they never, at any time, participated in the rhythmic swing or feeding movements of these last.

Gentle pressure on the anus or the sexual organs *excites or inhibits* the swimmerets, according as they are already at rest or in motion, and leads, where possible, to a folding of the abdomen. The feeding and preening movements are also, as a rule, brought to a complete standstill by slight irritation of the anus, the after movements being in all cases more violent. So long as the nervous connexion with the tail-fin remained intact, the swimmerets can be excited to considerable activity by touching this region, but when this connexion is destroyed, it is with difficulty they are made to move at all.

The experiments, of which the above is a brief and preliminary account, were carried on at the Physiological Laboratory, Cambridge.

II. "Preliminary Report upon the *Comatulæ* of the 'Challenger' Expedition." By P. Herbert Carpenter, M.A., Assistant Master at Eton College. Communicated by Sir Wyville Thomson, F.R.S. Received February 18, 1879. Published by permission of the Lords Commissioners of the Treasury.

The collection of *Comatulæ* made by the staff of the "Challenger" includes specimens from 45 different localities, but few of which are deep-water stations. *Comatulæ* were only obtained seven times from depths exceeding 1,000 fathoms, namely at:—

Station.	Depth.	Station.	Depth.
205	1,050 fathoms	158	1,800 fathoms.
218	1,070 ,,	160	2,600 ,,
175	1,350 ,,	244	2,900 ,,
147	1,600 ,,		

At lesser depths, 200—1,000 fathoms, *Comatulæ* were met with at 13 stations; but by far the greatest number both of species and of individuals were dredged at depths much less than 200 fathoms, and often less than 20 fathoms, at 26 widely distant stations.

No.	Station.	Locality.	Depth in fathoms.	Antedon.	Actinometra.	Promachocrinus.	Ophiocrinus.
1	48	.....	51	2			
2	..	St. Paul's Rocks.....	10—80	..	1		
3	122	.....	350	1			
4	..	Bahia.....	7—20	1	2		

No.	Station.	Locality.	Depth in fathoms.	Antedon.	Actinometra.	Promachocrinus.	Ophiocrinus.
5	135	Off Tristan d'Acunha	550	1			
6	..	Simon's Bay.....	10—20	..	1		
7	..	Marion Island.....	50—75	1			
8	147	.....	1,600	2	..	1	
9	149	Kerguelen { Balfour Bay ... / Royal Sound.. / Cape Maclear.. }	20—60 / 28 / 30	..	..	1	
10	150	.....	150	1			
11	151	Heard Island	75	1	..	1	
12	158	.....	1,800	..	..	1	
13	160	.....	2,600	1			
14	163A	Port Jackson	2—10	1	1		
15	164	.....	950	1	..	..	1
16	169	.....	700	..	..	..	1
17	170	.....	630	4			
18	..	Tongatabu Reefs	..	1	1		
19	174	.....	210, 255, 610	4	3		
20	175	.....	1,350	3			
21	186	Torres Straits { Sept. 7, 1874 / „ 8, „ }	3—11 / 8	.. / 2	3 / 6		
22	187	Cape York, Sept. 9, 1874. ..	6	1	2		
23	190	.....	49	2			
24	192	.....	129	11			
25	..	Aru Islands	..	1	1		
26	..	Banda	17	..	11		
27	..	Ternate	..	..	1		
28	..	Zamboanga	10	..	14		
29	201	.....	82—102	2			
30	..	Zebu Reefs	..	2			
31	205	.....	1,050	..	..	..	1
32	208	.....	18	3	1		
33	210	.....	375	2			
34	212	.....	10—20	5			
35	214	.....	500	3	..	1	
36	218	.....	1,070	1			
37	219	.....	150	1			
38	..	Admiralty Islands	..	..	2		
39	232	.....	345	1			
40	235	.....	565	..	..	..	1
41	236	.....	775	1			
42	244	.....	2,900	1			
43	308	.....	175	1			
44	320	.....	600	1			
45	344	.....	420	1			

At the present time I regard the collection as containing 111 species, mostly new; but as the work of examination and description progresses, it is not unlikely that forms which I now consider different may turn out to be merely local varieties of one and the same species, so that the number given above may be subject to alteration.

Of these 111 species, 59 belong to the genus *Antedon*, 48 to *Actinometra*, 1 to *Ophiocrinus*, and 3, which are peculiar in having ten rays to the calyx instead of only five, to a new genus for which I propose the name *Promachocrinus* (πρόμαχος, "Challenger.") It may be thought that this peculiarity is hardly a sufficient reason for the erection of a new genus to receive these three species. It is, however, a much more striking one than that on which the genus *Ophiocrinus* is based, viz., the presence of five arms only, as the rays, unlike those of most *Comatulæ*, do not divide but bear the arms directly. In *Promachocrinus* on the other hand, there are ten distinct rays, the radial pentagon which is in contact with the centrodorsal consisting of ten separate pieces, and not of five only, as in *Ophiocrinus* and in the other *Comatulæ*.

In two of the species the rays are undivided as in *Ophiocrinus;* but in the third they divide, as in our common *Antedon rosacea*, so that there are twenty arms.

This character, the presence of ten rays, is evidently not an accidental one, like the existence of more or less than five rays in other *Comatulæ* and in *Rhizocrinus*. In the latter genus individuals with four to six rays are common, and cases of seven, though rare, may occur. Among the *Comatulæ*, however, it is very different. I have carefully examined three large *Comatula* collections besides that of the "Challenger," viz., those of the British and Paris Museums, and Professor Semper's collection from the Philippine Islands. Out of the nearly 200 species contained in these collections I have found but two specimens in which there are not five rays in the calyx. In one of these there are only four, and in the other six rays, though in other individuals of each species there are five, the normal number.

The distribution of *Promachocrinus* is as follows:—

P. Kerguelensis (20 arms).	Balfour Bay, Kerguelen,	20—60	fathoms.
	Royal Sound ,,	28	fathoms.
	Cape Maclear ,,	30	,,
	Heard Island	75	,,
P. abyssorum (10 arms).	Station 147.....	1,600	,,
	,, 158.....	1,800	,,
P. Naresii (10 arms).	,, 214.....	500	,,

Ophiocrinus was obtained at four localities at depths varying from 565 to 1,070 fathoms, two in the South Pacific, off South Australia and New Zealand respectively, and two in the North Pacific, one off Japan, and one just north of the Philippine Islands. All the specimens belong to one species, which is by no means so slender and graceful as Semper's Philippine species from shallower water, but has a much more massive arm skeleton.

Among the numerous species of *Antedon* (59) and *Actinometra* (48)

the only species which I have been able to identify with any certainty are:—

Antedon Eschrichtii.
" *macrocnema.*
" *Brasiliensis* (*Lütk.*).

Actinometra multiradiata.
" *fimbriata.*
" *Novæ Guineæ.*
" *trichoptera.*

Müller's specific diagnoses are, as is well known, very incomplete; and it is possible that a personal examination of his original specimens will enable me to identify more of his species than I can at present. I am inclined to think that besides the above-mentioned species, the "Challenger" collection also includes the following:—

Act. purpurea.
Act. rotalaria.
Act. Wahlberghii.
Act. stellata (*Lütk.*).

The comparative distribution of these two genera is very striking. Relatively speaking, *Actinometra* is extremely limited in its range, both geographical and bathymetrical. It is almost exclusively a tropical genus, its northern limit being about 30° N. lat. and its southern 40° S. lat. Isolated species are known from the Cape of Good Hope, Natal, South Australia, and Port Jackson, but its chief home is Oceania, especially the Philippines and Moluccas, from which latter locality the "Challenger" brought home 11 species of *Actinometra*, but not a single *Antedon*. 14 species were found at Zamboanga, in the Philippines, but no *Antedon;* while at the Zebu Reefs, in another part of this group, two *Antedons* were obtained, but no *Actinometra;* and at Station 192, 11 *Antedons*, but no *Actinometra*, just the reverse of what was found at Banda, in the Moluccas. A few *Actinometra* species are also known from the west coasts of the Atlantic, as South Carolina, the West Indies, Bahia, and St. Paul's Rocks.

The bathymetrical range of *Actinometra* is likewise very narrow. Nearly all the "Challenger" species are from depths less than 20 fathoms, while only three come from a greater depth than 100 fathoms. These were all obtained at Station 174, where the depths of different hauls were 210, 255, and 610 fathoms. I have no information as to which of these hauls yielded the three species in question. The individual species of *Actinometra*, like the genus itself, are very local in their distribution. *Act. solaris* seems to have a fairly wide range in the Malay Archipelago and in Oceania, though oddly enough it does not occur in the "Challenger" collection. Each of the forty-eight species of this collection has its own locality. In no case have I been able to refer specimens from different localities to the same species, except that duplicates of the same species were found at two stations in Torres Straits (186, 187), very close to each other.

With *Antedon*, however, the case is different. Not only do nearly all the deep-sea *Comatulæ* belong to this genus, but some species of it

have a fairly wide range. *Ant. rosacea* ranges from the north of Scotland to the Mediterranean, while *Ant. Eschrichtii* is found over a much wider area. It is the common Arctic species, having been obtained by our own expedition under Nares, as far north as lat. 81° N., while the expeditions of Sweden, Norway, and other countries have found it abundant in the seas of Spitzbergen and Nova Zembla. It is well known on the American coast, and was dredged by the "Challenger" off Halifax, while the "Porcupine" met with it in the "cold area" of the North Atlantic.

The "Challenger" dredgings round Heard Island yielded several specimens which agree so very closely with *Ant. Eschrichtii* that I am very strongly inclined to believe in the identity of the southern and northern forms. There are, however, some minor points of difference between them, and the southern form may really turn out to be the representative species of *Ant. Eschrichtii*, but not identical with it. I cannot venture to give a definite opinion upon this point until I have had an opportunity of examining a greater variety of specimens than are accessible to me just at present.

There are other *Antedon* species, which occur in duplicate from different localities. Two specimens from near the Kermadec Islands (S. 170), also occur in the neighbourhood of the Fijis (S. 174, 175). A third species was dredged at Stations 147 and 160, two localities in the Southern Sea, in nearly the same latitude, but separated by almost 90° of longitude. A fourth species came up from 1,070 and 775 fathoms, off the Admiralty Islands and Japan respectively.

The above facts would seem to show that, with few exceptions, the geographical range of the individual members of the family *Comatulidæ*, is exceedingly limited, nearly every species having its own locality, and that not a very extensive one.

This is not surprising when it is remembered how rarely *Comatulæ* have been found at great depths. The stalked Crinoids, on the other hand, are especially characteristic of the abyssal fauna, *Pentacrinus*, *Bathycrinus*, and *Rhizocrinus*, all having a very wide distribution. This is true, also, even with the individual species of the latter genus. This accords well with our palæontological knowledge. Chalk *Comatulæ* are exceedingly rare. Hagenow found one in Germany, which he named *Hertha mystica*. From the figure which he gives of its calyx, I should judge it to be an *Antedon*, which agrees well with the facts stated above. Lundgren* has found a calyx in the chalk of Sweden, which "comes very near to *Antedon Fischeri*, Geinitz." There are also a few chalk *Comatulæ* in the Woodwardian and British Museums, viz., *Glenotremites* and similar forms, but they are as nothing compared to the remains of *Pentacrinus* and *Bourguetticrinus*, and even

* "Neues Jahrbuch für Mineralogie." Heft ii, 1876, pp. 180–182.

these are not too common. A few specimens are known from the Gault, Greensand, and Bath Oolite, while the Jurassic beds of the Continent have yielded *Solanocrinus* and a few little known forms from the Solenhofen slate (*Pterocoma*, *Saccocoma*).

It should be noted, however, at the same time, that Tertiary *Comatulæ* are also very rare, Philippi's *Alecto alticeps*, from the Sicilian Tertiaries being the only one which I can call to mind. This is scarcely surprising when it is remembered that the distribution of modern *Comatulæ* is chiefly in the tropics and temperate zones, there being but few Arctic or sub-Arctic species. The Australian Tertiaries might possibly yield different results.

The voyage of the "Challenger" has settled two curious questions in connexion with the Crinoids, the origin of which is due to Lovèn. They refer to *Hyponome Sarsii*, a so-called recent Cystid, and to *Phanogenia*, a supposed new genus of the *Comatulidæ*. *Hyponome* turns out to be nothing more than the disk of a *Comatula*, minus its skeleton. The anambulacral plating may be very extensive, forming a complete pavement over the ventral surface of the disk as in many *Pentacrini;* and the ambulacra are not wide and open as is usual in most *Comatulæ*, but almost entirely closed by the approximation of the marginal leaflets at their sides, so that the food-grooves radiating from the mouth are converted into tunnels. In Lovèn's specimen the mouth was central but almost concealed, and several similar ones were obtained by the "Challenger" at Cape York, together with one still retained in its calyx and similar in every respect to an ordinary *Antedon*. This last shows that it is only on the disk that the ambulacra are partially closed, for they are quite open and of the usual character on the arms.

Species of *Actinometra* may also exhibit this condition of more or less completely closed ambulacra on the disk. One of the most abundant *Comatulæ* at Cape York is a large *Actinometra*, the disk of which corresponds exactly to Lovèn's description of *Hyponome*, except in the eccentric position of the mouth. Since learning the true nature of *Hyponome* from Sir Wyville Thomson, I have looked out for a similar condition in other *Comatulæ*, and have found that it is not uncommon though rarely so marked as in the Cape York species.

Two species of *Antedon*, dredged by the "Challenger" at Station 214, have disks, which, if separated from their dorsal skeleton, would be very perfect *Hyponomes*. In each species the whole of the ventral perisome is covered with an extensive *anambulacral* plating, and the marginal leaflets at the edges of the grooves of both disk and arms also contain distinct plates. In most *Comatulæ* there are no plates in the marginal leaflets, or at most, a few calcareous spicules, irregularly disposed. In these two species, however, there are definite plates which are comparatively small as in *Pentacrinus*, and do not attain to

anything like the relative size of the reniform plates at the sides of the grooves of *Rhizocrinus*, *Hyocrinus*, and *Bathycrinus*. They are all folded down more or less completely over the grooves, which are thus converted into tunnels; while the mouth is also rendered more or less invisible by the folding over it of the plated leaflets around the edges of the peristome. The closure of the grooves is much more perfect in some specimens than in others and may extend far out on to the arms.

The plates in the marginal leaflets are probably moveable as the unplated leaflets are in *Antedon rosacea;* so that they can be erected when the arms are spread out, leaving the grooves open for food particles to travel towards the mouth. On the other hand, when the arms are all contracted over the disk, the marginal plates fold over the grooves and cover them in. This is the condition of most spirit-specimens, but it is not in any way comparable to that of the Palæozoic Crinoids, in which the mouth is truly subtegminal, while the ambulacra become real tunnels beneath the upper surface of the vault.

Sections through one of these plated *Hyponome*-disks show that all the various structures which underlie the grooves of ordinary *Comatulæ* are present and exhibit their usual characters.

A new *Comatula* has been described by Lovèn* under the name *Phanogenia*, which presents a very remarkable condition of the centrodorsal piece.

Lovèn's specific diagnosis of *Phanogenia typica* commences as follows:—"*Calyx fere planus, facie dorsali totus cum brachiis lævis, suturis linearibus, facie ventrali usque ad finem brachialis secundi sulcis aratus, quibus adhaeret perisoma. Articulus centrodorsalis, verticillaris, persistens, simplex, formam servans stellæ quinquangularis minutæ, sinubus rotundatis, radiis obtusis, facie dorsali leviter convexa lævis, cirris præditus perpaucis (circ. octo. ?), in sinubus sparsis, pusillis, quintem partem diametri stellæ longitudine vix superantibus, crassiusculis, versus basin validiusculis, teretibus, leviter arcuatis, lævibus, apice muticis, caducis foveolas relinquentibus minutas medio perforatas.*" The figure accompanying the above description shows the centrodorsal in the form of a five-rayed star, which does not, however, spread out over the radials so as to conceal them more or less completely, as is usual in most *Comatulæ*, except that the points of the star just overlie the inner ends of the lines of synostosis of every two adjacent radials. The dorsal surface of the star is level with that of the rest of the calyx, and is marked by a few cirrhus sockets, in two or three of which there are one or two very minute cirrhus stumps.

This is a very remarkable condition of the centrodorsal. In nearly

* "Phanogenia, ett hittills okändt slägte af fria Crinoideer." "Ofversigt af Kongl. Vetenskaps-Akademiens Forhandlingar." 1866. No. 9.

all the other *Comatulæ* it is circular or pentagonal, more or less convex, and marked with several cirrhus sockets, either only at the margin or all over its surface, while the cirrhi are rarely so imperfect as in Lovèn's specimen.

Among the *Comatulæ* in the British Museum is a specimen labelled *Actinometra stellata*, Ltk. It had been purchased from the collection of the Godeffroy Museum, having been previously examined and named by Dr. Lütken.

The mouth is not central as Lovèn describes it in *Phanogenia*, but eccentric, though comparatively only but slightly so. The condition of the centrodorsal, however, is essentially similar to that presented by *Phanogenia*, and it was this feature, I do not doubt, that caused Lütken to give the specific name *stellata* to this type. The stellate condition of the centrodorsal in *Phanogenia* has long been a puzzle to me, and I am therefore glad to be able to say that the material brought home by the "Challenger" throws a considerable light upon it. This condition appears to be one of the concluding stages of a long series of changes in the shape and relations of the centrodorsal, which do not commence until some time after the loss of the stem, and the entry upon the free state of existence.

The "Challenger" dredgings in Torres Straits brought up a considerable number of specimens of a hitherto undescribed *Comatula*. This species was first discovered by the late Professor Jukes, who brought home specimens and deposited them in the British Museum. I propose, therefore, to name it *Actinometra Jukesii*. The "Challenger" collection contains nine young specimens of this species, most of which have cirrhi on the centrodorsal. But in the adult the centrodorsal is a pentagonal plate four millims. in diameter, without a trace of cirrhi or even of cirrhus sockets. Its surface is level with that of the radial pentagon within which it is enclosed.

Stage 1. In the youngest specimen the centrodorsal is a nearly circular plate 1·5 millims. in diameter, just sufficiently raised above the surface of the radial pentagon to bear about eight marginal cirrhi.

Stage 2. In others from the same locality which have a centrodorsal 2 millims. in diameter, it bears no cirrhi, and the sockets are partly obliterated, while the height of the plate above the rest of the calyx is somewhat reduced. Three other specimens, however, of the same size which were obtained at Cape York on another day, still retain their cirrhi.

Stage 3. By the time that the diameter of the centrodorsal increases from 2 to 2·5 millims., its shape becomes more distinctly pentagonal and scarcely any trace of cirrhus sockets is visible, the plate being so thin that it rises very little indeed above the level of the radials. In one specimen of this size there is one rudimentary cirrhus stump and two

or three faint indications of sockets, very much as in the stellate centrodorsal of *Phanogenia*.

Stage 4. The adult condition succeeds to this. The centrodorsal is a simple pentagonal plate 3·5—4 millims. in diameter, and situated entirely within, and on the same level as, the radial pentagon.

This series of changes in the centrodorsal does not proceed any farther in *Act. Jukesii*, but in other species it may continue still farther, or on the other hand close sooner. Thus the centrodorsal of a gigantic *Actinometra* in Professor Semper's Philippine collection is in stage 2; while those of two other "Challenger" species, from the same locality and equally large, exhibit the next stage of metamorphosis (5).

Stage 5. In No. 37 (of my list) the centrodorsal is a pentagonal disk without a trace of cirrhus sockets. It is slightly *below* the level of the radials, and is only in contact with them by its inter-radial angles, its sides being separated from their inner margins by linear clefts.

No. 49 is in the same condition, and so are two others of Semper's Philippine species, except that one or two minute cirrhus stumps still remain on the centrodorsal. Another large "Challenger" species, also from the Philippines, is represented by four specimens. All of these show the gradual obliteration of the cirrhus sockets and the lowering of the centrodorsal to the level of the radial pentagon, or even below it, together with the presence of clefts at its sides. These may occasionally appear before the loss of the small cirrhus stumps, as is the case in *Phanogenia*.

Stage 6. In No. 6, another large Philippine species, the clefts are somewhat wider but very shallow. They are deeper in No. 30, but there is no trace of cirrhi on the stellate centrodorsal. Except in this point (a very variable one, as seen above) this seems to be about the condition of *Phanogenia*.

Stage 7. The last stage is reached in another of Semper's specimens which was purchased from the Godeffroy Museum, and appears to me to agree very closely with Lütken's *Act. stellata*. The centrodorsal is star-shaped, having a flat centre and five rays, the length of which is about one-third the diameter of the centre. The points of the rays abut on the radial pentagon at the synostoses of every two contiguous radials and are therefore *inter-radial*. The re-entering angles of the star are occupied by five clefts, each of which is somewhat planoconvex in shape. It is bounded centrally by the centrodorsal plate, laterally by two of its rays, and peripherally by the inner margin of a radial. These openings are large enough to admit the point of a good sized needle for a short distance.

The causes which lead to such remarkable changes in the appearance and relations of the centrodorsal piece, are I think, partly to be found

in an alteration of the relations of the different surfaces of the radials to one another which takes place during their growth. This is the conclusion to which I have been led by an examination of the separated radials of young and adult examples of *Act. Jukesii;* but it entirely fails to account for the stellate form of the centrodorsal in *Act. stellata* and in *Phanogenia*. This feature appears to me to be a further development of a condition which I have already described in *Act. pectinata;** but I do not expect to get a better understanding of it until I am able to separate the parts of the calyx, and also to make sections through it. Both of these modes of research are at present unavailable, owing to want of material.

The appearances presented by the dorsal surface of an isolated first radial are very different among the different species of *Comatula*. In many *Antedons* such as *Ant. Eschrichtii*, the whole of this surface rests upon the centrodorsal, and except for the edge separating it from the distal articular surface there is no external indication of the presence of a first radial at all, as the second seems to be in direct contact with the centrodorsal. The superior or ventral surface of the latter slopes downwards from its circumference towards the centre.

In such species as *Ant. macrocnema*, however, and in most *Actinometræ* a dorsal view of a first radial shows two surfaces inclined to one another more or less obtusely. One of these appears externally and is the true or outer dorsal surface of the radial. It is often marked by a median dark line which extends outwards over the other radials far on to the arms. The other, or inner dorsal surface, is the surface of synostosis with the centrodorsal plate, and may be at right angles to the outer surface when the ventral face of the centrodorsal is perfectly flat as in *Ant. macrocnema*. But in *Actinometra* it is always placed at an obtuse angle to the outer surface, for the ventral face of the centrodorsal on which it rests slopes downwards and outwards from the centre to the circumference. I have examined the separated radials of two specimens of *Act. Jukesii*, one young with a centrodorsal still marked by cirrhus sockets, and the other full grown with a large discoidal centrodorsal within the radial pentagon, and below the level of its outer surface when viewed from its dorsal aspect. There is a considerable difference in the relative sizes of the inner and outer portions of the dorsal surface of the radials in these two cases. The absolute length of the outer dorsal surface seems to increase very little after a certain stage of growth is reached, for it is nearly the same in the large specimen as in the small one, but the inner or synosteal surfaces of the two differ very greatly in size. This surface is not only absolutely, but also relatively larger in the older specimen,

* See cap. vi, sect. 61, of my memoir on *Actinometra*, now in course of publication in the "Transactions of the Linnean Society."

taking up more than half the whole dorsal face of the radial, while in the younger specimen it occupies much less than half.

The effect of this change in the component parts of the radial pentagon is to give its central synosteal surface a considerable slope inwards and downwards, so that the whole, when viewed from above, has the form of a wide and shallow funnel. The rim of the funnel (outer dorsal surfaces of the radials) is thick in the young specimen, but does not increase with the growth of the interior (inner dorsal surfaces). Consequently, the centrodorsal which forms, as it were, a plug fitting into the funnel, slips farther and farther down into it, until its dorsal surface becomes level with that of the radial pentagon, or even comes to be actually below it. At the same time it loses its few marginal cirrhi, and their sockets become obliterated, so that the whole dorsal surface of the calyx is one uniform plane. *Act. Jukesii* remains permanently in this condition; but there are other species, as we have seen, and notably *Act. stellata*, in which the centrodorsal loses its pentagonal shape, owing to the appearance of more or less deep clefts between its outer edge and the inner edges of the radials.

In *Act. pectinata* the ventral face of the centrodorsal is divided by ridges into five radial areas, corresponding with the five synosteal surfaces of the first radials that rest upon it. These radial areas are occupied by median depressions, which increase somewhat in depth from their peripheral to their central ends. But the synosteal surfaces of the radials do not exhibit corresponding ridges, for they are marked by similar median depressions, which are also deepest at their central ends. When, therefore, the synosteal surface of the radial pentagon and the ventral surface of the centrodorsal are in their normal state of apposition, they are separated from one another along the median lines of the five radials by five cavities or "radial spaces." Those are largest at their blind central ends, and extend in a peripheral direction to open externally by five minute openings, situated round the margin of the small centrodorsal piece, beneath the radial pentagon which rests upon it, and extends considerably beyond it. It seems to me that we have here an explanation of the large openings between the radials and centrodorsal of *Act. stellata* and *Phanogenia*, &c. In *Act. pectinata* these radial spaces end blindly around the central cavity of the radial pentagon, being shut off from it by the thickened inner margin of its synosteal surface. Whether they are also blind in *Act. stellata*, in which they are so very large, or whether they are in communication with the radial diverticula of the cœlom, which are inclosed within the spouts of the rosette, is a point which can only be settled by making a series of sections through the decalcified calyx.

I have elsewhere (*Actinometra*, cap. iv, § 61) drawn attention to the homology of these openings between the radial pentagon and

centrodorsal of *Act. pectinata* with the openings on the outside of the calyx of *Apiocrinus rotundus* and *Ap. obconicus*, which are situated between every pair of continuous basals, and the radials which rest upon them. Other homologues are the radially situated "inter-articular pores" in the upper part of the stem of *Pentacrinus*.

It is worth notice, that all the species in which the centrodorsal exhibits these variations of form are true *Actinometræ*, *i.e.*, they have an eccentric mouth and a terminal comb on the oral pinnules. In Lovèn's *Phanogenia*, however, the mouth is central, and there is a terminal comb to the oral pinnules. It is thus a very singular exception, for I know of no *Antedon* in which the oral pinnules have this terminal comb, nor one in which the centrodorsal has anything like the form which it has in *Phanogenia*.

In fact, I am able to say that the examination of the "Challenger" *Comatulæ* has entirely confirmed the opinions held by Dr. Lütken and myself (*Actinometra*, cap. ii, §§ 14, 15) respecting the distinguishing characters of *Antedon* and *Actinometra*. We both agree in referring forms with a (sub) central mouth, five equal ambulacra, and no terminal comb on the oral pinnules, to *Antedon*. On the other hand, species with an eccentric mouth, a variable number of unequal ambulacra, and a terminal comb to the oral pinnules, belong to *Actinometra*. There are only two specimens in the "Challenger" collection which have an eccentric mouth but no terminal comb. Pourtales' *Comatula meridionalis* appears to be another, but these are only three exceptions out of some sixty species.

It will be seen at once that these characters are of no use in distinguishing the genera of fossil *Comatulæ*. But, as has been hinted above, there are very considerable differences in the shape of the radials and centrodorsal piece in *Antedon* and *Actinometra* respectively, and as these are exactly the parts which are most met with as fossils, the generic determination of a fossil form is almost as easy as that of a recent one, which has given up its disk to produce a *Hyponome*. As I have described these differences very fully in my *Actinometra* memoir (cap. iv, § 41, 51, 54–56), it is not necessary to do more than refer to them here, with the remark that a more extended knowledge of the species of both genera has only strengthened the opinions which I have there expressed.

The same is the case with regard to the so-called "ventral nerve" of *Comatula*, viz., the fibrillar band underlying the epithelium of the ambulacral grooves. I have already shown (*Actinometra*, cap. iii, § 23–26) that, in *Act. polymorpha* and *Act. solaris*, half, or even more than half, of the arms may have neither groove, epithelium, "nerve," nor tentacles, and I have insisted, as strongly as possible, on the important bearing of this fact on the Ludwig-Gegenbaur view that these subepithelial bands constitute *the* nervous system of the Crinoids.

Neither of these two authors has referred to my statements at all, but both have entirely ignored them. I am now able to repeat them, and to give them much greater force. No less than twenty-three out of the forty-eight species of "Challenger" *Actinometræ*, and three species in Semper's collection, have more or fewer grooveless arms. I have cut sections of these arms in two species, and have obtained the same results as with *Act. polymorpha* and *Act. solaris*. The "ventral nerve" and ambulacral epithelium are conspicuous by their absence, while the axial cords in the skeleton, which I also regard as true nerves, give off branches freely in the centre of each arm-joint, as I have already described for other species both of *Actinometra* and of *Antedon*. Two points are noteworthy. In one species, one of the posterior ambulacral grooves stops quite abruptly on the disk, some little way from the arm bases, and the two arms to which it would naturally have gone with its "nerve," tentacles, &c., receive no branches from any of the adjacent grooves to supply the deficiency.

Lastly, in the gigantic Philippine species already referred to as No. 37, there are more than one hundred arms, many of which are grooveless and "nerveless," as I have found by section-cutting. But these abnormal arms are not limited to the posterior part of the body, as is usually the case, for there are several on each radius.

Evidence of this negative character appears to me to be a serious objection to the German view that the subepithelial bands constitute the *only* nervous apparatus of the Crinoids. Ludwig* attacks Lange's opinions as to the Asterid-nerves, on the ground that the structures supposed by Lange to be nerves are not constant, but are absent from the arms of certain species. It is curious, however, that Ludwig is unable to apply this reasoning to his own views respecting the nerves of the Crinoids!

III. "On the Characters of the Pelvis in the Mammalia, and the Conclusions respecting the Origin of Mammals which may be based on them." By Professor HUXLEY, Sec. R.S., Professor of Natural History in the Royal School of Mines. Received February 24, 1879.

[PLATE 8.]

In the course of the following observations upon the typical characters and the modifications of the pelvis in the Mammalia, it will be convenient to refer to certain straight lines, which may be drawn through anatomically definable regions of the pelvis, as *axes*.

* "Beiträge zur Anatomie der Asteriden." "Zeitschr. für Wiss. Zool.," Band xxx, p. 191.