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II. Report on the Comatulae.

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With one Plate.

Three species of Antedon were obtained by the naturalists of the »Varna«, together with a couple of Pentacrinoids, the specific identity of which is a little doubtful.

Two out of the three, Ant. Eschrichti and Ant. quadrata, are the most widely distributed of the Arctic Comatulae, and extend southwards into the North Atlantic as far as Lat. 45° N.; but the third, Ant. prolixa, had only been previously obtained in SMITH's Sound, 10° farther north, by the British Arctic Expedition of 1875—76.

As in the case of my previous Report [1]), I would express my thanks to the Commissioners of the Royal Zoological Society of Amsterdam for permitting me to describe this interesting collection, and also to Dr. C. KERBERT for the trouble which he has taken respecting it.

[1]) The Comatulae of the „Willem Barents" Expedition, 1880—1884. — in: „Bijdragen tot de Dierkunde", uitgegeven door het Genootschap „Natura Artis Magistra." 12e Afl. 1885.

1. Antedon Eschrichti. Müll., sp.

Specific formula [1]) — A. 10 $\frac{c}{c}$

The collection contains three examples of this type, all of them apparently from the same locality, though obtained at different times.

a. One specimen of moderate size, with the arm-joints rather longer and the pinnules somewhat stiffer than is generally the case in the type; while the modification of the two lowest pinnule-joints is less marked than usual.

b. Two large and very typical specimens, chiefly remarkable for the enormous size of their cirri. Some of these organs consist of 50 stout joints and reach 90 mm. in length, a size which I do not remember to have met with in any Crinoid that I have examined.

Locality. Lat. 71° N., long. 64°. E. 60 fathoms.

2. Antedon quadrata. P. H. Carpenter, sp.

Specific formula — A. 10 $\frac{c}{bc}$

Fig. 1.

Single individuals of this widely distributed Arctic species were dredged three times by the »Varna« at localities which were at no great distance apart.

Two of them are very characteristic and closely resemble one another, but are somewhat different from those dredged by the »Willem Barents« in 1880; while the cirri are better preserved. The largest of these organs may reach 50 mm. in length and may have as many as 55 smooth joints. The lowest joints are longer than broad, while the later ones are flattened and their dorsal edges project slightly; but the penultimate has no distinct opposing spine. There are, however, several smaller cirri, especially in the neighbourhood of the dorsal pole, which do not exceed 20 mm. in length. They consist of only about 30 joints, most of which project very markedly beyond their successors on the dorsal side, while there is a more definite opposing spine on the penultimate. It is possible that there may be the same sort of dimorphism in the cirri of this species as I have noted in Antedon hystrix and Ant. prolixa [1]); but I have not sufficient evidence at present to enable me to say so positively.

[1]) For an explanation of the signs used in these formulae, see F. J. Bell, Proc. Zool. Soc., 1882, pp. 530—535; and P. H. Carpenter, ibid. pp. 731—747.

[1]) On the Crinoidea of the North Atlantic between Gibraltar and the Faeroe Islands. Proc. Roy. Soc. Edinburgh. Session 1883—84. Vol. XII. pp. 365, 366.

The first radials are just visible above the centrodorsal, while the comparative squareness of the slightly incised second radials (as seen »full«) and the relative width of the axillaries are very marked. The arm-joints after the third syzygy (about the 12th brachial) are distinctly quadrate in form, and as long or longer than wide. The length is relatively greater in the younger specimen, in which too the sides of the joints are very unequal, so that their shape is more nearly triangular. Further out on the arms the width comes to exceed the length which is more equal on the two sides; but the terminal young joints are again a trifle longer than wide.

The two lowest pinnules (on 2nd and 3rd br.) reach nearly 14 mm. in length, and consist of some 40 joints but few of which are longer than wide. The terminal joints are somewhat carinate dorsally, while the lower ones are wide with their dorsal edges sharpened and produced upwards. The pinnule on the fourth brachial is almost exactly equal and similar to the previous pair, but that on the fifth brachial is rather smaller. The third pair are much shorter and stiffer, only consisting of about 15 relatively long and stout joints, and scarcely reaching more than 8 mm. in length. The next two pinnules remain small and the following ones increase slowly in size. The two lower joints are flatter and broader than their successors, somewhat trapezoidal in form, and in contact by their broader ends; but this character is by no means so marked as in Antedon Eschrichti.

The larger of these two specimens measures 8 mm. across the disc, and must have had a spread of 20 centimetres when perfect. The other is slightly smaller.

Localities. Lat. 71° N., long. 64° E. 60 fathoms; and Lat. 71° 25' N., long. 64° 17' E. 51 fathoms.

A third very feathery specimen (fig. 1) was obtained at Lat. 71° N., long. 64° E. 60 fathoms, together with two examples of Antedon Eschrichti; and at the first glance I quite took it to be an immature form of this species. A more detailed examination, however, and a comparison of it with various young individuals of Ant. eschrichti which were obtained by the Challenger revealed its true nature.

The cirri are larger and the axillaries relatively longer than in a young Ant. Eschrichti of the same size, while the arm-joints after the third syzygy, although barely quadrate or even triangular in form, are also relatively longer than in Ant. Eschrichti. Further out on the arm however, the quadrate form becomes very distinctly marked, and the length is equal to or greater than the width; but the corresponding joints of Ant. Eschrichti are wider than long and of a sharply triangular shape.

This is the most important difference between the two types; for the third pair of pinnules in the young Ant. Eschrichti do not reach their full size so as to be nearly equal to the second pair, until the individual has reached a diameter of 7 or 8 mm. across the calyx. In this respect, as in the shape of the joints, Ant. quadrata presents a permanently immature condition of Ant. Eschrichti [1]).

The first two pairs of pinnules in the individual of Ant. quadrata now under consideration are slender and flagelliform, reaching 14 mm. in length and consisting of about 40 joints; while the next pinnule (on the 6th br.) is only 8 mm. long and consists of but 15 joints.

The following ones are small and somewhat styliform, only increasing slowly in size; while the later pinnules are long, slender, and rather closely set, so that the arms present the feathery appearance which is so very marked in Antedon Eschrichti. They reach nearly 15 centimetres in length and contain over 150 joints.

Next to Ant. Eschrichti, Ant. quadrata is the most widely distributed Arctic Coma-

1) Proc. Roy. Soc. Edinb. Vol. XII. 1883—84. p. 374.

tula, having been obtained at the following localities, at or near all of which Ant. Eschrichti has also been found.

a. In the »Cold Area« between the Shetlands and the Faeroe Islands. Lat. 60° N. H. M. S. »Porcupine«. 1869. H. M. S. »Triton«. 1882.

b. In the West Atlantic, off Halifax. Lat. 43° 2′ N. H. M. S. »Challenger«. 1873.

c. Davis Strait. Lat. 64° 5′ N. H. M. S. »Valorous«. 1875.

d. Discovery Bay. Lat. 81° 41′ N. H. M. S. »Alert«. 1875.

e. The Barents Sea.

1. Lat. 74° 45′ N. The »Tegetthof«. 1872.
2. Lat. 74° 41′ 4″ N. The »Willem Barents«. 1880.

f. The Kara Sea. Lat. 71° N. The »Varna«. 1882.

Although Ant. quadrata resembles Ant. phalangium in the width of the axillary radials and in the relative proportions of the lower pinnules, there is in reality a considerable amount of difference between the two types.

Both have long cirri, but those of Ant. phalangium are composed of greatly elongated slender joints, even the terminal ones of which are longer than wide; while the length of even the longest cirrus-joints of Ant. quadrata is not excessive in proportion to the width, and those forming the distal third of the cirri are short, broad, and flattened.

The same kind of difference presents itself in the characters of the arm-joints, which are relatively much longer in Ant. phalangium than in Ant. quadrata; and the same is true of the later joints in the lower pinnules. Then again the axillaries of Ant. phalangium are triangular or pentagonal and do not project backwards into the nearly oblong second radials; whereas the second radials of Ant. quadrata are somewhat trapezoidal in form, and deeply incised to receive the quadrate axillaries; and the first two pairs of brachials in the two types differ in the same way.

3. Antedon prolixa. Sladen. 1881.

Figs. 2, 3.

Specific formula — A. 10 $\frac{c}{c}$

Special marks. The young cirri are dimorphic, being smooth round the edge of the centrodorsal, and more spiny at the dorsal pole. The former eventually consist of about 35—40 elongated joints, and the latter of a smaller number of shorter joints. Axillaries quadrate, as wide as long. The lower and middle arm-joints distinctly longer than wide. The first pair of pinules much longer than the second, which are slightly shorter than the third.

Locality. Lat. 71° 38′ N., long 64° 52′ E. 50 fathoms.

Two examples of this interesting species were obteined by the »Varna« in the Kara Sea, and and its geographical range is thus considerably extended. It was first discovered during the British Arctic Expedition of 1875—76 by Captain Feilden of H. M. S. »Alert«, who dredged it in Discovery Bay far the West of Greenland, and also ten degrees further north than the locality of the »Varna« dredgings. It is rather curious therefore that the numerous recent dredgings in the Spitzbergen and Barents Seas have not revealed its presence in any intermediate locality. It was doubtless obtained by the »Vega« but of this we have no information as yet.

SLADEN has given a good desciption of this species [1]), based on his examination of the individuals dredged by the »Alert«. But there are one or two points with respect to which I should like to add a few words, before saying anything about the »Varna« specimens.

Before describing the new species Antedon hystrix [2]) from the dredgings of the »Porcupine« and the »Triton«, I compared it carefully with the original types of Ant. prolixa, and found a very considerable resemblance between the two.

The curious dimorphism of the younger cirri which is such a marked character in Ant. hystrix reappears also, though in a less degree, in Ant prolixa. The joints of the more centrally placed cirri in FEILDEN's specimens have a small dorsal spine on their distal edge which projects forwards over the base of the next joint; and this spine becomes more rather than less prominent towards the end of the cirrus. In some rare cases it is so marked on the short penultimate joint as to be a distinct opposing spine to the terminal claw. The mare mature cirri, however, round the edge of the centro-dorsal answer to SLADEN's description, and have smooth joints without any definite opposing spine on the penultimate.

The first radials vary somewhat in their development. In some specimens they are visible all round the upper edge of the centrodorsal; while in others they can hardly be seen at all, except perhaps at the angles of the calyx. The second radials are very short in the median line, being deeply incised to receive the axillaries. But their sides are much longer and extend forwards under the lateral angles of the axillaries, where they usually become concealed by the abundant perisome of the disc. These features are well shown in SLADEN's fig. 8.

In most of the individuals from Discovery Bay the arms are bound to the disc as far as the sixth brachial and are well clothed by perisome. But in the one figured by SLADEN [3]) the arms become free after the fourth brachial, and the perisome is thinner at the sides of the ambulacra, so that the muscle-plates stand up rather prominently.

The size of the pinnule on the second brachial is a little understated by SLADEN who says that it measures »10 mm. long, with 26 or 27 joints«. I have found some, however, which are still incomplete to consist of 35 joints and measure 15 mm. The third brachial bears a pinnule of nearly the same size; while that on the fourth (called the second pinnule by SLADEN) is much shorter, 5 mm. or less. The fifth brachial also has a moderately short pinnule, after which the length increases and the joints become stouter.

It is in the relations of these lower pinnules, as well as in the dimorphic character of the cirri that Ant. prolixa differs from Ant. phalangium of the Mediterranean, Atlantic and the North-west Coasts of Scotland, with which, as pointed out by SLADEN, it has a certain amount of resemblance.

The systematic position of Ant. prolixa and its relations to the European species of Antedon will, however, be best discussed after the »Varna« specimens have been described. Both are small and one presents certain embryonic characters which render the determination of its specific identity a little difficult.

The larger specimen (fig. 3) has very numerous cirri, and those attached round the edge of the centrodorsal reach nearly 35 mm. in length and consist of about the same number of joints. These are all much elongated, with the exception of the first two or three, the middle ones being especially so. The distal edges of some of the later joints project slightly forwards over the bases of their successors, but there is no distinct opposing spine on the penultimate. Intercalated among these large cirri are several of the same smooth, long-jointed type in different

[1]) DUNCAN and SLADEN. A Memoir on the Echinodermata of the Arctic Sea to the West of Greenland. London. 1881. p. 77. Pl. VI.

[2]) Proc. Roy. Soc. Edinburgh. 1883—84, pp. 365—368.

[3]) Op. cit. Pl. VI. Fig. 7.

stages of development. Close around the dorsal pole, however, there are attached some other young cirri consisting of relatively shorter and stouter joints, which are more spiny than those of the marginal cirri; while the penultimate has a distinct opposing spine.

The older cirri of this second type have less developed spines and longer joints; but they do not seem ever quite to reach the size of the fully developed marginal cirri. Only a small part of the first radials can be seen; but the second are relatively large and quite visible in the middle line, though much incised to receive the quadrate axillaries. The first brachials are well separated above the axillary, and much incised to receive the large second brachials, though not in any way concealed by them. The lower arm-joints after the second syzygy are somewhat unequally quadrate in form; but the inequality of their sides gradually disappears and they become relatively shorter and wider.

The first pair of pinnules are nearly 10 mm. in length and consist of 25 joints, the lowest five of which are short and wide, and the remainder elongated. The second pair are about 4 mm. long, with 15 joints, and the third have the same number of somewhat stouter joints and so reach 6 mm. The later pinnules reach 12 mm. in length and consist of some 20 joints, all of which, except the terminal ones, are much elongated. The two lowest joints are enlarged and flattened as is usual in all the Arctic Comatulae.

The smaller individual dredged by the »Varna« (fig. 2) measures only 4 mm. across the disc, and has fewer cirri than its fellow; while their dimorphic character is less apparent. The first radials are distinctly visible above the margin of the centrodorsal, and the armjoints are relatively longer than in the older individual. Its immature condition is shown by the small size of the second and the three following pairs of pinnules [1]).

The pinnule on the second brachial, which is 6 mm. long, is larger than its fellow on the third and nearly twice the size of that on the fourth brachial [2]). The next two pinnule pairs are sometimes about the same size as this instead of being larger; while on other arms the size gradually decreases, so that the pinnule on the tenth brachial is little over 2 mm. long and consists of but eight joints.

The dimorphism of the cirri and the relative proportions of the lower pinnules readily distinguish Ant. prolixa from all the Arctic Comatulae; though in both these respects it resembles Antedon hystrix of the »cold area« between the Shetlands and the Faeroes. I have no doubt, however, that the two are distinct, having compared my three specimens of Ant. hystrix with the original types of Ant. prolixa, bevore describing the former as new.

Ant. prolixa is a much more slender and less robust species than Ant. hystrix; and so far as the arm-joints concerned, is relatively immature. The lower and middle arm-joints of Ant. hystrix are triangular, slightly wider than long, and only slowly become quadrate; whereas those of Ant. prolixa are distinctly longer than wide, so the intervals between the pinnules are longer than in Ant. hystrix.

The chief difference between the two types, however, is in the characters of the radials and of the three lowest brachials. The axillaries of Ant. hystrix are distinctly longer than wide, which is not the case in Ant. prolixa; they have very large backward projections which sometimes seem almost to overlap the centrodorsal; and the second radials are consequently often not visible at all in the middle line of the ray. Those of Ant. prolixa, however, are generally completely visible, and sometimes also parts of the first radials as well.

The first brachials of Ant. hystrix are more closely united above the axillary than are those of Ant. prolixa; but they are scarcely visible in the middle line of the arm, owing

[1]) Bull. Mus. Comp. Zoöl. Vol. IX. N°. 4. pp. 14, 15.

[2]) Several of the lower pinnules are much broken, so that it is a little difficult to obtain a correct estimate of heir relative proportions.

tho the strong backward projection of the second brachials, and this is far from being the case in Ant. prolixa; while the pinnule-facet both on the second and on the third brachials is much nearer the dorsal surface in Ant. hystrix than in Ant. prolixa.

Sladen has noticed a certain amount of superficial resemblance between the latter species and Ant. phalangium of the Mediterranean and North-west Atlantic. This lies, however, rather in the general facies of the two species respectively than in any important characters. Both of them have numerous, long-jointed cirri, and somewhat elongated arm-joints. But this latter feature is much more marked in Ant. phalangium than in Ant. prolixa; while the characters of the calyx and lower brachials are entirely different in the two species. The second radials and first brachials of Ant. prolixa are deeply incised, which is far from being the case in Ant. phalangium; while the relatively long quadrate axillaries, set diamondwise, are very different from the wide, subtriangular or pentagonal axillaries of Ant. phalangium.

The second brachials of the two types differ in the same way, and the characters of the lower pinnules are quite distinct. The second pinnule-pair in Ant. phalangium (4th and on 5th br.) are nearly as long as the first and larger than the third pair; while in Ant. prolixa they are shorter than the third pair.

In the characters of the pinnules and in the breadth of the axillaries Ant. quadrata stands much nearer to Ant. phalangium than Ant. prolixa does, but its cirri have fewer and shorter joints.

4. Pentacrinoids of Antedon, *sp.*

Fig. 4, 5.

Two fine Pentacrinoids obtained by the »Varna« at a depth of 50 fathoms in Lat. 71° 4′ N., long. 64° 5′ E. No adult Comatulae accompanied them, however, and the question of their specific identity therefore becomes a difficult one.

The length of the larger larva (fig. 5) is 35 mm., which is about equally divided between the head and the stem. The latter consists of 29 joints, the last of which is somewhat irregular in shape and has rather the appearance of being a root-joint like that at the bottom of the stem in Rhizocrinus and Bathycrinus. The stem as a whole, is singularly like that of the young Rhizocrinus.

Beneath the centrodorsal come three discoidal joints, gradually increasing in thickness. The next is about as high as wide, and those just below gradually increase in height while diminishing slightly in width, till they become cylindrical and elongated. In the lower part of the stem the width increases again, especially towards the ends of the joints which assume the characteristic dice-box shape; while the joints immediately above the root-joint, though the stoutest on the whole stem, are distinctly shorter than those above, just as in Rhizocrinus and Bathycrinus.

The centrodorsal bears 15 cirri, the longest of which reaches 5 mm. and consists of about 18 joints with a terminal claw, but no opposing spine, slight indications of which appear on some of the other cirri.

The first radials are partly overgrown by the centrodorsal, so that but little of their dorsal surface is visible, though they extend upwards in the interradial angles of the calyx at the sides of the second radials. These are relatively long, transversely oblong, and considerably incised to receive the hinder angles of the rhombic axillaries.

There are over 30 elongated joint in the arms, the second one with a slender pinnule 3 mm.

long and consisting of about 15 joints. The pinnules on the third brachials are mere stumps of less than half a dozen joints; but the next four pinnules gradually increase in size.

Beyond this point the arms present a certain amount of variation. Two or three joints are altogether devoid of pinnules in some arms, and the first long pinnule, consisting of 12 elongated slightly joints, appears on the tenth or eleventh brachial; while in other arms these joints bear pinnule-stumps, smaller, however, than those on the joints nearer the axillaries. The two basal joints of the outer and longer pinnules are shorter than their successors, trapezoidal in shape, and in contact by their longer ends, thus showing traces of the peculiarity which is so specially marked in Antedon Eschrichti. It is not shown at all in the middle pinnules of the largest larva of Antedon dentata which is figured by SARS [1]).

In the smaller of the two »Varna« larvae the stem measures 18, and the head 14 mm. The stem consist of 18 joints, most of which are cylindrical; but instead of three discoidal joints immediately beneath the centrodorsal, there is only one, which is somewhat hexagonal in outline, being wider a little above its equator than at either end; while the joint below it, although longer than wide, exhibits a similar expansion for some little way down from its upper end.

In the most mature Pentacrinoid which SARS observed [2]) the second and third joints below the centrodorsal have toghether very much the appearance of the single joint in the »Varna« Pentacrinoid; but in his younger larvae two or three of the upper stem-joints present indications of this character, which does not appear at all in Ant. rosacea. The condition of the mature Pentacrinoid of this last species is much more like that af the older of the two »Varna« larvae (fig. 5).

The cirri of this small larva are almost the same in number, size, and in the number of their joints as in the larger form. But the first radials are much less concealed, and form a well defined cup. The articular facets do not occupy their whole sides, but a portion of the dorsal surface remains on either side of each facet so that the width of the second radials is less than that of the first.

Neither the axillaries nor the second brachials have such strong backward projections as in the larger larva, and the pinnules borne by the latter are quite small, with only six or eight short joints. That on the third brachial is a mere stump, and traces of still smaller stumps appear on some of the fourth brachials. The next joints, up to the eleventh, bear no pinnules; and there are six or eight pinules on each side beyond this point.

With the evception of three Pentacrinoids dredged by the Challenger near Ascension, these are the largest and most robust larvae that I have seen; but they are much more developed than the Challenger ones. The largest of the latter has only five complete cirri and five interradial stumps; while there is no pinnule at all on the second brachial, though there are about 20 arm joints with the first pinnule on the eleventh.

It is just possible, though I do not think it probable, that these interesting larvae, obtained by the »Varna«,may belong to Antedon dentata. For the largest »larva« of this species which was examined by SARS had nearly thirty cirri, and was estimated to have reached 40 mm. when complete; while the relative size and shape of the first radials and also of the lower pinnules in the »Varna« larvae seem to indicate that they belong to another species. The rapid development of the centrodorsal after the appearance of the first whorl of cirri is a very stricking feature in all young Comatulae. It begins to extend itself over the basals when its second (interradial) whorl of cirri is formed, and the growth is so rapid that a large portion of the radials has disappeared by the time that the third whorl is completed; and they

[1]) Mémoires pour servir à la connaissance des Crinoïdes vivants. Du pentacrinoïde de l'Antédon Sarsii. Tab VI. Fig. 30.
[2]) Op. Cit. Tab VI. Fig. 24.

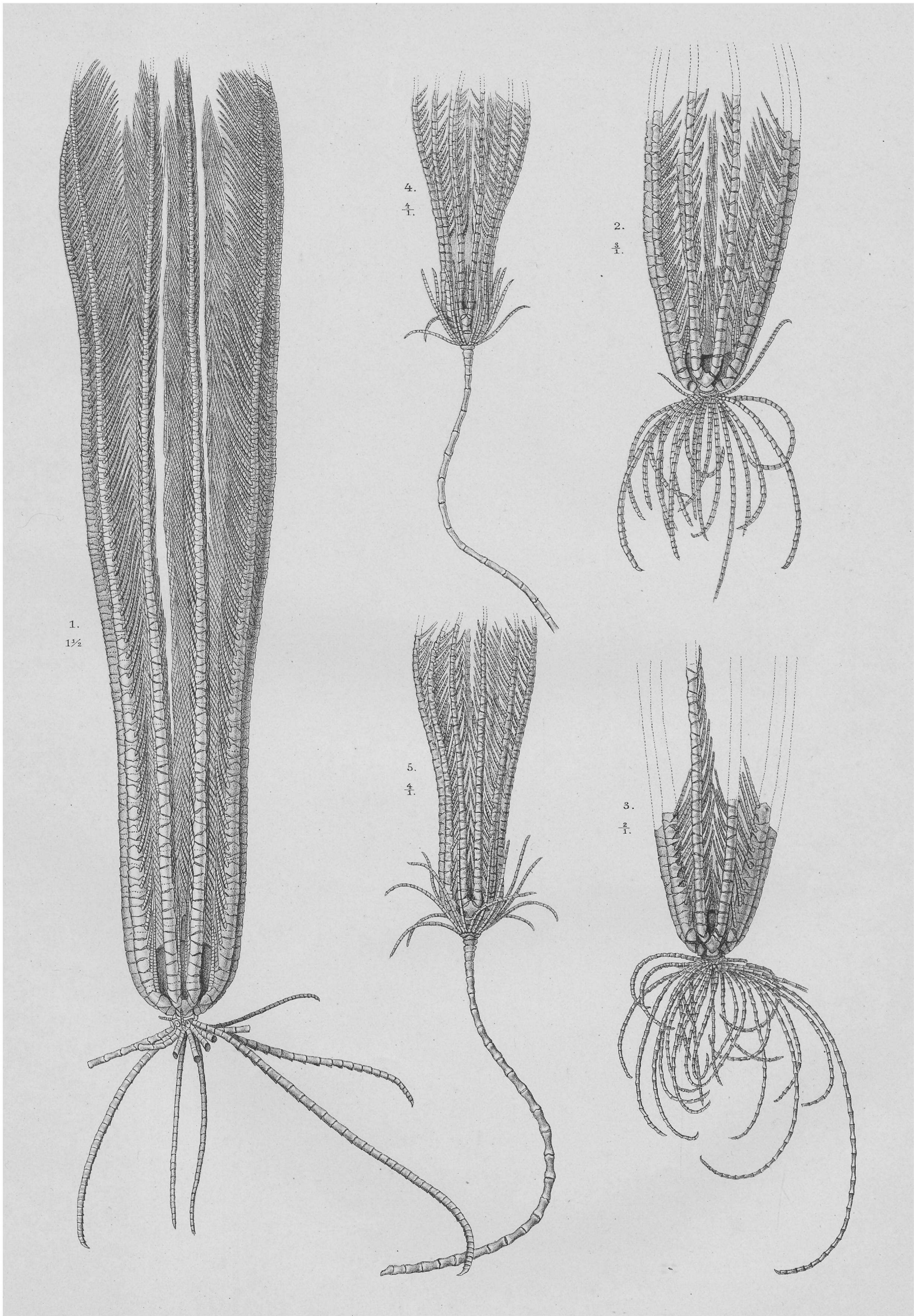
are altogether concealed by the centrodorsal in the largest larva of Ant. dentata which was examined by SARS and had nearly 20 cirri, with pinnules on all its arm-joints.

Now in the largest »Varna« Pentacrinoid (fig. 5), which has 15 well developed cirri besides the rudimentary stumps, the first radials are distinctly visible not only at the angles of the calyx, but also beneath the second radials between them and the centrodorsal and this is often the case in quite large individuals of Antedon Eschrichti. The shape of the two outer radials and of the two lower brachials in the »Varna« larvae is quite different from that of the same joints in the young Ant. dentata; though the two forms agree very closely as regards the development of the pinnules. The smaller larva, the cirri of which are slightly more advanced than that of the Pentocrinoid represented by SARS in his fig. 14, has short pinnules, not only on the second brachials but stumps on the third and sometimes on the fourth; while the larger, which has fewer cirri than SARS's most mature Pentacrinoid with pinnules on all its joints, has one or two joints immediately below the first formed pinnule (on 11^{th} or 12^{th} br.) as yet without these appendages.

These »Varna« larvae therefore resemble Ant. dentata rather than Ant. rosacea, Ant. phalangium and all the other species of which I have examined young individuals, in the appearance of pinnules upon the third and the following brachials before the close of the Pentacrinoid-stage.

My general impression of them is that they belong to Ant. Eschrichti, partly on account of the condition of the radials, but also especially as they present the peculiar flattening and trapezoidal shape of the basal joints of the later pinnules, which is so very marked in that species. The figure given by SARS [1]) of the pinnule-bases in the Pentacrinoid of Ant. dentata shows them to be of a totally different character from those of the »Varna« larvae; for both the basal joints, especially the second, are very much elongated.

[1]) Op. Cit. Tab. VI. Fig. 30.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