XXIV.—*The Anatomy and Relations of the Eurypteridæ.*

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(With Two Plates.)

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Though a great deal has been written on the Eurypteridæ, and many points of their anatomy elucidated in the brilliant memoirs of HUXLEY and SALTER, HALL, WOODWARD, SCHMIDT,* &c., nevertheless many points of morphological importance remain obscure. This is perhaps to be attributed to the fact that nearly all the writers on this group have treated them rather from the systematic than the morphological standpoint. In dealing with remains so fragmentary and obscure as the majority of these fossils are, the value of some theory as to their relations among recent forms is enormous, both as suggesting points to be looked for and aiding in the interpretation of structures observed. The greater part of the work on this group was done before the arachnid relationship of Limulus was fully appreciated, and it is in the light of a possible relationship to this form, and also to the lower orders of terrestrial Arachnida, that it seemed to me to be worth while to revise the anatomy of the group. It has been necessary to include a certain amount of what is already well known in the description of the different genera, and I have taken special care to confirm, as far as possible, points which seemed to me to rest on insufficient grounds.

The result of my researches has been to confirm me in the idea that these forms, as well as Limulus, must be included in the Arachnida, and also to suggest a new view of the relation of the different orders of Arachnida to each other. The anatomy and development of the recent forms has been studied in this connection, but the detailed results of that investigation are not included in this paper, as it seemed more fitting to publish them elsewhere.

The chief public collections of these fossils which I have examined are those in the British Museum, the Geological Museum Jermyn Street, the Woodwardian Museum in Cambridge, and the Edinburgh Museum, including the recent valuable acquisition of Mr POWRIE'S collection. I have also had the privilege of examining the large private collection of Dr HUNTER of Braidwood. I am glad to have this opportunity of expressing my thanks to all those with whom I have come in contact in the course of this work for the invariable courtesy and assistance which I have met with.

* HUXLEY and SALTER, *Mem. Geol. Surv.*, Mon. i. ; HALL, *Nat. Hist. of New York*, vol. iii.; WOODWARD, *Monograph of Merostomata. Palæontograph. Soc.*, 1866–1878 ; SCHMIDT, *Mem. Acad. Imp. St Petersb.*, vol. xxxi.

I. Slimonia.

It has seemed to me advisable to commence with this form, because I have been able, owing to its greater robustness and large size, to make out its anatomy in greater detail than that of the other members of this group. The principal locality for this genus is Lesmahagow, where it occurs at times in considerable abundance. A metastoma, figured by Salter,* from the Ludlow rocks of Leintwardine, as part of *Eurypterus punctatus*, is much like that of Slimonia in form, and Henderson † refers some fragments from the Pentland Hills to this genus, but in neither locality have good specimens been found.

Though the general anatomy is well enough known, a short recapitulation of the main facts may not be out of place here. Viewed from the dorsal aspect, the body is seen to consist of a large carapace, followed by twelve free segments, and terminated by a pointed telson. The carapace is sub-rectangular in this form, with a curved anterior and straight posterior margin, and bears two pairs of eyes. The lateral eyes, placed at the front corners of the carapace, are large, ovoid, and indistinctly facetted. The marginal position is common to this genus, and Pterygotus; Eurypterus, Stylonurus, &c., having the lateral eyes on the dorsal surface of the carapace. The central eyes, or ocelli, which are very small and not facetted, are placed close together near the centre of the carapace. The anterior margin of the carapace is bent over on to the under surface, and the same was probably the case with the lateral margins.

The first seven free segments of the body are represented by more or less band-like tergites, united by a soft membrane with the corresponding sternites. The last five segments, however, have no distinct tergite, but are cylindrical sclerites, considerably longer and narrower than those of the anterior segments. The body terminates in a telson, which is moderately broad at the base, expands slightly about a quarter of the way down, and then contracting rapidly, ends in a long pointed spine. This spine is triangular in section, and has far more the appearance of a weapon of offence or defence than merely an ornamental termination to the body.

Turning now to the ventral surface (fig. 9), the anatomy becomes less simple. In the region of the carapace we find a number of appendages and the sub-cordate metastoma. The metastoma appears to have been attached in the middle line, and to have extended in front and at the sides over the jaw-like bases of the posterior limbs, which thus worked in a more or less closed chamber. This arrangement has a functional parallel in Thelyphonus among recent arachnids, in which the cheliceræ and the mouth are shut in behind, and on the ventral side by the fused bases of the large second pair of appendages. The metastoma is always more or less heart-shaped, the anterior margin being deeply notched. The shape varies in different genera and species of Eurypterids,

* *Mem. Geol. Surv.*, Mon. i. pl. xi. fig. iv.

† *Tr. Ed. Geol. Soc.*, iii.

but it seems always present, and is one of the most characteristic structures of the group. The basal joints (coxæ) of the last pair of legs—the "ectognaths" or "swimming feet,"—which lie immediately under the margins of the metastoma, are retort-shaped, and armed with teeth along what would be the broken-off neck of the retort. They constitute the most powerful members of the five pairs of biting organs with which the animal was furnished. To the postero-external angle of the coxa is attached the leg, which consists, as far as I could ascertain, of six joints, the first four of which are short, and articulate somewhat obliquely with each other. The penultimate joint is long and rectangular, and bears at its distal end the oval terminal joint, and also, towards the inner margin, a small sub-triangular piece, which is probably a modified spine.

This appendage is always described as a swimming organ, but I am inclined to doubt the correctness of this interpretation of its function. The Eurypteridæ appear to me, from their general build, more fitted for crawling than swimming; and I am inclined to explain this appendage as having been used by the animal to get a firm hold on the bottom, and probably also for digging out sand and covering itself, in much the same way that Portunus uses its very similar pair of appendages.

The three legs next in front of the ectognaths resemble each other very closely, and need not be described separately. Fig. 1 may be taken as typical of them. Here we have again the basal joint with teeth along its inner margin and a six-jointed appendage, the joints of which bear spines attached to the anterior margin. The only hitherto undescribed point is the presence of a small process, articulated at the posterior end of the tooth-bearing edge (fig. 1, *epc*). Whether this structure, which corresponds to the epicoxite of Limulus (fig. 12, *epc*) and Scorpio, existed on all the appendages I am unable to say, as it is only visible in exceptionally well preserved detached appendages. Anterior to these three pairs of crawling legs or "endognaths" comes a pair which appear to be specially modified for a tactile function (fig. 2). This pair of appendages, first described by Dr WOODWARD, and termed by him "antennæ," are undoubtedly post-oral in position, as the basal joint is armed with teeth. To the basal joint is attached an elongate sub-triangular second joint, which is succeeded by four sub-cylindrical joints, which gradually diminish in width. This makes the appendage consist of six joints in all. Dr WOODWARD describes and figures it as consisting of eight joints, but I think he has been misled by crumplings of the surface. In its normal position this appendage lies directed backwards across the others (fig. 9), and is on this account not easily seen *in situ*. It resembles very closely the corresponding pair of appendages in Phalangium, and probably had the same tactile function. In other recent forms, *e.g.* Thelyphonus, a similar function is performed by the third pair of appendages, and it is possible that these appendages in Slimonia may prove to be also the third pair.

The most anterior pair of appendages, corresponding to the pincers of Pterygotus, has hitherto not been described. It is preoral in position, and consists of a small pair of cheliceræ (Pl. I. fig. 3). This pair of appendages is indistinctly shown in a specimen in the British Museum, and in one specimen in the collection of Dr HUNTER of Braidwood

a detached chelicera may be seen at some distance from the animal, but in neither of these specimens is the structure sufficiently distinct to place their existence beyond doubt; and it was not until I procured a specimen which I could "develop," that I was able to demonstrate their existence and position to my own satisfaction. This specimen I procured from Mr J. GREGORY, the well-known dealer in minerals and fossils. It probably came from TENNANT'S collection, but of this I cannot be sure, and I found afterwards that the other side of the same slab is in the Geological Museum, Jermyn Street. The specimen shows the appendages from the dorsal aspect, the carapace having been shoved off and lying a little distance in front and upside down. The walking legs are not distinctly shown, being much crushed together, and the position of the tactile appendages, lying as they do below the walking legs, can only just be made out. The position of the coxæ of the legs, however, is sufficiently distinct, and judicious excavation in front of them, and a little to one side of the middle line, exposed one of the cheliceræ (fig. 3). The first joint cannot be distinctly made out, but the second and third joints forming the pincers are quite clear. The pincers are broad at the base, and the two halves are strongly curved, so that they do not meet along their whole length, but only at the points, and there are traces of what may have been teeth along the inner margin of the two rami. They would seem to have lain outside the coxæ of the other appendages, as the excavation reached a depth of nearly 4 mm. at their apex. The dimensions of the appendage in my specimen are as follows:—

Length of second joint of chelicera,	22 mm.
Length of pincers,	10 „
Breadth at base of pincers,	11 „

The discovery of this appendage makes the thoracic appendages agree in number with those of other Eurypterids, and also with those of Arachnids in general.

The edges of the carapace were bent round on to the ventral surface along the anterior margin, and probably also at the sides. Fig. 4 shows a structure which is found associated with Slimonia, and probably represents the central part of the epistoma, a structure which is best shown in Pterygotus (*v.* p. 515). It appears not to have been very strong, as it is somewhat deformed and wrinkled. Whether any ventral sclerites existed between the bases of the legs is not known, but is rendered probable by the form of the coxæ of the legs, which would leave a certain space vacant between their attachments to the body, and would seem to need some fulcrum on which to turn.

When we come to the ventral surface of the free segments of the body, the most conspicuous point at first is that the number of segments appears less by one than when counted on the dorsal side. This is due to the absence of ventral sclerites on the first two segments, their place being taken by the large genital plate or operculum. This operculum consists of a pair of plates and a median lobe (Pl. I. fig. 5). These plates are attached by their straight anterior margins so close behind the metastoma that they were originally described as part of it. A triangular area is marked off from the main portion of each plate by a furrow which runs obliquely outwards and forwards from near

the base of the median lobe to the anterior margin of the operculum. The other two sides of this triangular area are bounded respectively by the anterior margin and the suture which runs down the middle line. These two triangular areas may represent the paired sternite of the first abdominal segment, the remaining portions of the plates representing the appendages. If this is a correct interpretation, the appendages must have been very firmly attached to this sternite, as I do not remember to have ever seen a fracture along this line. The outer and posterior margins of the plates are strengthened by a thickened border. The median lobe is undoubtedly genital in function, and appears in two distinct forms. In the first of these (fig. 5) the organ terminates at its free end in three sharp points. This form is considered by Dr WOODWARD to belong to the female, as he has found it associated with the eggs (*Parka decipiens*). This association appears not very conclusive, as the remains of these organisms are often crowded together very closely. The other form of median lobe (Pl. II. fig. 8) terminates in a more or less truncated cone which is marked by two or three deep furrows, which appear to me due to its having been eversible. The difference in the number of furrows and in the form of the end would in this case be due to the different extent to which it was protruded in different cases. Dr WOODWARD'S interpretation of this structure, however, is different.* He thinks that there are three similar plates, each with a median lobe lying one on the top of another, the end of each projecting a little beyond that of the one above it. His further arguments for the existence of more than one genital operculum are based on the presence on one slab of two opercula of the first type lying close beside one another along with what may be a portion of a third. Further, some of the specimens show scale markings on the surface of the plates, while others do not, and he suggests that these markings were only present on the uppermost plate. My reasons for dissenting from his views are as follows:—In the first place, the structure is almost certainly connected with reproduction, and it does not seem to me probable that a reproductive organ would be repeated two or three times in forms so highly organised as the Eurypterids. Secondly, if there were three plates, as Dr WOODWARD suggests, two of them must have been attached to the same segment, as only two segments are present in the portion of the body covered by the operculum. Thirdly, it seems to me very unlikely that the three plates and median lobes should fit so accurately as to show no sign of their existence, except at the apex of the lobe, even in obliquely crushed specimens. If my view that the genital operculum is single is correct, it follows that the presence of two specimens of it on the same slab is purely a coincidence. This is not so improbable as might appear at first sight, for Slimonia seems to have been gregarious, one slab in Dr HUNTER'S collection showing six or seven large specimens lying inextricably mixed within a space of less than four feet square. The preservation of markings on the remains of these animals seems to me to depend so much on the details of fossilization, and perhaps also on the condition of the animal at death, that their presence on some specimens, and absence on others, is not of much weight as an argument.

* *Loc. cit.*, p. 116.

If, then, as I have tried to show, the genital operculum was a single structure, the second free segment has still to be accounted for. Fig. 5 shows a portion of a specimen in the Woodwardian Museum, in which a structure closely resembling the branchial leaflets figured by Dr WOODWARD (pl. xix. figs. 3 and 4) can be seen through the genital operculum at one side. I have never found any trace of such a structure on detached genital plates, and am therefore inclined to consider that it was attached to the soft skin of the body. Fig. 6 is a specimen from Dr HUNTER'S collection, which, I believe, represents this portion of the body. One branchial leaflet is seen on the left and portions of four on the right side of the figure. The structure connecting the two sets had to me the appearance of a membrane, somewhat wrinkled and stretched. I ought perhaps to state, that Professor YOUNG, to whose kindness I am indebted for permission to describe and figure this interesting specimen, differs entirely from me in his interpretation of it, and considers it to be the inner surface of a limb, with the marks of muscle attachments. These branchial leaflets are unsymmetrically cordate in form, being deeply cleft at what was apparently their point of attachment. The margin is strengthened by a cord-like thickening, and the surface covered by branching ridges, which radiate out from the base of the cleft, and probably represent the course taken by the blood-vessels.

The succeeding segments have well-developed sternites extending across the whole width of the body, the posterior margin of each being strengthened by a broad border exactly like that of the genital operculum. In the majority of specimens there is no trace of appendages on these segments, but one or two specimens have yielded evidence enough to make the structure and arrangement of these appendages fairly clear. The specimen in the Woodwardian Museum (Pl. I. fig. 5), which has been cited above as showing branchial lamellæ underlying the genital operculum, shows also the appendage of the segment next behind the operculum, *i.e.*, the third free segment. This is seen to consist of a pair of plates resembling those of the genital operculum in general structure, but differing from the genital operculum in the absence of a median lobe, and in the fact that the plates overlap each other in the middle line. A branchial lamella can be seen apparently underlying the plate on the left side of the figure. In a specimen in the British Museum (Pl. II. fig. 8) the plate-like appendages are not shown, but traces of branchial lamellæ are visible on the fourth and sixth free segments. Finally, a specimen in the Jermyn Street Museum (Pl. II. fig. 7) shows, lying alongside the fifth free segment, the remains of a plate-like appendage which shows traces of a branchial lamella attached to it. The appendage shown in this last specimen agrees with the one shown in fig. 5 in having a broad, thickened border. From its size it would have extended about one-third across the segment, and from its unsymmetrical shape must have been one of a pair. From a careful comparison of these specimens, and from slight traces on many others, I have come to the conclusion that the abdominal appendages of Slimonia consisted of a series of plate-like structures (Pl. II. fig. 9), probably four in number, which were attached to the anterior margins of their respective segments, and each of which bore on the side next the body at least one, and probably more, branchial lamellæ. These plates decreased

in width from those on the third segment, which overlap each other in the middle line, to those on the sixth, each of which only occupied one-third of the breadth of the segment, and which were probably placed at the outer sides. The evidence against there having been similar appendages on the seventh free segment is purely negative, and, therefore, with forms like this, not very conclusive. Comparison, however, with the recent forms (Limulus and Scorpio) which seem to be nearly related to these fossils, makes it, *a priori*, probable that only six of the free segments bore appendages. The cylindrical form and reduced width of the last five segments renders it highly improbable that they bore appendages.

In fig. 9 I have attempted a restoration of Slimonia from the ventral side, showing the position and form of the various appendages.

Pterygotus.

The resemblances in most respects among the Eurypterids are so great that it will only be necessary, in the treating of the succeeding forms, to mention the points in which they differ from the normal type.

The carapace in Pterygotus is semicircular, and the compound eyes are marginal, a small pair of ocelli being also present near the middle of the carapace. The body is less differentiated into two regions than in Slimonia or Eurypterus, the abdomen passing into the tail with very little constriction.

The sclerites call for no special description, being simple and band-like, but the telson, occurring, as it does, in various forms, demands a few words. The type most like that of Slimonia, and probably the more primitive, is that found in *Pt. anglicus* and others. In these the telson is somewhat spatulate, ending in a short spine. This form of telson is usually strengthened by a longitudinal ridge down the middle line. The other extreme in form is found in *Pt. bilobus*, &c., in which the telson is oval in form, and deeply cleft at the posterior end. Some curious forms have been described from the Waterlime Group in America. *Pt. globicaudatus* * has a simple round telson, while *Pt. quadraticaudatus* has, as its name implies, a more or less square one, slightly cleft in the middle of its almost straight posterior margin. Personally I do not feel quite sure that these peculiar forms may not be due to fracture or folding, and this especially with *Pt. globicaudatus*. The forms with bilobed telson—which might be fairly separated from the rest as a sub-genus, were it not that the frequent absence of the tail would make such an arrangement highly inconvenient—are entirely confined to the Upper Silurian, and include almost all the forms from that horizon, the acute-tailed ones being, with the exception of *Pt. acuticaudatus* † and *Pt. Cummingsii*,‡ which may prove to be one species, confined to the Old Red and Devonian.

* Pohlmann, *Bull. Buff. Soc. Nat. Sci.*, vol. iv.

† Pohlmann, *loc. cit.*

‡ Grote, *Bull. Buff. Soc. Nat. Sci.*, vol. iii.

When we come to the under surface, the first point to note is the much better development of the epistoma. This structure (Pl. II. fig. 10) was figured and described by HUXLEY and SALTER,* but they were probably misled by the direction of the sculpture on it, and thought that it lay with the straight margin towards the front—a mistake which was corrected by SCHMIDT.† The scale markings on it having their convex side directed forwards, contrary to the almost universal rule among Eurypterids, would seem to indicate that we have here what is morphologically a portion of the carapace bent over. SCHMIDT describes this structure as consisting of three pieces; and in consideration of the beautifully preserved and abundant material he has had the opportunity of examining, one is almost bound to accept his description as correct. On the other hand, though some of the specimens I have seen have appeared to support his description, others have been fractured along quite different lines.

The first pair of appendages, the cheliceræ or claws, are well known in Pterygotus. They have been described as consisting of a large number of joints; but though there are often markings resembling articulations on the proximal portion, yet these show such a complete absence of similarity in different specimens that I believe them to be due to crumplings of the undoubtedly somewhat thin cuticle. These appendages are constantly found detached, and I think they were very likely retractile to a certain extent within the carapace, as are the cheliceræ of Thelyphonus among recent forms. If this was the case, there would, of course, be no properly-developed articulation between them and the epistoma, and they would easily become detached. I believe them to have consisted of three joints—a long, straight, proximal one, and the two distal ones, which form the toothed pincers. These appendages, unlike those of Slimonia, were probably prehensile rather than masticatory, and this function may account for the absence of spines on the other limbs, which are purely ambulatory.

The next four pairs of appendages (Pl. II. fig. 11) are far simpler and—in proportion to the size of the animal—smaller than in Slimonia, and the first pair seems not in any way different from those following. The basal joint or coxa is, as usual, provided with a row of teeth along its median edge, and these teeth are stronger than in Slimonia. At the posterior angle of the tooth-bearing margin there is a well-developed epicoxite, which may be compared with that of Limulus (Pl. II. fig. 12). The rest of the appendage consists of apparently six cylindrical joints, tapering towards the end, and destitute of anything in the way of spines.

The last pair of feet or ectognaths do not differ in any important respects from those of Slimonia. An exception to the usual simple type of appendage in this genus occurs in *Pt. osiliensis*,‡ in which the joints of the limb are flattened and almost foliaceous, with a single series of spines along one margin. The last pair of limbs in this form also differ from the usual type,§ the terminal joint being smaller and less expanded. This

* *Mem. Geol. Surv.*, Mon. i. pl. i. fig. i.
† *Mem. Acad. St Petersb.*, vol. xxxi. p. 71.
‡ *Ibid.*, i. pl. vii. fig. 9.
§ *Ibid.*, pl. iv. fig. 7.

may very likely be a more primitive form than the ordinary one; and if it be so, it would point to the bilobate telson as the original type.

The metastoma has the same position and relations as in Slimonia, but is broader in proportion to its length, agreeing in this respect with the broader form of the carapace.

The genital operculum has fundamentally the same structure as in Slimonia, but the median lobe never shows such elaboration. It appears in two chief forms; but as most of the specimens in which it can be made out are too fragmentary to be specifically determined, it is impossible to say whether the difference is merely sexual or not. The short form of the central lobe is shown in fig. 13, which probably belongs to *Pt. bilobus*. It is very short and broad, and the plates are also broad in proportion to their length. The other type (fig. 14) is long and narrow, with a ridge down the middle and ending in a triangular point. This form is found with *Pt. bilobus*, and in one case (fig. 14) is associated with an unusually large second abdominal tergite, which suggests that it appertained to a female.

The series of branchial lamellæ underlying the genital operculum has been figured by WOODWARD,* and I have been unable to add anything of importance to his description. Fig. 14 is part of the specimen which he figures, and shows these lamellæ. Whether there was a plate-like appendage behind the genital operculum, as in Slimonia, is not quite certain. POHLMANN† figures what appears to be one in *Pt. Buffaloensis*, and the specimen, which shows the branchial lamellæ (fig. 14), appears to have a second plate lying partly over the genital operculum (ix). The presence or absence of appendages on the succeeding segments is even more obscure. SCHMIDT figures a whole series in *Pt. osiliensis* similar to those in *Eurypterus Fischeri*, but his figures do not seem to me quite conclusive. He further denies the existence of abdominal sclerites; a statement in which I am unable to agree with him.

I have not been able to fit in the appendages figured by Dr WOODWARD on p. 91, and doubtfully referred by SALTER to Pterygotus. They certainly appear to belong to some member of the order, but do not resemble what is known of the abdominal appendages of this or other forms.

EURYPTERUS.

There is less to be added to what is already known of Eurypterus than was the case in the two preceding genera, partly because the specimens are as a rule less well preserved, but chiefly because its anatomy has been so well described by SCHMIDT.‡ My observations, therefore, will necessarily take the form of a criticism of some of the points described by SCHMIDT, though, as I have not had an opportunity of examining the magnificent collection in the Reval Museum, I feel that considerable caution is necessary in this.

The most conspicuous points in which Eurypterus differs from the two preceding

* *Loc. cit.*, pl. xii. fig. 1, *d*. † *Bull. Buff. Soc. Nat. Sci.*, vol. v. pl. iii. ‡ *Loc. cit.*, p. 73.

genera are, the position of the eyes, which are placed on the dorsal surface of the carapace, and the long spine-like telson. The appendages are much the same in general form as those of Pterygotus, but have certain well marked points of difference. The last pair have their proximal joints narrower and more cylindrical, while the last two joints are proportionally more expanded in the majority of cases. Of the four pairs of walking legs, the first three resemble one another closely, being simple, somewhat short sub-cylindrical limbs, bearing spines on the last four joints. The fourth pair differ from the others in being considerably longer and having no spines except at the end of the limb, which terminates in three spines. This differentiation of the fourth walking leg (fifth appendage) seems characteristic of the genus, and constitutes a step towards such forms as Stylonurus.

The first pair of appendages has in this genus, as in Slimonia, long remained obscure. HALL* says, "In two instances I have seen some indication of a small appendage in this position, but a further examination does not offer any confirmation of this view." SCHMIDT† was the first to describe it as actually existing, and he makes it out as a pair of jointed filiform appendages lying between the basis of the first pair of walking legs. He has apparently only found them in one specimen, but judging from his figure (pl. iii. fig. 1*a*) they seem clearly enough shown. Not having seen the specimen in question, I am unable to offer any criticism on his interpretation of this structure, but if he is correct in his description it differs very markedly from anything I have been able to find in other specimens. The first example of what I believe to be the preoral appendages was pointed out to me by Mr B. N. PEACH, and is the specimen of *Eurypterus scorpioides* figured in Dr WOODWARD'S monograph (pl. xxx. fig. 9), and now in the Geological Museum, Jermyn Street,—not, as stated in the explanation of the plate, in the British Museum. In the figure, and more clearly in the original specimen, may be seen what appear to me a pair of small chelate structures, lying with their apices close behind the front margin of the metastoma. The one on the right-hand side of the middle line is most distinct, and measures 17 mm. in length, the pincers occupying 10 mm. of this. The only other specimen in which I have been fortunate enough to see these appendages is the specimen of *E. conicus* which I have figured (pl. iii. fig. 14) in my paper on "Some Eurypterids from the Pentlands."‡ In this specimen the bases of the five pairs of limbs can be made out, and lying between the most anterior pair is a pair of conical depressions, the apices of the cones being directed backward. These structures, which measure some 3 mm. in length, are not sufficiently well preserved for one to say definitely that they are chelate, but their general form, taken together with the structures described above in *E. scorpioides*, and the presence of chelate preoral appendages in both Pterygotus and Slimonia, justify one, I think, in assuming that such was the case.

If my interpretation of these structures is correct, it would seem to be necessary to separate *E. Fischeri* from *E. scorpioides* and *E. conicus* as at least a distinct genus.

* *Loc. cit.*, p. 396, footnote.

† *Loc. cit.*, pl. iii. figs. 1 and 1*a*.

‡ *Trans. Roy. Soc. Edin.*, vol. xxxvi.

Such a change in classification, however, based upon structures so seldom preserved, would, even if logically correct, be practically a great disadvantage, as it would be impossible to say to which section any Eurypteri, other than the above three, should be relegated. Altogether it seems more advisable to wait until one is compelled by a large mass of evidence before making a change which would certainly be troublesome, and may prove to be unnecessary.

The ventral surface of the abdomen is described by SCHMIDT as being covered by five pairs of plate-like appendages, each pair being united in the middle line. He further states that there are no ventral hard parts except these plates, and the ends of the dorsal sclerites, which are bent round on to the ventral surface. I have unfortunately not been able to confirm his observations, and am inclined to doubt the absence of ventral sclerites, as many comparatively well preserved specimens show no sign of a line down the centre of the ventral plates. I do not, however, feel at all confident of the correctness of my interpretation of these structures, as it is evident from his figures that SCHMIDT had very much better material on which to make his observations than has fallen to my lot.

STYLONURUS.

I have been unable to make out any new details of the structure of this form. The form of the body is simple, and more like that of Pterygotus than Eurypterus, though the dorsal position of the eyes ally it to the latter. The inturned portion on the under side of the carapace is remarkably broad, and, owing to the chronic absence of the limbs, is not unfrequently well shown. The presence of well-marked epimera on the posterior segments in some forms, reminds one of some of the Hemiaspidæ, but the resemblance is only a superficial one. The form of the two last pairs of legs, which are long and pointed at the end, and are among the most characteristic structures of the genus, is possibly derived from Eurypterus through some form like Drepanopterus, though it is also possible that Stylonurus is descended from an ancestral type in which the last pair of legs were less modified than in Eurypterus. Of the other appendages comparatively little is known. WOODWARD in his restoration of this form* figures five pairs of appendages, the most anterior of which are antenniform. This pair has not, I believe, been seen, and whether it was distinctly modified for a tactile function, as in Slimonia, or more closely resembled the other walking limbs, as in Eurypterus, is a matter for conjecture. A chelate appendage has recently been figured by HALL and CLARKE† in St. Excelsior, which they describe as follows (p. 222):—"Directly behind the base of the right member of this pair lies a single joint terminating in a chela, the whole measuring 60 mm. in length. The other joints of this appendage do not appear on this specimen, and it is impossible to determine positively whether this is, as it seems, the terminal portion of a third gnathopod or is analogous to the chelate antennules of Limulus."

* *Loc. cit.*, p. 131.

† HALL and CLARKE, *Geol. Surv. New York, Palæontology*, vol. vii.

Considering the presence of preoral cheliceræ in Slimonia, Pterygotus, and Eurypterus, I have little hesitation in supporting the latter view and regarding this chela as a preoral appendage.

I have been unable to ascertain anything new with regard to the other important genera of Eurypterids:—*Dolichopterus*,* *Drepanopterus*,† and *Glyptoscorpius*.‡ With regard to the last of these, I can add nothing to Mr PEACH'S admirable description, and am happy to find myself in agreement with him on almost every point. I think it is quite certain that many carboniferous forms are true Eurypteri;§ but that Glyptoscorpius is a good genus, and perfectly distinct from Eurypterus, admits of no doubt. Mr PEACH suggests that it had eyes like those of *Eurypterus Scouleri*; but, if this be so, it is against its having any very near relationship with Scorpio, since the lateral eyes in Scorpio are marginal in position. The combs and appendages seem to relate it closely to Scorpio, and therefore, according to my view, to separate it from the Eurypteridæ.

RELATIONS OF THE EURYPTERIDS AMONG THEMSELVES.

The geological record is manifestly so incomplete as regards these forms—all the important genera appearing practically simultaneously in the Upper Silurian, while fragments of undetermined relationship occur as low down as the Moffat Shales—that no deductions as to the phylogenetic relations of the various forms can be made from their order of appearance. From a morphological standpoint, the family seems to fall into two sections, determined chiefly by the position of the compound eyes. The first section, in which the eyes are marginal, contains Pterygotus and Slimonia; the rest of the genera falling into the other section, with the eyes on the dorsal surface of the carapace. This position of the eyes, however, while useful as a classificatory character, is not decisive as to morphological grade. If, as seems probable, the Eurypterids are to be derived from such forms as Olenellus, it would seem, at first sight, natural to take those forms which have the eyes on the dorsal surface of the carapace as the more primitive, and to make Eurypterus the starting-point for the whole series. It is quite possible, however, that the free cheeks of the Trilobite correspond to the inturned portion of the carapace in Eurypterids—the facial suture corresponding to the margin. In this case, the forms with marginal eyes, such as Pterygotus, are the more primitive. A further argument in favour of this point of view is that the lateral eyes in the Scorpionidæ and Thelyphonidæ are marginal in position, and these forms must be derived from some way down the Eurypterid stem. Other considerations appear to me to give greater probability to the view that Pterygotus is the more primitive form.

In the first place, the form of the body, with markedly differentiated tail segments,

* HALL, *loc. cit.*, 414. † LAURIE, *loc. cit.* ‡ PEACH, *Trans. Roy. Soc. Edin.*, vol. XXX.

§ Such forms as *E. mansfieldi*, *E. mazonensis*, and *E. stylus*, from the carboniferous rocks of Pennsylvania (HALL, *Second Geol. Surv., Pennslyvania*, vol. PPP), are undoubtedly true Eurypterids. *E. Scabrosus* (WOODWARD, *Geol. Mag.*, Dec. 3, vol. iv. p. 481) seems less certain, as the limbs are very different from the normal Eurypterid type.

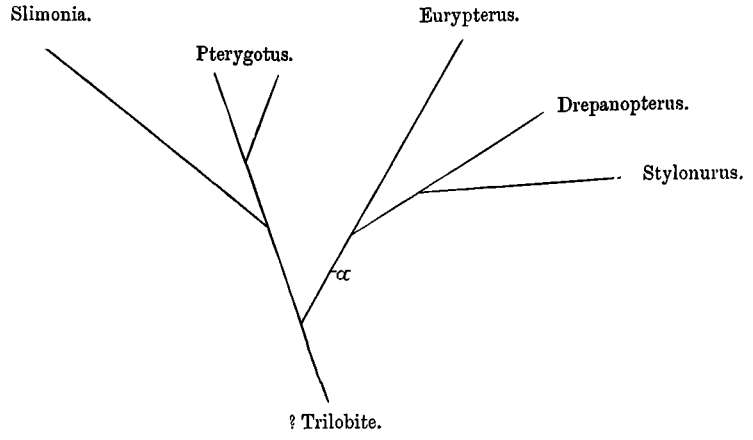
which is characteristic of Eurypterus, seems to be more advanced and further removed from the Trilobite type than forms like Pterygotus, in which the distinction between body and tail segments is not distinctly marked. The only Silurian Eurypterus known to me in which the distinction between body and tail is not well marked is the little *E. conicus*;* and this form, which furthermore has the eyes remarkably near the margin of the carapace, may very probably prove to be the young of some of the larger forms from the same locality. On the other hand, it may be said that Stylonurus, which is almost certainly derived from the Eurypterid stem through forms related to Dolichopterus, or more likely Drepanopterus, has much the same generalised form of body as Pterygotus. The limbs of Stylonurus, however, are highly specialised.

Another argument which has influenced me in favour of Pterygotus, as representing the form most nearly related to the primitive Eurypterid, is drawn from the appendages. The first pair is, it is true, remarkably different from the common type in the family, as shown in Slimonia and Eurypterus, and has probably been independently modified, while the last pair have no claim to being primitive over those of the same two genera. The four pairs of appendages, however, which lie between these extremes seem to me to yield a very strong argument in favour of my view, inasmuch as they are all alike, and all simple in construction, without any elaborate development of spines. In Slimonia the second pair of appendages are highly modified, apparently for a tactile function; while in Eurypterus, and still more in Stylonurus, the fifth pair differ markedly from the second, third, and fourth pairs. A further point is the apparently much greater development of the epicoxite—a structure common to the Eurypterids, Limulus and Scorpio, and therefore probably primitive—in Pterygotus than in the other genera. A further argument for placing Pterygotus below Slimonia and Eurypterus is the lesser degree of development of the median lobe of the genital operculum, though, perhaps, the details of this structure are hardly sufficiently well known to admit of our attaching very much morphological value to it.

Whether the bilobed telson, which characterises the majority of Silurian Pterygoti, is to be regarded as more primitive than the pointed form or not, must remain for the present an open question. I think, however, that the balance of evidence is against so regarding it, especially if one considers how characteristic of the earlier Trilobites a pointed telson appears to be. Geological succession gives us no clue to this question, because, while the bilobed forms are certainly the most numerous in the Silurian, nevertheless we have, in America at all events, contemporaneous forms with pointed telsons.† It might be argued that, while the advantage of having a weapon at the end of the tail is manifest, it is difficult to see what is to be gained by substituting a bilobed telson for the pointed form; but we know far too little of the conditions under which these creatures lived for such an argument to have much weight. The only advantage which occurs to one as possibly appertaining to the bilobed form of telson is its greater efficiency as a swimming organ.

* *Trans. Roy. Soc. Edin.*, vol. xxxvi. † POHLMANN, *Bull. Buff. Soc. Nat. Sci.*, vol. iv.; and GROTE, *ibid.*, vol. iii.

The genealogical tree which I would suggest for this group is, then, as follows:—



Slimonia has differentiated itself from Pterygotus chiefly by the greater development of its genital organ and by the specialisation of the second pair of appendages for a tactile function. Along with this it has also acquired, or, more probably, retained, the short cheliceræ, masticatory rather than prehensile in function, which are characteristic of the other forms.

Eurypterus specialises in the position of the eyes, which is common to all the forms above α, and further, in the form of the tail segments and telson and in the specialisation of the fifth appendage, which, however, is comparatively slight.

Stylonurus develops from Eurypterus *via* forms probably most nearly represented by Drepanopterus, by the greater specialisation of the fifth appendage, and the reduction of the sixth appendage from the typical digging foot to a purely crawling one. This may indicate more purely littoral habits, or a more active predatory existence, demanding rapid locomotion rather than firm anchorage.

Relations of Eurypterida to other Groups.

In attempting to arrive at some conclusion as to the place in classification of the Eurypterids, the Geological Record again gives us but little help. The contemporaneous Arthropoda are for the most part very obscure, and in many cases appear to belong to well-defined types. Some of these, such as the Scorpions and Pedipalpi, have persisted almost unchanged till the present day; while those which have died out, such as the Trilobites and Anthracomarti, afford little information of morphological value, owing chiefly to their imperfect state of preservation. I have not thought it necessary in the following speculations to recapitulate at length the arguments adduced for and against the relationship of Limulus to the Arachnida and Eurypterida, as these are well known and easily accessible.*

* Lankester; Packard; Woodward, &c.

Relation to Trilobita.

In our present state of comparative ignorance as to the details of the different appendages of Trilobites, any attempt at comparing them with Eurypterids must be more or less superficial. The form of the body presents certain points of resemblance, inasmuch as it consists of a carapace followed by a number of free segments, and ending in a telson. The carapace probably corresponds to that of Eurypterus, &c., and shows in some forms indications in the glabellar furrows of five segments,* or, if one counts the frontal lobe, of six. The lateral eyes are situated on the dorsal surface; and unless we consider the margin of the carapace to be the facial suture, this is, as mentioned above, an argument for considering Eurypterus as a more primitive form than Pterygotus. If the facial suture be taken as representing the margin of the carapace, then the free cheeks probably correspond with the inturned portion. The presence of central eyes must be held as not yet proven, though I think Woodward's† interpretation of the small openings in the glabella as central eyes is probably correct.

The number of free segments in the lower Trilobites is usually greater than in Eurypterids, but one sees within the group itself how easily the number of segments in such comparatively unspecialised forms can be increased or diminished. The structure of the segments is more important, and here there seems to be very little resemblance between Trilobites and Eurypterids, as the latter show no trace of pleuræ, unless indeed the epimera of some species of Stylonurus may be regarded as much reduced pleuræ.

What is known of the appendages affords little ground for comparison. The maxilla and palp, described by Woodward in *Asaphus platycephalus*,‡ are not unlike the first postoral appendage of Eurypterids. If they correspond to this last, there ought to be a preoral pair which are probably concealed beneath the hypostoma, which would correspond to the epistoma of Eurypterids. The traces of appendages in *Asaphus platycephalus* § and *Asaphus megistos* ‖ show little of importance for comparison. Far more suggestive is Walcott's restoration of *Calymene senaria* ¶ with the last larger pair of thoracic appendages. His restoration of a transverse section of a body segment, however, shows nothing comparable to what is found in Eurypterids.

It must be remembered, that what little is known as to the anatomy of the Trilobites is almost entirely based on the more highly specialised forms. If we could get reliable information as to the appendages of such forms as Olenellus or Paradoxides, there would be some fair chance of comparing them successfully with Eurypterids.

Relation to Crustacea.

That the Eurypterids are usually classed with Crustacea, must be ascribed to their aquatic habit and branchial respiration. It is difficult to free one's mind of the idea that

* *Olenellus Callavei*, Lapworth, *Geol. Mag.*, III. viii., pl. xv.
† *Geol. Mag.*, 1883.
‡ *Quart. Jour. Geol. Soc.*, vol. xxvi., 1870.
§ Billings, *Palæozoic Fossils of Canada.*
‖ Walcott, *Bul. Mus. Comp. Zool.*, Harvard, 1881.
¶ *Ibid.*

an arthropod which breathes by gills must be a crustacean, but as LANKESTER * and CLAUS have pointed out in the case of Limulus, the morphological value of this fact has been greatly overestimated. The branchia of Eurypterids, like those of Limulus, are constructed on a type unknown among the Crustacea, and further, structures such as these, which are the product of a physiological necessity, are not of much value as indicating close relationship. Against the crustacean relationship must be put the segmentation of the body and position of the genital aperture—which does not agree with that of any known crustacean—the absence of anything representing the first antennæ, the chelate structure of the one pair of preoral appendages, and the fact that there is no trace of the typical crustacean biramous structure in the appendages. The presence of compound eyes has been urged as a resemblance, but the eyes were most probably constructed on the same plan as those of Limulus, which have been shown† to be at all events very different in type from those of the Crustacea. Further, the Crustacea have all—with the exception of a few Ostracods—three pairs of appendages specially modified as mouth organs, and modified in a more or less definite way as mandible and first and second maxillæ. Even in a low form like Apus, though all the thoracic appendages are to some extent masticatory in function, nevertheless the first three pairs are very different from the rest. Of this specialising of the first three pairs of postoral appendages, there is no trace in the Eurypteridæ; and, indeed, instead of the chief masticatory function being acquired by the first pair, it is always best developed in the last pair.

On the whole, then, there seems very little reason for considering the Eurypterids as related at all closely to the Crustacea. If their relationship to the Arachnida be admitted, as I think it must, the Eurypterids may be considered as intermediate between Crustacea and Arachnida, in the sense that they are among the most primitive Arachnids, and therefore, nearer the junction point of the two stems; but that they show any points of affinity to the Crustacea beyond the fact that they are arthropods must be considered as at all events not proven. That the point of union of the two stems was a very much simpler and less specialised form, is very clearly indicated, especially if we regard the nauplius larva of Crustacea as possessing any phylogenetic value, nothing at all comparable to it having been found among other Arthropoda.

LIMULUS.

Whatever doubts there may be as to the relation of Eurypterids to other forms, there is an almost universal consensus of opinion that they are closely related to Limulus. The detailed comparison of the two forms has been so thoroughly worked out, that I need not enter into it here. The only points of importance which I have been able to add to the resemblance are the existence of preoral cheliceræ and abdominal appendages. The latter differ in Slimonia at all events from those of Limulus, chiefly in not being united

* *Quar. Jour. Micr. Sci.*, vol. xxi.

† LANKESTER and BOURNE, *Quar. Jour. Micr. Sci.*, vol. xxiii.

in the middle line. Another point of great morphological importance is the fact that Limulus has a pair of plate-like appendages on the second abdominal segment. This would seem to indicate that Limulus branched off from the Eurypterid stem before the genital operculum was so highly specialised as it is in the Eurypterids, and, consequently, before the appendage of the second abdominal segment had become reduced. This is also hinted at by the absence in Limulus of anything comparable to the central lobe of the genital operculum. Probably also the metastoma had not reached the high state of development it has in Eurypterids, and the last pair of legs was less highly specialised.

Limulus, then, represents a more primitive type in almost every respect except the fusion of the abdominal segments, and is to be related to the Eurypterids not by direct descent, but through a comparatively unspecialised ancestor. Whether this ancestor is one of the Trilobites must remain a matter for speculation, but it seems within the bounds of possibility.

Scorpio.

The relationship of Scorpio to Limulus has long been maintained, and no one who has studied the articles by Lankester, Claus, &c., on the subject will have much doubt that it exists. The relationship of Scorpio to the Eurypterids, however, has never been so fully dealt with. Lankester points out certain characters which they have in common, such as the number of body segments, thoracic appendages, &c., and these seem to show that the point of divergence of Limulus, Scorpio, and Eurypterids must have been before the fusion of the body segments which we have in Limulus. On the other hand, the second abdominal segment in Scorpio is well developed, and shows no signs of having been suppressed by the genital operculum. This would seem to give us a clue to whereabouts the Scorpions came off from the Eurypterid stem, namely, before the great development of the genital operculum. The lung-books on the third to sixth abdominal segments are probably derived, as I have pointed out elsewhere,* by the fusion of the margins of the abdominal appendages to the ventral surface of the body, much in the way suggested by Macleod.† My reasons for holding this view rather than that of Professor Lankester,‡ who has suggested that lamelligerous appendages became invaginated are, briefly, (1) that to produce the structure shown in the lung-books of young Scorpions, the appendage prior to invagination would have had to have the branchial lamellæ attached to its anterior surface—a position in which they are not found either in Limulus or Eurypterids; and (2) that one can see how the transformation could take place, step by step, as the animal became more terrestrial in its habits, instead of having to explain it by a sudden change in the embryonic development, as Professor Lankester's hypothesis demands.

* *Zool. Anz.*, No. 386, 1892. † *Arch. de Biol.*, vol. v. ‡ *Q. J. M. S.*, vol. xxv.

Other Arachnids.

It is usually taken for granted that once the ancestry of the Scorpion is settled, the ancestry of all the terrestrial Arachnids is fixed, but there seem to me to be good grounds for dissenting from this point of view.* As I hope shortly to publish a paper with full anatomical details of the recent forms, I will only give here a brief resumé of some of the points which seem to me to show a relationship with the Eurypterids.

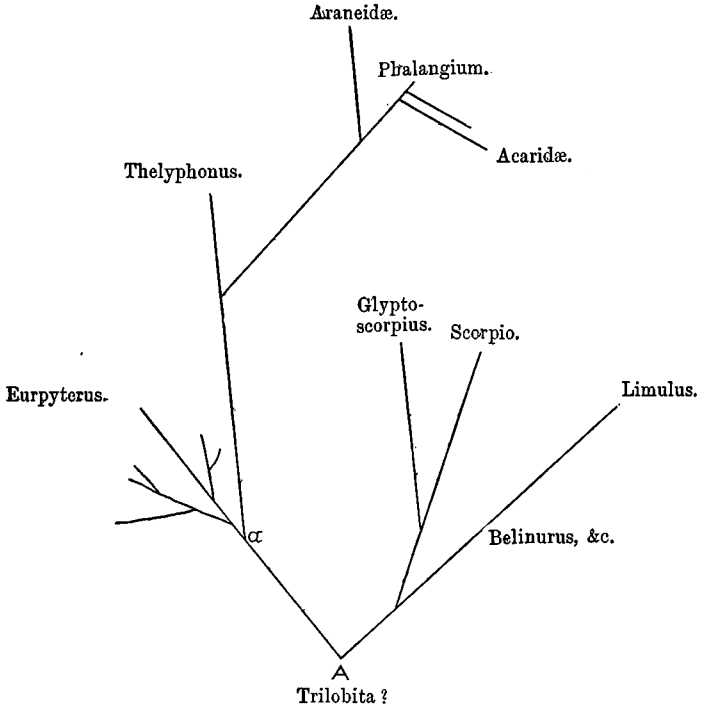
In Thelyphonus (Pl. II. fig. 15) and Phrynus we have arachnids as primitive in most respects as Scorpio. The body consists of a carapace bearing six pairs of limbs on its under side, and followed by twelve free segments. One chief difference, however, between this form and Scorpio is that Thelyphonus has, when examined on the ventral surface, apparently only five abdominal segments, the ventral portion corresponding to the first two tergites being covered by a single plate, beneath which is the aperture of the generative organs. Thelyphonus further differs from Scorpio in having only two pair of lung-books, the more anterior of which lie beneath the large genital plate, while the second pair lie beneath the second ventral sclerite, *i.e.*, that belonging to the third segment. Now, this suppression of the sclerite of the second abdominal segment—its ventral surface being covered by the genital plate—is exactly what we find in Eurypterids, and very different from the condition of things in Scorpio. Further, if the two pairs of lung-books of Thelyphonus correspond to the anterior two pairs of Scorpio, then the first pair is shifted from its proper position on the third segment, and lies right forward in the second. My interpretation of this—based upon as complete a study of the anatomy and development of these forms as the material at my command would permit of—is that in the first pair of lung-books of Thelyphonus we have the homologues of the pectines of Scorpions, and of the branchial lamellæ, found beneath the genital operculum in Slimonia, &c., while the second pair of lung-books correspond to the first pair of Scorpio, the second sclerite being, like the first, an appendage, and not part of the body-wall. If this view be correct it would mean that the Pedipalpi arose after the great development of the genital plate which is characteristic of Eurypterids. The chief difficulties which this view involves seem to me to be (1) the resemblance between the lateral eyes of Scorpio and Thelyphonus, and (2) the fact that it requires lung-books to have been developed from gills twice over. These difficulties I hope to meet in a future paper. It is unfortunate that our knowledge of the Anthracomarti is too fragmentary to enable any deductions to be safely drawn as to their position.

If the above views are correct, it would tend to separate Glyptoscorpius from the Eurypteridæ along with the Scorpions. I do not see any difficulties in the way of this,

* Since the above was written, Mr R. I. Pocock has published a paper on the "Morphology of the Arachnida" (*Ann. and Mag.*, vol. xi.), in which he advocates the division of the Arachnida into two sub-classes, one which he terms Ctenophora containing the Scorpiones, and the other—the Lipoctena—containing the rest of the class. This division entirely agrees with my views, but it is unfortunate that he should have chosen Ctenophora as the name of a sub-class, as it is already accepted as the name for a class of the Cœlenterata.

since the scale markings, the presence of which has caused fragments of Glyptoscorpius to be referred to Eurypterus, are, as I have mentioned above, widely distributed among the Arachnida.

I have summarised the main ideas in the following table. A is the intermediate form between Limulus and Eurypterus suggested above. I derive the Scorpions from some little way up the Limulus stem, on account of some peculiarities in the anatomy of their soft parts, which tend to separate them from the other Arachnids, and ally them to Limulus. At (*a*) on the Eurypterus stem, the genital operculum was already well developed.



If the views set forth above prove to be correct, some changes will be necessary in the classification and terminology of the groups involved. Arachnida, if the name is to have any scientific meaning, must either be limited so as to exclude the Scorpions, or the Eurypteridæ and Xiphosura must be admitted within its bounds. The latter is manifestly the better course to take; and the Xiphosura, Scorpionina, Eurypteridæ, and Thelyphonina will form sub-orders of about equal value. Whether the other groups of Arachnids—Pseudo-Scorpions, Phalangidæ, &c.—are also to be placed as sub-orders of equal value to the four mentioned above is a question rather outside the sphere of this paper, and which I hope to discuss later. The term *Pœcilopoda*, used first by M'Coy,* and used by Walcott to include the Trilobites, Xiphosura, and Eurypteridæ, must, if it be retained, be used for the Arachnida plus the Trilobita.

"Merostomata" has such a classic position, as including the Eurypteridæ and Xiphosura,

* *Ann. and Mag.*, ser. 2, vol. iv., 1849.

that it would be impossible to abolish it, though it expresses a stage in the evolution of the group rather than a relationship of those forms in contradistinction to the rest of the Arachnida. WALCOTT's proposal to use Merostomata for the Eurypterina alone, excluding Limulus, seems to be carrying change of meaning rather far, as the name was invented by DANA for Limulus.

In a tabular form the arrangement would be—

Class Pæcilopoda.
- Sub-class A, Trilobita.
- Sub-class B, Arachnida.
  - Order i. Xiphosura.
  - ii. Scorpionina.
  - iii. Eurypteridæ.
  - iv. Pedipalpi.
  - v. Araneæ, &c.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. Walking leg of Slimonia, showing general form and epicoxite (*epc*) on basal joint.

Fig. 2. Second appendage of Slimonia, "Antenna" of Dr WOODWARD.

Fig. 3. First appendage (chelicera) lying in front of mouth. × ½.

Fig. 4. Epistoma of Slimonia.

Fig. 5. Ventral view of first few abdominal segts. of Slimonia, showing genital operculum (vii); branchial lamellæ of second segment (viii); and plate-like appendages, with underlying branchial lamellæ, of third segment (ix). × ½. From a specimen in the Woodwardian Museum.

Fig. 6. Series of branchial lamellæ, probably belonging to the second abdominal segment. From a specimen in the collection of Dr HUNTER of Braidwood. × ½.

Fig. 7. Plate-like appendage with branchial lamellæ of one of the posterior abdominal segments, probably the fifth. From a specimen in the Jermyn Street Museum.

PLATE II.

Fig. 8. Ventral body-wall of abdomen seen from inside, and showing branchial lamellæ on segments xi. and xii. × ½. From a specimen in the British Museum.

Fig. 9. Restoration of Slimonia from the ventral surface.

Fig. 10. *Pterygotus*. Epistoma, from a specimen in the Woodwardian Museum.

Fig. 11. One of the walking legs of Pterygotus. *epc*, epicoxite.

Fig. 12. A leg of Limulus showing the epicoxite.

Fig. 13. Genital plate (form *α*) of Pterygotus.

Fig. 14. *Pterygotus bilobus*, showing genital plate (form *β*). A second plate-like structure (? ix), some branchial lamellæ, &c. From a specimen in the Jermyn Street Museum.

Fig. 15. Thelyphonus. Ventral surface, for comparison with fig. 9. Ge.a., genital aperture. LB 1 and LB 2, first and second lung-books of left side.

Mr Malcolm Laurie on the structure of the Eurypteridæ. — Plate I.

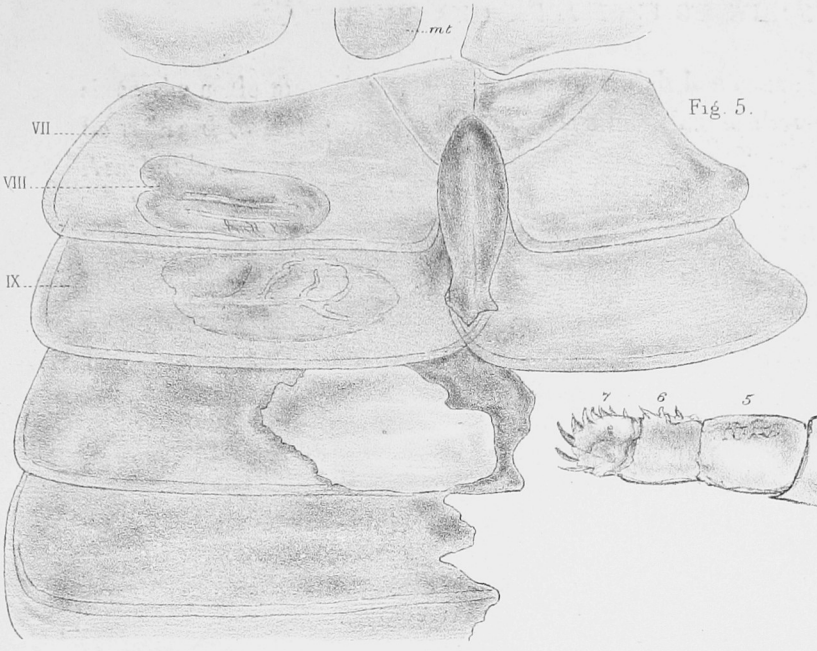


Fig. 5.

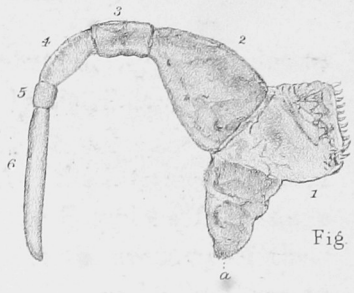


Fig. 2.

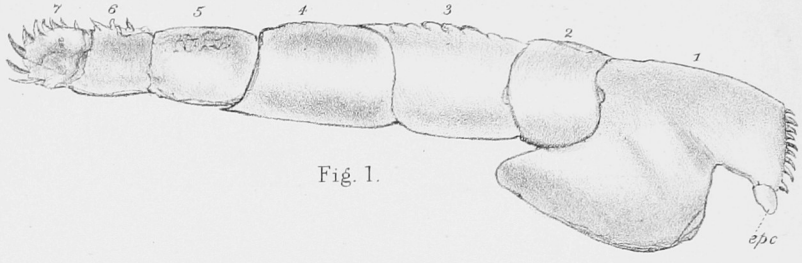


Fig. 1.

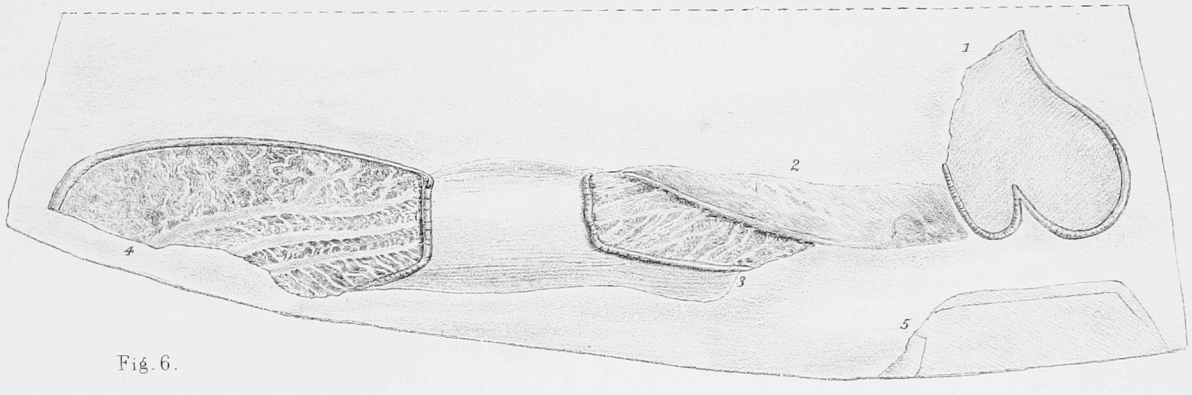


Fig. 6.

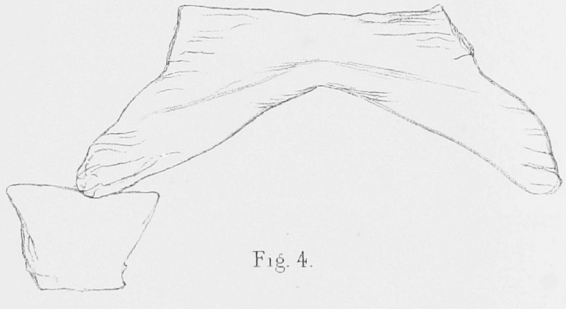


Fig. 4.

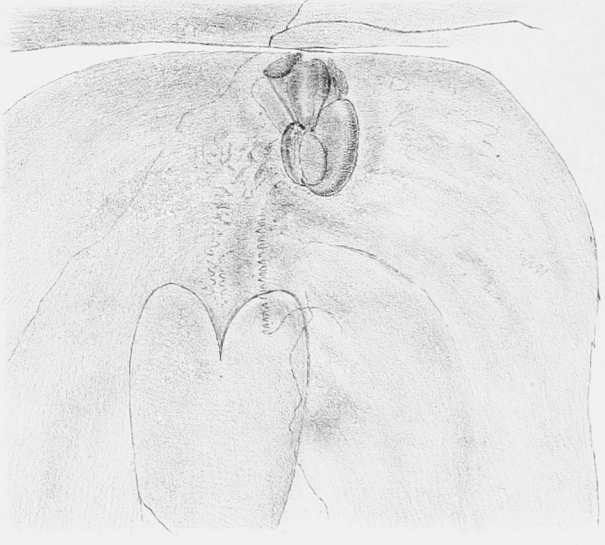


Fig. 3.

Mr Malcolm Laurie on the structure of the Eurypteridæ. — Plate II.

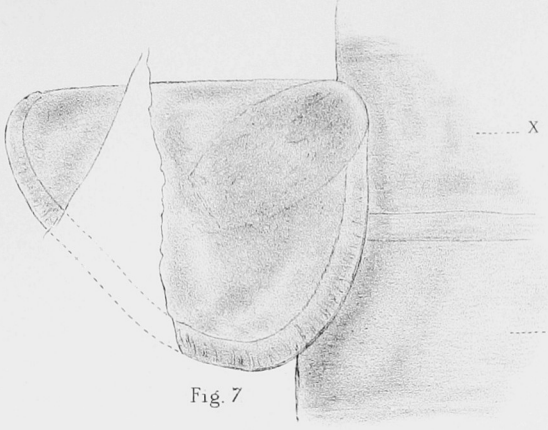


Fig. 7.

Fig. 13.

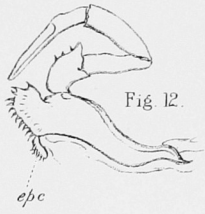


Fig. 12.

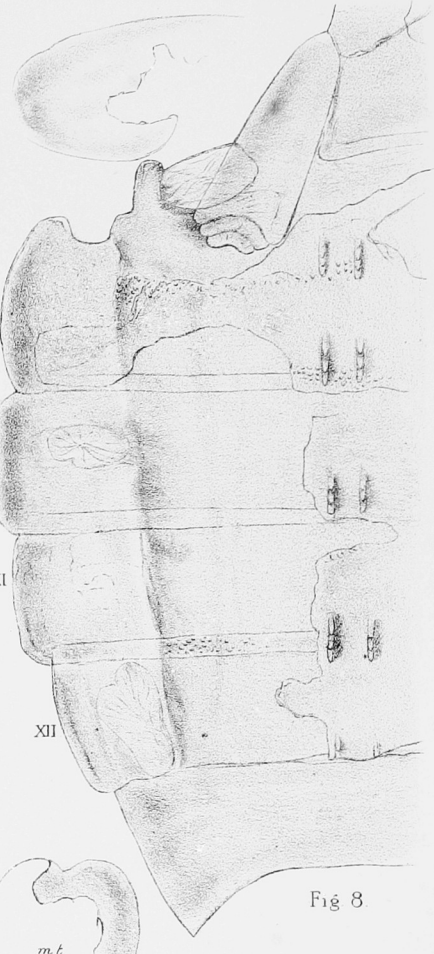


Fig. 8.

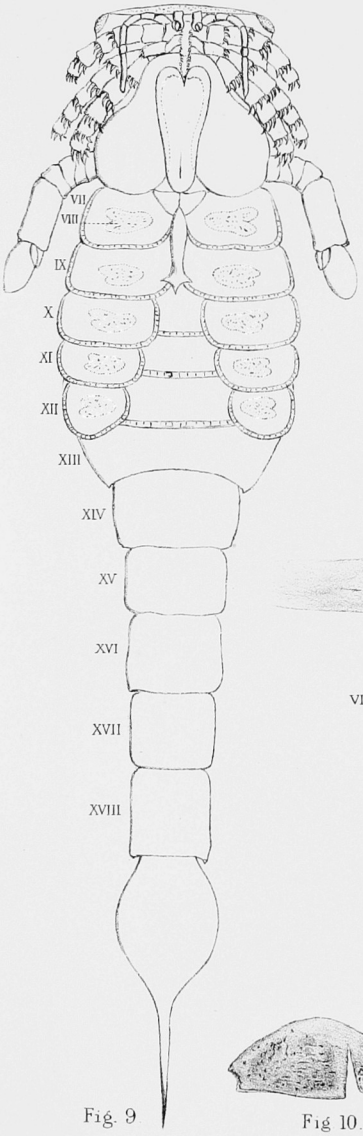


Fig. 9.

Fig. 10.

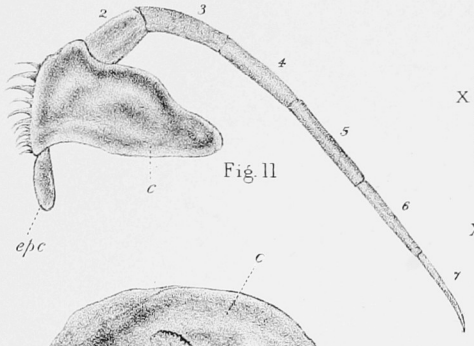


Fig. 11.

Fig. 14.

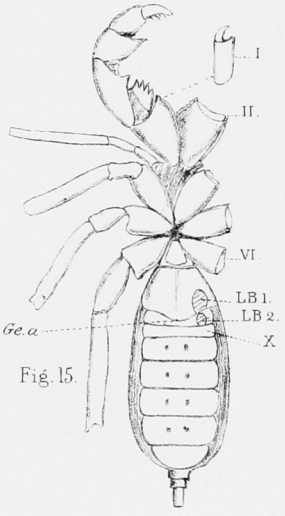


Fig. 15.

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