formed by the two approaching segments of a circle, on which each of the clavicles reposed. Within this star is another star, also of five points. To each of these clavicles are attached two scapulæ, into each of which the first two bones of the animal are inserted. On each of these is another scapula, from which proceed two arms. To two opposite sides of every alternate articulation of these arms, which gradually diminish in size to the extremity, are attached fingers, gradually tapering to a point, formed of several joints, which appear to vary in number according to the size and age of the specimen. In one of these I have counted twenty. Each of the joints of the arms is of a circular figure, with an oval orifice in the centre, from which proceed radii to the circumference. With its fingers, which the animal can either extend or contract at pleasure, either in a lateral or perpendicular direction, and which all curve outwards, the *Encrinus Australis* presents an appearance under the water of that species of lily called the Turk's cap, and of a beautiful lilac colour."

R. E.

9th August, 1911.