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XIX.—*On a Silurian Scorpion and some additional Eurypterid Remains from the Pentland Hills.* By MALCOLM LAURIE, B.A., D.Sc. (Plates I.–V.)

(Read 6th June 1898.)

In 1892 I communicated to this Society an account of a collection of Eurypterids from the Upper Silurian rocks of the Pentland Hills, in which I described new species and a new genus. Since that time I have had the opportunity of examining two other collections from the same locality. One of these was formed with the aid of a grant from the British Association. The fossiliferous bed—for these remains occur in a single thin bed of rock—was laid bare, and a considerable amount of it removed and split up. In this latter work I was fortunate to get the assistance of Mr JOHN HENDERSON, the original discoverer of the locality, and I am glad to have this opportunity of recording my indebtedness to him. A fair number of specimens was thus procured, which not only threw considerable light on the structure of some of the already described forms, but gave evidence of some species as yet undescribed. More important than this collection, however, was the one formed by the late Mr HARDIE of Bavelaw Castle, who had for many years collected among the Pentland Silurians. His collection was, on his death, acquired by the Edinburgh Museum of Science and Art, and Dr TRAQUAIR kindly put the collection in my hands for examination. From the size of the collection I expected some new and interesting results, and have been far from being disappointed. Seven new species of Eurypterids have come to light and one Scorpion. These, and the new facts about the already described species, form the subject of this paper. Some fragments of *Ceratiocaris* have also been found, but they do not seem to me sufficient to determine the species.

The horizon of the beds is Wenlock, so far as can be ascertained from the other fossils contained in it, and from the very scanty fauna of the neighbouring rocks. I had come to this conclusion from my own investigations, and am glad to find that the position assigned to it in the forthcoming memoir of the Geological Survey corresponds to my own idea on the subject.

The discovery of so many forms (10 in all) puts this locality far ahead of any other for Eurypterids. The total number hitherto described from the Silurian of Great Britain, apart from this deposit, is about 16. The only deposit approaching this for the richness of its Eurypterid fauna is the Water Lime in America, from which about 15 species have been described. Some five or six of these, however, are of very doubtful specific rank, being based either on small fragments or on slight differences in proportion. The latter is for Palæozoic fossils, very unsatisfactory when one considers how much compression and distortion they have undergone. The reason for the extraordinary abundance of these

forms in this particular bed along with masses of "Dictyocaris" and layers of structureless black matter must remain obscure. They must have existed both before and after the period marked by this particular bed, but so far as is known have with one exception left no trace in the surrounding rocks. The variety of forms—4 genera being represented—suggest that even in this bed we are far from the time when this group came into existence. On the other hand, no one, I think, will deny that *Drepanopterus bembicoides* is the least differentiated form known. The presence of a Scorpion indicates that the origin of that group is earlier than had been supposed, a conclusion which agrees quite well with the views I have published elsewhere as to the relation of the Scorpions and Eurypterids. That this Scorpion was an air-breather does not necessarily follow. The characters which mark it as a Scorpion may well have been developed before the terrestrial mode of life and consequent modification of the respiratory organs took place. Unfortunately, these respiratory organs are necessarily so delicate in texture that we know very little of their structure and arrangement in any of the fossil orthopoda, and, as in respect of many other interesting points in Palæontology, must wait for further evidence before we can pronounce an opinion.

I cannot let this opportunity pass without expressing the gratitude I owe to Dr TRAQUAIR for the opportunity of examining the Hardie Collection, and for the sympathy and encouragement which has helped me to surmount many difficulties. I am also indebted to Mr B. N. PEACH for much assistance in the more difficult points which have arisen; assistance which only those who have worked with him can appreciate the value of.

The forms to be described come under six genera:—*Palæophonus*, *Slimonia*, *Stylonurus*, *Drepanopterus*, *Eurypterus*, and *Bembicosoma* (n. g.), and are dealt with in the above order. The new species are *Palæophonus loudonensis*, *Slimonia dubia*, *Stylonurus elegans*, *Drepanopterus lobatus*, *Drepanopterus bembicoides*, *Eurypterus scoticus*, *E. minor*, and *Bembicosoma pomphicus*.

Palæophonus loudonensis, n. sp. (Pl. I., fig. 1.)

Carapace long and narrow, median eyes on a double papilla very far forward; mesosomatic sclerites band-like; tail long; chelicerae comparatively long and narrow.

The single specimen on which this species is founded is very obscure—so much so that it was long before I realised that it was anything more than a crushed Eurypterus. It had also been carelessly developed, so that the limbs for the most part are destroyed, and the tail entirely loses itself among some of the black layers which are so frequent in this Gutterford bed. The specimen shows the dorsal surface.

The carapace is 10 mm. long and 7 mm. wide, a very different proportion to *Palæophonus nuncius* (9), in which the carapace is 7.5 mm. long and 8 mm. wide. The anterior margin is distinctly concave, and the sides almost parallel, but slightly convex. The posterior margin appears fairly straight. Situated about 1 mm.

from the anterior border is a double depression, which I take to mark the position of the median eyes. If they corresponded in size to these depressions they must have been very large. Their position far forward on the carapace corresponds to what is found in *P. nunciatus* and *Proscorpius osborni* (Whitfield). In the middle line behind the eyes and some 3 mm. from the anterior margin is a small depression, the significance of which is unknown to me. There is a slight roughness at the left anterior corner of the carapace, which probably marks the position of the lateral eyes.

The six mesosomatic segments are wider than the carapace, *i.e.*, about 11 mm., but the lateral boundaries of this part of the body are very indistinct. In striking contrast to the length of the carapace is the shortness of these segments. The first measures only 2 mm., the next two 3 mm. each, and the remaining ones 4 mm. They are thus considerably shorter and wider than the corresponding sclerites in *P. nunciatus*. Some obscure markings occur on them and seem to have some meaning.

The first segment is cut across at the corners by the basal joints of the last pair of legs. On the fifth segment is clearly seen a curved ridge cutting off the anterior right-hand corner. Indications of a similar structure are visible on the three preceding segments. That on segment two, one may take as the impression of the outline of the pectines, but the succeeding segments in recent scorpions bear no free appendages, but only the respiratory organs or "lung books." If this curved ridge is an indication, as I think probable, of the breathing organs, they must have been of a very different type to those in the modern Scorpions. The lung books are generally regarded as modifications of plate-like appendages, bearing gill lamellæ on their posterior surface. It does not follow that because this form agrees with the recent ones in respect of the body form and the arrangement of the prosomatic appendages that it had reached the same point of specialisation in respect of its respiratory organs. The terrestrial mode of life and consequent adaptation to air breathing may have come later. It is thus just possible that this curved ridge on the mesosomatic segments is the outline of a plate-like gill bearing appendage. It is interesting to compare this structure with fig. 1α, which is a reproduction of a figure of an embryo *Scorpio fulvipes*, published some years since (5). The mesosomatic segments in this are seen to be marked with a curved ridge corresponding more or less closely to that in *P. loudonensis*. At the time, I regarded this ridge as indicating the line of fusion of the edge of the abdominal appendage with the body, and I see no reason to change my view.

The first metasomatic segment is as usual a truncated cone. The breadth at the posterior margin is just equal to the length, *i.e.*, 4.5 mm. This segment is marked off from the sixth, as the sixth is from the fifth, by a well-defined ridge. This ridge marks the overlap of the two sclerites. The last five segments are even more obscure than the rest of the specimen. The tail, which they constitute, appears to have been narrow (2.5 mm.) and long, though the few segments remaining vary so much in length that it is difficult to estimate the length of the whole. The first segment (No. 8 of the body) measures 4 mm. in length, the next 6 mm. Beyond this the tail can be traced for

some distance, but finally gets itself lost in one of the black layers so common in this bed, and the details of the posterior segments and the telson cannot be made out. The tail segments appear to have been ornamented with longitudinal ridges possibly composed of a series of knobs.

The limbs are, as mentioned above, very imperfectly preserved. Careful following out of what was left has however yielded some results.

The chelicerae are well shown and are remarkable for the large size of the pincers and the length of the basal portion. They project 4.5 mm. beyond the front of the carapace and the movable limb of the pincers measures 3 mm. The inner border of the fixed limb is crenulated, and probably the corresponding border of the movable limb was also. Compared with *Palaeophonus nuncius*, the basal part of this limb is longer, while the width both of the basal part and the two limbs of the pincers is considerably less. They seem to agree more closely with the *Palaeophonus* from Lesmahagow (7).

The second pair of appendages—Chelae—are partially preserved on the left side—the right side showing only the barest traces of them. The segments agree in form with recent Scorpions so far as their outline can be ascertained. The fourth segment is much longer than in *P. nuncius*, and the hand seems to have been stouter. This last, however, is so badly preserved that it would be unwise to say anything definite about its form. Part of one of the walking legs is preserved. The proximal part is very indistinct, but the last three segments are visible. Unfortunately the extreme end is gone, so it is impossible to say whether these limbs ended in a single spine as in the other species of *Palaeophonus*.

This specimen is the fourth scorpion from Silurian strata. The other three are *Palaeophonus nuncius* of Thorell (9) from Gothland; a *Palaeophonus* described by PEACH (7) from the collection of the late Dr Hunter, Selkirk; and *Proscorpius osborni* of Whitfield (11) from the Lower Helderberg rocks of America. This present form is probably the oldest of the four, and this makes it the more to be regretted that so few details can be made out.

SLIMONIA.

Slimonia dubia, n. sp. Pl. I., figs. 2–3.

Carapace quadrangular; eyes at the anterior corners; body tapering gradually; telson oval, terminating in a long sharp spine.

The type of this species is a very badly preserved carapace (fig. 2), with parts of the first eleven segments attached. Enough can, however, be made out to place it as a *Slimonia*, as no other genus possesses the quadrangular carapace with eyes at the corners. The other specimen I have relegated to this species shows the body segments and telson of a somewhat larger individual than the type. The telson has a more elongated form than in *S. acuminata*, and the broadest part is not so far back. The

shape of the body differs from *S. acuminata* in tapering evenly the whole way down, instead of narrowing suddenly at the seventh segment into a cylindrical tail. This difference of body form is so marked that at first I was disposed to place these body segments and telson under *Pterygotus*, to which *Slimonia* is closely allied. *Slimonia acuminata* comes from the Lesmahagow beds, and belongs to a higher horizon than the Pentland beds. A telson indistinguishable from *S. acuminata* has also been found in the Pentlands in beds belonging to a higher horizon in the Esk Valley.

STYLONURUS.

Stylonurus macrophthalmus. (Pl. I., figs. 4-7.)

Of this form the general shape is better shown in fig. 4 than in the type specimens described in my former paper. The median appendage of the genital operculum is characterised by extreme length, reaching down across four segments. It appears to have terminated in a point. The hind segments of the body are very characteristically furnished with epimera (figs. 5-6). These are not mere backward prolongations of the posterior angles of the segments, but project from the sides of each segment, being attached by a narrower peduncle, and expanding into a thin oval plate. The only form with epimera approaching these is *St. scoticus*, but in it they are not so well marked or so large in proportion.

Appendage III. (fig. 4) is moderately long and very stout, ending in a curved spine. The other joints probably bore spines also, as in *St. ornatus* (7).

Appendage IV. (fig. 7) is about twice the length of III., but not so broad. The distal joints are furnished with strong, curved spines—probably a pair to each segment, and the limb terminates in a spine.

Appendages V. and VI. do not differ much from the typical *Stylonurus* form. V. seems to have a small spine arising from the anterior side of the joint, between segments 4 and 5, while VI. shows the narrowing and elongation characteristic of *Stylonurus* to a marked degree.

Stylonurus ornatus. (Pl. I., fig. 8. Pl. II., figs. 10-12.)

A great deal has been added to our knowledge of this species. Only the general body form the metastoma, and portions of the last appendage and telson were described in my former paper. The greater part of the structure of all the six appendages has now been made out and the telson completed. In many specimens, the characteristic ornamentation is quite invisible, but I regard this as merely due to difference in the details of preservation.

Appendage I. (Pl. I., fig. 8).—The most anterior appendages are a small pair of chelicerae well shown in the figure. Only the two end joints forming the pincers are preserved, and the bases of the first somewhat broken. The proximal joint, probably the 2nd of the limb, is 10 mm. long, with an articular surface for the terminal joint half way

up on the outer side. Beyond this articular surface the joint continues as a triangular process which forms the inner ramus of the pincers. The outer margin of this—*i.e.*, that against which the terminal joint bites—is straight, and shows no sign of denticulation. It ends in a sharp point. The terminal joint forming the outer movable ramus of the pincers is 2 mm. longer than the inner ramus (*i.e.*, 7 mm.) and is curved, the convexity being toward the outer side. It also appears quite smooth on the margin. The basal joint of this appendage probably passed upwards at a sharp angle (or may even have been directed backwards) to its point of attachment. From their structure it would seem as though the chelicerae could only bite by a single point.

Appendage II.—Slanting inwards and backwards from outside the chelicerae and overlapping each other just behind their apices lie the ends of the 2nd pair of appendages. The form is somewhat indefinite, and they had probably a thin cuticle that on the right side shows two conical spines, while on the left side there are indications of spines and a considerable number of setae. These appendages were probably tactile like the corresponding pair in *Slimonia*.

Appendage III. (fig. 10).—The gnathobase of this, I have not made out; in fact, only the four distal joints are known. They are all short and tapering, and the two proximal ones furnished each with a stout spine. Markings on the sides of these joints seem to be the points of attachment of other spines. This limb is very short when compared with the corresponding one in *St. elegans*.

Appendage IV. (fig. 11).—This is a reproduction of Appendage III. on a larger scale. The spines are longer and more delicate, and the terminal segment appears to bear several. A spine is seen arising from the side of the antepenultimate segment.

Appendage V.—The five distal segments of this limb are shown in fig. 12. They are less elongated and slightly broader than the corresponding segments in Appendage VI.

Appendage VI. (fig. 12) shows the great elongation of all the segments, especially the two proximal ones (2nd and 3rd). The length and narrowness of the 2nd joint is in marked contrast both to *St. macrophthalmus* and *St. elegans*.

The metastoma was incorrectly figured in my former paper (*loc. cit.*, Pl. I., fig. 7), the front margin being shown much too deeply cleft and simple. Fig. 8 shows it as it ought to be, and shows further that the front margin is crenulated.

St. elegans, n. sp. (Pl. II., figs. 13-15. Pl. III., fig. 19.)

Carapace long and narrow, tapering towards the front. Metastoma comparatively wide; 3rd and 4th appendages long and furnished with backwardly directed longitudinally ridged spines; 5th and 6th appendages with 2nd joint comparatively short, broad, and subconical; tail segments probably narrow and with sharply pointed epimera, and telson wide in proportion to last segment.

Five specimens certainly, and two probably, belong to this species. The type

specimen (Pl. II., fig. 13) shows about half the carapace, the metastoma, fragments of five body segments, and portions of appendages III. to VI. of the left side. Another specimen (Pl. III., fig. 19), mounted in the same slab of plaster of paris, shows appendages III., IV., V., and VI., and is probably the other side of the same animal as fig. 13, a portion of the carapace being gone. Two other specimens (one the very fragmentary reverse of the other) show parts of the carapace, and appendages III.-VI. of a much smaller individual. These two specimens have been useful in confirming certain points, but have added nothing to the information derived from the specimens, figured. The other two specimens show the posterior body segments, and I have ascribed them to this species, as they show certain differences from the corresponding portions of *St. ornatus*. Their place must be considered as only probable, however, till the discovery of fresh material. A somewhat broken carapace (fig. 14) belonging to a small individual is valuable as giving the anterior margin and the position of the eyes.

The carapace (Pl. II., fig. 13) is widest about one-third from the hind margin. In front of this it narrows, the anterior one-third being concave in outline. There is a narrow but well-marked border in the anterior third which narrows as it approaches the level of Appendage IV. Whether it continues beyond that point is doubtful, the outline of the carapace being rather indicated than preserved behind this point. The anterior margin (fig. 14) is crenulated.

The metastoma is proportionately broad and short and slightly concave on its anterior and posterior margins. The ratio of width to length is 5 to 7, a marked contrast to *St. ornatus* in which the ratio is 5 to 11. The proportionate width of metastoma and carapace also differs markedly from *St. ornatus*, being in *St. elegans* as 5 to 11.5, and in *St. ornatus* as 1 to 8. The surface of the metastoma was covered with scattered projections.

The only appendages known are parts of III., IV., V., and VI., lying beyond the carapace. The gnathobases have left no impressions.

The third and fourth appendages are well furnished with spines along the posterior margin of the four distal joints. These spines are slightly curved and longitudinally striated and were probably arranged in a double row. Those towards the end of the limb are larger than those towards the base.

Appendage III.—Presuming that this appendage consisted of the typical number of joints (*i.e.* 7), portions of 3 and 4 are shown on the left side (fig. 13), and 3, 4, 5, 6, and probably the beginning of 7, on the right side along with a small fraction of 2 (fig. 19). Joint 3 is short, the length being only one-third greater than the width. There are apparently no spines on the posterior margin, but the distal end of the anterior margin is produced into a short spine (fig. 13). Joint 4 is twice the length of joint 3, and appears to expand at the distal end owing to the presence of spines on both anterior and posterior margins. The posterior margin bears a number of spines. Joint 5 tapers slightly and is three-fourths the length of joint 4. It is furnished with spines on the posterior surface. Joint 6 is nearly the same length and is well furnished with spines along the posterior

margin—at least two of these being considerably larger than the rest. Of the last joint almost nothing remains. Half a spine lying along the edge of the slab and a short process arising at its base are all that are left.

Appendage IV.—This limb (figs. 13 and 19) is somewhat longer and stouter than III. Joint 3 is longer in proportion than in the foregoing appendage, and seems free from spines. Joint 4 is the longest, and joint 5 the shortest in this leg, both being furnished with well-developed spines. Joint 6 is long and tapering, and bears a remarkably powerful spine at its distal extremity. The last joint is narrow and runs out into three spines, that near the base being the stoutest.

The 5th and 6th appendages have the elongated form characteristic of *Stylonurus*, each joint being somewhat narrower than the last. The proximal joints of them are, however, much wider and shorter in proportion than in *St. ornatus*.

The points of difference between this form and *St. ornatus* are very marked. The narrow carapace and wide metastoma would alone serve to distinguish the two forms, while the greater length of the 3rd and 4th appendages, especially the 3rd, afford equally good diagnostic characters. The proportion of the joints of the two posterior limbs, and especially the shortness and width of the proximal joints, also offer a point of difference. The only form I am acquainted with which resembles this species in the form of the carapace is *St. excelsior* (3) from the Upper Devonian (Catskill group) of New York. The appendages of this form do not, unfortunately, admit of comparison with those of *St. elegans*.

DREPANOPTERUS.

Two new species come under this genus, and the point of chief generic importance in the light of these new forms would seem to be a negative one:—"Last pair of appendages neither expanded, as in *Eurypterus*, etc., nor excessively elongated, as in *Stylonurus*."

The genus unquestionably comes very near *Stylonurus* in some respects. The form of the carapace and the comparatively elongated last appendages in *D. Pentlandicus* are suggestive of stylonuroid affinities, but *D. bembicoides* is a very well marked form, easily separated from *Stylonurus*, and quite justifies the existence of the genus.

Drepanopterus lobatus, n. sp. (Pl. II., fig. 16. Pl. III., figs. 17, 18.)

Carapace almost semi-circular; body without marked differentiation of meso- and metasoma; last segment with posterior angles produced into ovate lobes; telson long.

I have ventured to found this species for the reception of three or four specimens, which are most definitely characterised by the form of the last segment.

The carapace (Pl. II., fig. 16) has a length of 15 mm. and a breadth at its widest point of 25 mm. The proportion in this specimen is probably not quite correct, as the

animal seems to have been squeezed out laterally and slightly telescoped into itself. The greatest width of the carapace is about one-third from the posterior margin. The position of the eyes is unfortunately not shown.

The body segments become progressively narrower and longer from before backwards. The last six at least have the posterior angles produced into processes. These are large on the 11th segment, and on the 12th form a pair of ovate lobes about the same length as the segment itself. The telson is long, and in one specimen (Pl. III., fig. 17) curved, but this is probably accidental. The end of the telson is not shown.

Some fragments of a carapace and body segments with the two last limbs attached (Pl. III., fig. 18), I am inclined for the present to regard as belonging to this species, and it is this specimen which has decided the generic position of the species. Apart from the limbs here shown, the general body shape of *D. lobatus* is more suggestive of a *Stylonurus*. The carapace shows little of the shape, but is covered with a scattered punctate marking. The body segments, portions of six of which are shown, are covered—especially the anterior part of each segment, with flattened scale markings. The greater part of appendages V. and VI. is shown, and these undoubtedly belong to a *Drepanopterus* though approaching the *Stylonurus* form more closely than *D. bembycoides*. The fifth appendage appears to have had a long spine arising from probably the 5th segment. The sixth appendage has the second and third joints considerably elongated, while the fourth, fifth, sixth, and seventh joints might belong to *D. bembycoides*. The measurements of the limbs are:—

Segment.	Appendage V.		Appendage VI.	
	Length.	Breadth.	Length.	Breadth.
3	?	9 mm.	19 mm.	6 mm.
4	12 mm.	6 mm.	7 mm.	6 mm.
5	} 16 mm.	} 4·5 mm.	9 mm.	5 mm.
6			2 mm.	3 mm.
7	5 mm.	1·2 mm.	6 mm.	2 mm.

This specimen, whether belonging to *D. lobatus* or not, is interesting as giving us an intermediate form between *D. bembycoides* and *Stylonurus*.

Drepanopterus bembycoides, n. sp. (Pl. III., figs. 20–21).

Surface smooth; carapace with comparatively straight anterior margin and sides, length = one-half breadth; body tapering regularly and ending in a stout conical tail spine; segments increasing in length towards posterior end; eyes inside a well-marked marginal band; limbs increasing in length from before backwards, last pair neither expanded as in *Eurypterus* nor elongated as in *Stylonurus*, ending in a slightly sickle-shaped subconical joint; spines wanting on the limbs; metastoma oval; genital plate with broad oval median process hardly extending beyond lateral portions.

The carapace, which, as stated above, is twice as broad as it is long, has a well-marked border about 5 mm. wide. This border is ornamented with fine reticulating lines.

Immediately inside the border and just behind the antero-lateral angle of the carapace are the comparatively small oval eyes. The metastoma (Pl. III., fig. 20) is oval, narrowing slightly towards the front, and with a small but deeply-cut notch in the anterior border.

The limbs are short and stout, formed of a series of sub-cylindrical joints of approximately the same length. Each joint is narrower than the one before it, and the distal end of each expands slightly. The last joint is subconical and slightly concave on the post. marg.

No spines have been observed on any of the appendages. The most marked feature of these limbs is the close resemblance of one to another and the absence of any marked specialisation. The increase in size from before backwards is an increase in both length and breadth, so that the proportions of the limbs remain unaltered.

The body segments are short, increasing slightly in length towards the posterior end as far as the 11th. The 12th is very much longer than any of the preceding ones, and has the shape of a truncated cone, from the posterior end of which arises the short conical telson. The tapering of the body is almost uniform from the hind margin of the carapace to the end of the telson. The tergites of the segments have their posterior angles produced into short spines.

The genital plate is short and the median process oval and scarcely projecting beyond the posterior margin of the plate.

This form is easily distinguished from *D. pentlandicus* by the smooth body surface, the less central position of the eyes, the markedly conical form of the body. The proportions of the carapace and indeed of the whole animal show a greater breadth in proportion to the length. It resembles *E. conicus* in general form, but is usually easily distinguished by the large submarginal eyes of *conicus* and the absence in it of the well-marked border to the carapace. The telson in *Conicus* is also much longer and slighter.

Taken as a whole, this form appears to me the most primitive Eurypterid known. The absence of differentiation of the body into meso- and metasomatic regions is shared by it with several Eurypterid forms, but to this must be added the comparatively slight development of the genital plate, and above all the legs. The almost entire absence (much more marked than in *D. pentlandicus*) of differentiation of the posterior pair, either as flattened paddles as in the majority of the Eurypterids, or as enormously elongated walking legs as in *Stylonurus*, is a very striking feature. It is unfortunate that in this, as in so many of these Pentland specimens, the form of the gnathobases cannot be made out.

I have termed it *bembycoides* from $\beta\acute{\epsilon}\mu\beta\iota\zeta$, a peg-top.

Drepanopterus pentlandicus. (Pl. IV., fig. 22.)

Some good specimens of this species have come to light. The most instructive is the small individual figured in fig. 22. It is less distorted than the type specimen, and

probably approximates closely to the true form. The form of the carapace reminds one of *Stylonurus*, being distinctly horse-shoe shaped, with a well-marked marginal band. The eyes are situated rather far back, and show only a narrow semi-circular band. This, however, is probably merely the outer margin, and does not represent the size of the whole visual area. The body expands slightly down to the fourth segment, and then contracts regularly to the tail. The last segment is very long and conical like the corresponding one in *D. bembycoides*. The telson is remarkably large, being nearly half as long as the body, and is covered with the granular markings characteristic of this form.

Of the Appendages, No. IV. is comparatively short, stout, and sub-conical. V. is somewhat elongated, the 3rd joint being most markedly modified. The last joint is conical and slightly concave on the posterior margin. This form of terminal joint seems to occur in all the members of this genus.

The last pair of appendages are considerably elongated, without, however, reaching the specialisation shown in *Stylonurus*. They appear longer in proportion in this specimen than in the type, a difference which may be due to the different stage of growth of the two. None of the segments are particularly elongated, and the chief point of interest is the presence of short, coarse spines on the third and fourth joints. Spines are not common on this pair of limbs in the Eurypteridæ. A very large number of specimens of this species in the Hardie Collection have not yielded any further information of importance.

Eurypterus scoticus. (Pl. IV., figs. 23-25. Pl. V., fig. 26.)

Carapace conical, broadest at hind margin and narrowing forwards. Body progressively wider to the third segment, narrowing abruptly at the 7th; last five segments almost equal in width; dorsal surface with finely punctate markings. Appendages.—2nd pair short, provided with spines; 3rd, 4th, and 5th pairs long, the four distal joints armed with a double series of long, curved spines directed forwards; 6th with last segment (paddle) much narrower than penultimate. Gnathobases and metastoma unknown.

In my former paper I provisionally referred two fragments belonging to this species to *E. scorpoides* (Woodward), as there was not evidence enough to justify the foundation of a new species. A large number of fragments in the Hardie Collection have, however, enabled me to found a new species with some certainty.

Carapace.—The carapace (Pl. V., fig. 26) has a curved posterior margin and somewhat rounded posterior angles. Its width in this specimen at this, the broadest point, is about 100 mm. The lateral margin is concave, and narrows rapidly for the hind one-third of its length, for the other two-thirds it is convex, the two sides sloping in so that the anterior margin is scarcely one-third the width of the posterior. Nothing could be ascertained as to the organs lying below the carapace, or as to the presence or absence of eyes.

Body Segments.—The type specimen shows the inside of the tergites of the first four segments. The specimen does not, however, extend far enough to show the margins of any of these segments except the first. This segment is only half the length of the succeeding ones (*i.e.*, 9 mm.), and extends laterally some 15 mm. beyond the angles of the carapace, which would make the total width of the segment more than 130 mm. Of the other segments in this specimen nothing can be made out except that they are band like sclerites, measuring some 18 mm. from front to back. A small portion of the ventral surface is shown on a small island towards the right side. One of the specimens referred to in my former paper shows the ventral surface of all the body segments of a specimen, the total length of which, without the telson, must have been between 550 and 600 mm. (Pl. IV., fig. 24.)

APPENDAGES.

1st pair. (Pl. V., fig. 26.)—The position of the chelicerae can be made out on each side, the middle line commencing 10 mm. behind the anterior margin, and having a length of 12 mm., and a breadth of about 5 mm. at the base. They are somewhat conical in form, the apex of the cone being directed backwards. They agree in all essentials with the corresponding appendages in *E. scorpoides* and other forms.

2nd pair.—This appendage projects some 22 mm. beyond the anterior margin of the carapace on the right side. The number of joints cannot be ascertained. The last joint ends in a powerful pair of curved spines very broad in proportion to their length. The penultimate joint carries a spine on the inner side, and another rather doubtful spine lies immediately in front of the carapace.

3rd-5th pairs. (Pl. IV., fig. 23. Pl. V., fig. 26.)—The next three limbs resemble one another in being powerful, curved organs armed with a double series of curved spines along the anterior margin of the four distal joints. The terminal (7th) segment bears a pair of particularly powerful spines, and the strongest spines on the 5th and 6th joints appear always to arise from the distal angle; indeed, it is doubtful if these joints bear any spines beyond the one pair. The 4th joint bears, at all events, in the 3rd pair of appendages, three or four moderate sized spines. The spines themselves are smooth except when occasionally an extra large one shows signs of longitudinal striæ. The proportion of the joints to one another seems to be slightly different in the different pairs, but I have not been able to get any certainty as to which is which.

6th pair. (Pl. IV., fig. 23.)—Only one fragmentary specimen of this has been found. It probably belonged to an individual slightly larger than the type. The last two joints only are preserved, and of these the penultimate is a good deal broken. It (the penultimate joint) is very broad (40 mm.) and comparatively short (45 mm.), but presents no points of special interest. The terminal joint is oval in shape, comparatively long (63 mm.) and narrow (25 mm.). It narrows towards its point of articulation. The posterior border is marked along the distal third of its length by a series of four oblique

incisions. Of these the one nearest the apex is the best developed and marks off a distinct lobe. The other three are much smaller.

The triangular plate, arising as usual from the posterior portion of the distal end of the penultimate joint, is very large in this form. Its breadth at the base is 27 mm., and the length must have been about 35 mm. It is larger in proportion to the last joint than in any other *Eurypterus* with which I am acquainted.

I have ascribed a fragment of tail spine (Pl. IV., fig. 25) to this form. The chief reason for placing it here is that it does not seem to belong to either of the large species of *Stylonurus*. It had a triangular ridge running down the middle and occupying one third of the width.

In comparison with other species, *Eurypterus scoticus* seems most nearly allied to *E. scorpoides* (Woodward); *E. punctatus* (Salter); *E. (Eusarcus) scorpionis*, Grote; *E. (Echinognathus) clevelandi* (Walcott); *E. acrocephalus* (Semper). The last two may be disposed of in a few words. *E. clevelandi* was founded on a single limb, which in structure shows a close resemblance to the *Eurypterids* of this type, being furnished with long, curved spines. The number of spines is greater than in any of the usual forms, and it is possible that more than one limb may be present. Of *E. acrocephala* only the general shape of the carapace and body segments is known. These agree fairly well with *E. scoticus*, the carapace being conical, and the body widening in the first few segments and suddenly narrowing in the seventh. The remains of appendages in this Bohemian form are too slight and indistinct to admit of comparison.

E. punctatus of Salter resembles our form closely in some respects. The spine bearing legs are, on the whole, similar, but the spines are, according to the description, markedly striated. Further, the form of the swimming foot differs in the much greater length in proportion to breadth of the terminal joint, and in the greater breadth of the terminal joint in proportion to the penultimate one. *E. scorpoides* can be distinguished by the proportionately shorter spines on the 3rd—5th appendages, and by the less-marked width of the swimming foot as a whole. The terminal joint of this foot in *E. scorpoides* is also of the same width as the penultimate, while the triangular plate on the posterior side is very small. *Eurypterus obesus* resembles *E. scoticus* in the general body form, but the anterior appendages do not seem to be furnished with spines, while the last pair have a form more like *E. remipes*, the terminal joints being much expanded.

Eurypterus minor (Pl. V., figs. 27–29).

Carapace subquadrate, breadth slightly greater than length; eyes oval; body tapering; telson strong, triangular in section about equal in length to the last three segments; body surface granular.

This is a small form, the type specimen (fig. 27) measuring only 74 mm. in length. The specimen from which fig. 29 was drawn is somewhat larger, but wants the carapace. The carapace is widest at the posterior margin which is slightly concave. The sides

converge slightly towards the front and the anterior margin is comparatively straight. The eyes are well marked and oval in form, placed about equidistant from the lateral and anterior margins. There is a curious curved line arising from the posterior end of the eye (fig. 28). The body segments increase in length and decrease in breadth from before backwards, and are not marked by any special characters except the fine and sharply-cut granular markings. There appears to be no prolongation back of the posterior angles of any of the segments.

The telson is powerful in proportion to the animal, with a triangular section. The ridge which is on the dorsal surface is expanded at the proximal end (fig. 29) and forms a triangular, flattened area.

Only traces of the appendages are preserved, but the last pair seem to have been expanded.

This form differs from *E. lanceolatus* in the shape of the carapace and eyes and the squareness of the posterior segments which are conical in *lanceolatus*. The form of carapace and position of the eyes recall the arrangement in *E. Fischeri* (13) and its allies, but the eyes are more oval in form and the last body segment is not lobed.

Bembycosoma, gen. nov.

Carapace shaped like the ace of clubs, breadth greater than length, body conical short; telson stout.

It is with much hesitation that I create this genus for the reception of an obscure form of which a number of mostly fragmentary specimens have come to light. My hesitation is not so much due to any doubt of the generic value of the form, but to the absence of sufficient information to supply a satisfactory diagnosis. Insufficiently described genera are the greatest curse of systematic zoology, and I should be sorry to add to their number. The one species known is:—

B. pomphicus, n. sp. (Pl. V., figs. 31 and 32.)

Characters, those of the genus and in addition a warty texture of skin. The cuticle was from its state of preservation thin and delicate, and the exact outlines are difficult to make out in many parts. The trilobed form of the carapace is only shown in one specimen (fig. 31), the others having a well-defined semi-circular form (fig. 32). The semi-circular outline of the carapace can be seen in the type specimen, and I am inclined to think that this is the true shape of the edge; and that the lateral lobes are due to the flattening of dorso-lateral protuberances of the carapace. No trace of eyes has been made out, and though some obscure markings in some specimens probably indicate the gnathobases, I have not been able to interpret them. Any sign of limbs beyond the carapace is wanting.

The body tapers evenly down to the whole way and the telson continues the same

slope, being as wide at its base as the posterior margin of the last segment. The number of segments is not certain. I have never been able to count more than nine, but in fig. 32 the second segment is so large that it may represent two, and the posterior end is incomplete. The telson is 7 mm. wide at its base and seems to have been about 12 mm. long. The whole surface of the body is covered with the pimply structure from which the specific name has been derived, but the telson seems to have been smooth.

If the number of segments is really less than 12 this form would have to be removed from the Eurypterida and placed along with *Bellinurus* and *Prestwichia* among the *Xiphosura*. There is a resemblance in texture between this species and *Eurypterella ornata* described by MATTHEW (6) from the Lower Devonian of New Brunswick. According to his description, however, the carapace is triangular and segmented. It is just possible that his specimen showed only the body segments (he only figures 9 including the segmented carapace) and these broken away in front. I have not, unfortunately, had an opportunity of seeing the original specimen.

LIST OF PAPERS REFERRED TO.

- (1) GROTE AND PITT, "New Crustacea from the Water Lime," *Bull. Buffalo Nat. Hist. Soc.*, vol. iii.
- (2) HALL, "Natural History of New York," *Palaontology*, vol. iii.
- (3) HALL AND CLARKE, "Natural History of New York," *Palaontology*, vol. vii.
- (4) LAURIE, "Some Eurypterid Remains from the Upper Silurian Rocks of the Pentland Hills," *T. R. S. E.*, vol. xxxvii.
- (5) LAURIE, "Some points in the development of *Scorpio fulvipes*," *Q. J. M. S.*, vol. xxxii.
- (6) MATTHEW, "Remarkable Organisms of the Silurian and Devonian in S. New Brunswick," *T. R. S.*, Canada, vol. vi.
- (7) PEACH, "Ancient air breathers," *Nature*, 1885.
- (8) POHLMANN, "Additional notes on the Fauna of the Water Lime," *Bull. Buffalo, Nat. Hist. Soc.*, vols. iv. and v.
- (9) THORELL AND LINDSTRÖM, "A Silurian Scorpion from Gothland," *Kongl. Svensk. Vetinck. Acad. Handl.*, vol. 21.
- (10) WALCOTT, "New Genus of the order Eurypterida from the Utica," *State Am. J. Science and Art*, vol. xxiii.
- (11) WHITFIELD, "An American Scorpion," *Bull. Amer. Mus. Nat. Hist.*, vol. i.
- (12) WOODWARD, "Monograph of the British fossil Crustacea, belonging to the order *Merostomata*," *Palaontographical Society*.
- (13) SCHMIDT, *Mem. de l'Acad. Imp. de St Pétersbourg*, vol. xxxi.

DESCRIPTION OF PLATES.

(Except where otherwise stated, the figures are natural size.)

PLATE I.

- Fig. 1. *Palæophonus loudonensis*, n. sp. $\times \frac{2}{1}$
 Fig. 1a. Embryo of *Scorpio fulvipes*. Magnified.
 Fig. 2. *Slimonea dubia*, n. sp. Carapace and body segments.
 Fig. 3. *Slimonea dubia*. Body segments and telson.
 Fig. 4. *Stylonurus macrophthalmus*.

- Fig. 5. *Stylonurus macrophthalmus*. Posterior segments showing epimera.
 Fig. 6. *Stylonurus macrophthalmus*. Last two segments.
 Fig. 7. *Stylonurus macrophthalmus*. Fourth appendage.
 Fig. 8. *Stylonurus ornatus*. First and second appendages.

PLATE II.

- Fig. 9. *Stylonurus ornatus*. Appendage 3.
 Fig. 10. *Stylonurus ornatus*. Appendage 4.
 Fig. 11. *Stylonurus ornatus*. Appendages 5 and 6.
 Fig. 12. *Stylonurus elegans*, n. sp. Left side.
 Fig. 13. *Stylonurus elegans*. Portion of carapace of a small specimen to show nature of margin.
 Fig. 14. *Stylonurus elegans*. Posterior segments presumably belonging to this form.
 Fig. 15. *Drepanopterus lobatus*, n. sp.
 Fig. 16. *Drepanopterus lobatus*.

PLATE III.

- Fig. 17. *Drepanopterus lobatus*. Fragment of specimen showing appendages and ornamentation.
 Fig. 18. *Stylonurus elegans*. Right side.
 Fig. 19. *Drepanopterus bembycoides*, n. sp.
 Fig. 20. *Drepanopterus bembycoides*.
 Fig. 21. *Drepanopterus pentlandicus*.

PLATE IV.

- Fig. 22. *Eurypterus scoticus*, n. sp. Last two appendages.
 Fig. 23. *Eurypterus scoticus*. Body segments $\times \frac{1}{4}$.
 Fig. 24. *Eurypterus scoticus*. Telson.
 Fig. 25. *Eurypterus scoticus*. Type specimen.

PLATE V.

- Fig. 26. *Eurypterus minor*, n. sp.
 Fig. 27. *Eurypterus minor*. Carapace.
 Fig. 28. *Eurypterus minor*. Posterior segments and telson of a somewhat larger specimen.
 Fig. 29. *Eurypterus conicus*. Last segments and telson.
 Fig. 30. *Bembicosoma pomphicus*, n. gen. and sp.
 Fig. 31. *Bembicosoma pomphicus*.

CORRIGENDA.

On p. 590, Fig. 9 should be numbered Fig. 10, and so on throughout, the last fig. being No. 32. The figs. numbered 16, 21, and 25 appear in Plates III., IV., and V. respectively.

P. 583, lines 17 and 31, for "*bembycoides*" read "*bembicoides*."

P. 588, for "*Bembycosoma*" read "*Bembicosoma*."

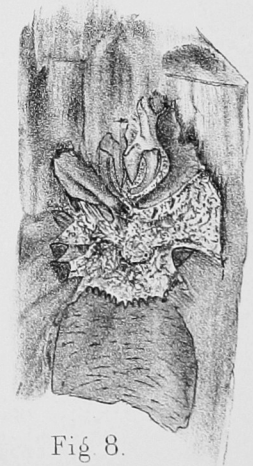
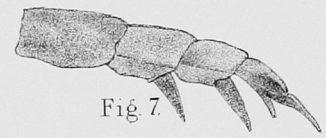
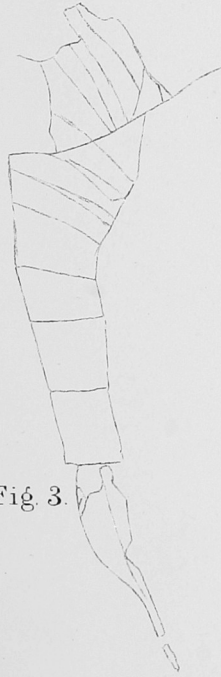
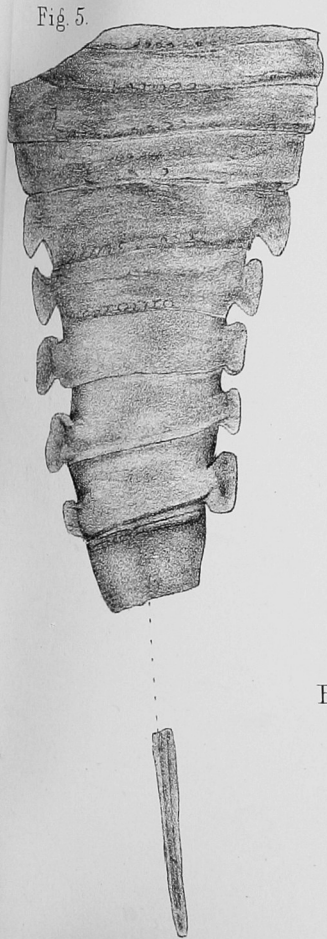
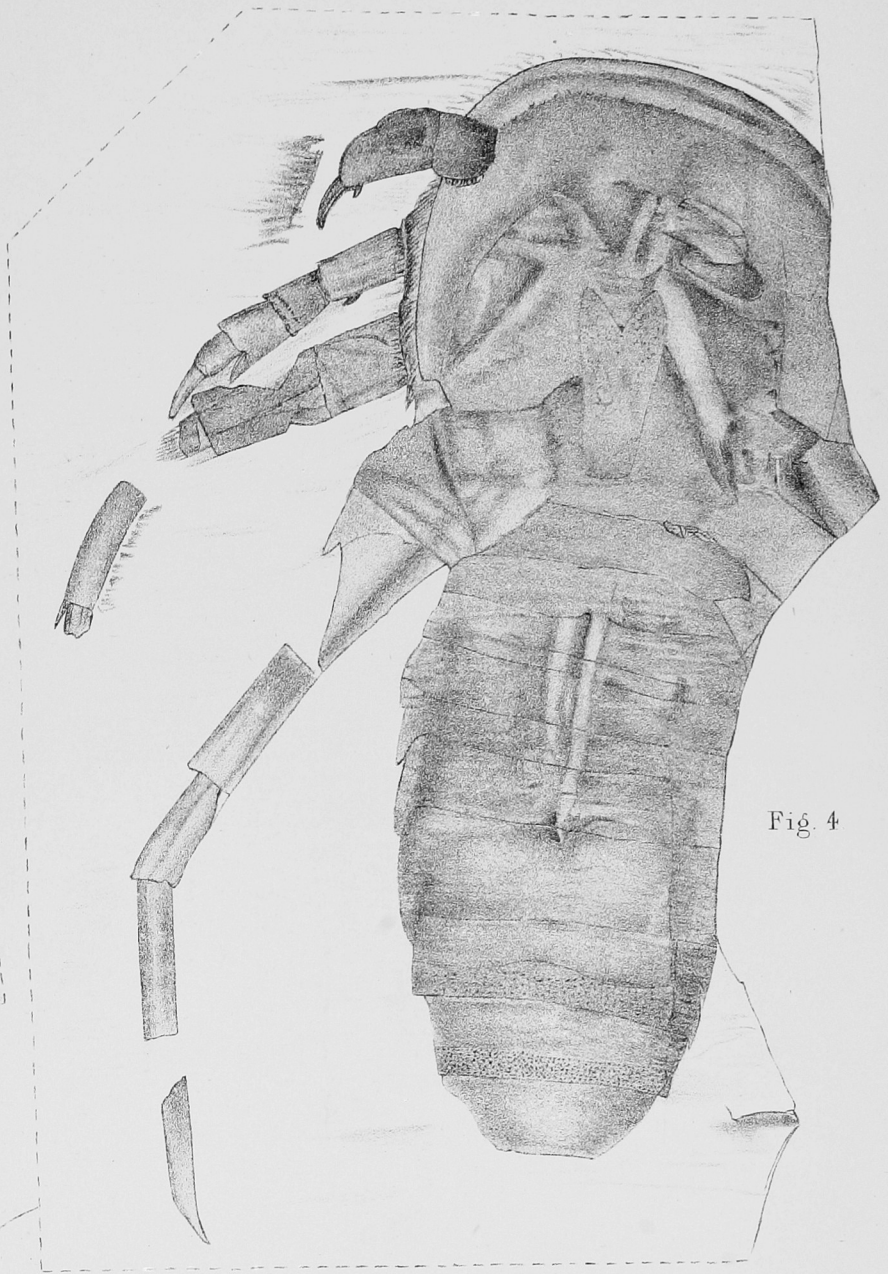
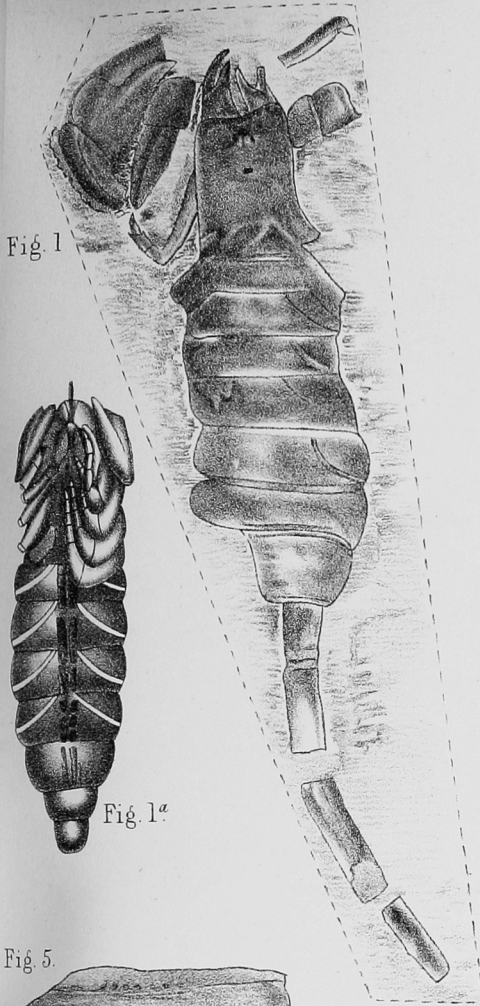


Fig 12.

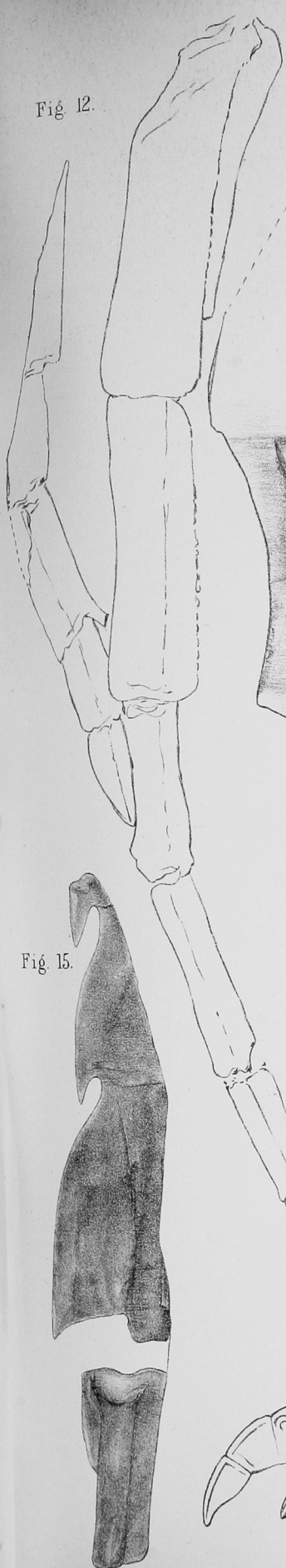


Fig 13.

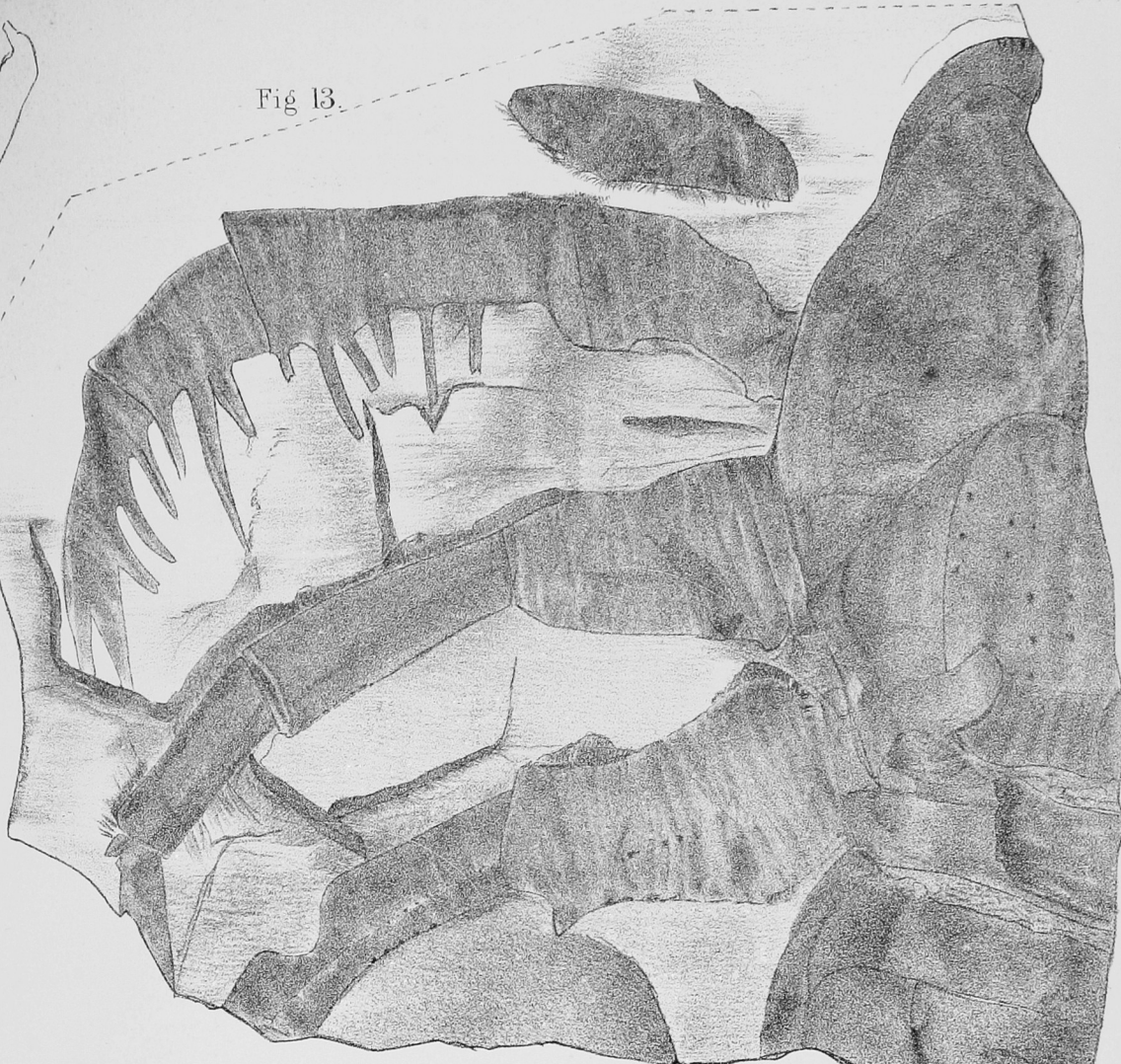


Fig 15.



Fig 16.



Fig 11.

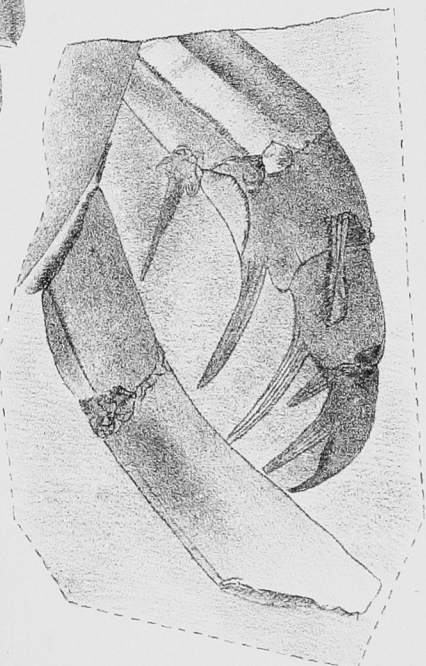


Fig 14.



Fig 10.

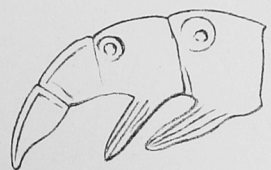


Fig. 20.



Fig. 19.



Fig. 17.



Fig. 18.

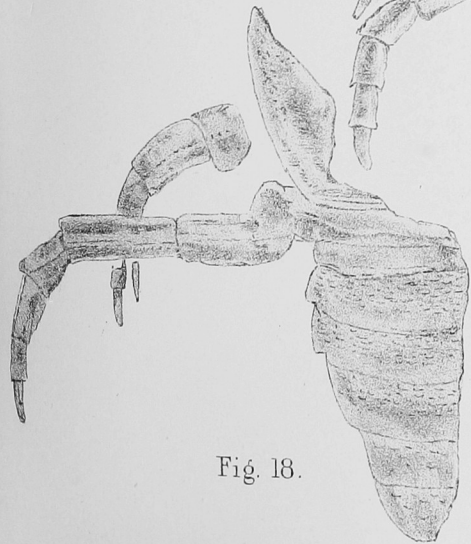


Fig. 21.



Fig. 22.

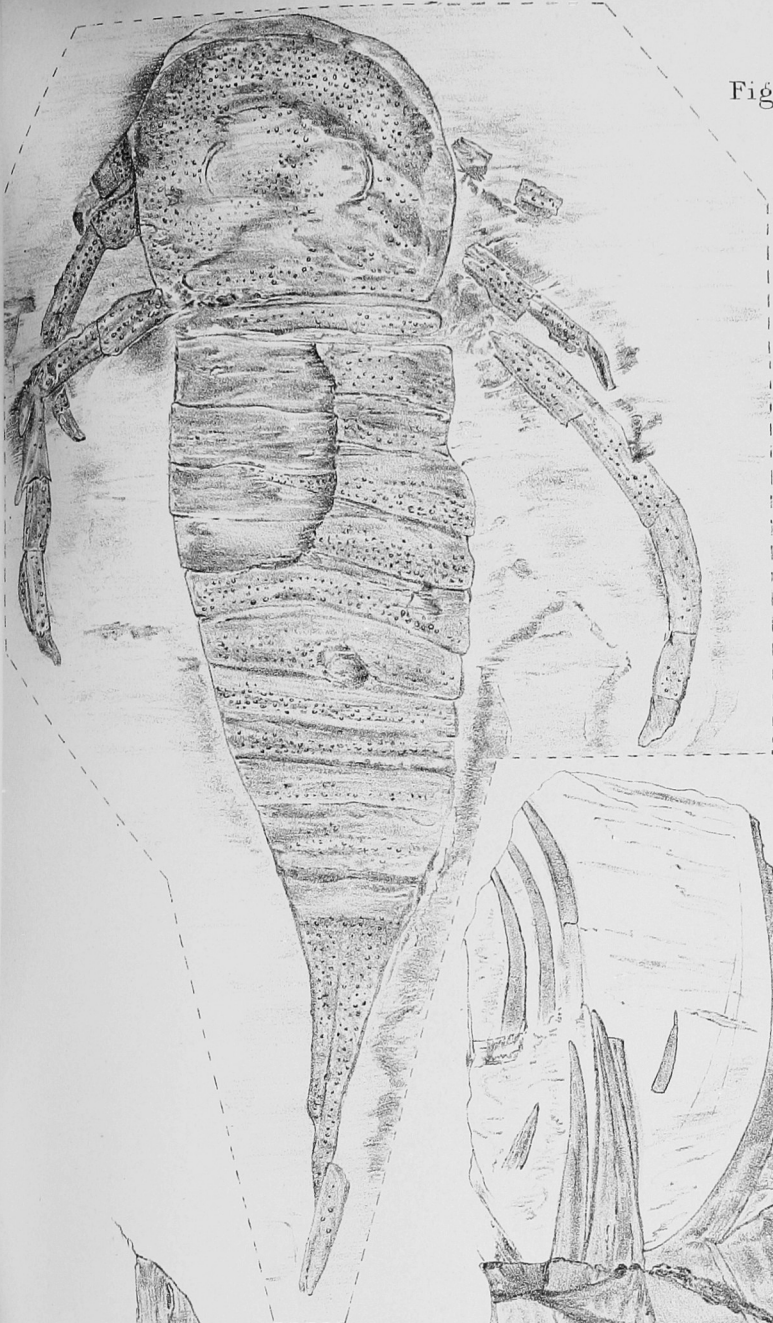


Fig. 24.

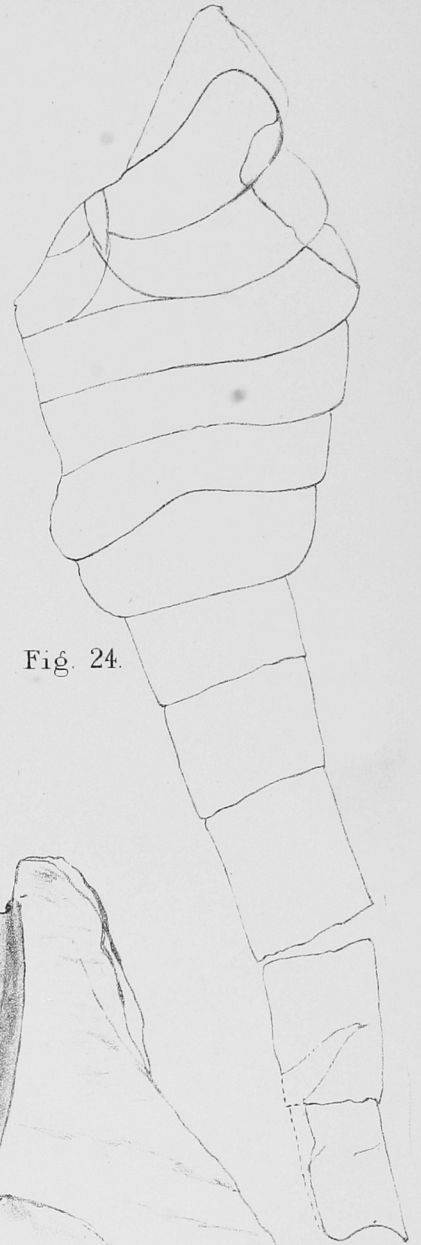
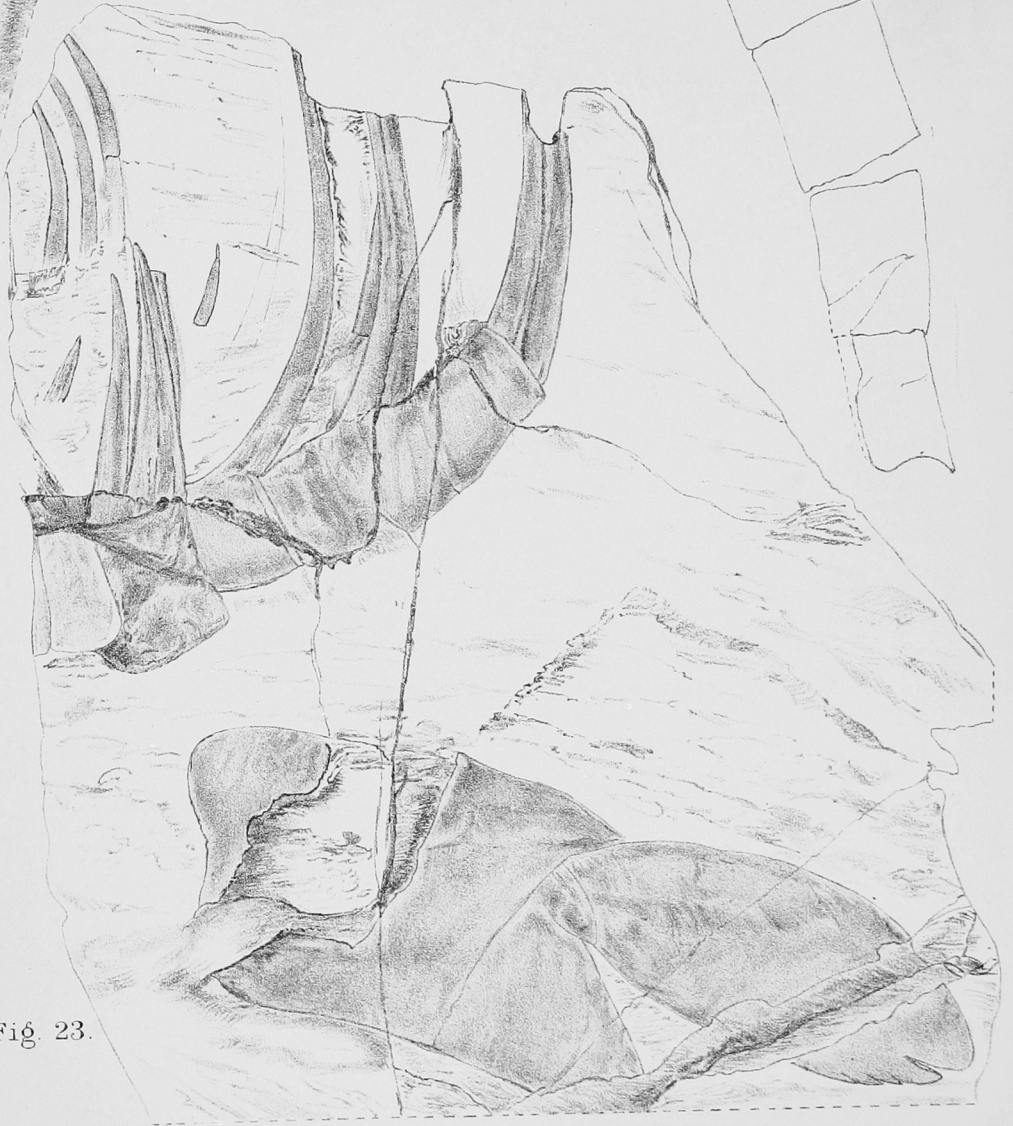


Fig. 25.



Fig. 23.



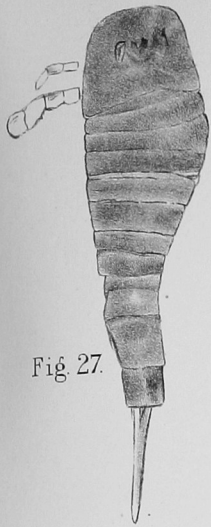


Fig. 27.



Fig. 28.



Fig. 29.



Fig. 30.



Fig. 31.



Fig. 32.

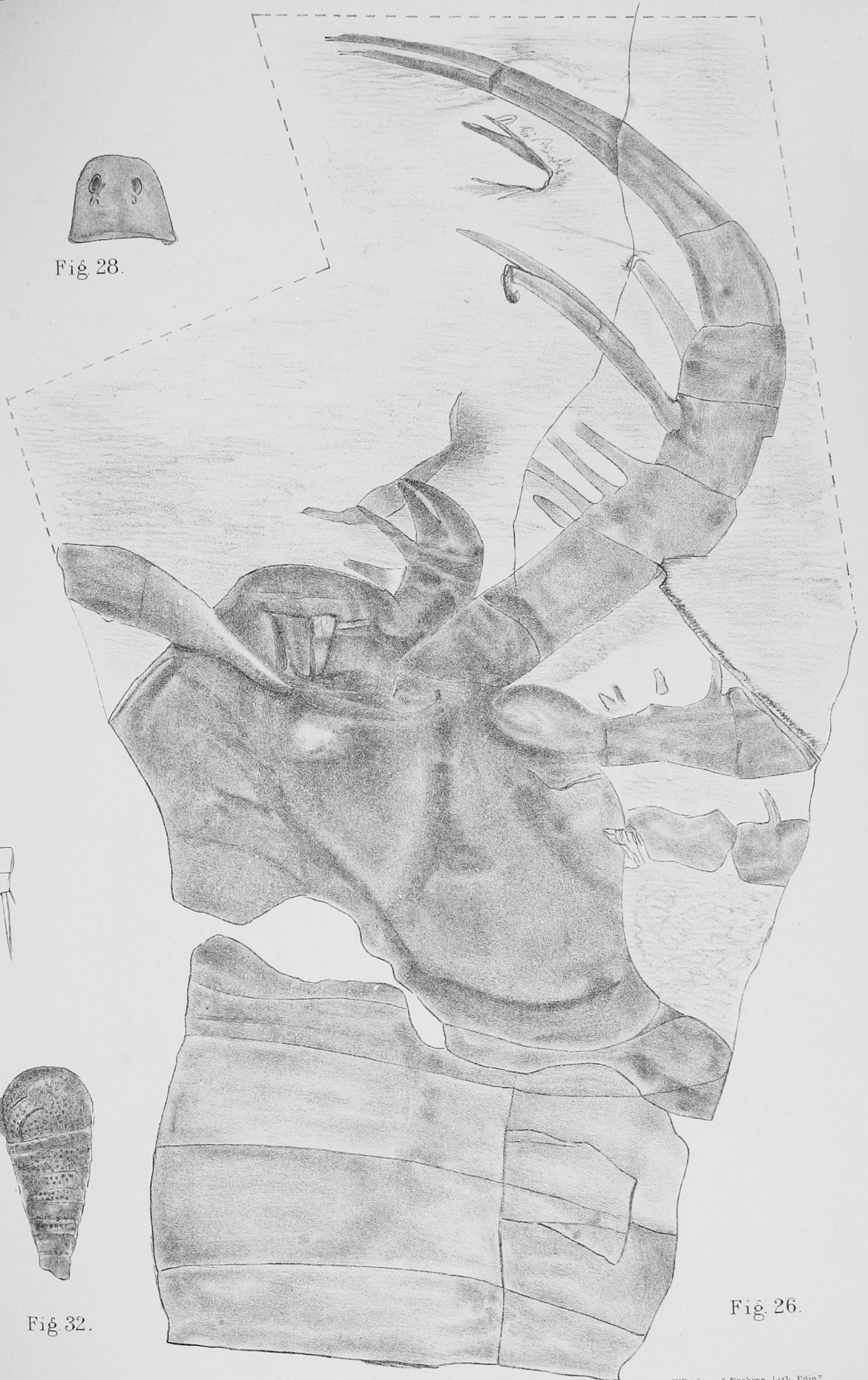


Fig. 26.