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A Monograph of the Terres-
trial Palaeozoic Arachnida
of North America

BY

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TO

PROFESSOR CHARLES SCHUCHERT

THIS MONOGRAPH IS RESPECTFULLY DEDICATED

BY

THE AUTHOR

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I.—A MONOGRAPH OF THE TERRESTRIAL PALAEOZOIC ARACHNIDA OF NORTH AMERICA

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INTRODUCTION

While European Carboniferous Arachnida have been made the subject of careful study, the results of which are incorporated in two extensive monographs, one by *Fritsch* in 1904 and the other by *Pocock* in 1911, the North American forms have received little attention since the publication of *Scudder's* researches. It is true that a few new forms have been described recently, but no attempt has been made to reinvestigate the whole subject. Moreover, as an extensive knowledge of Arachnology and especially of the external morphology of arachnids, is imperative for a correct interpretation of fossil remains, there is nothing surprising in the fact that errors crept into the diagnoses of *Scudder* and that these were repeated by *Melander*. Another reason for such errors was the fact that *Scudder's* and *Melander's* specimens were not sufficiently cleaned of the white¹ mineral which often entirely concealed the important characters. We find the most striking examples of this in an unpublished specimen belonging to the U. S. National Museum, which has been identified by *Scudder* as *Graeophonus carbonarius*, while it is in fact a new species of *Anthracomartus*, and in *Kustarachne sulcata* of *Melander* which is a typical *Curculioides*. Naturally the diagnoses of the genera themselves have likewise suffered from incomplete knowledge of the type specimens. This is rather unfortunate, since it not only necessitates a shifting of the American species from one genus to another, but resulted also in a wrong application of some generic names for European species, an unavoidable error on the part of the European investigators who did not have an opportunity to examine the Ameri-

¹ In some specimens it is calcium carbonate mixed with iron carbonate, in others kaolin.

can types. I feel therefore quite sure that the European palaeontologists and arachnologists will share with me the feeling of gratification at the great opportunity which was afforded me through the kindness of Professor Schuchert, to reëxamine and redescribe all American types and to extend the investigation over many as yet undescribed specimens. In view of my indebtedness to Professor Schuchert, at whose suggestion I undertook the research, through whose exertions the various collections were placed at my disposal, and who throughout my studies has given me many valuable and stimulating suggestions, it affords me great pleasure to dedicate this monograph to him. My thanks are also due to the U. S. National Museum, the University of Chicago, Harvard University, McGill University, the University of Illinois, Mr. L. E. Daniels, and the Peabody Museum of Yale University for permission to reinvestigate their collections. I also acknowledge with thanks the kind permission given to me by the Encyclopaedia Britannica Company to reproduce two figures of *Liphistius* from the eleventh edition of the Encyclopaedia, and by the University Press of Cambridge six figures from Hansen & Sørensen's monograph "On two Orders of Arachnida."

Every specimen was carefully cleaned under a binocular microscope and the rock covering unexposed parts removed by means of a needle and a small chisel. In some cases the chitin was found still preserved and was examined under higher power. The removal of the white mineral often covering the entire specimen and useful in the detection of appendages concealed in the rock, was not difficult and brought to light many important structures. More difficulties were offered by the rock in which the specimens are imbedded and which had to be removed in some cases to the depth of about $\frac{1}{4}$ of an inch. The specimens which are best preserved are nearly all imbedded in very hard nodules, a clay-iron stone, and required great care in handling. The softer rock surrounding other specimens showed all signs of decomposition and here the chiseling was easier but the preservation of the specimens themselves, not so good. After careful study under the binocular with the aid of artificial light which allows a more perfect reflection of the rays from the exposed surfaces, a drawing of each specimen was made by measuring its parts and enlarging them a given number of times. Thus all the text figures represent the specimens more or less correctly as they appear under the microscope. In many cases, however, both halves of the concretion show superimposed imprints of the dorsal and ventral surfaces of the specimen and obscure the actual structure. In such cases the super-

imposed structures were omitted from the drawing and where possible, each surface was drawn separately. Wherever this was necessary, special reference to it will be found in the text; but to avoid the possible objection of misinterpretation or misconception, all specimens drawn in text were photographed from the originals and are reproduced on the plates directly from the photographs. The photographing was done by Doctor R. S. Bassler of the U. S. National Museum.

The net results of the present investigation are as follows: (1) 101 specimens including all types were studied and found to belong to 42 species distributed over 25 genera; of these, 24 species and 13 genera are new to science; (2) the diagnoses of old genera are corrected in accordance with the new data obtained from the study of the types and of specimens which undoubtedly belong to the type species; (3) the genus *Eoscorpium* was found to be sound and is retained in the system; the genera *Hadrachne* Melander and *Geraphrynus* Scudder were found to be synonyms of *Architarbus* Scudder; (5) the type of *Geraphrynus carbonarius* was found to be in every detail identical with the type of *Architarbus rotundatus*, the former name being, therefore, a synonym of the latter; (6) a representative of the order Solifugae hitherto unknown to Palaeontology has been found in *Protosolpuga carbonaria* n. gen., n. sp.; (7) a new order *Kustarachnae* has been established for the three species of *Kustarachne*.

THE SYSTEM

Although the class of Arachnida has received a good deal of attention from zoologists and palaeontologists, there exists still considerable divergence of opinion as to the essential characters separating this class from the rest of the arthropods. The typical forms such as scorpions and spiders have only 6 pairs of uniramous appendages of which the first pair is praeoral. The segmentation of the legs is also alike in the typical forms and shows the close relation existing between them. This is also true of the Xiphosura and Gigantostraca (Eurypterida) which are now usually placed in the class of Arachnida.

Yet under the influence of parasitism this character becomes more or less obliterated and we find only 4 pairs of appendages in the family Eriophyidae among the Acari. On the other hand Pycnogonida which are often classed as an order of marine Arachnida, show

a variable number of appendages from 4 pairs in *Pycnogonum littorale* to 8 pairs in *Decalopoda*. The order Tardigrada has also been considered to belong to the class Arachnida, as highly degenerate forms descended from Acari. This view has recently been abandoned on good grounds, since the internal organization of these little invertebrates has little in common with either typical or aberrant forms. It has been pointed out by different authors that a complete absence of a meso- and metasoma and the opening of the sexual ducts into the intestinal canal, has no homologon among Arachnida. It is true that the abdomen has almost completely disappeared in the case of Pycnogonids also, and that the sexual ducts in this group also open in a way not similar to that in Arachnida. But the Pycnogonids have, at least, segmented appendages, while the so called feet of the Tardigrada are not segmented. But the absence of segmentation may be due to the loss of it during the phylogenetic development just as it has been lost in the abdomen of true spiders and ticks, where it appears only in the embryonic development. Moreover, the legs of some mites show a considerable tendency in the same direction of reducing the normal number of segments and of obliterating the external signs of segmentation. The order of Pentastomida is also frequently placed in the class of Arachnida. The four chitinous hooks of the adult are homologized with the first and second pair of appendages and derived from the two pairs of appendages of the larval stage. The loss of the remaining four pairs is attributed to the highly specialized parasitism of the Pentastomida. But if these forms have ever developed from typical Arachnida, there is certainly no evidence of their past history left either in the anatomy or the embryology of the now living forms. It may be safer, therefore, to derive both the Tardigrada and the Pentastomida directly from primitive, annulated worms, and to regard them as separate phyla.

In the internal organization of Arachnida there are several structures in common to the majority of them, such as the coxal glands for example, but the influence of parasitism extends to internal characters as well as to external structures and has resulted in a degeneration of many organs. Thus the characteristic organs of respiration are wholly lacking in many mites and in other forms have followed two different courses of development. The division of the body into a cephalothorax and an abdomen, also holds good only in the case of typical Arachnida. In the Solifugae we find the cephalothorax not yet completely fused, since the last three segments are free; in the Ricinulei there is a movable plate in front of the first pair of appendages; in the Opiliones the body shows a tendency

toward a fusion of cephalothorax with abdomen and this is brought to completion in the Acari.

In view of such difficulties in the way of building a system based on comparative anatomy alone, *Ray Lankester* has made the attempt to employ as main character of the class, the true segmentation of the head. We must bear in mind that the *visible* segmentation is not always a correct criterion for the true segmentation and that segments may without difficulty be traced in the internal organization of an animal when all evidence of their existence has been entirely obliterated from the chitinous exoskeleton; but even the internal organization of an adult arachnid may show no evidence of segmentation while the embryological stages leave no doubt of its having once existed.

Lankester divides the Euarthropoda which form his Grade C in the subphylum Arthropoda of the phylum Appendiculata, into 5 classes: Diplopoda, Arachnida, Crustacea, Chilopoda and Hexapoda. He derives them from a "common ancestor resembling a Chaetopod worm, but differing from it in having lost its chaetae and in having a prosthomere¹ in front of the mouth (instead of prostomium only) and a pair of hemignaths (mandibles) on the parapodia of the buccal somite. The structure of the head in Arthropods presents *three* profoundly separated grades of structure dependent upon the number of prosthomeres which have been assimilated by the prae-oral region." His classification is as follows:

Phylum APPENDICULATA

- Sub-phylum I. Rotifera
- „ II. Chaetopoda
- „ III. Arthropoda

Grade A. Hyparthropoda (Hypothetical forms)

- „ B. Protarthropoda
 - Class Onychophora
- „ C. Euarthropoda

- Class 1. Diplopoda (Head monoprosthomeros, deutero-
gnathous)
 - „ 2. Arachnida (Head diprosthomeros, tritognathous)
 - „ 3. Crustacea
 - „ 4. Chilopoda
 - „ 5. Hexapoda
- } Head triprosthomeros, tetarto-
gnathous

* Prosthomeres are the segments in front of the mouth opening.

The second class or Arachnida are characterized by Lankester as follows :

“Head diprosthomerous, tritognathous—that is to say, with two prosthomeres, the first bearing typical eyes, the second a pair of appendages reduced to a single ramus which is in more primitive forms antenniform, in higher forms chelate or retrovert. The ancestral stock was pantognathobasic—i. e. had a gnathobase or jaw process on every parapodium. As many as six pairs of appendages following the mouth may have an enlarged gnathobase actually functional as a jaw or hemignath, but a ramus is well developed on each of these appendages either as a simple walking leg, a palp or a chela. In the more primitive forms the appendage of every post-oral somite has a gnathobase and two rami ; in higher specialized forms the gnathobases may be atrophied in every appendage, even in the first post-oral.

“The more primitive forms are anomomeristic ; the higher forms nomomeristic, showing typically three groups or tagmata of six somites each.

“The genital apertures are placed on the first somite of the second tagma or mesosoma. Their position is unknown in the more primitive forms. The more primitive forms have branchial respiratory processes developed on a ramus of each of the postoral appendages. In higher specialized forms these branchial processes become first of all limited to five segments of the mesosoma, then sunk beneath the surface as pulmonary organs, and finally atrophied, their place being taken by a well-developed tracheal system.

“A character of great diagnostic value in the more primitive Arachnida is the tendency of the chitinous investment of the tergal surface of the telson to unite during growth with that of the free somites in front of it, so as to form a pygidial shield or posterior carapace, often comprising as many as fifteen somites (Trilobites, Limulus).”

Sub-divisions of the class Arachnida according to Lankester:

Class ARACHNIDA

Grade A. Anomomeristica

Sub-class Trilobitae

Orders. Not satisfactorily determined

Grade B. Nomomeristica

Sub-class I. Pantopoda

Order 1. Nymphonomorpha

„ 2. Ascorhynchomorpha

„ 3. Pycnogonomorpha

Sub-class II. Euarachnida

Grade a. Delobranchia, Lankester (vel Hadropneusta Pocock)

Order 1. Xyphosura

„ 2. Gigantostraca

Grade b. Embolobranchia, Lankester (vel Aeropneustea Pocock)

Section α . Pectinifera

Order 1. Scorpionidea

Sub-order a. Apoxypoda

„ b. Dionychopoda

Section β . Epectinata

Order 2. Pedipalpi

Sub-order a. Uropygi

Tribe 1. Urotricha

„ 2. Tartaridea

Sub-order b. Amblypygi

Order 3. Araneae

Sub-order a. Mesothelae

„ b. Opisthothelae

Tribe 1. Mygalomorphae

„ 2. Arachnomorphae

Order 4. Palpigradi (= Microtelyphonidae)

Order 5. Solifugae (= Mycetophorae)

Order 6. Pseudoscorpiones (= Chelonethi)

Sub-order a. Panctenodactylii

„ b. Hemictenodactylii

Order 8. Opiliones

Sub-order a. Laniatores

„ b. Palpatores

„ c. Anepignathi

Order 9. Rhynchostomi (= Acari)

Sub-order a. Notostigmata

„ b. Cryptostigmata

„ c. Metastigmata

„ d. Prostigmata

„ e. Astigmata

„ f. Vermiformia

„ g. Tetrapoda

This classification does not include some of the extinct orders and involves several assumptions which possess as yet only the value of more or less useful hypotheses. In his article on Arthropoda in the

eleventh edition of the Encyclopaedia Britannica, Lankester himself writes.

“According to older views the increase in the number of somites in front of the mouth would have been regarded as a case of intercalation by new somite-budding of new prae-oral somites in the series. We are prohibited by a general consideration of metamerism in the Arthropoda from adopting the hypothesis of intercalation of somites. However strange it may seem, we have to suppose that one by one in the course of long, historical evolution somites have passed forwards and the mouth has passed backwards. In fact, we have to suppose that the actual somite which in grades 1 and 2 bore the mandibles lost those mandibles, developed their rami as tactile organs, and came to occupy a position in front of the mouth whilst its previous jaw-bearing function was taken up by the next somite in order, into which the oral aperture had passed. A similar history must have been slowly brought about when this second mandibulate somite in its turn became agnathous and passed in front of the mouth. The mandibular parapodia may be supposed during the successive stages of this history to have had, from the first, well-developed rami (one or two) of a palp-like form, so that the change required when the mouth passed away from them would merely consist in the suppression of the gnathobase. The solid, palpless mandible such as we now see in some Arthropoda is, necessarily, a late specialization. Moreover, it appears probable that the first somite never had its parapodia modified as jaws, but became a prosthomere with tactile appendages before parapodial jaws were developed at all, or rather *pari passu* with their development on the second somite.”

In discussing the validity of Lankester's system which unquestionably has much in its favor, we have to subject the following questions to a careful scrutiny: (1) Do we possess any evidence that post-oral somites (opisthomeres) have passed forward and become prosthomeres? (2) What evidence can be brought in support of the assertion that both grades of Lankester's class Arachnida have two prosthomeres, while the Crustaceae, Chilopoda and Hexapoda have three prosthomeres? (3) Is it right to assume that the appendages of the somites which passed in front of the mouth have changed their function as jaws to become tactile organs, or is the second alternative of Lankester's more correct, “that the buccal gnathobasic parapodia (the mandibles) were in each of the three grades of prosthomerism only developed after the recession of the mouth and the addition of one, of two, or of three post-oral somites to the prae-oral region had taken place.”? (4) Is the segmentation of the head of fundamental,

phylogenetic value and does it justify the expansion of the class to include also the Trilobites and Pantopods ?

Numerous embryological studies have given an affirmative answer to the first question. It has been shown by *Heymons* that in the Chilognatha, of the three pairs of post-oral embryonic segments designated respectively as prae-antennal, antennal and prae-mandibular, the second develops the antennae of the adult, the first forms transient appendages, while the third disappears altogether at an early stage. The fourth post-oral segment gives rise to the mandibles. In insects we have a somewhat similar condition, the antennae arising from the second post-oral segment while the third segment gives origin to a temporary, embryonic pair of appendages. The protencephalon, on the other hand, representing the first, prae-oral segment, is divided into three lobes, the first of which develops into the optic ganglion while the second and third give rise to the brain proper. In the adult insect the procerebral lobes of the brain give rise to the nerves of the ocelli or simple eyes. The class Crustacea is somewhat different from the two preceding ones. Here it is more or less customary to regard the eyes as modified appendages of the first prae-oral segment and this view has gained some support in the experiments of *Herbst*, which show that in place of an amputated eye under circumstances an antenna may develop. But it is far from being evident that regeneration repeats past history. Double members may be produced artificially in lower vertebrates by splitting the germ of the anterior or posterior leg and it is clear that they do not represent structures which once existed but have been lost. Moreover, the early larva of the lowest crustaceans, the so called Nauplius, has only three pairs of appendages, all of which belong to post-oral somites. Of these appendages the first pair becomes the antennules, the second the antennae and the third remains post-oral and changes into the mandibles. The eyes of higher crustaceans develop later and occupy a position in front of the antennules.

Among the recent Arachnida the spiders have been studied by different investigators and their embryology is better known than that of any other order. It is beyond any doubt that the cheliceral segment appears originally as a post-oral metamerite and occupies later the position in front of the mouth. There is, however, a great divergence of opinion as to whether the eyes represent a separate segment and whether they are homologues to the eyes of crustaceans and insects. In a recent paper on the development of *Ischnocolus*, *Schimkewitsch* writes :

„Das Nervensystem besteht auf diesem Stadium im Cephalothorax aus Ganglien, welche in ihrem Inneren deutliche, noch nicht verschlossene Höhlen aufweisen, und zwar aus dem unpaaren Nackenganglion und einer Reihe von paarigen Ganglien: zwei Paaren Scheitelganglien, zwei Paaren Augenganglien (das eine für die seitlichen, das andere für die mittleren Augen) dem paarigen Chelicerenganglion, dem paarigen Pedipalpenganglion, vier Paaren Beinganglien und einem paarigen Abdominalganglion; im Hinterleibe dagegen liegen drei Paare einzelner Ganglien und eine hintere gangliöse Masse, welche aus mehreren Ganglien zusammengesetzt ist“ (S. 705).

With other words we have one single and five paired ganglia which will make up the brain of the adult spider and furnish the nerves for the prae-oral segments. The single ganglion may be compared to the ganglionic mass in the prostomium of Polychetes but there seems to be no good reason why the paired ganglia should not be considered as forming five segments. Although Schimkewitsch does not mention any ganglion for the rostrum (upper lip) the latter has been considered by *Montgomery* to represent in *Theridium* "a pair of true prae-oral appendages, of which the rostral sacs constitute the coelom and the cerebral ganglia the neuromeres." He based his idea of the segmentation of the head on the number of coelomic sacs and of paired appendages and came therefore to the conclusion that spiders have only two prae-oral segments, the rostral (the first) and the chelicer (the second). This conception seems to me to contain an error since the rostrum lies behind and not in front of the chelicera. On examining my own sections through young *Lycosas* and adult *Pholcus* I find that the pair of nerves supplying the rostrum arises *behind* the nerves of the chelicera and represents the last pair of nerves given off by the supraoesophageal ganglionic mass or brain. At present I am, however, unable to state whether these rostral nerves arise merely from the lower lobes of the paired ganglion of the chelicera or have their own pair of ganglia. The neuromeres of the brain are well defined in young spiders, although of course not completely separated as in embryonic stages. Do they represent separate segments? It is hard to say. A typical segment is usually composed of several meroms such as skeletal plates, myomeres, coelomic sacs, neuromeres and a pair of appendages. In different regions of the body any one of these meroms may be entirely eliminated or fused with a corresponding merom of the adjoining metamere and there seems to be no good reason why neuromeres should not be as important as coelomic meroms. We may therefore say that, while it is certain that post-oral somites have occupied a prae-oral position, there is no sufficient evi-

dence for the assertion that Arachnida and Diplopoda have only two prosthomeres while the Crustacea, insects and Chilopoda have three. It seems to me, on the contrary, that in Arachnida and insects more than three prosthomeres went into the formation of the prae-oral part of the head. The anterior middle eyes of Arachnida correspond both in structure and nerve supply to the simple eyes of insects (ocelli) and did not originally belong to the same segment as the side eyes. In the following tables I give for comparison the segmentation in arthropods according to E. R. Lankester, and of the homologous organs of the head, as it appears from a comparative study of the development and structure of the brain. I want to state, however, that the second table is only a tentative one and that further research will be necessary before the true segmentation of the head in arthropods may be clearly understood.

TABLE I.

Segmentation of the head in different classes of arthropods according to E. R. Lankester¹

Segments	Diplopoda	Arachnida	Crustacea	Chilopoda	Hexapoda
1.	Eyes	Eyes	Eyes	Eyes	Eyes
2.	Antennae	Chelicera	Antennules	Antennae	Antennae
3.	Mandibles	Pedipalpi	Antennae	Intercalary	Intercalary
4.	Maxillulae	1 p. legs	Mandibles	Mandibles	Mandibles
5.	Gnathochilarium	2 p. legs	1 Maxillae	Maxillulae	Maxillulae
6.	Embryonic segment	3 p. legs	2 Maxillae	1 Maxillae	Maxillae
7.	1 p. legs	4 p. legs	1 Maxilliped	2 Maxillae	Lower lip

TABLE II.

Homologous structures in the head of some arthropods according to my own interpretation

Crustacea	Diplopoda	Chilopoda	Hexapoda	Araneae	Limules
				Median ganglion	
				1 p. parietal gangl.	
				2 p. parietal gangl.	
Eyes	Eyes	Eyes	Ocelli	Median eyes	Median eyes
Procerebrum			Comp. eyes	Lateral "	Lateral "
Antennules	Antennae	Antennae	Antennae		Olfactory org.
Antennae		Intercalary	Intercalary	Chelicera	Chelicera
Upper lip	Upper lip	Upper lip	Upper lip	Upper lip	Upper lip

¹ This table was not taken from any of Lankester's writings, but composed by me on the basis of his ideas.

A definite answer to the third question cannot be given at the present state of our knowledge. This much seems to be beyond doubt, that appendages *do* change their function in passing from a post-oral to a prae-oral position. Thus the two anterior pairs of appendages in the Nauplius of lower crustaceans serve as swimming legs, while the homologous appendages in adult Malakostraca are antenniform sense organs. On the other hand the chelicera of arachnids are still usually functioning as mouth parts although in somewhat different way owing to their position in front of the upper lip. They have, however, lost their gnathobase which is still present in the embryological stages.

From the foregoing it does not appear reasonable to use the true segmentation of the head as basis for a classification of arthropods before new embryological data are brought in support. The very fact that the segmentation is of primal importance should caution us against drawing conclusions from insufficient premises. The classification which I give further on, is therefore based on characters ascertainable even from palaeontological specimens although derived mainly from the comparative anatomy of recent forms. As the different systems proposed by various investigators are to be found in the recent monograph of Pocock, I refer the reader who is desirous of becoming acquainted with them, to this monograph. The discussion of Pocock's system will be found in connection with the definition of each separate order.

Phylogenetic Development of the Arachnida.

Little may be said concerning the phylogenetic development of arthropods. That they have developed from chaetopodous segmented worms appears to be the only possible conjecture. But the lines along which they developed are so different and the forms so specialized that the assumption of a polygenetic origin with diverging and converging development seems to be more probable than that of a gradual branching of a common ancestral stock. By this I mean that the different classes of arthropods must have developed not from one ancestor, but at different times and from different species of chaetopodous worms, and that this may be true even for some orders of the same class.

Until quite recently the origin of the scorpions presented, as it seemed, the least difficulties. The segmentation of their body, the shape and size of the cephalothorax, the number of appendages, the presence of a simple telson, remind so strongly of Eurypterids that their derivation from these aquatic arachnids appeared to be much

more than a mere hypothesis. One had only to imagine that such eurypterids as *Slimonia acuminata* or *Eusarcus scorpionis* acquired the habit of living in very shallow water and changed gradually into scorpions. The only difficulty in the way of such change seemed to lie in the difference of the respiratory organs of scorpions and Eurypterids. But the ingenious explanation of the origin of lung-books from gill-books through an insinking of the latter first brought forward by Lankester and the subsequent observations of Brauer on the embryos of scorpions tended to obviate even this difficulty. The correctness of this interpretation is so apparent, that Lankester has even ventured to express the hope of finding some day specimens of Silurian scorpions which still led aquatic life and breathed by means of gill-books. The absence of spiracles in the fossil *Palaeophonus*, a negative character on which Lankester builds his hope, may however be due merely to poor preservation. This seems to be the more probable since none of the upper Carboniferous arachnids of North America show the slightest trace of spiracles and yet there cannot be any doubt as to their having led a terrestrial life. For a while I thought that perhaps the eurypterids themselves had already internal gill-books of the lungbook type, with spiracles somewhat similar to those of the scorpion, and connecting the gill cavity with the outside. In that case nothing but a change in function would be required to transform them into the lung-books as we find them in recent scorpions. One could imagine that the insinking took place in aquatic arachnids as a protection against injuries on the one hand and against too rapid drying in case of temporary exposure to air on the other hand. I tried to find support for my assumption not in the absence of spiracles in remains of terrestrial arachnids, but in the size and position of the gill-books in Eurypterids. Disregarding the presence of gill-books in the second abdominal somite where in the scorpion they are modified into combs, their size and position in the following four somites correspond almost exactly with the size and position of the lung-books. A mere impression of lamellae on the concretion in the absence of an impression of spiracles could be readily interpreted in either sense. Moreover, the overlapping of the gill-plates and still more the presence of narrow bands, of the same width as the overlapping, in specimens with distended abdomen reminded me strongly of the conditions in modern scorpions where the abdominal sclerites are connected with each other by means of soft membrane. However, after some search for an explanation Professor Schuchert was able to convince me that what I was inclined to interpret as overlapping sclerites of the abdominal wall

were in reality overlapping gill-plates which are slightly longer than each segment and are connected with the body wall at the anterior edge of each segment. At least on the longitudinal section of one specimen of *Eurypterus remipes* one can see on the outside the heavier outline of the gill-plate with the mould of the gill-book and at a little distance from it inward a thin black line representing evidently the body wall. The appearance of this line suggests that the ventral body wall of the mesosoma in eurypterids was not chitinized, but thin and soft. Herein it resembles the ventral body wall of Palaeozoic scorpions, which as I try to show in the Special Part was most likely thin and soft. But a derivation of the scorpion's lung-books from such gill-books as those in *Eurypterus* seems highly improbable. The line of attachment of the gill-plates in *Eurypterus*, as I have mentioned above, is at the anterior edge of the somite, whereas the spiracles of the scorpion are in the posterior half of the segment. Before an insinking could have taken place, the gill-plate must have first moved down along the surface of the somite, a condition not known to occur in any of the described eurypterids. Another blow to a theory of the origin of scorpions from eurypterids comes through the beautiful work of Clarke and Ruedemann on the Euryptera of New York which was published while my present monograph was still in the printing. In this exhaustive study of the rich material obtained from different horizons the authors not only bring together all that was known already about eurypterids, but widen and deepen our knowledge of the group in many respects. Although they seem to be in error when they refuse to homologize the sternum of the scorpion with the metastoma of the eurypterids and the chilaria of *Limulus*, they show conclusively that eurypterids have in some respects more similarities with limuloids than with scorpions. The presence of five pairs of gills, the large operculum of the second abdominal somite, the structure of the eyes, the large carapace and smaller number of segments in embryonic stages are of especial importance. The long prosoma and thin metasoma of scorpion embryos are the most important characters separating them from eurypterids. On the other hand the fusion of abdominal segments even in the oldest limuloid, *Protolimulus eriensis*, from the Devonian and the absence of even partial fusion in eurypterids from the Cambrian to the Permian suggests "that the limulids and eurypterids were probably separate in Precambrian time." It is interesting to mention in this connection that according to our authors the eurypterids of New York may be divided into four groups in regard to their mode of life and that the different deposits in which they are found show

that "while the earlier eurypterids were marine and their climacteric fauna euryhaline; their later habit throughout the Devonian and Carbonian led them finally into the fresh water." The species which is most interesting inasmuch as it shows a close resemblance to scorpions, is *Eusarcus scorpionis* from the Silurian (Bertie waterlime) quarries at Williamsville and Buffalo. Yet it does not seem reasonable to imagine that *Eusarcus* is an ancestor of scorpions, first because of the differences in structure and development mentioned above, and then because of the occurrence in the same waterlime of a true Silurian scorpion, *Proscorpius osborni*, which must have led a marine life. Of the European eurypterids none resembles scorpions more than *Slimonia acuminata*, yet in this case the same objection holds true and true scorpions were there already represented by *Palaeophonon*. There remains then the only alternative that the Xiphosura, Eurypterida and scorpions developed independently and that the great similarity between such forms as *Slimonia*, *Eusarcus* and scorpions is due to convergence, as Thorell has already suggested.

The Haptopoda, Phalangiotarbi, Anthracomarti, Opiliones and Acari show some remarkable similarities in structure and may have had another common ancestor, but no Acari are known to have occurred in the Palaeozoic era and there are no connecting links between either of these orders and the trilobites. The pseudoscorpions are not known to occur in the Palaeozoic. They show only external similarity to scorpions and their origin cannot be traced. In the number of abdominal segments and in the arrangement of the coxae they resemble rather the Pedipalpi, but it would be very hazardous to derive them from this group. The Solifugae stand quite isolated. The Pedipalpi and Araneae have much in common both in their external and internal organization, but their origin is as dark as that of the preceding orders.

Great activity in the production of new arachnid forms must have taken place at the end of the Devonian or the beginning of the Lower Carboniferous period, since, the Coal Measures or Pennsylvanian show already the majority of orders in full development. All these forms have undoubtedly the structure of terrestrial arachnids, although it is not impossible that some Anthracomarti and Phalangiotarbi led an aquatic life similar to that of recent hydrachnids among the Acari. *Fritsch* has pointed out that on the bodies of two Bohemian species of *Promygal*, which genus according to *Pocock* is synonymous with *Anthracomartus*, are found parasitical gastropods, *Spiroglyphus*, whereas all other arachnids from the same region are free from them. This argument, however,

does not seem to me to be convincing. The specimen of *Geralinura gigantea* in the possession of the U. S. National Museum shows a lamellibranch in the same concretion, yet there can be no doubt that all species of *Geralinura* were terrestrial arachnids. As Professor Schuchert has pointed out to me, the impression of marine animals on the same concretion with arachnids is probably due to the fact that the dead creatures were washed from the land into the sea where they became fixed in the mud with the other brackish-water remains. The more or less frequent occurrence of ferns in the same concretion with arachnids is due to the same cause and points to the fact that such species lived in a moist climate. We may further conjecture that it was a hot climate, since the majority of living forms of the same orders are mainly distributed throughout the tropical and sub-tropical zones. It is true that the recent representatives of Pedipalpi and especially of Solifugae are more characteristic of dry regions, many of them being even true desert forms; yet on the one hand, a change in climate may have brought about a change in habits, and on the other, species are known which still prefer wet regions. Thus I have found a Solifugid and amblypygous Pedipalpi under bark of decaying tree trunks on the western coast of Chiapas where the yearly rainfall is very high and the country rich in tropical rain forests. Some species of scorpions and many Theraphosid spiders are found in quantities in the lowest parts of tropical jungles.

The similarity in structure between extinct forms and recent ones suggests that the food must also have been similar, consisting of land animals belonging to the arthropods, possibly some arthrostracous crustaceans, and more certainly Palaeodictyoptera, Protoblattoidea, and arachnids. The Anthracomarti and Phalangiotarbi must have been preying on very small invertebrates since their mandibles were so weak that no traces of them are left. It is not impossible that some of them were phytophagous. The methods of defense against enemies must also have been similar, since the scorpions show a well-developed poison gland and the mandibles of the Pedipalpi and Araneae were apparently of the same type as those of recent forms. It might be supposed that the poison apparatus developed for the purpose of killing the prey and not for self defense, but the study of living arachnids show that they avoid using their poison for that purpose. I have tried in vain to find among the fossils studied some evidence in regard to their methods of reproduction. The distended abdomen of some scorpions and Pedipalpi is indicative of their being gravid females.

Whether the scorpions of the late Palaeozoic were already viviparous or still laying eggs, and whether the male spiders had their copulatory apparatus in the palp as is the case with recent spiders and those from the amber, can be determined only when more favorably preserved material is found.

Comparison of the North American Upper Carboniferous Arachnological Fauna with that of Europe and with the Recent Fauna.

In comparing extinct Arachnida of one fauna with those of another we must remember that the most important generic and specific characters are often missing. To avoid unnecessary repetition I shall give an illustration of the truth of this statement in the case of the scorpions which by virtue of their size and the hardness of their skeleton ought to present the least difficulties. One of the most important not only specific, but generic characters is the arrangement of the granules on the edge of the fingers of the pedipalp. None of the Carboniferous scorpions of Europe and North America shows the slightest sign of these granules. Of course it may be assumed that they did not have such granules, that the granules are of more recent origin. But the similarity in other characters makes such an assumption improbable. The very fact that the pedipalp, bent in its normal position, presents the sides of the fingers, is a sufficient cause to prevent us from seeing the granules and would make it extremely difficult to obtain a mould of them even in large recent forms. A character of great importance in the systematics of recent scorpions is the presence of one or of two spines in the articular membrane at the base of the last joint of the legs. The recent family Scorpionidae has only one such spine, while in the other five families there are at least two spines. This character in recent forms is naturally combined with other characters of importance, such as the shape of the sternum, the structure of the comb and the number of side eyes. Anyone who has had opportunity to study recent scorpions will agree with me that the side eyes are visible only when the light falls on them under a definite angle and cannot be distinguished from round granules accompanying them when the light strikes them under another angle. It is nothing strange, then, that our knowledge of the side eyes in Carboniferous scorpions is inaccurate and that this character is not of great use. The sternum and the comb are sometimes very well preserved, but in the great majority of cases the comb is missing. To hope ever to find some of the finer specific characters such as the trichobothria, would be simply childish. What

is true of the scorpions is true to a still greater extent in some of the other orders. Thus the genera and species of recent spiders are based almost entirely on such characters as will never be found preserved in Carboniferous forms. What value then have the genera and species of that extinct fauna? We may safely say that in the majority of cases the species of Carboniferous arachnids would have the value of genera in a recent fauna. Many genera would be regarded as families and some families as suborders. If therefore, basing our judgment on the preserved characters, we should come to the conclusion that a certain Carboniferous European species is identical with a North American one, we would be judging from insufficient evidence. Fortunately such cases do not exist and the Carboniferous species of North America are clearly distinct from those of Europe.

Of the extinct orders the Haptopoda, represented by a single species *Plesiosiro madeleyi*, are known only from Europe, and the Kustarachnae, represented by three species of a single genus, only from North America. The orders Anthracomarti and Phalangiotarbi, both extinct, are represented in both countries. The order Anthracomarti is much richer in Europe than in North America. Its first family, Anthracomartidae, is represented there by 4 genera with 12 species; of these the genus *Anthracomartus* is represented in Europe by 9 species as against 2 species in North America. It is the only genus of the family so far discovered in North American deposits, and it is interesting to mention that neither of the two species has been found at Mazon Creek, the *A. trilobitus* being a common arachnid from Arkansas in strata somewhat older and *A. triangularis* being represented by a single specimen from the Joggins Mines in Nova Scotia from Leds younger than those of Mazon Creek. The second family, Eophrynidae, is represented in Europe by 13 genera with 16 species, in North America by 3 genera with 4 species. Of these the genera *Areomartus* and *Trigonomartus* are American, while the two species which I have placed under Pocock's genus *Trigonotarbus* may in reality be representatives of a separate genus. Among the Phalangiotarbi the family Heterotarbidæ with its single species *Heterotarbus ovatus* is known only from this country. The family Phalangiotarbidæ is represented in Europe by a single genus and species, *Phalangiotarbus subovalis*, which does not occur in North America, as against 3 genera with 4 species in this country. The family Architarbidæ is represented in North America, by the genera *Opiliotarbus* and *Architarbus*, the first with 1, the second with 3 species. In Europe it is represented by *Architarbus* alone, of which there are known 5 species.

Turning now our attention to the other orders represented both in the Carboniferous and recent faunas, we must first of all exclude from consideration the few very inadequately known forms of Opiliones. The presence of maxillary lobes in the coxae of recent Opiliones would speak for an old origin of this order, but for some reason it is very poorly represented in the Carboniferous fauna, if indeed the species described under it belongs to it. The order Ricinulei is at present entirely confined to Africa and Brazil, but is represented in the Carboniferous of both Europe and North America. The carboniferous genus *Polyochera* belongs apparently to the recent family Cryptostemmidae. One species is known from Europe and 2 from Mazon Creek. The genus *Curculioides* belongs to the extinct family Holotergidae, which represents a further development inasmuch as the separate tergites are fused into one shield. It is represented by a single species in Europe and 2 species in North America. The order Solifugae is at present represented mainly in tropical and hot countries, but some species occur in the southern United States, going as far north as Kansas, and some in South Russia and southern Europe (Greece, Spain). The only Carboniferous species of this order is from North America. The order Araneae or spiders is, perhaps with the exception of the Acari, the richest among recent Arachnida. Of its three sub-orders, the Arachnomorphae are spread all over the world. The Theraphosae or Mygalomorphae, including all "tarantulas" and trap-door spiders, are preëminently tropical, but some species occur as far north as southern France in Europe and the District of Columbia in this country. The third suborder, or Mesothelae, is almost wholly extinct. Only 2 recent species are known from Pinang and Sumatra. This was the best represented sub-order among the spiders of the Carboniferous period. It was much better represented in Europe than here; we have only 1 genus with 2 species, whereas 5 genera containing 5 species have been described from Europe and 6 more European species have been probably incorrectly placed under the American genus *Arthrolycosa*. No remains of the Mygalomorphae are known either from Europe or from North America. Of the Arachnomorphae 3 species belonging to as many genera have been described from Europe, but no representatives of this sub-order have been found in North America, although the recent North American spider fauna is richer than the European one. The order Pedipalpi is at present restricted to hot and tropical countries. It is totally absent in Europe, while 1 species of a whip scorpion and 2 species of the sub-order Amblypygi are found in Texas, Florida, Arizona and California. The sub-order Uropygi or whip scorpions are re-

presented in the North American Carboniferous fauna by the genus *Generalimura* with 3 species. In England it is represented by 1 species, *G. britannica*, and in Bohemia by *G. bohémica*. The real generic characters used in the systematics of recent whip scorpions are not preserved in the Carboniferous specimens, and the American species may in reality belong to a different genus from the European ones. The sub-order Amblypygi is represented in this country by 3 species belonging to as many genera, one of which, namely Graeophonus, has also a representative from England in *G. anglicus*. The order Scorpiones is at present restricted to tropical and hot countries with 2 species, however, living as far north as the Karpathian mountains and southern Germany, and several other species in southern Europe. In the United States occur 22 species of scorpions, two of which go as far north as Colorado, Utah, Nevada and Nebraska. Leaving out of consideration *Mazonia woodiana* from Mazon Creek, a species which may eventually prove to be not a true scorpion, the Carboniferous scorpions may be divided into 3 families, at least one of which, Isobuthidae, is distinct from all recent scorpions and therefore extinct. This family is represented in Europe by 3 species belonging to 2 genera, and by a third with a single species in North America. The family Cyclophthalmyidae is represented in Europe by 3 genera with 5 species. A fourth, rather uncertain genus is represented by a single species in North America. The family Eoscorpionidae shows many relations to recent Scorpionidae and Vejovidae and represents probably two or three families thrown together for lack of distinctive characters. The genus *Microlabis* with its single species, *M. sternbergi* is known only from Europe. The genera *Palaeopisthacanthus* with 2 species and *Trigonoscorpio* with a single species are American. Of the genus *Eoscorpionus* 4 species occur in Europe and 4 in this country.

While any conjecture as to the direction in which the phylogenetic development of arachnids took place in Europe and North America, would be premature, the following conclusions seem to have sufficient foundation in fact: (1) that the Carboniferous arachnological fauna of North America is distinct from that of Europe and developed along somewhat different lines, and (2) that both faunas have more similarity with recent faunas of tropical countries, than with such of the same locality.

SPECIAL PART

PHYLUM ARTHROPODA

Invertebrates with a chitinous exoskeleton and usually segmented appendages, with a prae-oral supraoesophageal brain composed of not less than 2 pairs of ganglia, and a ventral chain of ganglia, which shows different grades of concentration. Organs of respiration, when present, in form of gill-books, lung-books, or tracheal tubes. Organs of circulation, when present, never in the form of a closed system, heart open at both ends, with side ostia. Excretory organs either in form of modified nephridia or as malpygian tubes. Development direct or indirect, in the latter case often with a complicated metamorphosis.

The phylum is composed of 10 classes.

Key to the classes of the Phylum Arthropoda.

1. Two pairs of prae-oral appendages (behind the eyes)
 - Crustacea
 - + one pair of prae-oral appendages (behind the eyes) . . . 2
2. Legs biramous Trilobita
 - + legs uniramous 3
3. Segmentation of the body homomeric 4
 - + segmentation of the body heteromeric 8
4. Head with 1 pair of post-oral appendages (mandibles) and a pair of papillae. Genital opening on penultimate segment.
 - Legs with 2 claws Protracheata
 - + head with at least 2 pairs of post-oral appendages. Legs with 1, 2 or 3 claws 5
5. Head with 2 pairs of post-oral appendages. Antennae short, not more than 7-jointed 6
 - + head with more than 2 post-oral appendages. Antennae long, with many joints 7
6. Antennae simple. Tracheal spiracles at base of all legs. Genital opening on third somite
 - Diplopoda
 - + antennae with 4 basal joints, from the distal of which arise 2 1-jointed branches, the external with 1 bristle, the internal with 2 bristles. Respiratory organs absent. Genital openings at base of 2d pair of legs
 - Pauropoda
7. Three pairs of post-oral appendages in the head. First pair of legs modified as maxillipeds. Tracheal spiracles numerous, never on the head. Genital opening on penultimate segment. Chilopoda

- + four pairs of post-oral appendages. No maxillipeds. One pair of tracheal spiracles only, on the head. Genital openings on third somite Symphyla
- 8. Abdomen rudimentary. Genital openings on the 2d joint of legs of the 4th pair, or 3d and 4th, or 2d, 3d and 4th. Number of post-oral appendages 5—7 pairs Pycnogonida
+ abdomen not rudimentary. Genital opening never on legs 9
- 9. Head and thorax fused together. Cephalic part with 1 pair of post-oral appendages. Thoracic part with 4 pairs of legs (the last 2 pairs absent in 1 family of Acari)
Arachnida
+ head not fused with thorax. Three pairs of post-oral appendages in the head. Thorax with 3 pairs of legs
Hexapoda (Insecta)

CLASS ARACHNIDA

Arthropods with at least 3 prae-oral segments, with 1 pair of prae-oral appendages modified as chelicera, with 5 pairs of postoral appendages, the first of which is represented by the pedipalpi. Head fused with at least 1 thoracic segment, usually with entire thorax, forming a cephalothorax. Genital opening on first somite of mesosoma. Nephridia modified as coxal glands. Legs typically with 7, pedipalpi with 6 joints.

This class is composed of 15 orders.

Key to the Orders of Arachnida.

1. Opisthosoma with an unsegmented telson 2
+ Opisthosoma without a telson, sometimes with a segmented whip 4
2. Post-abdominal segments fused. Abdomen with a large genital operculum and 5 gill-books. Legs of the 1st, 2d, and 3d pair chelate Xiphosura
+ post-abdominal segments free; legs not chelate 3
3. All post-oral appendages with gnathobases. 5 pairs of gill-books Gigantostraca
+ only the anterior 3 pairs of post-oral appendages with gnathobases. Pedipalpi chelate. 4 pairs of lung-books
Scorpiones
4. In front of the cephalothorax a movable plate (cucullus)
Ricinulei

- + cucullus absent 5
- 5. All segments of the cephalothorax fused together 7
 - + two or three posterior segments of the cephalothorax free. Mandibles always chelate 6
- 6. Only 2 posterior cephalothoracic segments free. Abdominal segments 11, the last with a segmented whip
 - Palpigradi
 - + three cephalothoracic segments free. Abdominal segments 10. No whip Solifugae
- 7. Abdomen with petiolus 8
 - + abdomen broadly joined to the cephalothorax 10
- 8. Coxae of pedipalpi completely fused together, forming a triangular plate. Pedipalpi chelate. Coxae of legs radiating from the central sternum, equal in size. All legs thin and long Kustarachnae
 - + Coxae of pedipalpi not fused into one plate 9
- 9. Pedipalpi raptorial; 1st pair of legs transformed into an antenniform sense organ. No spinning organs
 - Pedipalpi
 - + Pedipalpi pediform; 1st pair of legs not transformed into an antenniform sense organ. Spinning organs in abdomen Araneae
- 10. Pedipalpi powerful, chelate. Chelicera chelate. Spinning glands in front or behind the genital openings, their ducts opening on movable finger of chelicera
 - Pseudoscorpiones
 - + Pedipalpi not chelate. Spinning glands absent 11
- 11. Abdomen not segmented (with exception of the suborder Notostigmata in which there are 4 dorsal abdominal stigmata). Coxae of all legs devoid of maxillary lobes
 - Acari
 - + abdomen clearly segmented 12
- 12. Coxae of the 1st pair of legs and often also of the 2d and 3d pair with maxillary lobes. Chelicera chelate. Abdomen composed of 10 segments, the 10th being represented by the operculum, but the number of visible tergites and sternites is usually smaller, owing to a fusion of the anterior segments with the cephalothorax
 - Opiliones
 - + all coxae without maxillary processes 13
- 13. Tarsi and metatarsi of 1st pair of legs converted into a 7-jointed tactile organ. Abdomen composed of 11 seg-

- ments, the 11th being represented by the operculum situated on the ventral surface Haptopoda
 + first pair of legs pediform, not converted into a tactile organ 14
14. Four, 5 or 6 anterior abdominal tergites very narrow. Dorsal surface of abdomen never divided into longitudinal fields Phalangiotarbi
 + anterior abdominal tergites not conspicuously narrow. Dorsal surface of abdomen divided into 3 or 5 longitudinal fields Anthracomarti

ORDER SCORPIONES

Head completely fused with thorax. Abdomen twelve-jointed, the last five somites forming the so called cauda or post-abdomen, considerably narrower than the anterior seven. Telson with a poison gland and sting. Chelicera three-jointed, chelate. Pedipalpi six-jointed, chelate, powerful. Coxae of first and second pair of legs with maxillary lobes. Abdominal tergites and sternites heavily chitinized, connected laterally with each other by means of a soft chitinous cuticle capable of considerable distension. Post-abdominal segments without such pleural membranes, their sternites and tergites completely fused in each segment. First sternite represented by the genital opercula, second sternite by the basal joint of the comb. Four pairs of stigmata leading to lungbooks in third to sixth sternites, one pair to each sternite. Anus without operculum, at the end of the twelfth abdominal segment, ventral to the poison gland. Two middle eyes and two to five pairs of side eyes on cephalothorax, some recent species completely blind. All recent scorpions are viviparous.

The classification of recent scorpions is based entirely on external characters, the most important being: the shape of the sternum, the structure of the comb, the position of spines on legs, the shape and sculpture of the pedipalpi, etc. These characters should naturally be of the same importance for the classification of extinct scorpions. Unfortunately it is not always possible to see all important characters in the same Palaeozoic specimen and the knowledge of the group remains therefore incomplete. There are several genera based upon specimens which do not show the most important structures. The position of such genera in the system is naturally not certain. Some species, too, have been placed under genera which they most resemble, i. e., owing to their general resemblance to the type species and not on account of their generic characters which unfortunately have not

been preserved. Such a method is certainly open to grave criticism, but it is the only possible one. The text figures 1—4 showing the external characters of recent scorpions will help the understanding of the incomplete remains of Palaeozoic specimens.

The scorpions have been divided into two sub-orders, the distinguishing character being the presence or absence of two claws on the walking legs.

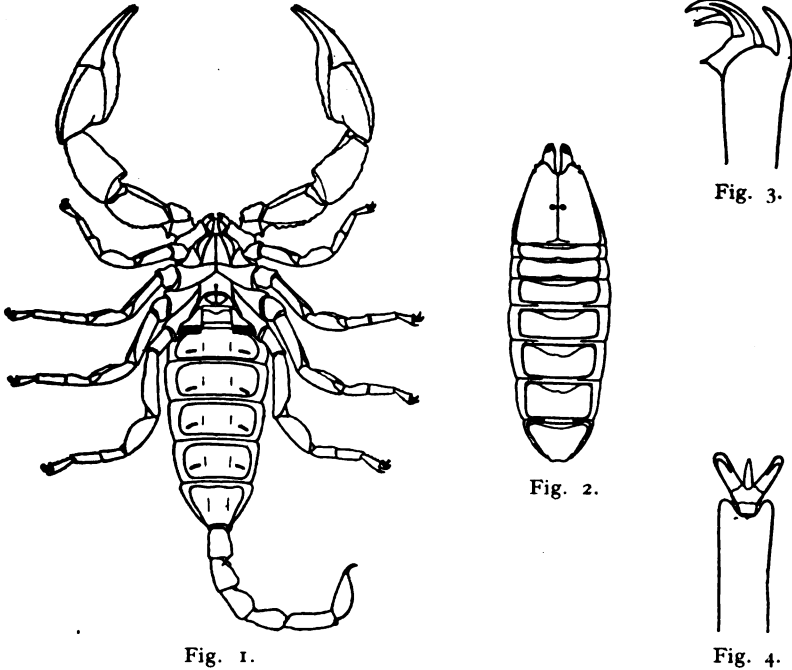


Figure 1.—*Opisthacanthus elatus* (Gerv.), from the West Indies, ventral surface of a gravid female. Figure 2.—Same, dorsal surface of cephalothorax and anterior seven abdominal segments. Figure 3.—*Centruurus junceus* (Herbst), from Cuba, end of tarsus with walking spine, two claws and dorsal lobe. Figure 4.—Same, viewed from below to show the position of the dorsal lobe.

LIST OF DESCRIBED SPECIES OF SCORPIONS

SUB-ORDER APOXYPODA. SILURIAN SCORPIONS

Tarsi terminating in a sharp point, without claws.

Family Palaeophonidae Thorell and Lindström

Genus *Palaeophonus* Th. and L. 1884.

Genotype *P. nuncius* Th. and L.

1. *P. nunciatus* Th. and L., K. Svensk. Vet. Ak. Handl., Vol. 21, No. 9. 1884, pl. I. Pocock, Q. J. M. S., 1902, p. 296. Fritsch, Pal. Arachn., 1904, p. 63, fig. 78.

From the Silurian (Wenlock) of Gotland.

2. *P. caledonicus* Hunter, Trans. Geol. Soc. Glasgow, Vol. VIII. 1886, p. 169. Id., Ibid., Vol. V, 1887, pp. 185—191. Peach. Nature, Vol. XXXI, 1885, p. 295.

= *P. hunteri* Pocock, Q. J. M. S., 1902, p. 291, pl. 19. Fritsch, Pal. Arachn., 1904, p. 63, fig. 79.

P. caledonicus Bather, Ann. Mag. Nat. Hist., (8), Vol. VIII, 1911, p. 676.

From the Silurian (Ludlow), of Scotland.

3. *P. loudonensis* Laurie, Trans. Roy. Soc. Edinb., Vol. XXXIX. 1889, p. 576, pl. I, fig. 1. Fritsch, Pal. Arachn., 1904, p. 64, fig. 80.

Found in the Silurian of Scotland.

Genus *Proscorpius* Whitfield 1885.

Genotype and only species *P. osborni* Whitt., Bull. Am. Mus. Nat. Hist., 1885, Vol. I, p. 181, pls. 19 and 20. Clarke and Ruedmann. Eurypterida of New York, 1912, Vol. I, p. 387, ff. 81—83, Vol. II, pl. 88.

From the Silurian (Cayugan series, Bertie formation), Waterville, N. Y.

SUB-ORDER DIONYCHOPODA

Scorpions with two claws at the end of each tarsus.

Pocock in his monograph proposes to divide this sub-order into two groups: Lobosterni "with bilobed, posteriorly laminate sternal plates on the opisthosoma and skeletal plates, whether belonging to the fourth leg or not, on each side of the genital operculum," and Orthosterni, with plates similar to those in recent scorpions. To the first belong the genera *Eobuthus* and *Isobuthus*, to the second *Cyclophthalmus*, *Archaeoctonus*, *Anthracoscorpio*, *Microlabis* and possibly *Palaeomachus*. It seems to me, however, that the two groups of Pocock are artificial inasmuch as the new genus *Palaeobuthus* described below, although agreeing in the character of its sternites with recent scorpions, is closely related to *Eobuthus* and *Isobuthus* in the structure of the coxae. I propose therefore to divide the palaeozoic Dionychopoda into families without reference to the shape of the abdominal sternites.

Family Isobuthidae.

Late Palaeozoic scorpions in which the coxae of the fourth pair of legs are abutting against the genital opercula. To this family belong

three genera, *Isobuthus*, *Eobuthus* and *Palaeobuthus*. They may be distinguished as follows:

1. Abdominal sternites with straight posterior edges. Sternum triangular *Palaeobuthus* n. gen. (see below).
Genotype *P. distinctus* n. sp., from Mazon Creek.
+ abdominal sternites with posterior edges curved, so that the sternites appear bilobed 2
2. Sternum rhomboidal Genus *Isobuthus* Fritsch 1904
Genotype and only species *I. kralupensis* Th. and L., Kongl. Svensk. Akad., Vol. 21, No. 9, 1884, p. 17. Fritsch, Pal. Arachn., 1904, p. 70, fig. 88; pl. 10, figs. 1-11.
Found in the Coal Measure of Kralup, Bohemia.
+ sternum oval Genus *Eobuthus* Fritsch 1904
Genotype *E. rakovnicensis* Fritsch.
Described species:
 1. *E. rakovnicensis* Fritsch (ad partem), Pal. Arachn., 1904, p. 74, figs. 90, 92; pl. 8, figs. 1, 2. Pocock, Carb. Arachn., 1911, p. 13.
Found in the Coal Measures (Noegerathienschiefer) of Rakonitz, Bohemia.
 2. *E. holti* Pocock, Carb. Arachn., 1911, p. 14, fig. 1; pl. II, fig. 2.
From the Coal Measures of England.

Family Cyclophthalmidæ.

Late Palaeozoic scorpions with normal arrangement of coxæ, middle eyes not close to the anterior edge of the cephalothorax, hand comparatively wide with short fingers and sternum "pear"-shaped.

This family contains three genera from Europe and one from North America.

Genus *Cyclophthalmus* Corda 1835.

Genotype *C. senior* Corda.

1. *C. senior* Corda, Verh. Ges. vaterl. Mus. Böhmen, 1835, p. 36. Fritsch, Pal. Arachn., 1904, p. 66, figs. 84-86; pl. 7, figs. 1-4; pl. 8, figs. 3-5.
From the "Steinkohlensandstein" of Bohemia.
2. *C. euglyptus* (Peach)
= *Eoscorpium euglyptus* Peach, Trans. Roy. Soc. Edinb., Vol. XXX 1883, p. 402, pl. XXII.
C. euglyptus Pocock, Carb. Arachn., 1911, p. 19, fig. 4.
From the Lower Carboniferous (Cementstone) of Scotland.
Genus *Palaeomachus* Pocock 1911.
Genotype and only species *P. anglicus* (Woodward).

= *Eoscorpium anglicus* Woodward, Quart. Jour. Geol. Soc., Vol. XXXII, 1876, p. 58, pl. VIII, fig. 3.

P. anglicus Pocock, Carb. Arachn., 1911, p. 16, fig. 2.

Bather, Ann. Mag. Nat. Hist., (8), Vol. VIII, 1911, p. 673, with fig.

From the Coal Measures of England.

Genus *Archaeoctonus* Pocock 1911.

Genotype *A. glaber* (Peach).

1. *A. glaber* (Peach).

= *Eoscorpium glaber* Peach (ad partim), Trans. Roy. Soc. Edinb., Vol. XXX, 1883, pp. 398-400, pl. XXII, figs. 2-21.

A. glaber Pocock, Carb. Arachn., 1911, p. 17, fig. 3.

From the Lower Carboniferous of Scotland.

2. *A. tuberculatus* (Peach).

= *Eoscorpium tuberculatus* Peach, Trans. Roy. Soc. Edinb., Vol. XXX, 1883, p. 398, pl. XXIII, figs. 8-8h.

A. tuberculatus Pocock, Carb. Arachn., 1911, p. 19.

From the Lower Carboniferous (Coal Measures, Calciferous) of Scotland.

Eoctonus n. gen.

Genotype *E. miniatus* n. sp.

From the Pennsylvanian (Lower Allegheny) of North America.

Family Eoscorpionidae.

Late Palaeozoic scorpions with normal arrangement of coxae, middle eyes not close to the anterior edge of cephalothorax, hand comparatively narrow with long fingers; pentagonal sternum.

The family contains four genera.

Genus *Eoscorpium* Meek and Worthen 1868.

Cephalothorax more or less rectangular, cauda normal.

Genotype *E. carbonarius* M. and W.

1. *E. carbonarius* M. and W., Amer. Jour. Sci. & Arts, (2), 1868, Vol. XLV, p. 25. Id., Geol. Surv. Ill., Vol. III, 1868, p. 560 with fig.

From the Pennsylvanian (Lower Allegheny) of North America.

2. *E. sparthensis* Baldwin and Sutcliffe, Quart. Jour. Geol. Soc., Vol. LX, 1904, p. 396, fig. 2.

= *Eubuthus rakovnicensis* Fritsch (ad partem British specimen), Pal. Arachn., 1904, p. 74, fig. 91, pl. 12, figs. 1-3.

= *Anthracoscorpium sparthensis* Pocock, Carb. Arachn., 1911, p. 20.

From the Coal Measures of England and Bohemia.

3. *E. dunlopi* (Pocock).

= *Anthracoscorpium dunlopi* Pocock, Carb. Arachn., 1911, p. 21, fig. 5, pl. I, fig. 1.

From the Upper Coal Measures of Scotland.

4. *E. buthiiformis* (Pocock).
 = *Anthracoscorpio buthiiformis* Pocock, Carb. Arachn., 1911,
 p. 24, figs. 6–8; pl. I, fig. 2; pl. II, fig. 1.
 From the Coal Measures of England.

5. (?) *E. ornatus* (Fritsch).
 = *Feistmantelia ornata* Fritsch, Pal. Arachn., 1904, p. 75, pl. XI,
 fig. 1–5.

From the Middle Permian (Lebach) of Bohemia.

6. *E. typicus* n. sp.
 From the Pennsylvanian (Lower Allegheny) of North America.

7. *E. danielsi* n. sp.
 From the Pennsylvanian (Lower Allegheny) of North America.

8. *E. granulatus* n. sp.
 From the Pennsylvanian (Lower Allegheny) of North America.

Genus *Trigonoscorpio* n. gen.

Cephalothorax triangular, cauda rather weak.

Genotype and only species *T. americanus* n. sp.

From the Pennsylvanian (Lower Allegheny) of North America.

Palaeopisthacanthus n. gen.

Cephalothorax trapezoidal, cauda very small.

Genotype *P. schucherti* n. sp.

1. *P. schucherti* n. sp.
 From the Pennsylvanian (Lower Allegheny) of North America.

2. *P. mazonensis* n. sp.
 From the Pennsylvanian (Lower Allegheny) of North America.

Genus *Microlabis* Corda 1839.

Cephalothorax trapezoidal, cauda not known, hand very weak.

Genotype and only species *M. sternbergii* Corda, Verh. böhm.

Ges. vaterl. Mus., 1839, pp. 14–18, pl. I. Fritsch, Pal. Arachn.,
 1904, p. 69, fig. 87, pl. 9, figs. 1–4.

Family Mazoniidae.

Middle eyes close to anterior edge of cephalothorax. Structure of pedipalpi and sternum not known.

Genus *Mazonia* Meek and Worthen 1868.

With the characters of the family.

Genotype and only species *M. woodiana* M. and W., Geol. Surv.
 Ill., Vol. III, 1868, p. 563, with figs.

From the Pennsylvanian (Lower Allegheny) of North America.

KEY TO GENERA OF NORTH AMERICAN CARBONIFEROUS SCORPIONS

1. Seventh abdominal tergite similar to the preceding ones, 8th similar to the 7th of recent scorpions.
- Mazonia*
- + seventh abdominal tergite as in recent scorpions. Post-abdomen with 5 segments 2
2. Coxae of 3d pair of legs abutting against the sternum, those of 4th pair against the genital opercula.
- Palaeobuthus*
- + coxae of 3d and 4th pair of legs abutting against the sternum (coxae of *Trigonoscorpio* and *Eoctonus* not known but presumably of this type) 3
3. Cephalothorax triangular; anterior border more than 4 times narrower than the posterior one.
- Trigonoscorpio*
- + cephalothorax never as narrow in front 4
4. Post-abdomen very short and slim.
- Palaeopisthacanthus*
- + post-abdomen normal 5
5. Hand short and wide, with short fingers.
- Eoctonus*
- + hand narrow, fingers very long.
- Eoscorpius*

DESCRIPTION OF NORTH AMERICAN PALAEOZOIC SCORPIONS

Family Eoscorpionidae.

Genus *Eoscorpius* Meek and Worthen.

New definition. Sternum pentagonal. Cephalothorax with more or less parallel sides, never conspicuously narrowed in front. Middle eyes either removed from the anterior edge of the cephalothorax at least $\frac{1}{8}$ its length, or if placed close to it then the edge itself straight. Cauda normal. Hand narrow with very long fingers.

The type species, *E. carbonarius*, resembles very closely the European *E. dunlopi* (Pocock) and *E. sparthensis* Baldwin and Sutcliffe, but is considerably smaller. Pocock rejects the genus *Eoscorpius* in favor of *Anthracoscorpio* since the characters of the former are not sufficiently known. A comparison of the type with *E. typicus* and *E. danielsi* shows, however, that these species are very closely related to the type species, although sufficiently distinct not to be placed under the same species. In fact, *E. typicus* could have been regarded

as a small variety of *E. carbonarius* if there were more gradations between the two. As it is, both types being probably gravid females, I thought it wiser to regard *E. typicus* as specifically distinct from *E. carbonarius*. It may be objected that since the additional characters of the genus are derived from new species, the genus *Anthracoscorpio* should have precedence. But the characters of the latter genus are also based on a defective specimen and were supplemented later when new species were found. Besides, if we were to accept Pocock's definition of *Anthracoscorpio*, then *Eoscorpius typicus* would certainly have to be placed under that genus and with it *E. carbonarius*, on account of its extreme similarity. The name *Eoscorpius* has priority and should therefore not be changed.

The Palaeozoic scorpions of the genus *Eoscorpius* resemble most some of the recent Vejovis.

Key to North American Species of *Eoscorpius*.

- 1. Cephalothorax as long as wide, or longer than wide. Eyes removed from anterior edge 2
 - + cephalothorax wider than long. Eyes closer to anterior edge 3
- 2. Sixth abdominal tergite wider than 1st. Size about 90 mm.
 - E. carbonarius*
 - + first abdominal tergite wider than 6th. Size from 45 to 65 mm.
 - E. typicus*
- 3. Abdominal tergites smooth.
 - E. danielsi*
 - + abdominal tergites with a transverse row of punctuated depressions along their posterior border.
 - E. granulatus*

Eoscorpius carbonarius Meek and Worthen.

Plate II, figure 6.

E. carbonarius Meek and Worthen, Amer. Jour. Sci. & Arts (2), Vol. XLV, 1868, p. 25. Geol. Surv. Ill., Vol. III, 1868, p. 560 with fig.

The obverse of the type specimen in the Museum of the University of Chicago, the reverse in the University of Illinois collection.

Careful examination of both halves of this important fossil convinced me that the description of Meek and Worthen is quite correct and that nothing of importance could be added to it. I therefore quote it here with such abbreviations as seem to be advisable and with the substitution of metric measurements for inches.

"The only specimen of this fossil yet known to us consists of a cast and mould as revealed in splitting open a concretion. It shows most of the cephalothorax and mandibles in somewhat crushed condition, the dorsal side of the seven abdominal segments, and three of those of the tail, all in place. Also four of the legs on one side and one on the other, with one of the peculiar comb-like organs, . . . the latter being detached and lying in the matrix near the side of the abdomen.

"The cephalothorax seems to be subquadrangular in form, somewhat wider behind than long, the breadth being about 11.5 mm. Unfortunately it is not in a condition to show the ocelli, nor can we see whether or not its anterior edge is emarginate. It shows a minute marginal line behind, from near which there originates a distinct mesial furrow, which extends forward to near the middle, where it is intersected by, or rather bifurcates into, two oblique furrows, with the prominence for the mesial ocelli between them. Two other rather deep lateral furrows extend, one on each side, from the posterior end of the mesial one, obliquely outward, near the posterior margin. The surface is ornamented with irregular scattering granules, mostly upon the prominences between the furrows. The mandibles are stout, . . . but appear to be without teeth or serrations. The movable finger is curved and sharp at the point. The legs are rather stout, with most of the divisions long. Palpi unknown.

"The abdomen is a little more than twice the apparent length of the cephalothorax, or about 23.0 mm. in length, and 15.2 mm. in breadth. Its segments gradually increase in their antero-posterior diameter, from the front one backward to the seventh, which is about twice and a half as long as the sixth or largest of the others (being 9.0 mm. long, and 12.3 mm. wide), subtrigonal in form, with the posterior angle broadly truncated for the attachment of the tail, and the anterior lateral angles a little rounded. The six shorter abdominal segments, especially the anterior ones, have their front margin more or less sinuous along the middle, and their lateral extremities more or less rounded. They all have the surface a little granular, the granules being very small and arranged mainly along the posterior margin. The last, or subtrigonal one, also has on its posterior half, near the middle, two longitudinal, parallel rows of minute pits or punctures.

"Of the tail, only the anterior three segments are preserved in the specimen. These show that it was rather stout, but as distinct from the abdomen by its sudden contraction in breadth, and in the form of its segments, as in the existing Scorpions. Its segments measure as follows: first one, 6.5 mm. in length, 6.0 mm. in breadth; second,

8.2 mm. in length, 5.5 mm. in breadth; third, 9.5 mm. in length, 4.5 mm. in breadth. They are all oblong in form, more or less nearly rectangular at their ends, and, as near as can be determined from a flattened specimen, apparently provided above with three or more longitudinal rows of granules, and some scattering ones.

"The single detached comb-like organ, seen lying in the matrix on the left side of the abdomen, shows some eleven or twelve of the little laminae or divisions, but apparently had more, as it is incomplete, at least at one end."

It is unfortunate that both the cast and the mould show the dorsal surface of the scorpion. In consequence nothing is known of the shape of the sternum. The total size can also be only guessed and is probably about 90 mm. The specimen was found by Mr. M. Prendel on Mazon Creek, Illinois, in Pennsylvanian (Lower Allegheny) strata.

Eoscorpium typicus n. sp.

Plate I, figures 1-4; text figures 5-7.

This species is represented by four specimens. Two of these, Nos. 37986 and 37987, are in the U. S. National Museum, and two, Nos. 126 and 127 in the Peabody Museum of Yale University No. 37986 of the U. S. National Museum I chose for the holotype.

The obverse of the nodule containing the type specimen (Pl. I, fig. 2) shows clearly the mandibles, cephalothorax, abdomen, first three segments of the post-abdomen and parts of the right palpus and legs. The reverse (Pl. I, fig. 3) shows the complete right palpus, all coxae, sternum, genital opercula, abdomen and four segments of the post-abdomen; also parts of the legs, as represented in text figure 6. The cephalothorax is almost rectangular in shape, 5.5 mm. long, 5.5 mm. wide at posterior edge. Its posterior edge is quite straight, the anterior one almost straight, with a scarcely perceptible emargination. The antero-lateral angles are rounded and the lateral edges distinctly emarginated. Two curved ridges run from the anterior edge, uniting behind the eyes approximately in the middle of the cephalothorax, whence a median ridge proceeds almost to the posterior edge, forming here a small triangular field. A pair of curved ridges run from the middle of the lateral edges obliquely toward the posterior edge where they, too, join the triangular field. The median eyes have apparently the shape of segment of a circle, but it is probable that the segment represents only the socket and that the lens itself was round or oval. No trace of side eyes could be detected, although the edges of the cephalothorax are very distinct.

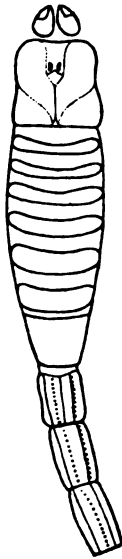


Fig. 5.

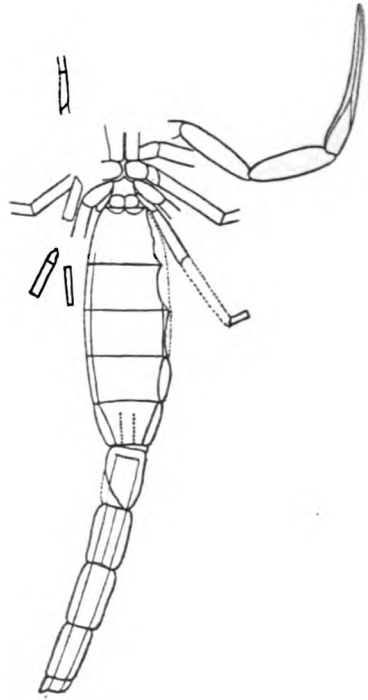


Fig. 6.

Figure 5.—*Eoscorpilus typicus* n. sp., holotype, U. S. N. A. No. 37986, dorsal surface.—Figure 6.—Same, ventral surface. $\times \frac{2}{1}$

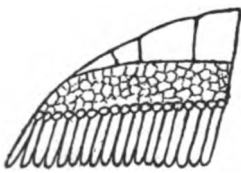


Fig. 7.

Fig. 7. *Eoscorpilus typicus* n. sp., U. S. N. M. No. 37987, comb. $\times \frac{8}{1}$

The abdomen is 16 mm. long. The tergites are separated from each other by a considerable space which must have been occupied by the soft chitinous membrane the outlines of which are clearly visible on each side; this speaks in favor of the assumption that the type specimen was a gravid female. The third and fourth tergites are the widest, the width of the abdomen being in this region 6.4 mm. The length of the tergites increases gradually from the first backward, the seventh being the longest. It is wider than long, with a slightly procurved anterior edge and sharp angles. All abdominal tergites are with smooth surface. The first post-abdominal or caudal segment is shorter and wider than the second. It has three longitudinal ridges and two rows of

small, round depressions which evidently are the moulds of what have been granules. The second has two longitudinal ridges and two rows of depressions; the third two ridges and one row of depressions. The genital opercula, representing the first abdominal sternite, are round. The basal plates of the comb, representing the second sternite, have the shape of segments of a circle with the curve directed posteriorly. The next or third sternite (usually called the first) is the longest. The lines between the sternites 3, 4 and 5 are straight, while the anterior edge of the seventh sternite is slightly recurved. Superimposed over the sternites are visible the tergites. There are two parallel rows of round depressions extending over the posterior three-fourths of the seventh sternite. The ventral surface of the caudal segments shows two longitudinal sulci, to which is added in the first caudal segment a transverse row of depressions and in the third a median longitudinal sulcus.

It may seem strange that the abdominal sternites are not separated from each other like the tergites. One would naturally expect that to be so, since this is the rule in recent scorpions. Two explanations may be given to the fact, that the sternites of extinct scorpions are not separated from each other by intersternal membranes. Either the sternites were so long that they overlapped each other under normal conditions in non-gravid females, or the ventral surface of the abdominal segments was soft without hardened plates representing sternites. In the first case we should expect to see double lines separating each segment and that being so, that the anterior line would represent the anterior edge of the posterior segment, while the posterior line, the posterior edge of the anterior segment. I do not know American Palaeozoic scorpions which would show such double lines and assume therefore that the ventral surface of the third to sixth abdominal segments was soft. It is different in the case of the seventh segment. This segment had evidently a strongly chitinized sternite as evidenced by the presence of depressions. The pleura may be seen on each side of the abdomen on the ventral surface of the specimen superimpressed over the segments of the abdomen.

The sternum is pentagonal. The mandibles, preserved only on the obverse of the nodule, are egg-shaped, chelate; their basal joint is lost. The coxa of the palpus is not visible, and of the trochanter only the distal end is preserved. Femur is 5.5 mm. long, patella 5.5 mm. long and scarcely wider than the femur, tibia with finger 7.0 mm. long. The movable finger (the tarso-metatarsus) is almost twice as long as the hand, if both are measured in the line of contact of the two fingers.

The coxae of the first pair of legs meet in the middle line where they apparently form maxillary lobes, the anterior ends of which are, however, not preserved. The second coxae are short, wide and almost contiguous. If they ever had maxillary lobes they certainly are not preserved. The third coxae are longer and thinner than the second and separated from each other by the full width of the sternum against which they are abutting. The fourth coxae are the weakest of all. They are also abutting against the sternum.

Of the legs are preserved only more or less incomplete joints. The femur of the second leg is 5.0 mm. long. The chitin which was preserved in many places has a uniform brown color. The comb is not preserved. The total size was probably about 45 mm.

The nodule No. 37987 of the U. S. National Museum (Pl. I, fig. 4) is broken in three pieces and the specimen itself is not complete. The specimen must have been considerably larger, since the abdomen is 26 mm. long and the two post-abdominal segments (the only ones preserved) 14.5 mm. But the general appearance of the specimen, the shape of the tergites, especially of the seventh, leave no doubt that it belongs to the same species. Neither sternum, nor coxae are preserved and the palpi are also missing. But the interest of the specimen lies in the comb of one side, which is extraordinarily well preserved on both obverse and reverse of the specimen (fig. 7). It is very high at the base. The space between the supporting plates and the teeth is occupied by apparently one long and broad, granulated plate and a row of bead-like small plates. The number of teeth is eighteen. Parts of the comb and of the abdomen were still covered with chitin of the same color as in the preceding specimen.

Specimen No. 126 of the Peabody Museum (Pl. I, fig. 1) belongs to the same species. Only the reverse, however, is preserved, and the ventral surface alone is visible. The palp, sternum, fourth coxae, genital plates, basal plates of the comb, the abdominal sternites, and the first post-abdominal segment, the only one preserved, have the same structure as the type specimen. Of the remaining coxae only parts are visible on the left side of the nodule, and the first, second and third trochanters on the right. Comb and mandibles not preserved.

Length of pedipalp: femur 7.0 mm., patella 9.6 mm., tibia with finger 12.5 mm.

Specimen No. 127 of the Peabody Museum belongs also to this species. The probable length of the specimen is 60–65 mm. The specimen is badly depressed, the cephalothorax scarcely recognizable. Length of abdomen from cephalothorax to first post-abdominal

segment, 21.0 mm. Length of the four preserved post-abdominal segments, 23.0 mm.

Length of pedipalp: femur, 6.3 mm., patella, 6.3 mm., tibia with finger 11.7 mm.

All four specimens are from the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Eoscorpius danielsi n. sp.

Plate IV, fig. 16; text fig. 8.

The reverse of the nodule containing the type specimen is not in existence. The obverse is in the collection of Mr. L. E. Daniels.

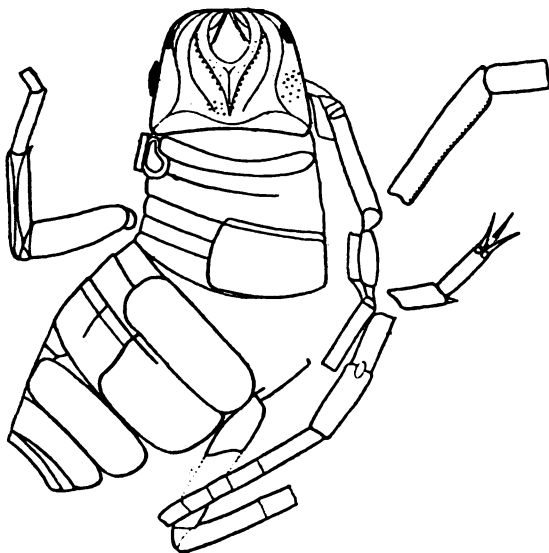


Fig. 8.

Figure 8.—*Eoscorpius danielsi* n. sp., holotype, Daniels coll. $\times \frac{1.5}{1}$

It is a badly deformed specimen without palpi and cauda and with the legs torn from the body and intercrossing each other to such an extent that it is impossible to decide to which each remnant belongs.

The cephalothorax is preserved better than the rest, and is 11 mm. long and 14 mm. wide at the posterior edge, which is slightly recurved. Anteriorly the cephalothorax is somewhat narrower, the width in the region of the alveolate areas being 10 mm. The anterior and the side edges are straight, the angles rounded. A curved ridge runs on each side close to the alveolate region, from the anterior edge backward, gradually becoming lower and changing into a shallow sulcus,

then turning more outward and rising again in shape of a low ridge which joins the curved transverse ridge in the posterior end of the cephalothorax. The surface carrying the alveolated area on each side is more or less horizontal, but the surface inward from the lateral curved ridges has a steep declivity toward the curved grooves which begin on the sides of the ocular depression and meet in the median line close to the transverse curved ridge. These grooves are outwardly accompanied by a row of small, round depressions. A heavy ridge runs in the median line, gradually rising anteriorly and is highest at the place where it forms a small fork. Immediately in front of this fork lies the oval depression which represents evidently the mould of the eye tubercle. It is very large, reaching anteriorly the edge of the cephalothorax. Within the depression one may recognize a triangular ridge and two pairs of oval depressions (one pair on each side of the triangular ridge). These oval depressions look very much like moulds of eyes. It is possible, however, that only the anterior pair represents eyes, while the posterior pair is a mould of what may have been chitinous granules.

The number of abdominal tergites cannot be counted owing to the presence of transverse lines which represent probably artificial folding of the skin. Moreover they are visible only on the left side of the specimen, the right side being covered by wide plates which I interpret as sternites. A proof of this interpretation I see in the fact that the left side representing the tergites is concave, as in the cephalothorax, while the plates on the right side are convex. All abdominal plates are smooth. On the left side of the abdomen is visible a part of a leg, four segments of which are complete. The femur is 9 mm. long, the tibia 9 mm. and the metatarsus 6 mm. The legs on the right side of the specimen represent a hopeless tangle. One of them, however, is of extraordinary interest since it shows the structure of the two last segments. We note one spine which was probably in the articular membrane of the proximal tarsal joint. The distal joint shows the impression of its ventral surface. One may clearly distinguish a tubercle representing the walking spine, two long claws, a median long, pointed dorsal lobe and two round depressions behind the tubercle. Another fragment of a leg, lying in front of the one just mentioned and probably representing a tibia, shows a row of punctuated depressions along its inner edge. On the left side of the cephalothorax is a long lens-shaped body, probably the transverse section of a leg. Immediately behind the posterior left corner of the cephalothorax is a bean-shaped depression, perhaps also a transverse section of a leg.

The abdomen is torn in the middle, as shown in the text figure and on the photograph. If straightened out, it would measure about 35 mm.

. Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Eoscorpium granulatus n. sp.

Plates II, fig. 10; III, figs. 11, 12; text fig. 9.

This species is represented by three specimens in the possession of the Peabody Museum, labelled respectively as Nos. 128, 129 and 130.

I designate No. 128 as the holo type, it being the best preserved. Only the obverse of the nodule containing the type specimen is in existence (Pl. II, fig. 10; text fig. 9). It shows the cephalothorax with the median eyes, abdomen, three and a quarter segments of the post-abdomen, mandibles, left pedipalp and fragments of right pedipalp and of two legs, one on each side of the body.

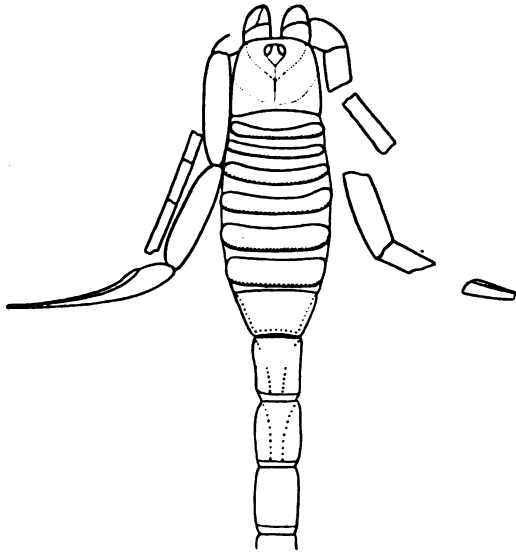


Fig. 9.

Figure 9.—*Eoscorpium granulatus* n. sp., holotype, Peabody Mus. No. 128. Nat. size.

The cephalothorax is somewhat like that of the preceding species.

It is 9.5 mm. long

and 12 mm. wide at posterior edge which is slightly recurved.

The oval eyes are almost their diameter from the anterior edge.

A median ridge runs from the edge of the semicircular declivity anteriorly, dividing almost in the middle of the cephalothorax and surrounding the depression representing the mould of the eye tubercle. The anterior angles of the cephalothorax are quite rounded, while the posterior ones are scarcely blunted. The abdomen is 30 mm. long, the tergites considerably separated from each other showing that the specimen was a gravid female. The length of the tergites increases gradually backward, so that the first is the shortest and the seventh

the longest tergite. Along the posterior edge of each tergite and on the sides of the seventh tergite runs a row of small, round punctuated depressions. The combined length of the three post-abdominal segments is 27 mm. Two rows of punctuated depressions, representing the dorsal crests, are visible on the first and second post-abdominal segments. The pedipalp is long and slender, hand with very long fingers; length of femur 15 mm., patella 15 mm., tibia with finger 23.0 mm. Length of movable finger 17.5 mm.

Specimen No. 130, showing also the dorsal side alone, is somewhat smaller; the cephalothorax measures 7.8 mm. in length and 11.0 mm. in width. It is badly deformed. Only six abdominal tergites are preserved. The right pedipalp is complete and the length of its joints is as follows: femur 7.5 mm., patella 6.4 mm., tibia with finger 13.5 mm. A few severed joints of three right and two left legs are preserved, but it is not possible to identify them. It may be that the specimen is a male or represents a different species, since the relative length of the palpal joints is different from that of the type specimen. But the general appearance is much as in the type specimen and the preservation not sufficient to make of this specimen a different species.

Specimen No. 129 (Pl. III, figs. 11, 12). The nodule containing this specimen consists both of the obverse and the reverse, but the latter is badly deformed. The obverse shows the cephalothorax with the eyes, abdomen and one post-abdominal segment, mandibles and parts of femora and tibiae of the legs. One complete pedipalp is preserved on the reverse. The structure of the cephalothorax which is 6.7 mm. long and 8.0 wide, is the same as in the type specimen. The abdominal tergites increase gradually in length and have the same sculpture as the type specimen. On the other hand the pedipalp is more like that in specimen No. 130. The length of its segments is as follows: femur 12.3 mm., patella 9.4 mm., tibia with finger 14.3 mm.; length of movable finger 9.2 mm.; length of abdomen 18.0 mm. Unlike the two preceding specimens the rock in which this specimen is imbedded shows no signs of decomposition and is exceedingly hard.

All three specimens are from the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Trigonoscorpio n. gen.

This genus is characterized by the triangular shape of the cephalothorax, comparatively thin and short tail the last segment of which is $3\frac{3}{4}$ as long as wide, and by the hand with long fingers. The state

of preservation of the only existing specimen makes it impossible to recognize the shape of the sternum or the position of the coxae. Genotype *T. americanus* n. sp.

Trigonoscorpio americanus n. sp.

Plate IV, figs. 17, 18; text fig. 10.

The nodule containing the type specimen consists of two parts, but both show the same structure, so that we have before us a cast and mould of the dorsal surface.

The cephalothorax has an almost triangular shape, being 5 mm. wide at the posterior edge and only 1.17 mm. at the anterior edge. Its length in the middle line is 4.8 mm. Its shape is best understood from the text figure 10. The eye tubercle is close to the anterior edge and carries two oval eyes. Two sulci run from the sides of the eye tubercle backward uniting in a transverse sulcus. Another shallow sulcus runs transversely close to the posterior edge. The abdomen is 11.5 mm. long. The first tergite is the longest and the seventh the shortest, being almost completely fused with the sixth. The post-abdomen is comparatively short and slim. Its fourth segment is $2\frac{3}{4}$, and its fifth $3\frac{3}{4}$ times as long as wide. The whole body is very flat and smooth.

The right pedipalp is complete but for the middle of the femur the ends of which are, however, well outlined. The femur is 5.7 mm. long, patella 2.9 mm., tibia with finger 6.0 mm. Both mandibles are well preserved. Of the legs one can see three pairs on the right and four on the left, but none of them is complete. The complete length of this specimen, which is in the collection of Mr. L. E. Daniels of La Porte, Indiana, is about 25 mm. It was found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

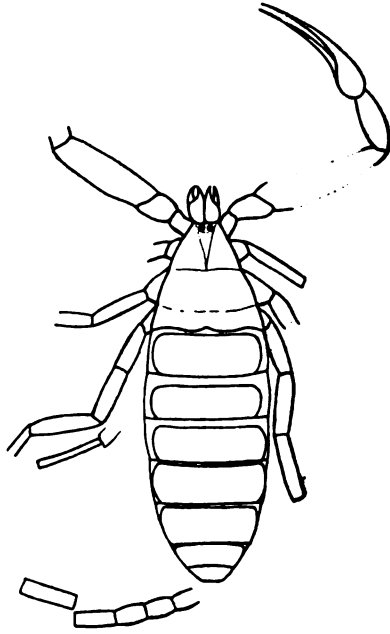


Fig. 10.

Figure 10.—*Trigonoscorpio americanus* n. sp., holotype, Daniels coll., [dorsal surface. $\times \frac{3}{1}$

Palaeopisthacanthus n. gen.

Sternum pentagonal. Hand with long fingers. Post-abdomen very short and slender. Genotype *P. schucherti* n. sp.

Key to the Species of *Palaeopisthacanthus*.

Cephalothorax widest a little in front of posterior edge, and here wider than long.

P. schucherti n. sp.

+ cephalothorax widest at posterior edge, slightly longer than wide

P. mazonensis n. sp.

Palaeopisthacanthus schucherti n. sp.

Plate II, figs. 8, 9; text figs. 11, 12.

The type specimen, the only one of the species in existence, is in the collection of the Peabody Museum under the number 140.

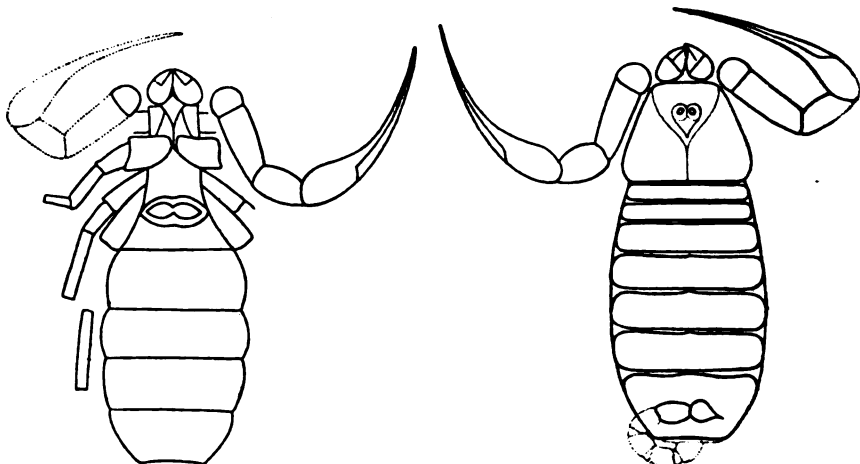


Fig. 11.

Fig. 12.

Figure 11.—*Palaeopisthacanthus schucherti* n. sp., holotype, Peabody Museum No. 140, ventral surface. Figure 12.—Same, dorsal surface. $\times \frac{4}{1}$

It is an excellently preserved specimen, showing both the obverse and reverse with great detail. The obverse shows both mandibles and palpi, the cephalothorax with the median eyes, the abdomen, the fifth post-abdominal segment with poison gland and fragments of legs to the left of the body; the reverse, both mandibles, one pedipalp, sternum with coxae, genital opercula, abdomen and fragments of legs.

Total length about 16 mm. Cephalothorax 3.25 mm long, 4.25 mm. wide in the widest place, and 3.75 mm. wide at posterior edge,

2.2 mm. wide at anterior edge, which is straight like the posterior and the side edges. All angles rounded. A median ridge runs in the specimen from the posterior edge forward, soon dividing and forming two curved ridges surrounding the eye tubercle and ending in the anterior corners. Median eyes small, oval, about $\frac{1}{3}$ the length of the cephalothorax from the anterior edge. No side eyes visible. The tergites of the abdomen gradually increasing in length, the seventh being the longest. The anterior edge of the fourth, fifth and sixth tergite has a sharp projection in the middle.

The sternum is very large, distinctly pentagonal, with a recurved posterior edge. Apparently both the first and second coxae have maxillary lobes and the second pair is with its posterior edge abutting against the sternum, so that the third and fourth pair are abutting only against the side edges of the sternum, a condition completely resembling the arrangement of coxae in recent scorpions, such as *Opisthacanthus*. The genital opercula occupy the whole width of the sternum and have the shape represented in text figure 11.

Of the post-abdomen or cauda is left only the last segment with the poison gland, both impressed on the seventh abdominal tergite. The tail was evidently bent sidewise and over the tergite when the dead specimen was imbedded in the mud. From the size of the last segment as well as from comparison with the cauda of *P. mazonensis* it is evident that the tail was very small and slim and it seems strange that the seventh tergite has such a wide posterior edge. We must conclude that the cauda was connected with it by means of a comparatively large soft membrane, a condition unlike anything known in modern scorpions.

Both mandibles are preserved except for their basal joint and are almost egg-shaped.

The palpi are characterized by a short patella and a hand with very long fingers, characteristic of the family. Femur 2.35 mm., patella 1.75 mm., tibia with finger 6.65 mm. The length of the movable finger is 5.0 mm.

Of the legs are left only the trochanters and femora of the second and third pair and apparently a tibia of the fourth pair.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Palaeopisthacanthus mazonensis n. sp.

Plate II, fig. 1; text figs. 13, 14.

The type and only specimen of this species is in the collection of the U. S. National Museum under the number 37977. The

obverse shows clearly the cephalothorax, abdomen, post-abdomen, both palpi, one leg complete on the right and fragments of the corresponding leg on the left. The reverse is baldy deformed, yet it is possible to recognize the coxae of the left side, sternum, genital opercula and the basal joints of the comb.

Total length about 23 mm. Cephalothorax 6.6 mm. long and 6.3 mm. wide at posterior edge which is straight, and unlike the preceding species represents the broadest part of the cephalothorax. The anterior edge is somewhat procurved, the anterior angles rounded,

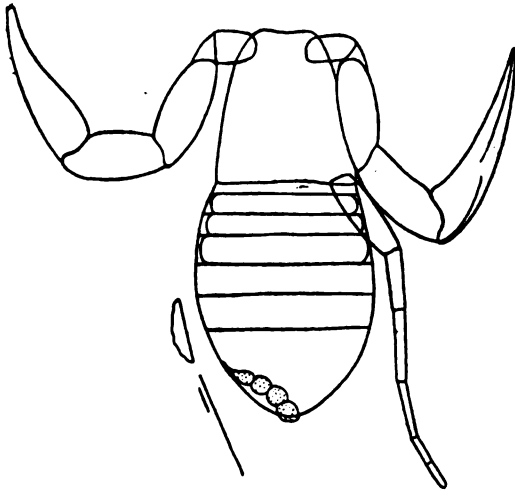


Fig. 13.

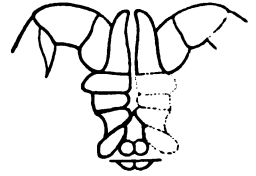


Fig. 14.

Figure 13.—*Palaeopisthacanthus mazonensis* n. sp. holotype, U. S. N. M. No. 37977, dorsal surface. Figure 14.—Same, ventral surface showing the sternum and coxae. $\times \frac{5}{1}$

the posterior ones almost sharp. No eyes are visible. The abdomen is 10.5 mm. long, the tergites gradually increasing in length from the first to the seventh which is as long as the anterior four segments together. It has no distinct posterior edge, but the whole segment has the form of a half oval. The pedipalpi are heavier than in the preceding species. Femur 5.0 mm., patella 5.0 mm., tibia with finger 9.0 mm. The length of the movable finger cannot be ascertained. The only completely preserved leg belongs probably to the fourth pair and is 15.0 mm long. Of the post-abdomen which is very short and thin, are preserved the last three segments and the poison gland. Like that of the preceding species it was lying over the seventh abdominal tergite when the specimen became imbedded in the mud. The segments are short and broad, the poison gland with a curved stigm.

The arrangement of the coxae is different from that of the preceding species. The first coxae alone show maxillary lobes which are long, slightly curved and somewhat pointed at the distal end. If the second coxae had any maxillary lobes there is no trace left of them. The coxae themselves lie in front of the sternum. The third coxae abut against the triangular part of the sternum, the fourth against its sides. The sternum is distinctly pentagonal, longer than wide, and comparatively small. The genital opercula are circular. The basal joint of the comb consists of two semioval plates. The sternites of the abdomen cannot be made out with clearness. The whole body is smooth.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Family Cyclophthalmidae

Eoctonus n. gen.

Hand short and wide with almost straight, short fingers. Fifth post-abdominal segment considerably longer than the preceding, $2\frac{1}{2}$ times as long as high. Genotype *E. miniatus* n. sp.

Owing to the poor preserving of the specimens this genus is as badly characterized as the other three genera, all from Europe, belonging to the same family. *Eoctonus* may be distinguished from *Palaeomachus* and *Archaeoectonus* by the shape of the seventh post-abdominal segment and the hand; from *Cyclophthalmus* by the same characters as well as the shape of the cephalothorax. None of the four genera, is however, sufficiently characterized to warrant a safe position in the system and they have only relative value.

Eoctonus miniatus n. sp.

Plate III, figs. 14, 15; text fig. 15.

This species is represented by two specimens in the Peabody Museum. I chose as the holotype the specimen numbered 131 and represented in Plate III, fig. 14. Although both halves of the nodule containing this specimen are in existence, the dorsal surface alone appears on both. It shows the complete body, both mandibles, one pedipalp, part of the fingers of the other pedipalp, and the trochanters and proximal parts of femora of four legs of the left side. Total length 14.0 mm. Cephalothorax a little narrower in front than behind, 1.7 mm. long and 1.5 mm. wide at posterior edge. Abdomen 5.7 mm. long; post-abdomen, not including the poison gland, 6.6 mm. The right pedipalp is 5.2 mm. long, its

femur is more slender and considerably longer than the patella. The hand is as wide as the patella, the immovable finger comparatively short and almost straight. The median eyes are small, oval, about $\frac{1}{4}$ the length of the cephalothorax distant from the anterior edge. Side eyes not present or at any rate not preserved. The abdominal tergites increase in length from the first to the seventh which is the longest. The second to sixth tergites have each a median crest and the fifth and sixth have besides two short, curved grooves, diverging posteriorly. The post-abdomen lies on its side and each segment shows two deep grooves which correspond to what have been in life the lateral crests. The seventh post-abdominal segment is slightly longer than the cephalothorax and $2\frac{1}{2}$ times as long as high. The poison gland is small with a curved sting and without a spine.

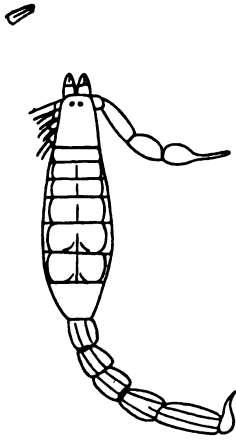


Fig. 15.

Figure 15. — *Eoctonus minutus* n. sp., holotype, Peabody Mus.

No. 131. $\times \frac{4}{1}$

Specimen No. 132, Plate III, fig. 15, is considerably larger, but resembles in all details the type specimen. Although the nodule containing this specimen shows both the obverse and reverse, yet the ventral surface is so badly deformed, that no details of structure can be made out. Total length 21.2 mm. Cephalothorax 3.0 mm. long. Its correct width cannot be ascertained owing to the fact that the specimen is considerably compressed longitudinally. Two oval eyes about $\frac{1}{3}$ the length of the cephalothorax distant from the anterior edge. Abdomen 7.3 mm. long, post-abdomen 11.5 mm. (not including the poison gland). Seventh post-abdominal segment as long as the cephalothorax and $2\frac{1}{2}$ times longer than high. Right pedipalp 12.5 mm. long, the hand somewhat slenderer than in the type specimen. The fourth left coxa, the only one visible, is abutting against the sternum, but the shape of the latter cannot be ascertained. The genital opercula are in the form of a transverse figure ∞ .

Found in the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

Family Isobuthidae.

Palaeobuthus n. gen.

Sternum triangular. Third coxae abutting against the sternum, fourth against the ellipsoidal genital operculum. Abdominal sternites with straight posterior edges. Genotype *P. distinctus* n. sp.

Palaeobuthus distinctus n. sp.

Plate I, fig. 5; text fig. 16.

The nodule containing the type and only specimen of the species and genus consists of two halves the one of which is so badly deformed that nothing can be made out clearly. The obverse, however, is very well preserved and shows the sternum, genital operculum, comb, abdomen, four and a third post-abdominal segments, third and fourth pairs of coxae, and fragments of legs. No traces of other appendages are left, but for a part of the tibia with finger of the right pedipalp on the obverse, showing that the specimen had a narrow hand with probably long fingers.

The sternum is small, triangular, with a spine-like projection running between the second pair of coxae. The genital operculum is transversely ellipsoidal, wider than the base of the sternum. Against it are abutting the ends of the fourth coxae. The comb is clearly defined, but the teeth do not show the lines between them and therefore cannot be counted. The abdomen is 22.0 mm. long from base of the genital operculum to end of last sternite. The

second sternite is by far the longest. The posterior edge of all sternites is entire, almost straight and not bilobed as in *Eobuthus*. The four post-abdominal segments measure together 17.0 mm. Length of straight line from genital operculum to base of hand 23.0 mm. Length of visible fragment of hand with finger 5.5 mm., width of hand 1.8 mm. Probable length of specimen 55 mm. The whole body is smooth.

No. 133 in the collection of the Peabody Museum.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

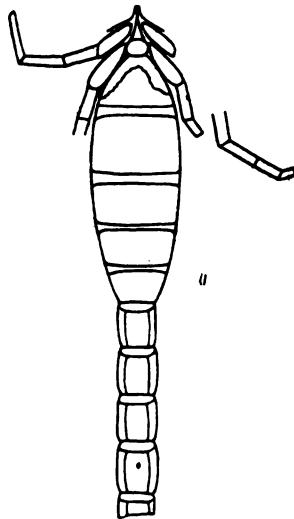


Fig. 16.

Figure 16.—*Palaeobuthus distinctus* n. sp., holotype, Peabody Mus. No. 133, ventral surface. $\times \frac{1.5}{1}$

Family Mazonidae.

A very little known family represented by one genus with one species only. Middle eyes large, sitting on a tubercle close to anterior edge of the cephalothorax. Post-abdomen, chelae, palpi and sternum with coxae unknown.

Genus *Mazonia* Meek and Worthen 1868.

With the characters of the family.

Genotype and only species *M. woodiana* M. and W.

Mazonia woodiana Meek and Worthen.

Plate III, fig. 13.

Mazonia woodiana Meek and Worthen, Geol. Surv. Ill., 1868, Vol. III, p. 653 with figure.

The description of this unique specimen given by Meek and Worthen is sufficiently exact to be quoted here almost in full. But their interpretation is at variance with mine, and I will therefore add my views below.

"The only specimen of the type of this proposed genus and species yet known, is in a crushed condition, and of course shows but few of its characters. Its cephalothorax is moderately convex, of a sub-quadrangular form (its length being about 11.25 mm., and its breadth 10.5 mm.), with rounded anterior lateral margins, and the anterior margin transversely truncated on each side of a small triangular mesial projection. Its posterior lateral regions slope off abruptly from an obscure ridge extending obliquely forward and outward, from near the middle of the posterior margin, to a point near the middle of each side, the sloping surface being marked by a few very minute irregularly scattering granules. From near the posterior margin, a mesial furrow extends forward, widening and deepening rapidly to the front, where it occupies one-third of the entire breadth, and is partly filled by the oculiferous prominence, which is the most elevated part, and bears on each side a large eye. These mesial eyes (the only ones known, or believed to exist) are circular, convex, about 1.75—2.00 mm. in diameter, and arranged for looking obliquely forward, outward and upward. They are each surrounded by a ridge, and so much elevated as to be seen almost entirely above the surface of the cephalothorax on each side. *No traces of lateral eyes* can be seen in the specimen, even by the aid of a magnifier, although the anterior lateral margins (particularly on one side) are well preserved.

" The abdomen measures about 33.65 mm. in length, and near 13.7 mm. in breadth, as seen in its crushed condition. There appear to be at least seven segments, with just space enough between the anterior, or seventh one seen, and the cephalothorax, for an eighth one. Excepting the posterior one (which is ornamented on the central region of the posterior half with small granules, some of which are arranged in longitudinal rows), these segments seem to be smooth. The exact outline of the posterior segment is not clearly seen in the specimen. . . . In clearing away the matrix, its posterior margin was seen to be truncated, as if for the attachment of a stout tail, but trying to work away more of the matrix, its margin was broken away so that it does not now show the truncated edge so clearly as represented in the figure. Its lateral margins are somewhat flattened. No traces of the tail are preserved, the concretion being too small to have included it.

" Just in front of the cephalothorax, extending obliquely forward, and outward to the right, a part of apparently one of the palpi is seen in the matrix. Unfortunately, however, its terminal portion is broken away. It seems to have been long and slender. At the inner end, there appears to be but one, though there may be two, short joints, and beyond these, there are two long slender ones. . . . An obscure impression of a part of one of the legs is also seen farther back, extending out from the right side."

As will be seen from the above quotation, Meek and Worthen suppose that the abdomen may have been composed of eight segments, in which case, if *Mazonia* is a scorpion, the cauda must have been only of four segments, since the number of segments in all known scorpions is twelve. On examining the specimen I too came to the conclusion that the last segment shows all semblance of the seventh abdominal tergite of a normal scorpion. There is also no doubt that behind the cephalothorax is a segment. It may be clearly seen even on the photograph. The two alternatives would be therefore that this segment represents the last thoracic segment which remained free as is the case in Solifugae and Palpigradi or the pregenital segment characteristic of embryos. Neither of these alternatives, however, finds a support in the structure of either extinct or recent scorpions. One could rather conceive a scorpion with six abdominal and six caudal segments, as that would be more in agreement with some Eurypterids and Xiphosura. Perhaps *Mazonia* had after all no distinct separation between abdomen and cauda, and the last four segments were small. In that case it could be considered a transitional form be-

tween scorpions and Pedipalpi, not in the sense that *Mazonia* was an ancestor of Pedipalpi, which it certainly was not, but that it represents a tendency in the same direction of diminution in size of the last segments.

To the description of Meek and Worthen may be added that in front of the cephalothorax are visible the impressions of the first joints of the mandibles, but it is not possible to decide whether the mandibles were chelate or retroverte. Pocock thinks that a separate group should be created for *Mazonia*, and I fully agree with him on this point. But the specimen is too fragmentary for that purpose and this is the reason why I have retained the genus *Mazonia* in the order of scorpions where it has been originally placed. The specimen was found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois. At present it is in the collection of the University of Illinois, at Urbana, Illinois.

Scudder has described two other specimens of *Mazonia*; the one he calls *M. acadica*, the other *Mazonia* sp. (cf. Geol. Surv. Canada, Vol. II, 1895, pp. 62–65, pl. V, figs. 4–9). I have carefully examined both specimens but am not able to find sufficient characters to place them among the arachnids. They represent what may have been an arthropod, but nothing more definite can be said about them.

ORDER PEDIPALPI

With the exception of the recent family Schizonotidae in which the two last thoracic segments, fused together, are movably jointed to the anterior part of the cephalothorax, the head is completely fused with the thorax. The abdomen, composed of eleven to twelve segments, is never broadly joined to the cephalothorax. The chelicera always retroverte; the pedipalpi powerful, raptorial, retroverte or chelate. The first pair of legs modified as tactile organs. All five post-oral appendages with a patella.¹ Two pairs of lungs

¹ Kraepelin is certainly in error when he calls the patella of the pedipalp, tibia, and the tibia, hand. The muscular system of the patella is characteristic of this joint. But whereas in scorpions the chelate pedipalp hand is formed by the tibia with its process as immovable finger and the tarso-metatarsus as movable finger, the immovable finger of Pedipalpi is usually formed by the process of the patella. There is often a line of separation between the tarsus and metatarsus as shown in text figure 17.

with **stigmata** at the posterior edge of the second and third abdominal sternites. Genital opening between the second and third sternites.

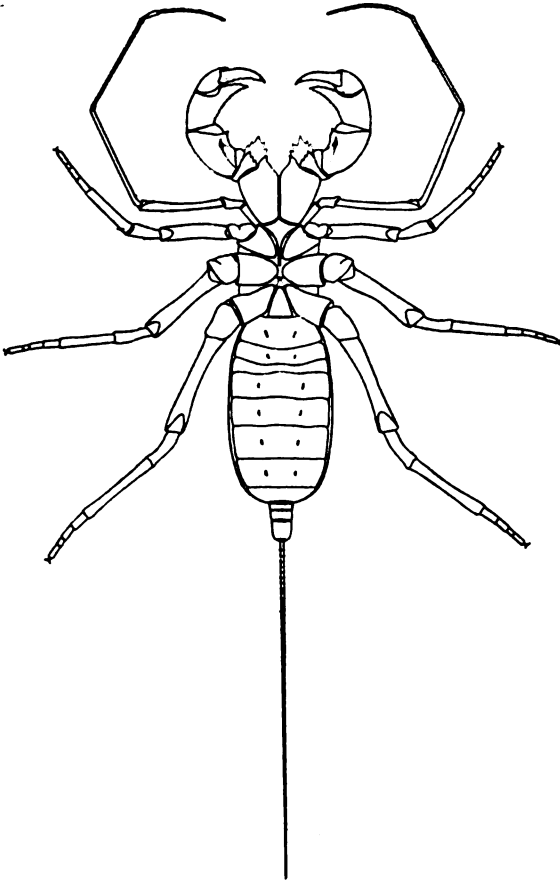


Fig. 17.

Figure 17.—*Mastigoproctus giganteus*, from Texas.

Recent forms probably all oviparous. Two median and in recent forms three pairs of lateral eyes, sometimes totally blind. All **Pedipalpi** are tropical or subtropical forms. They lead a nocturnal life, **hiding** during the day under rocks, also in dark places of human dwellings. For the palaeontologist dealing often with imperfectly preserved specimens, the position and structure of the coxae are

of great importance. In the sub-order Uropygi or whip scorpions the coxae of the pedipalpi are so large that they cover completely the chelicera. Movably jointed to the anterior part of the sternum they meet in the middle line. Immediately behind them are the coxae of the second pair of legs, while the considerably smaller first coxae, widely separated from each other, are situated in front of the anterior distal corner of the second at the sides of the palpal coxae. In the sub-order Amblypygi the coxae of the pedipalpi do not meet in the middle line, being separated from each other by the anterior part of the sternum, while the weak first coxae are so situated that their sides are in contact with the distal part of both the palpal and second coxae. No other arachnids have anything similar to the arrangement of the coxae in both sub-orders of Pedipalpi.

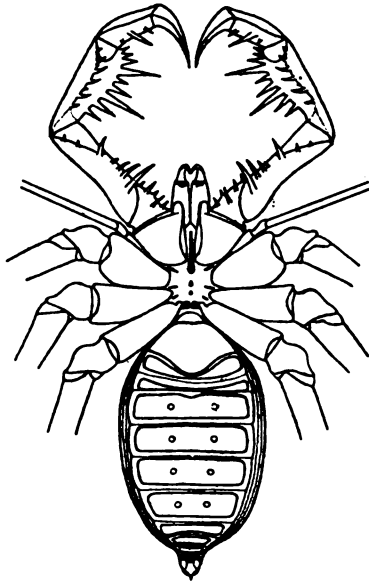


Fig. 18.

Figure 18.—*Tarantula fuscimana*, from Central America, a representative of the suborder Amblypygi.

LIST OF DESCRIBED SPECIES OF PEDIPALPI

Sub-Order Uropygi.

Cephalothorax longer than wide. Abdomen with a segmented whip or a short style. Coxae of pedipalpi meeting in the middle line.

Family Thelyphonidae Lucas.¹

Cephalothorax entire. Abdomen with a segmented whip.

¹ Family Gerialinuridae Scudder is a synonym of Theliphonidae. Its definition was based on specimens incorrectly described. Moreover it includes the genus *Græophonus* which belongs to the sub-order Amblypygi.

Genus *Geralinura* Scudder¹ 1884.Genotype *G. carbonaria* Scudder.

1. *G. carbonaria* Scudder, Proc. Amer. Acad. Arts Sci., Vol. XX, 1884, p. 19. Id., Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 455, pl. 39, fig. 1 (nec 3 and 4).
From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.
2. *G. similis* n. sp.
= *G. carbonaria* Scudder, Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 455 ad partem, pl. 39, figs. 3 and 4 (nec fig. 1).
From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.
3. *G. gigantea* n. sp.
From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.
4. *G. bohémica* (Kůsta).
= *Telyphonus bohemicus* Kůsta, Sitz. k. böhm. Ges. d. Wiss., 1884, p. 186, pl. I.
= *G. bohémica* Id., Ibid., 1888.
= *G. scuddari* Id., Ibid., 1888, p. 205, pl. fig. 5.
? = *G. noctua* Id., Ibid., p. 201, pl. fig. 6.
? = *G. crassa* Id., Ibid., 1888, p. 203.
= *Protelyphonus bohemicus* Fritsch, Pal. Arachn., 1904, pp. 59–62, pl. 6, figs. 1–8, text figs. 71–77.
From the Carboniferous (Noegerathienschiefer, Coal Measures) near Rakonitz, Bohemia.
5. *G. britannica* Pocock, Carb. Arachn., 1911, p. 29, pl. I, fig. 3; pl. II, fig. 3; text fig. 9.
From the Coal Measures of Coseley, near Dudley, England.

Sub-Order Amblypygi.

Cephalothorax wider than long. Coxae of pedipalpi not meeting in middle line. Abdomen without a whip.

Family Tarantulidae Karsch.

With all the characters of the sub-order.

Genus *Graeophonus* Scudder 1890.Genotype *G. carbonarius* Scudder.

1. *G. carbonarius* Scudder.
= *Libellula carbonaria* Scudder, Can. Nat. (2), Vol. VIII, 1876, p. 88, fig. 1.
G. carbonarius Id., Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 454, pl. 40, figs. 2, 3, 6.

¹ *Protelyphonus* Fritsch is a synonym of *Geralinura*.

- From the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.
 2. *G. anglicus* Pocock, Carb. Arachn., 1911, p. 32, pl. I, figs. 4-4d.
 From the Coal Measures of Coseley, near Dudley, England.

Telyphrynus n. gen.

Genotype *T. elongatus* n. sp.

1. *T. elongatus* n. sp.
 From the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Protophrynus n. gen.

Genotype *P. carbonarius* n. sp.

1. *P. carbonarius* n. sp.
 From the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

KEY TO GENERA OF NORTH AMERICAN CARBONIFEROUS
 PEDIPALPI

1. Cephalothorax longer than broad. Abdomen with a whip—Sub-
 order Uropygi *Geralinura*.
 + Cephalothorax wider than long. Abdomen without a whip—
 Sub-order Amblypygi 2
2. Coxae of 3d and 4th pair of legs joined in a median line, not
 triangular. Eyes absent *Telyphrynus*.
 + coxae of 3d and 4th pair of legs converging toward a point 3
3. Abdomen with 7 visible tergites. Trochanters 1-jointed. Four
 eyes *Protophrynus*.
 + abdomen with 10 tergites. Trochanters 2-jointed. Two eyes
Graeophonus.

DESCRIPTION OF NORTH AMERICAN CARBONIFEROUS
 PEDIPALPI

Sub-Order Uropygi.

Family Thelyphonidae Lucas

Genus *Geralinura* Scudder.

(New definition.) Cephalothorax entire, longer than wide. Sternum composed of one piece. Abdomen with twelve segments. Whip many jointed.

Key to North American Species of *Geralinura*.

1. No constriction between the cephalothorax and the first abdominal tergite. Coxae of 4th pair of legs rectangular and contiguous *G. similis* n. sp.
 + a distinct constriction between the cephalothorax and the 1st abdominal tergite; abdomen anteriorly rounded 2

2. Cephalothorax oval

G. carbonaria Scudder.

+ cephalothorax anteriorly truncated

G. gigantea n. sp.

Geralinura carbonaria Scudder.

Plate IV, figs. 21, 22; -text figs. 19, 20.

G. carbonaria Scudder, Proc. Amer. Acad. Arts Sci., Vol. XX, 1884, p. 19. Id., Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 455, pl. 39, fig. 1.

Scudder's description of this species is based on two specimens one of which, specimen a, alone belongs to it and is therefore the type. Specimen b is undoubtedly a different species and forms the type of *G. similis* n. sp.

The type specimen was originally labelled 1754 a and b, but is at present in the collection of the U. S. National Museum under the number 37985. Both the obverse and the reverse are well preserved. The obverse shows the cephalothorax, abdomen, and fragments of pedipalpi and legs; the reverse the sternum with coxae and femora, abdomen, and five segments of the whip.

The cephalothorax is oval, 4.03 mm. long; its greatest width is about $\frac{1}{3}$ from posterior edge and measures 3.0 mm. Eyes are absent. The abdomen is 11.8 mm. long, rounded in front; the total length

of the specimen to base of tail, 16.0 mm. The anterior ten segments of the abdomen are subequal in length and their tergites are considerably narrower than the width of the abdomen. The eleventh and twelfth segments are somewhat longer than the preceding ones and considerably narrower, but there is no abrupt difference in size, the abdomen narrowing posteriorly, but gradually. The five segments of the whip measure together 4.06 mm. The

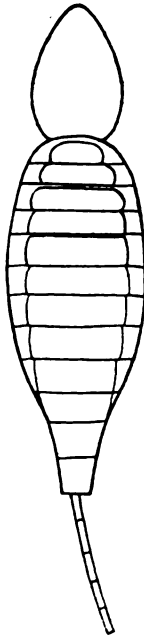


Fig. 19.



Fig. 20.

Figure 19.—*Geralinura carbonaria* Scudder, holotype a, U. S. N. M. No. 37985 (1754a and b), dorsal surface. $\times \frac{4}{1}$.

Figure 20.—Same, sternum. $\times \frac{8}{1}$.

arrangement of all coxae is exactly the same as in *G. similis*, but the sternum is somewhat different as will be readily understood from a comparison of text figures 20 and 22. The femur of the third pair of legs is 2.8 mm. long, that of the fourth 3.7 mm. (Scudder's figures include the trochanters). The whole body is smooth. Only one specimen in existence.

From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

Geralinura similis n. sp.

Plate IV, figs. 19, 20; text figs. 21, 22.

= *G. carbonaria* Scudder, ad partem, Mem. Boston Soc. Nat. Hist. Vol. IV, 1890, specimen b, pl. 39, figs 3-4.



Fig. 21.

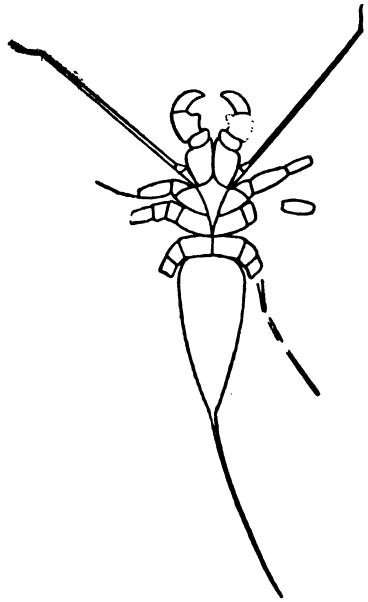


Fig. 22.

Figure 21.—*Geralinura similis* n. sp., holotype b, U. S. N. M. No. 37985 (1754c), dorsal surface. Figure 22.—Same, ventral surface, showing the arrangement of the coxae. $\times \frac{2.5}{1}$

As I have already pointed out, the type and only specimen of this species, at present in the collection of the U. S. National Museum, is easily distinguished from *G. carbonaria* by the shape of the cephalothorax and abdomen, as well as by the sternum. Total length to base of whip 1.4 mm. Cephalothorax 5.25 mm. long, 3.0 mm. wide at posterior edge which is slightly recurved. Eyes absent. First ab-

dominal segment same width as cephalothorax, but the constriction between cephalothorax and abdomen is well visible on the ventral surface. Segmentation of abdomen indistinct, neither the tergites, nor the sternites being preserved. Whip 10 mm. long. Pedipalpi heavy, their coxae meeting in the median line, longer than wide, with a distal internal process. The trochanters wider than long, the femora with a process at inner edge. The patellae curved, their distal end possibly representing the immovable finger. Tibia and tarso-metatarsi lost. The first coxae as in recent Thelyphonidae. The femora long and thin, the rest not preserved with exception of the proximal end of the patellae. First femur 8.5 mm. long. Second femur much thicker and only 1.75 mm. long. The sternum 3.00 mm. long, pointed behind. The coxae of the second pair conical, those of the third pair with parallel sides, diverging in front, contiguous at posterior end. Coxae of fourth pair contiguous, rectangular. It is doubtful whether the fourth leg is as thin as it appears, more probably it was as heavy as the second and third, this being indicated by the width of the proximal fragment of the femur.

From the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Geralinura gigantea n. sp.

Plate V, figs. 23-25; text figs. 23-26.

The holotype of this species is in the collection of the U. S. National Museum under the number 37976. The obverse shows the cephalothorax, five segments of the abdomen, pedipalpi, chelicera and fragments of legs; the reverse, the palpi, chelicera, coxae of all legs, abdomen, almost complete first right leg and several joints of the remaining legs. The whip is not preserved.

Total length 21.0 mm. The flat, excellently preserved cephalothorax is 6.3 mm. long and 4.5 mm. wide $\frac{2}{3}$ from anterior edge, i. e., in its widest place. Anteriorly the cephalothorax is truncated, the posterior edge is very slightly recurved, almost straight and about twice as wide as the anterior edge. Immediately behind the widest place there is a conspicuous median ridge sloping posteriorly and anteriorly where it goes over gradually into curved grooves running towards the deep lateral grooves. The lateral grooves themselves begin at anterior edge and run parallel to the sides of the cephalothorax. They represent the moulds of the lateral crests as in recent forms, and the enlarged portion of their posterior end may have been the place where the lateral eyes were in the living specimen, but no trace of the lenses is left. The middle eyes are oval, small, separated

from each other and from the anterior edge by about their diameter. The mandibles or chelicera are unusually large, but only the basal joint visible, so that it is not possible to decide whether the fang was movable upward and downward as in recent forms, or inward and outward as in true spiders. The former is, however, more probable since it is the rule in all recent pedipalpi.

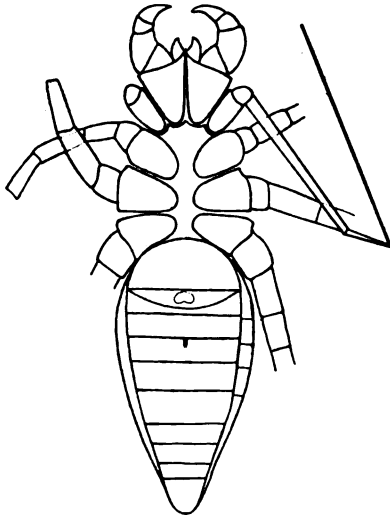


Fig. 23.

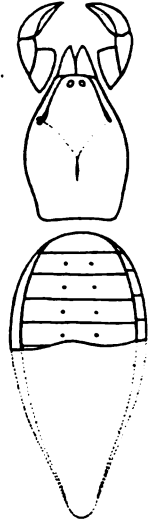


Fig. 24.

Figure 23.—*Geralinura gigantea* n. sp., from the Upper Coal Measures, Braidwood, Illinois, holotype, U. S. N. M. No. 37976, ventral surface, showing arrangement of coxae. Figure 24.—Same, dorsal surface. $\times \frac{3}{1}$

The abdomen is rounded in front, gradually narrowing posteriorly. The pleura are well visible and were soft and entire, the irregular segmentation appearing in the specimen being due probably to artificial folding. The second to fifth abdominal tergites show clearly the round attachment points of the dorso-ventral muscles, one pair in each segment. On the ventral side one can see only ten sternites. Of these the first, corresponding to the first and second segments, is by far the largest and has a semicircular shape. The second sternite has the shape of a segment, its posterior edge being procurved. Impressed on it we see the bean-shaped genital opening. Only the anterior edge of the sternum is preserved and this is peculiar in its structure inasmuch as it has articulation surfaces not only for the pedipalpi, but also for the coxae of the first pair of legs. The pedi-

palpi are heavy and rather short and the immovable finger is formed by the tibia and not by the patella. The coxae of the first pair of legs are unusually heavy, the femur 7.3 mm. long, getting evenly thinner toward its distal end. The patella is about as long as the coxa. Whether the last visible joint represents only the tibia, or whether some joints of the tactile organ form the end of it, is not possible to decide. The second, third and fourth pair of legs were short and stout and their coxae at even distances from each other. The whole body is smooth.

In the same nodule is a marine lamellibranchiate.

Specimen No. 147 of the Peabody Museum. Plate V, fig. 25; text figs. 25, 26. Paratype.

Total size 22.0 mm. Cephalothorax 5.65 mm. long, 4.3 mm. wide in the widest place, has the same shape and structure as in the type specimen. Middle eyes not preserved. Mandibles visible only on the obverse. Palpi much heavier than in the type specimen, their fingers not preserved. The sternum as in type, but the metasternum clearly visible in front of the first abdominal sternite, separating the hind

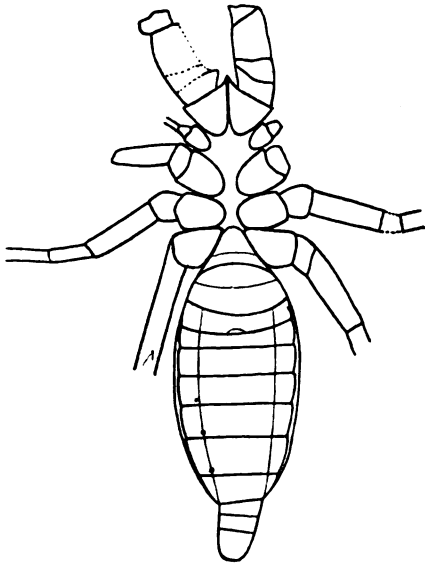


Fig. 25.



Fig. 26.

Figure 25.—*Geralinura gigantea* n. sp., paratype, Peabody Mus. No. 147, ventral surface. Figure 26.—Same, dorsal surface. $\times \frac{8}{1}$

coxae. The first abdominal sternite with a procurved posterior edge. The second with both edges procurved, almost concentric. At the posterior edge the impression of a semilunar genital opening. The last three abdominal segments set off sharply from the preceding segment, much as in recent whip scorpions. Of the legs only frag-

ments preserved as shown in text figure 25. Notwithstanding the differences in the shape of the pedipalpi, of the coxae of the first pair of legs and of the last three abdominal segments, the similarity in size and structure between the cotype and type is so great, that I am rather inclined to attribute the differences to sexual dimorphism than to make a separate species of the cotype.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Sub-Order Amblypygi.

Family Tarantulidae Karsch.

Thelyphrynus n. gen.

Cephalothorax wider than long, bean-shaped. Eyes absent. Coxae of third and fourth pair contiguous, not triangular. Genotype *T. elongatus* n. sp.

Thelyphrynus elongatus n. sp.

Plate V, fig. 26; text figs. 27, 28.

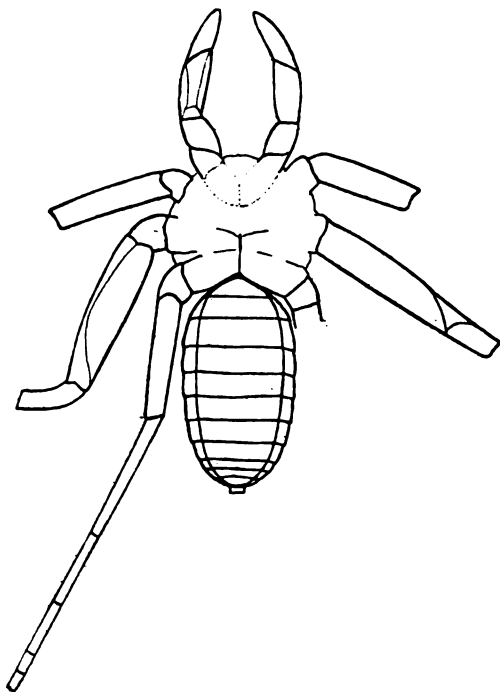


Fig. 27.



Fig. 28.

Figure 27.—*Thelyphrynus elongatus* n. sp., holotype. Daniels coll., ventral surface. Figure 28.—Same. cephalothorax. $\times \frac{3}{1}$

The type and only specimen of this species, showing only the reverse, is in the collection of Mr. L. E. Daniels. It shows the pedipalpi, trochanters and femora of the second pair of legs, trochanters, femora and patellae of the third pair, an almost complete fourth leg,

faint impressions of the coxae of the third and fourth pair, complete abdomen and superimposed over the coxae the cephalothorax.

Total length without pedipalps 16 mm. Cephalothorax 4.1 mm. long, 5.8 mm. wide in the widest place, with a median depression as in text figure 28. Abdomen 9.6 mm. long; it consists of eleven segments and a short pygidium. The pleura is clearly segmented. The pedipalpi are heavy and long. The first pair of legs is not preserved, but presumably it was thin and long. The second femur is 5 mm. long, the third 7 mm. The fourth leg is much thinner than the third, its femur is 5.6 mm. long, and the total length of this leg from the base of the trochanter to the end of the last visible joint is 21 mm. Whether the transverse lines represent the limits of joints it is not possible to ascertain. The whole body is smooth.

The general appearance of this specimen reminds one much of a true whip scorpion, but the shape of the cephalothorax is characteristic of the sub-order Amblypygi and there are no signs of a whip, although the abdomen is in an excellent state of preservation.

From the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Genus *Graeophonus* Scudder 1890.

New definition. Cephalothorax wider than long, reniform, with one pair of eyes placed on an eye tubercle. Third and fourth pair of coxae triangular, meeting in a median point. Trochanters two-jointed. Abdominal tergites ten. Genotype *G. carbonarius* Scudder.

Graeophonus carbonarius (Scudder).

Plate V, figs. 27–29; text figs. 29–31.

= *Libellula carbonaria* Scudder, Can. Nat., (2), Vol. VIII, 1876, p. 88, fig. 1.

G. carbonarius Id., Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 454, pl. 40, figs. 2, 3, 6.

Scudder drew the characters of this species from specimen No. 1762 of the Lacoë collection "before it was recognized as the same species as that described by many years ago from an abdomen alone, under the name of *Libellula carbonaria*." Since both specimens received the same specific name and since the generic characters were first drawn by Scudder from specimen No. 1762, moreover since this specimen is the more complete one, it should have the value of the holotype. We must remember that characters of extinct arachnids do not have the same value as those of recent forms. It is probable that *Libellula carbonaria* belongs to the same genus and species as *Graeophonus carbonarius*, but the specimen is too incomplete to make it an absolute certainty. I have carefully compared the type specimen of *Libellula carbonaria* with the type specimen of *Graeophonus carbonarius*

and believe them to belong to the same species, as far as one may judge from the abdomen alone. But in the systematics of *Amblypygi* the abdomen is the least important part of the body and may not have even generic value. I therefore regard as type specimen No. 1762 of the Lacoe collection. The description of Scudder is not correct. He describes the palpi as chelate, whereas they are incomplete and consequently show no chela. He also describes the second pair of legs as the first, but the first pair is

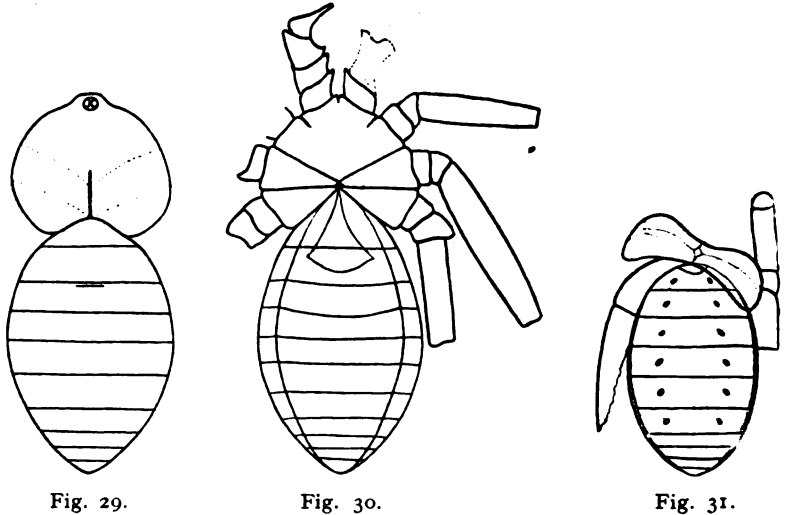


Fig. 29. —*Graeophonus carbonarius* holotype, U. S. N. M. No. 37969, dorsal surface. Figure 30.—Same, ventral surface. Figure 31.—*Graeophonus carbonarius* (Scudder), from the Upper Coal Measures, Joggins Mines, Nova Scotia. specimen No. 37964 of the U. S. National Museum, dorsal surface. $\times \frac{3}{1}$

lost altogether. The following description of the type is made after the specimen has been cleaned from the kaolin which was hiding from view many of its structures.

Total length 17.0 mm. Cephalothorax reniform, with a slight projection in front of the eye tubercle, 5.66 mm. long in the middle line and 7.0 mm. wide about $\frac{2}{3}$ from anterior edge. A median crest extends from the middle of the cephalothorax to its posterior edge. Two pairs of oblique, curved crests run from the sides of the cephalothorax to the median crest. Eyes round, contiguous, on a round tubercle (depression in the specimen being the mould of the tubercle) close to anterior edge. Abdomen oval, without pygidium. On the dorsal surface may be counted ten tergites, on the ventral eleven

sternites. The pleura is preserved only on the ventral surface and is segmented. A deep, triangular depression extends from the anterior end of the abdomen to the middle of the second sternite, possibly the result of deformation. Of the coxae only those of the third and fourth pair are preserved. They are triangular and their apices meet in a median point. The pedipalpi are heavy, their joints wider than long. The tarso-metatarsus is lost, the tibia has a long internal process which may have had the function of an immovable finger. The second femur is 5.3 mm. long, the third 7.9 mm., the fourth (incomplete) 4.8 mm. The trochanters of the legs (and palpi?) are two-jointed.

Specimen No 3085 in the collection of McGill University is the type specimen of *Libellula carbonaria*. I can add nothing to Scudder's description and refer the reader to his plate 40, figs. 2, 6.

Specimen No. 37964 of the U. S. National Museum from the Joggins Mines, Nova Scotia, text figure 31, plate V, figure 29, belongs probably to the same species.

The cephalothorax of this specimen is so badly deformed that it is impossible to reconstruct its shape. The abdomen is excellently preserved and is composed of ten segments. A pair of oval depressions in each of the first six tergites represent the places of attachment of the dorso-ventral muscles. Only fractions of two legs are preserved and they show that the legs were fully as heavy as in the type specimen. The abdomen is 9.3 mm. long and 5.7 mm. wide.

The type specimen is from the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois; the type of *Libellula carbonaria* from the Pennsylvanian ("Millstone Grit") of Cape Breton; and specimen No. 37964 from the Upper Coal Measures at Joggins Mines, Nova Scotia.

Protophrynus n. gen.

Cephalothorax broader than long, reniform, with two pairs of eyes. Trochanters normal, one-jointed. Abdomen with seven tergites. Genotype *P. carbonarius* n. sp.

Protophrynus carbonarius n. sp.

Plate VI, figs. 30, 31; text figs. 32, 33.

The type and only specimen of this species is in the collection of Mr. L. E. Daniels. Both the obverse and reverse are well preserved. The flat cephalothorax is reniform with a wide projection in front, 5 mm. long, 7 mm. wide. It has a median crest and lateral crests radiating from it, being moulds of the longitudinal and thoracic grooves. Two small, round median eyes close to anterior edge and two larger, round, lateral eyes touching the sides of the projection. Abdomen

7 mm. long, oval, with seven tergites. The coxae of the pedipalp small, the pedipalpi not heavier than the second legs, Trochanters of all appendages normal, one-jointed. The femora of the pedipalpi short and stout. The other joints missing. Immediately behind the palps

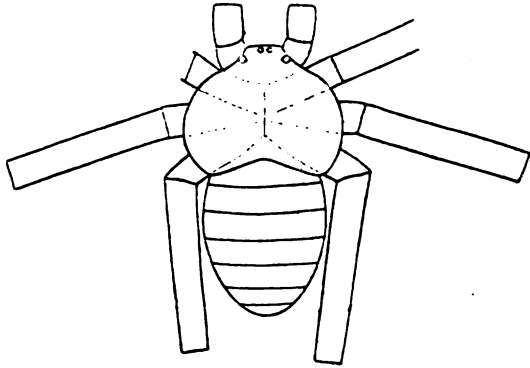


Fig. 32.

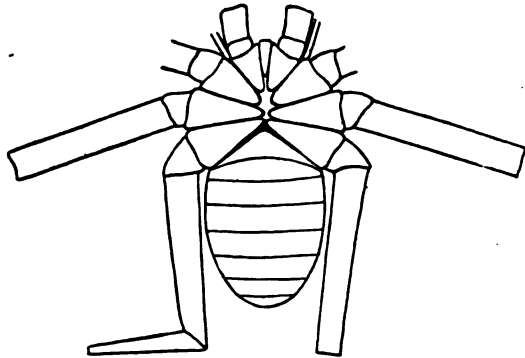


Fig. 33.

Figure 32.—*Protophrynus carbonarius* n. sp., holotype, Daniels coll., dorsal surface. Figure 33.—Same, ventral surface. $\times \frac{8}{1}$

one may see the faint impressions of the proximal part of the thin legs of the first pair. Abdominal sternites eight. The legs must have been very long, if judged by the length of the femora. Third femur 7.5 mm. long, fourth femur 7.8 mm. The whole body smooth and flat.

Found in the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

ORDER KUSTARACHNAE

Head completely fused with thorax. Abdomen segmented, probably with a pedicel. All coxae radiating from a central, small sternum, probably immovable. Coxae of pedipalpi fused together without a suture. Pedipalpi chelate. Chelicera not known. Legs thin and long. Eyes to the number of two, placed on a tubercle.

The above characters make it impossible to place the three species of the only genus of this order under any other order. Pocock has pointed out that *Kustarachne sulcata* Melander is a *Curculioides* and thinks that the other species may also belong to the order Ricinulei. As will be shown further below, *Kustarachne sulcata* is a *Curculioides*, but *K. tenuipes* Scudder, *K. extincta* Melander and *K. conica* n. sp. have nothing in common with either extinct or recent Ricinulei, while they are very closely related to each other.

Genus *Kustarachne* Scudder 1890.

With the characters of the order. Genotype *K. tenuipes* Scudder.

Key to the Species of *Kustarachne*.

- 1. Abdomen with 10 sternites *K. extincta*
- + abdomen with 7 sternites 2
- 2. Abdomen conical without pygidium *K. conica*
- + abdomen oval with a pygidium *K. tenuipes*.

Kustarachne tenuipes Scudder.

Plate VI, figs. 33, 34; text figs. 34, 35.

K. tenuipes Scudder, Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 450, pl. 40, fig. 7.

The type and only specimen of this species, originally labelled No. 1756 a and b is now in the collection of the U. S. National Museum as No. 37967. Since Scudder's description is incorrect owing to the specimen not having been properly cleaned, the following description should take its place.

Total length 11.5 mm. Cephalothorax with strongly recurved posterior edge, rounded in front, quite flat, 3.0 mm. long in the median line, 5.8 mm. wide between the posterior corners. About $\frac{1}{3}$ the length of the cephalothorax from its anterior edge is the mould of the transversely ellipsoidal eye tubercle with two perfectly round eyes. Chelicera missing. The coxae are all triangular, apparently immovable, radiating from a small sternum. The coxae of the pedipalp are completely fused together without a sign of a suture. The palpi themselves are composed of only four segments, the last two forming

a distinct chela. The trochanters of the first and fourth leg, and probably of all legs are two-jointed, the first joint rectangular, broader than long, the second joint conical. The femora very long and thin. The abdomen oval, the first sternite very large, triangular. The last or seventh sternite the smallest, crescent-shaped. Behind it a short pygidium and at a little distance from the pygidium a fraction of either a whip or of some joint of the last leg which in this case must have been



Fig. 34.

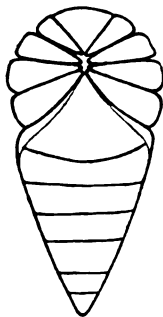


Fig. 36.

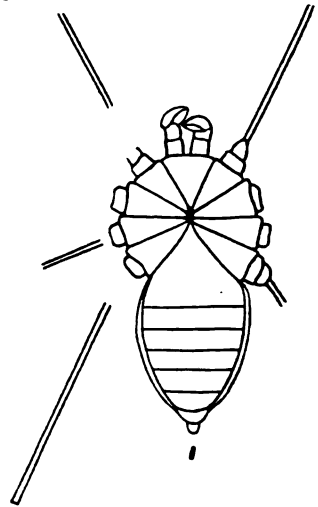


Fig. 35.

Figure 34.—*Kustarachne tenuipes* Scudder, holotype, U. S. N. M. No. 37967, ventral surface. Figure 35.—Same, cephalothorax. $\times \frac{8}{1}$. Figure 36.—*Kustarachne conica* n. sp., holotype, Daniels coll., ventral surface. $\times \frac{4}{1}$

bent. The former alternative seems, however, to be more probable. The pleurae entire. The abdominal tergites apparently similar in number to the sternites, but not well defined.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Kustarachne conica n. sp.

Plate VI, fig. 35; text fig. 36.

The nodule containing the type and only specimen of this species is in the collection of Mr. L. E. Daniels. The obverse is missing. The reverse is very poorly preserved, owing to pronounced decomposition of the rock. Nothing but the coxae and abdomen is visible. Total size 10 mm. Arrangement of coxae same as in *K. tenuipes*. Abdomen composed of seven segments, without pygidium. The first sternite triangular with a procurved posterior edge.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Kustarachne extincta Melander.

Text figs. 37, 38.

K. extincta Melander, Jour. Geol., Vol. XI, 1903, p. 182, pl. V, fig. 4; pl. VII, fig. 5.

The type and only specimen is in the Walker collection of the University of Chicago, No. 9236. Careful cleaning of the specimen showed that the description given by Melander is not correct, and the following description should be substituted.

Total length 15 mm. Cephalothorax with a slightly recurved posterior edge, rounded in front, 6.0 mm. long, 7.0 mm. wide. Two contiguous, perfectly round eyes on a transversely ellipsoidal tubercle a little in front of the middle of the cephalothorax. Pedipalpi (not counting the coxae) four-jointed, chelate. Arrangement of coxae same as in *K. tenuipes*, but the fused coxae of the pedipalpi with a slightly angular anterior edge. First and probably all trochanters two-jointed, first joint rectangular, second conical. First leg thin and long other legs missing. Abdomen oval, composed of ten segments with two minute segments behind the tenth representing possibly the first joints of a whip.

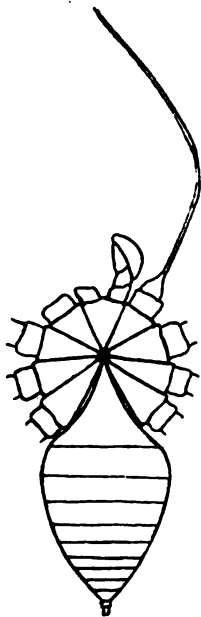


Fig. 37.



Fig. 38.

Figure 37.—*Kustarachne extincta* Mel., holotype, Univ. of Chicago Mus. No. 9236, ventral surface. Figure 38.—Same, cephalothorax. $\times \frac{2.75}{1}$

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

ORDER SOLIFUGAE

Only the first segment of the thorax fused with the head, the last three segments free. Abdomen composed of ten segments. Chelicera chelate. Pedipalpi pediform. Trochanters of legs two-jointed. Patella absent. Coxa and trochanter of fourth leg with a row of malleoli on underside. Organs of respiration in form of tracheal tubes. First pair of stigmata behind the coxae of the second pair of legs, second pair on the second abdominal segment, third pair on

the third abdominal segment, and a single stigma on the fourth abdominal segment in some species. Genital opening, protected by two opercula, on the first abdominal segment. Oviparous.

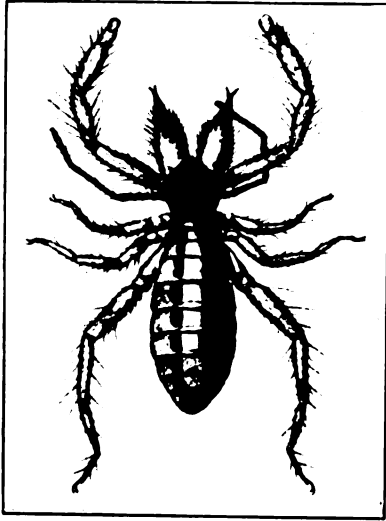


Fig. 39.

Figure 39.—*Ammotrecha cubae* (H. Lucas), a recent solifugid. (From Putnam, *The Solifugidae of America*, 1883).

The recent Solifugids lead a nocturnal life, feeding on insects. They inhabit hot countries and are preëminently desert forms, although some species are found in tropical rain regions. Until now no representative of this order has been found in any of the geological periods. The recent Solifugae are divided into three families, but the poor preservation of the only Palaeozoic specimen prevents me from placing it in any of them.

Protosolpuga n. gen

Three posterior thoracic segments free. Chelicera chelate, powerful. Pedipalpi pediform, heavy. Second pair of legs considerably thinner than the

others. Abdomen apparently composed of seven segments only. Genotype *P. carbonaria* n. sp.

Protosolpuga carbonaria n. sp.

Plate VI, fig. 32; text fig. 40.

The type and only specimen of this interesting arachnid is in the Peabody Museum, No. 155. Unfortunately it is in a very poor state of preservation, the details being exceedingly difficult to see. The lines separating the segments of the thorax and abdomen are very faint. The obverse is fairly well discernible, but the reverse totally useless, since the ventral surface was evidently softer and shows superimposed over it the structures of the dorsal surface.

Total length with chelicera 24.0 mm.; abdomen 12 mm. long. Chelicera heavy, chelate, their ends somewhat curved; a row of small punctuated depressions along their edge. The head much wider than

long. Eyes absent. Of the three free thoracic segments the anterior one the shortest. Abdomen oval, broader behind than in front, anteriorly truncated, posteriorly rounded. It seems probable that the curved lines belong to the ventral surface and if the straight lines alone are counted, then the abdomen was composed of seven segments only. The pedipalpi both visible, the right one showing even segmentation. They are heavier than the legs and about 22 mm. long, their joints subequal in length with exception of the terminal joint, which is quite small, semilunar. Of the remaining appendages only fragments are preserved. The second pair of legs is considerably thinner than the others, the third leg was probably the shortest if judged by the comparative shortness of its femur.

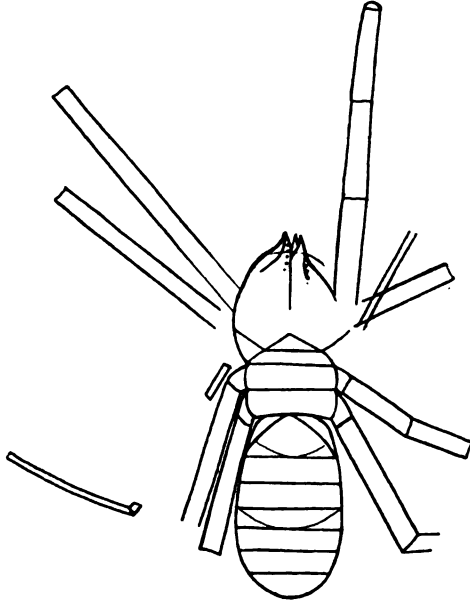


Fig. 40.

Figure 40.—*Protosolpuga carbonaria* n. sp., holotype, Peabody Mus. No. 155, dorsal surface. $\times \frac{2}{1}$

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

ORDER RICINULEI

Arachnids with hard, granulated integument, with a plate or cucullus in front of the cephalothorax and a broad abdomen composed of nine segments with a pedicel and coupled to the cephalothorax by means of a special apparatus. Of the abdominal tergites the third to sixth are by far the largest, usually divided into three areas. The first tergite, or pedicel, and the second tergite are not visible when the abdomen occupies its normal position. The seventh to ninth segments are very small, annular, and form a "tail". Of the sternites the first and second are small, semilunar, seldom visible

in the normal position of the abdomen. Chelicera two-jointed, chelate. Pedipalpi chelate, composed of coxa, a two-jointed trochanter, femur, tibia and tarsus, the latter forming with a process of the tibia a small chela. All coxae contiguous, those of the anterior three pairs immovable, while the fourth pair is movable. Patella present in all legs. Trochanter of the first and second pair

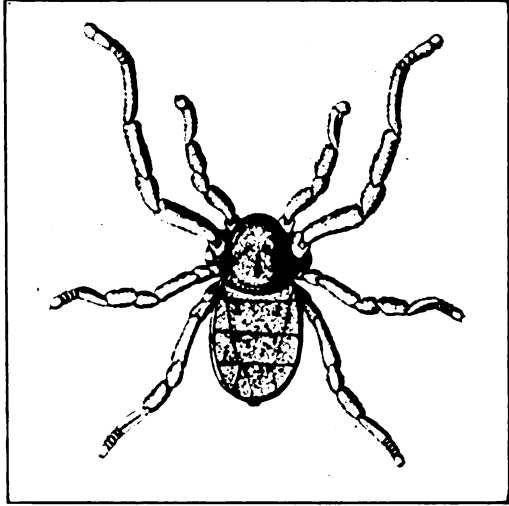


Fig. 41.

Figure 41.—*Cryptostemma karschii* H. and S., a recent representative of the order Ricinulei from Kamerun and Congo; dorsal surface showing the cucullus, cephalothorax, the 3d—6th abdominal tergites, the "tail", and the four pairs of legs. Between the trochanters of the 2d and 3d pair of legs one may see a part of the pedipalpi, which are bent downward.

(From H. J. Hansen and W. Sørensen, On two Orders of Arachnida, 1904.)

of legs single, of the third and fourth pair two-jointed. First tarsus one-jointed, second five-jointed, third four-jointed, fourth five-jointed. In the male the third metatarsus and tarsus are modified, representing probably an organ of copulation. Eyes absent. Genital opening between the first and second sternite. Organs of respiration in form of two tracheal tubes with a pair of spiracles on the cephalothorax. Oviparous. Only few recent species known, all from Africa and South America.

This order may be divided into two families. The family Cryptostemidae Westwood, comprising all recent forms and the extinct

genus *Polyochera*, is characterized by the visible segmentation of the abdomen. The family Holotergidae, new, contains the single

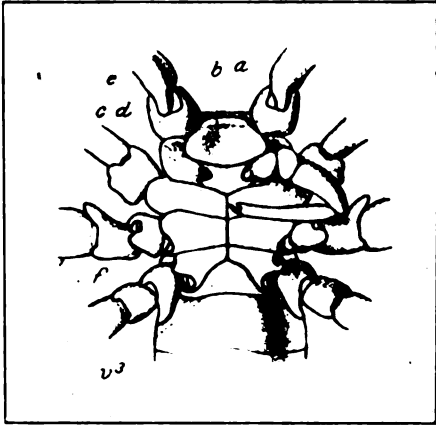


Fig. 42.

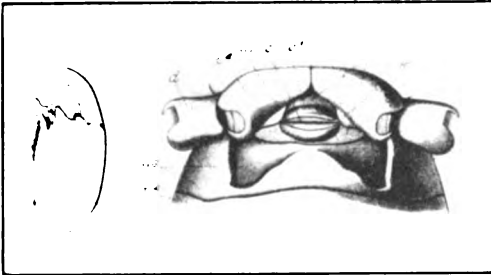


Fig. 43.

Figure 42.—*Cryptocellus simonis* H. and S., from Brazil; underside, showing the cucullus (b), the coxae and trochanters, one pedipalp (the other is removed), and the 3d (v_3) and 4th abdominal sternites. Figure 43.—*Cryptostemma afzelii* Thorell, from Africa (Sierra Leone); on the left an isolated mandible; on the right the coxae of the 4th pair of legs (c^4), genital opening (o), 1st abdominal sternite (v^1), 2d sternite (v^2), and 3d sternite (v^3). (From H. J. Hansen and W. Sørensen, On two Orders of Arachnida, 1904.)

extinct genus *Curculioides* and is characterized by the externally unsegmented abdomen which was evidently protected by a heavy, chitinous shield.

Family *Cryptostemmidae* Westwood.

Abdominal tergites distinctly separate.

Genus *Polyochera* Scudder 1884

Tarsus of second leg fused with the metatarsus, forming one joint. Genotype *P. punctulata* Scudder.

Key to the Species of *Polyochera*.

1. Abdominal tergites of the 4th, 5th and 6th segments each marked with 2 pairs of round impressions. Cucullus nearly as long as wide
P. alticeps
+ abdominal tergites divided into fields by 2 or 4 longitudinal lines. Cucullus much wider than long. 2
2. No constriction between cephalothorax and abdomen. Body punctulate. Abdominal tergites of the 4th, 5th and 6th segments each divided into 5 fields by longitudinal lines
P. punctulata
+ a distinct constriction between cephalothorax and abdomen. Body smooth. Abdominal tergites, including that of the 3d segment, divided into 3 fields each by 2 parallel longitudinal lines
P. glabra

Polyochera alticeps Pocock

P. alticeps Pocock, Carb. Arachn., 1911, p. 40, pl. II, fig. 6; text fig. 14. From the Coal Measures of Coseley, near Dudley, England.

Polyochera punctulata Scudder.

Plate VIII, figs. 41, 42; text figs. 44, 45

P. punctulata Scudder, Proc. Amer. Acad. Arts Sci., Vol. XX, 1884, p. 16. Id., Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 444, pl. 39, figs. 2, 6.

The nodule containing the type specimen, No. 1745 of the Lacoe collection, at present No. 37971 of the U. S. National Museum, shows both the obverse and reverse in an excellent state of preservation. The description of Scudder not being quite correct, the following should be substituted for it.

Total length 15.5 mm. Cucullus 1.0 mm. long, 3.8 mm. wide. Cephalothorax 4.7 mm. long, 5.5 mm. wide at posterior edge which is procurved. Abdomen rounded behind; only the third to sixth tergites visible, the segments composing the "tail" missing. The tergite of the third abdominal segment, the one adjoining the cephalothorax, is the shortest; the tergite of the sixth, or last visible seg-

ment, the longest. Chelicera and pedipalpi missing. All legs with a patella. First leg somewhat thinner than the others. Trochanter of the first and second pair of legs one-jointed, of the third and fourth pair two-jointed. Last joint of second leg formed by a tarso-metatarsus with two round pads and two long, curved claws at the end. The following joints of the legs are preserved: First pair: coxa, trochanter, femur, patella and tibia of both sides; femur 3.0 mm. long. Second pair: coxa, trochanter, femur of

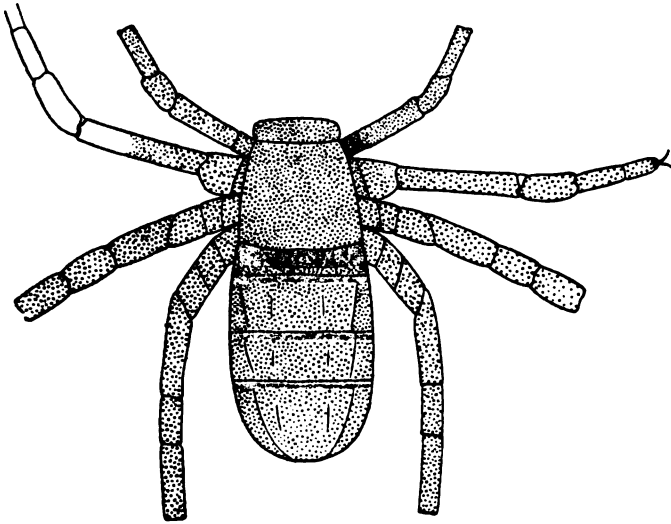


Fig. 44.

Figure 44.—*Polyochera punctulata* Scudder, holotype, U. S. N. M. No. 37971, dorsal surface. $\times \frac{8}{1}$

the left leg and a complete right leg; complete length 15.5 mm.; femur alone 5.5 mm. Third pair: coxa, two-jointed trochanter, femur, patella and tibia of both sides; femur 3.0 mm. long in middle line. Fourth leg: coxa, two-jointed trochanter, femur, patella and tibia of both sides; femur 3.7 mm. long in middle line.

" The front border of the cephalothorax is a little elevated, and behind it, extending nearly to the middle, a very broad, very shallow, transverse depression; there is also an equally slight but small central depression, but all of these scarcely affect the extreme flatness of the whole field which is shared also by the abdomen; both cephalothorax and abdomen are regularly and deeply punctate,

excepting on the brief first (= third, A. P.) abdominal segment which is only punctate along its hinder edge" (Scudder, 1890, p. 444).

One pair of shorter, inner, and one pair of oblique, longer, outer lines divide the second, third and fourth visible tergites into five fields of which the middle one is the widest. Along the posterior edge of the first, second and third visible tergites runs a row of punctate depressions, much heavier than those covering the rest of the body and the legs.

The reverse of the specimen shows clearly that the cucullus was anteriorly bent downward, much as is the case in recent *Ricunlei*.

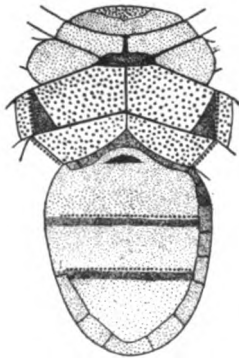


Fig. 45.

Figure 45.—Same, ventral surface, showing coxae and sternites. $\times \frac{3}{1}$

and appears in form of a punctate, triangular plate. Behind it is an almost smooth transverse area, probably the coxae of the pedipalpi. The long and narrow coxae of the first pair of legs, and the triangular coxae of the second pair are almost smooth, those of the third and fourth pair punctate like the dorsal surface of the abdomen. Between the widely distant second coxae is visible a dark plate with a narrow anterior process separating the first coxae. This plate is probably the anterior part of the sternum, which is hidden posteriorly by the contiguous third and fourth coxae.

Only three abdominal sternites are visible, belonging to the fourth, fifth and sixth segments, with a row of deep round depressions along the posterior edge of the first and second visible sternite. Covering the edge of the abdominal sternites is the unsegmented pleura, the lines simulating segmentation evidently due to artificial folding.

A second specimen, in the collection of Mr. L. E. Daniels, is not so well preserved as the type, yet shows sufficiently clearly all structures as to leave no doubt of it belonging to the same species. The pleura in this specimen shows no artificial segmentation, but is folded longitudinally. Total length 12.5 mm. Width of abdomen 6.0 mm.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Polyochera glabra n. sp.

Plate VII, figs. 39, 40; text fig. 46.

U. S. National Museum No. 37981. Obverse shows the cucullus, cephalothorax, abdomen and part of what is probably the second and fourth leg. The reverse shows the somewhat deformed coxae of which only those of the third and fourth pair are sufficiently clear to show that they have the same arrangement as in *P. punctulata*, the abdomen with an entire, not segmented pleura and the fragments of the same legs.

Total length 13.8 mm. Cucullus 1.05 mm. long, 3.5 mm. wide. Cephalothorax 4.3 mm. long, 5.7 mm. wide, with rounded corners and striaght posterior and anterior edge. Between the oval abdomen and the cephalothorax is a deep groove. The tergites are divided into three fields by longitudinal ridges. Whole body smooth.

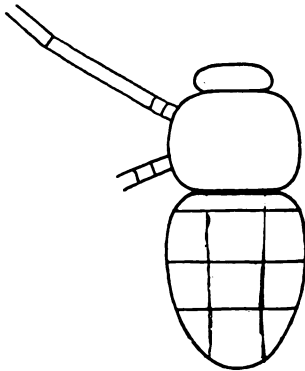


Fig. 46.

Figure 46.—*Polyochera glabra* n. sp., holotype, U. S. N. M. No. 37981, dorsal surface. $\times \frac{3}{1}$

Found in the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

Holotergidae new family.

Abdomen covered with an entire shield, probably corresponding to the third to sixth segments.

Genus *Curculioides* Buckland 1837.

With the characters of the family.

Key to the Species of *Curculioides*.

- 1. Abdominal shield with a median longitudinal ridge
 - C. scaber*
 - + abdominal shield without a median ridge 2
- 2. Cephalothorax wider than long
 - C. sulcatus*
 - + cephalothorax as wide as long
 - C. ansticii*

Curculioides ansticii Buckland.

C. ansticii Buckland, Bridgewater Treatise (ed. 2), Vol. II, 1837, p. 76, pl. 46, fig. 1. Pocock, Carb. Arachn. 1911, p. 39, pl. II, fig. 7; text figs. 12, 13.

Found in the Coal Measures of Coseley, near Dudley, England.

Curculioides scaber (Scudder).

Plate VII, figs. 36, 37; text figs. 47, 48.

= *Geratarbus scabrum* Scudder, Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 448, pl. 39, fig. 5.

The type and only specimen, No. 1765 a b of the Lacoe collection, is at present in the collection of the U. S. National Museum under the number 37965. Scudder has not sufficiently cleaned the spe-

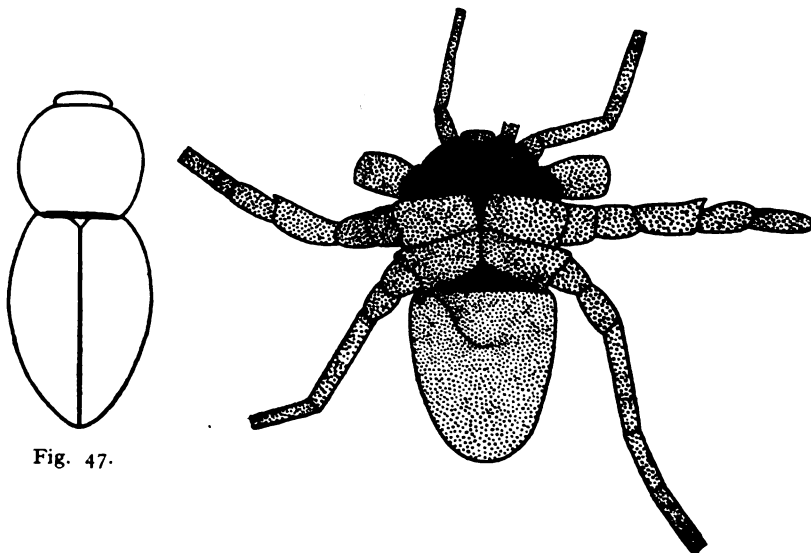


Fig. 47.

Fig. 48.

Figure 47.—*Curculioides scaber* (Scudder), holotype, U. S. N. M. No. 37965, dorsal surface. Figure 48.—Same, showing the whole specimen from the ventral side. $\times \frac{3}{1}$

cimen of the kaolin and some important structures have escaped his attention.

Total length 15.0 mm. Cucullus 0.55 mm. long, 2.5 mm. wide. The reverse shows that the cucullus was bent downward as in recent *Ricinulei*, thus having two surfaces standing at right angles to each other. Cephalothorax 5.0 mm. long, 5.25 mm. wide in the middle, only 3.6 mm. wide at posterior edge, which is straight. The abdomen is oval, covered with one shield with a longitudinal median ridge. In the specimen the left side of the abdomen is longitudinally folded, the fold being artificial, but the ridge is quite distinct. A heavy fold separates the abdomen from the cephalothorax. The whole

dorsal surface is uniformly punctuate. The underside of the abdomen also uniformly punctate, has a procurved line, in front of which, in the triangle between the hind coxae, are two parallel ridges and a deep, hemispherical depression, probably the genital opening. All coxae well preserved. Those of the first and second pair widely separate, between them the sternum visible posteriorly as far as the posterior end of the third coxae. Fourth coxae contiguous. Immediately behind the ventral part of the cucullus is a large, almost round plate, divided longitudinally in two by a median ridge. It is possible that this plate represents the outer aspect of the chelicera. At the sides of this plate are the coxae of the pedipalpi. Four joints of the left pedipalp are visible, showing that the pedipalp was slender and that its trochanter is two-jointed. Of the first pair of legs, which were considerably thinner than the others and only little heavier than the pedipalpi, are preserved both coxae and the trochanter, femur, patella, tibia and metatarsus of the right leg. Of the second pair of legs only the coxae and trochanters are preserved. Like that of the first pair the trochanter is one-jointed, but extraordinarily large. The legs of the third and fourth pair are almost complete, missing are the metatarsi and tarsi. The femur of the first leg is short and stout with a sharp apical process. The fourth femur is slender and long, measuring 5.0 mm. The ventral surface is also uniformly punctuate with the exception, however, of the parts minutely dotted on text figure 48, which appear quite smooth.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Curculioides sulcatus (Melander).

Plate VII, fig. 38; text figs. 49, 50.

= *Kustarachne sulcata* Melander, Jour. Geol., Vol. XI, 1903, p. 181, pl. V, fig. 5, pl. VII, fig. 4.

The type and only specimen of this species, No. 9235, is in the collection of the Walker Museum of the University of Chicago. The nodule containing it consists both of the obverse and reverse, but the whole specimen was heavily covered with kaolin, this being the reason why Melander's description is quite incorrect. Basing his opinion on the similarity in the relative measurements of *Curculioides sulcatus* and *Kustarachne tenuipes*, Pocock suggests in his Monograph that "one shows the dorsal, and the other the ventral view of specimens belonging to the same species." This suggestion is excusable only in view of the fact that Pocock had no occasion to examine the specimens themselves and based his judgment on the incomplete and erroneous

descriptions. The following description is drawn from the type specimen after it had been cleaned of the kaolin and the legs exposed as far as possible.

Total length 16.5 mm. Cucullus 1.15 mm. long, 3.0 mm. wide. Cephalothorax 4.25 mm. long, 6.0 mm. wide in posterior $\frac{1}{3}$, 5.25 mm. wide at posterior edge, which is straight. Abdomen with an entire shield, folded in median line but not with a median longitudinal ridge,

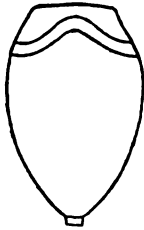


Fig. 49.

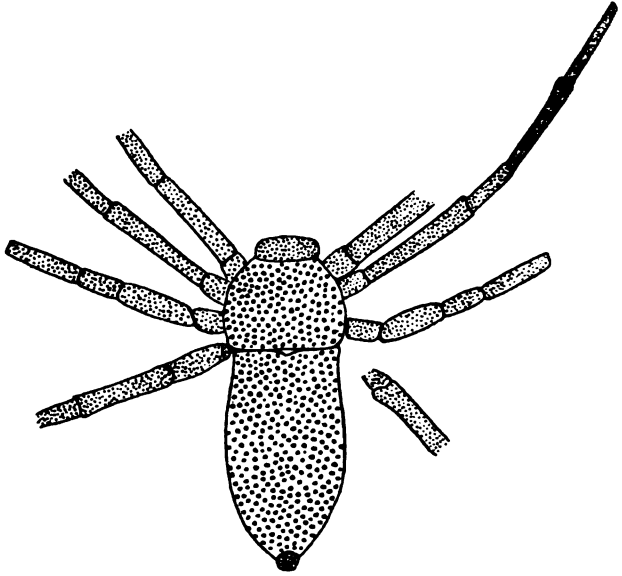


Fig. 50.

Figure 49.—*Curculioides sulcatus* (Melander), holotype, Univ. of Chicago Mus. No. 9235, ventral surface of abdomen. Figure 50.—Same, showing entire specimen from dorsal surface. $\times \frac{2.5}{1}$

folding being due to pressure. Behind the shield is visible a small segment representing probably the seventh to ninth segments. Legs very long and rather thin. The cucullus and legs minutely punctate, the cephalothorax and abdominal shield coarsely punctate. The tibia and metatarsus of the second leg and the terminal abdominal joint smooth.

The ventral surface is not sufficiently well preserved to show the arrangement of all coxae, but the third and fourth coxae are distinctly contiguous. In the anterior part of the abdomen there is a strongly procurved fold represented by the two lines in text figure 49.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

ORDER ARANEAE

Head completely fused with thorax. Abdomen with pedicel, segmented in the lowest forms, in all higher forms unsegmented. Chelicera retroverte. Pedipalpi pediform, six-jointed, their coxa in higher forms with a maxillary lobe. Legs seven-jointed, movably articulated to a sternum. Patella present in all legs and palpi. Trochanters all one-jointed. Spinning glands in the abdomen with numerous ducts opening on the spinnerets; spinnerets always on the abdomen, either in the middle of its ventral surface as in Liphistiidae, or at the end, immediately in front of the anus. Respiratory organs in form of two pairs of lungs in lower forms, or one pair of lungs and a pair of tracheal tubes, in higher forms; sometimes without lungs, but with two pairs of tracheal tubes, or with one pair of lungs, but without tracheal tubes. Spiracles in all cases on the ventral surface of the abdomen. Genital opening in both sexes on the ventral surface of the abdomen, not far from its anterior end. Sperm receptacles in the female either connected with the uterus, or blind, often with a complicated chitinous structure or epigynum. Organs of copulation in the male on the pedipalpi, the terminal joint of which is specially modified for this purpose. Usually eight eyes (sometimes six, four, two or none) in two or three rows on the cephalothorax. Morphologically they represent two groups: one pair of median eyes with direct retina and two groups of lateral eyes with inverted retina. All spiders are oviparous. They eat insects and other spiders. Their instincts are highly developed and manifold. Some have burrowing habits, others make snares, some are true vagabonds. With very few exceptions they lead terrestrial life, and those living under water or between the tides are not really aquatic, since they use air for breathing.

Key to the Sub-Orders of Araneae.

- 1. Abdomen segmented. Four pairs of spinnerets in the middle of the abdomen on its ventral surface
 - Mesothelae
 - + abdomen not segmented. Spinnerets immediately in front of the anus 2
- 2. Chelicera so articulated, that the fangs move parallel to the plane of symmetry of the animal. Two pairs of lungs
 - Mygalomorphae
 - + Chelicera so articulated, that the fangs move in a plane clearly intersecting the plane of symmetry. One pair of lungs and one

pair of tracheal tubes, or tracheal tubes absent, or two pairs of tracheal tubes and no lungs

Arachnomorphae

LIST OF DESCRIBED SPECIES OF ARANEAE

Sub-Order Mesothelae.

Abdomen segmented. Four pairs of spinnerets in the middle of the abdomen on its ventral surface. Two pairs of lungs. Chelicerae

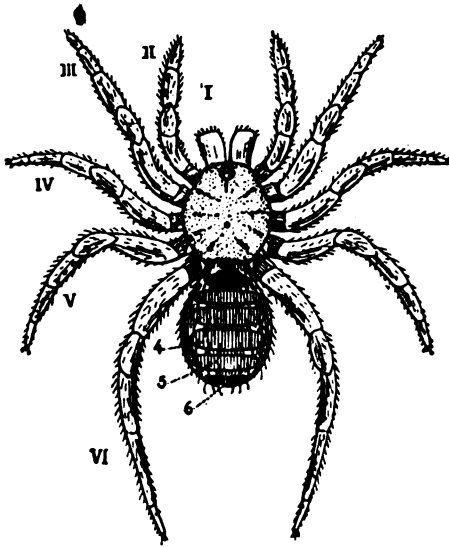


Fig. 51.

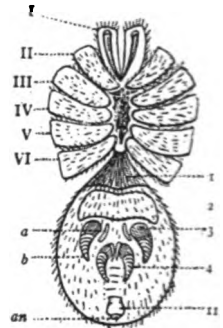


Fig. 52.

Figure 51.—*Liphistius desultor* Schiödte from Pinang; dorsal view. Figure 52.— Same, ventral surface. (From Encyclopaedia Britannica, 11th ed.)

so articulated that the fangs move in a plane parallel to the plane of symmetry.

Family Arthrolycosidae Fritsch.

Genus *Arthrolycosa* Harger.

Genotype *A. antiqua* Harger.

1. *Arthrolycosa antiqua* Harger, Amer. Jour. Sci., (3), Vol. VII, 1874, pp. 219—223. Beecher, Ibid., Vol. XXXVIII, 1889, p. 219—223, figs. 1—3.

From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

2. *Arthrolycosa danielsi* n. sp.

From the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

3. ?*Arthrolycosa* sp. Pocock, Carb. Arachn., 1911, p. 34, fig. 10.

From the Coal Measures of Coseley, near Dudley, England.

Fritsch refers to the genus *Arthrolycosa* the following species from Bohemia, which according to Pocock "represent at least six genera and possibly as many families if the drawings are to be trusted."

1. *A. carbonaria* (Kůsta)

= *Scudderia carbonaria* Kůsta, Sitz. k. k. Gesell. d. Wiss., 1888, p. 203.

A. carbonaria Fritsch, Pal. Arachn., 1904, p. 6, pl. 1, fig. 1, fig. 2, text figs. 2, 3.

2. *A. fortis* Fritsch, loc. cit., p. 8, pl. 1, figs. 1, 2, text fig. 4.

3. *A. beecheri* Fritsch, loc. cit., p. 9, pl. 1, figs. 3-5, text fig. 5.

4. *A. lorenzi* (Kůsta)

= *Eolycosa lorenzi* Kůsta, Sitz. k. k. Gesell. d. Wiss., 1885.

A. lorenzi Fritsch, loc. cit., p. 10, pl. 2, figs. 2, 3; text fig. 6.

5. *A. (?) palaranaea* (Fritsch)

= *Palaranea borassifoliae* Fritsch, Archiv. f. Landesf. v. Böhmen, Vol. II, 1813, p. 8, pl. II, fig. 7.

A. (?) palaranaea Id., Pal. Arachn., 1904, p. 11, text fig. 7.

Genus *Protolycosa* F. Römer.

Genotype *P. anthracophyla* Römer.

1. *P. anthracophyla* Römer, Jahrb. f. Min., 1866, p. 136, pl. III.

Fritsch, Pal. Arachn., 1904, p. 12, pl. 13, fig. 14; text figs. 8-10.

From the Coal Measures of Upper Silesia, Germany.

Genus *Geralycosa* Kůsta.

Genotype *G. fritschii* Kůsta.

1. *G. fritschii* Kůsta, Sitz. k. k. Gesell. d. Wiss., 1888, p. 194, fig. 1.

Fritsch, Pal. Arachn., 1904, p. 14, pl. 3, fig. 1; text figs. 11-13.

From the Coal Measures of Rakonitz, Bohemia.

Genus *Rakovnicia* Kůsta.

Genotype *R. antiqua* Kůsta.

1. *R. antiqua* Kůsta, Sitz. k. k. Gesell. d. Wiss., 1884, p. 400, pl. I.

fig. 3. Fritsch, Pal. Arachn., 1904, p. 15, pl. 2, fig. 4; text fig. 15.

From the Coal Measures (Noegerathienschiefer) of Rakonitz, Bohemia.

Genus *Perneria* Fritsch.

Genotype and only species

- i. *P. salticoides* (Fritsch)
 = *Arthrolycosa salticoides* Fritsch, Fauna der Gaskokle, Vol. IV, 1901, pl. 153, fig. 10.
P. salticoides Id., Pal. Arachn., 1904, p. 22, text fig. 27.
 From the Coal Measures of Nyřan, Bohemia.

Genus *Eoecteniza* Pocock.

Genotype and only species

- i. *E. silvicola* Pocock, Carb. Arachn., 1911, p. 34, pl. 34, fig. 4.
 From the Coal Measures of Coseley, near Dudley, England.

Sub-Order Arachnomorpha.

Genus *Eopholcus* Fritsch.

Genotype and only species

- i. *E. pedatus* Fritsch, Pal. Arachn., 1904, p. 22, text fig. 28.
 From the Coal Measures of Nyřan, Bohemia.

Genus *Pyritaranea* Fritsch.

Genotype and only species

- i. *P. tubifera* Fritsch, Fauna d. Gaskohle, Vol. IV, 1901, fig. 63.
 Id., Pal. Arachn., 1904, p. 25, text fig. 31.
 From the Coal Measures of Nyřan, Bohemia.

Genus *Archaeometa* Pocock.

Genotype and only species

- i. *A. nephilina* Pocock, Carb. Arach., 1911, p. 37, text fig. 11.
 From the Coal Measures of Coseley, near Dudley, England.

DESCRIPTION OF NORTH AMERICAN CARBONIFEROUS ARANEA

Sub-Order Mesothelae.

Genus *Arthrolycosa* Harger 1874.

New definition. Cephalothorax longer than wide. Eyes on a tubercle. Genotype *A. antique* Harger.

Key to Species of *Arthrolycosa*.

- i. Femora of all legs shorter than cephalothorax. Eye tubercle not in line with outer edge of cephalothorax

A. antique

+ femur of the first pair of legs almost as long as the cephalothorax, the other femora longer than cephalothorax. Eye tubercle touching anterior edge

A. danielsi

Arthrolycosa antiqua Harger.

Plate VIII, figs. 43, 44; text figs. 53, 54.

A. antiqua Harger, Amer. Jour. Sci., (3), Vol. VII, 1874, pp. 219—223. Scudder, Proc. Amer. Acad. Arts Sci., 1884, p. 15. Beecher, Amer. Jour. Sci., (3), Vol. XXXVIII, 1889, pp. 219—223, text figs. 1—3.

Type specimen No. 161, Peabody Museum. The description of this specimen given by Beecher in his excellent paper in 1889, while

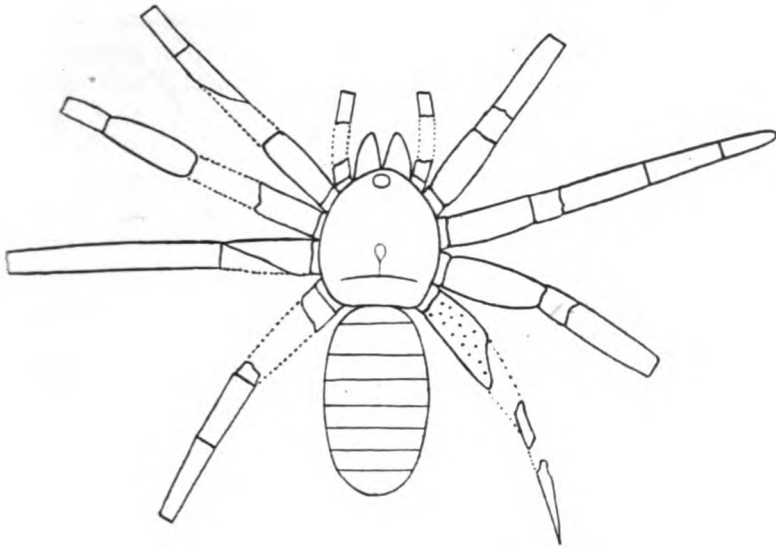


Fig. 53.

Figure 53.—*Arthrolycosa antiqua* Harger, holotype, Peabody Mus. No. 161, showing dorsal surface after the abdomen has been all exposed. $\times \frac{2}{1}$

it has considerably advanced our knowledge of the spider is incorrect in some regards, since the specimen was not entirely exposed. Thus he failed to notice that the terminal joints of the palpi are altogether missing and that the abdomen is larger than it appears on his drawing. I have carefully cleaned the entire nodule and am able to say that the specimen is now completely exposed and appears as drawn in my text figure 53, the dotted parts and the terminal joints of the palpi and legs actually missing. The obverse alone shows the spider. The reverse shows only fractions of legs, but no body.

Total length without mandibles 22.0 mm. Cephalothorax 9.0 mm. long, 8.0 mm. wide in the middle. All femora shorter than cephalothorax.

The cephalothorax is rounded anteriorly, the posterior edge almost straight. A deep, oval depression somewhat behind the middle of the cephalothorax, and behind the depression a transverse ridge. Eye tubercle transversely ellipsoidal, high, eyes not preserved. Abdomen composed of eight segments, oval, its right side somewhat pressed out of shape and lower than the rest, yet clearly showing segmentation. Since the spinnerets were probably on the ventral surface as in *Liphistius*, the number of visible segments may not be

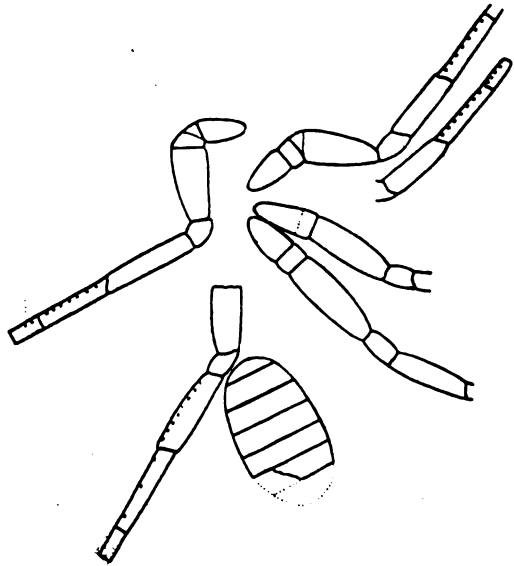


Fig. 54.

Figure 54.—*Arthrolycosa antiqua* Harger. No. 163, Peabody Museum, showing the specimen as it appears on the nodule. $\times \frac{1.5}{1}$

the true number. Mandibles strong, conical, the fang not visible. Pedipalpi slender, their terminal joints missing. Legs heavy and long, but only the right leg of the second pair complete. Femur 5.7 mm. long, patella and tibia 9.5 mm., metatarsus 5.0 mm., tarsus 3.7 mm. Fourth femur punctate.

It must be added that the specimen presents its actual dorsal surface and not a mould of it, as is evident from the appearance of the eye tubercle and oval dorsal depression.

Specimen No. 162 of the Peabody Museum (Plate VIII, fig. 43). Like the type specimen, the dorsal surface is not a mould, but the actual surface of the spider. Total length 14 mm. Cephalothorax 6.2 mm. long, the side margins obliterated so that the width cannot be

ascertained. The thoracic part is rather flat, but the cephalic part elevated, highest at the eye tubercle, gradually sloping laterally and posteriorly to the oval depression. Abdomen flat, oval, 6.0 mm. wide in the middle. The segmentation not as clear as in the type specimen, the lines being rather faint. Chelicera heavy and long. Of the legs and palpi only fragments preserved.

Specimen No. 163, Peabody Museum. Text fig. 54.

A badly crushed specimen, probably belonging to this species. Only part of the abdomen, four right and two left legs preserved. The abdomen is oval, six segments can be counted, the lines between the segments quite distinct. First leg almost complete. Femur 6.5 mm. long, patella and tibia 9.3 mm., metatarsus 6.5 mm. with a row of seven round depressions. Second leg: tibia alone 6.0 mm., metatarsus 6.03 mm., tarsus 2.8 mm. Both metatarsus and tarsus with a row of round depressions of which the metatarsus has seven and the tarsus four. Third leg: femur 7.3 mm. Fourth leg: femur 8.5 mm., patella + tibia 10.0 mm., metatarsus 8.0 mm. The tibia of the leg close to the abdomen (probably the fourth left leg) has a row of eight round depressions.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Arthrolycosa danielsi n. sp.

Plate VIII, figs. 45, 46; text figs. 55, 56.

The type and only specimen of this species is in the collection of Mr. L. E. Daniels. It is much better preserved than either of the three specimens of the preceding species. Total length, without mandibles, 14.5 mm. Cephalothorax flat, 5.6 mm. long, 5.0 mm. wide in posterior $\frac{1}{3}$, oval, with recurved posterior margin. Two small tubercles in the middle of the cephalothorax, and radiating from them four pairs of ridges. The transversely ellipsoidal depression, the mould of the eye tubercle, touching the anterior margin. In it are two pairs of oval depressions, moulds of the eye lenses. Abdomen shows clearly six segments but, as in the preceding species, the true number of abdominal segments was probably greater. Small, round, punctate depressions probably mark the attachment places of the dorso-ventral muscles. The chelicera strong, angular, prismatic with a thickened inner edge. Of the pedipalpi only the coxae and trochanters preserved, but it is impossible to say whether the coxae had a maxillary lobe. Legs all in position, but all joints beyond the femur missing. Coxae of first and second pair triangular. Trochanter

typical, one-jointed. First femur 5.2 mm. long, second 6.1 mm., third 6.9 mm., fourth 6.1 mm.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

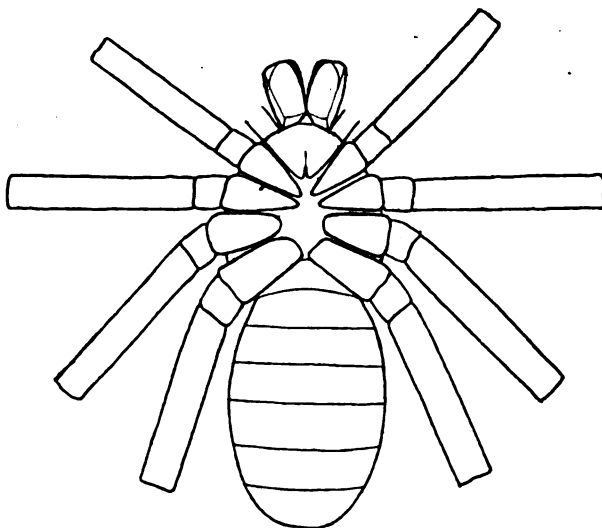


Fig. 55.

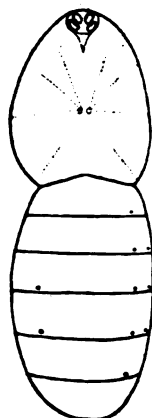


Fig. 56.

Figure 55.—*Arthrolycosa danielsi* n. sp., holotype, Daniels coll., showing the ventral surface of the specimen as it appears on the nodule. Figure 56.—

Same, showing dorsal view of the body. $\times \frac{8.5}{1}$

ORDER ANTHRACOMARTI

Head completely fused with thorax. Abdomen segmented, the anal operculum representing probably the eleventh abdominal segment. Dorsal surface of abdomen divided into three or five longitudinal areas, the central one formed by the tergites, the lateral ones by the pleural sclerites. Chelicera not known. Pedipalpi pediform. Legs seven-jointed, with movable coxae, apparently articulated to a sternum.

Pocock, who made a careful study of this order and has had more species before him than are known to occur in North America, describes the morphology of the abdomen in his Monograph as follows:

“Opisthosoma without appendages, movably jointed to the prosoma, but with its individual segments apparently welded together, though the sutural lines persist. Seven tergal plates are always

traceable on the dorsal side, the first of the seven (*i. e.* the seventh counting forwards from the posterior end) being almost invariably longer than those that succeed it; each tergum is marked on each side with a longitudinal sulcus or groove which separates a lateral lamina from the median area of the tergum; sometimes there is a second sulcus nearer the external margin than the one just mentioned; hence each tergum is divided into either three or five distinct areas according to the number of sulci. In front of the seventh tergum from the end, either one or more tergal sclerites may be traced; these are usually not provided with lateral laminae and may be overlapped more or less by the posterior border of the carapace; they appear to represent from one to three additional tergal plates undergoing excalation. The last tergal plate on the dorsal side, that is to say the seventh, not counting the variable number of anterior tergal plates just mentioned, is the narrowest of the series; but it is almost invariably provided with an unpaired posteriorly-expanding median lamina, in addition to its paired laminae, with which it forms a continuous series; this lamina is itself sometimes marked off by a transverse sulcus from the median area of the tergum. This median lamina of the last tergum visible from the dorsal side, overlaps the tergal element of the next succeeding segment; the tergum of this segment is fused with its sternal element to constitute a subannuliform sclerite, near the center of which lies a plate, the anal operculum, which is the tergal element of the last segment. Thus ten tergal elements may be traced with certainly in almost all genera, the last being the anal operculum and the first the short tergal area that lies between the carapace and the first large tergal plate of invariable occurrence, namely the seventh from the end on the dorsal side.

"The sternal elements of the opisthosoma appear to correspond in number with the terga, except that, with the doubtful exception of *Eophrynus*, there is no sternal plate to represent the tenth tergum or anal operculum. Hence there are nine sternal plates in all, the last being the ventral element of the plate surrounding the anal operculum. The anterior sterna are variously modified and arranged according to the genus, the arrangement in *Anthracomartus* being very different from that of *Eophrynus*, the first, whether large as in the former or small as in the latter, being probably the genital operculum."

Not having sufficient material to make a study of the morphology of the abdomen in *Anthracomarti*, I am not able to either accept or criticize Pocock's interpretation. One point, however, I cannot leave without mention. If Pocock's interpretation is correct and

the anal operculum normally appearing on the ventral surface of the specimen represents the tergite of the last abdominal segment, then the anal operculum is the tergite of the eleventh and not of the tenth segment. This is clear from Pocock's own text figures 29—31 and his assertion that in front of the first large tergite is at least one segment partly covered by the cephalothorax.

Pocock recognized four families of Anthracomarti, basing his classification on the shape of the pleural laminae and the presence of a transverse sulcus on the cephalothorax. Neither of these characters has in my opinion the value of a family character. We find in the order of recent spiders widely different chitinized structures of the abdomen in species belonging to the same genus and even in the two sexes of the same species. A much better character seems to be the number of pleural sclerites. I therefore recognize only two families.

The order of Anthracomarti consists entirely of extinct forms.

Key to the Families of Anthracomarti.

I. Pleural laminae subdivided

Anthracomartidae

(= Anthracomartidae + Brachypygidae Pocock)

+ pleural laminae entire

Eophrynidae

(= Eophrynidae + Anthracosironidae Pocock)

LIST OF DESCRIBED SPECIES OF ANTHRACOMARTI.

Family Anthracomartidae.

Genus *Anthracomartus* Karsch.

Genotype—*A. voelkelianus* Karsch.

1. *A. voelkelianus* Karsch, Zeits. deutsch. geol. Gesell., Vol. XXXIV, 1882, p. 556. Haase, Beitrag z. Kenntniss d. foss. Arachn., Ibid., Vol. XLII, 1890, p. 645, pl. XXX, figs. 8, 9. Fritsch, Pal. Arachn., 1904, p. 40, text fig. 47.
From the Coal Measures of Silesia, Germany.
2. *A. granulatus* Fritsch, loc. cit., p. 40, text fig. 48.
From the Coal Measures of Silesia, Germany.
3. *A. palatinus* Ammon, Geogn. Jahresb., Vol. XIII, 1900, figs. 1—4. Fritsch, Pal. Arachn., 1904, p. 41, text fig. 50.
From the Coal Measures of Palatinate (Pfalz), Germany.
4. *A. krejci* Kušta, Sitz. k. b. Gesell. d. Wiss., 1883, p. 340, pl. I.
? = *A. affinis* Id., Ibid., 1885.

A. krejci Fritsch, Pal. Arachn., 1904, p. 36, pl. 4, fig. 1, text figs. 40, 41; p. 39, pl. 3, fig. 1; pl. 4, fig. 7; text fig. 45.

From the Coal Measures (Noegerathienschiefer) of Rakonitz, Bohemia.

5. *A. minor* Kusta, Sitz. k. b. Gesell. d. Wiss., 1885, p. 3, pl. fig. 1.
? = *A. socius* Id., Ibid., 1888, p. 203, pl. fig. 4.

A. minor Fritsch, Pal. Arachn., 1904, p. 38, pl. 4, figs. 4-7, text figs. 42-44; p. 39, text fig. 46.

From the Coal Measures (Noegerathienschiefer) of Rakonitz, Bohemia.

6. *A. bohemicus* (Fritsch).

= *Promygal* *bohémica* Fritsch, Fauna d. Gaskohle, Vol. IV, 1901, p. 58, pl. 153, figs. 6-8; pl. 154, fig. 1. Id., Pal. Arachn., 1904, p. 19, pl. 15, fig. 1, text fig. 20-22.

From the Carboniferous (Secundakohle) of Nyřan, Bohemia.

7. *A. elegans* (Fritsch)

= *Promygal* *elegans* Fritsch, Fauna d. Gaskohle, Vol. IV, 1901, p. 61, text fig. 365. Id., Pal. Arachn., 1904, p. 21, pl. 15, figs. 2-4 text fig. 26.

From the Carboniferous (Gaskohle) of Nyřan, Bohemia.

8. *A. hindi* Pocock, Carb. Arachn., 1911, p. 64, pl. III, fig. 3, text figs. 30-32.

From the Coal Measures of Coseley and Dudley, England.

9. *A. priesti* Pocock, loc. cit., p. 67, text figs. 33, 34.

From the Coal Measures of Coseley and Dudley, England.

10. *A. trilobitus* Scudder, Proc. Amer. Acad. Arts Sci., Vol. XX, 1884, p. 17. Id., C. R. Soc. Ent. Belg., (3), 1885, p. 85. Id. Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 451, pl. 39, figs. 7-10.

From the Pennsylvanian (Up. Pittsville) of Fayetteville, Arkansas.

11. *A. triangularis* n. sp.

From the Joggins Mines, Nova Scotia.

Genus *Brachypyge* H. Woodward 1878.

Genotype and only species

1. *B. carbonis* Woodward, Geol. Mag., (2), Vol. V, 1878, pp. 433-436, pl. XI. Fritsch, Pal. Arachn., 1904, p. 42, text fig. 52. Pocock, Carb. Arachn., 1911, p. 59, text fig. 28.

From the Coal Measures of Mons, Belgium.

Genus *Maiocercus* Pocock 1911.

Genotype and only species

1. *M. celticus* (Pocock)
 - = *Eophrynus carbonis* Howard and Thomas, Cardiff Nat. Hist. Soc., Vol. XXVIII, 1896, p. 52, figs. a, b.
 - = *Brachypyge celtica* Pocock, Geol. Mag., (4), Vol. IX, 1902, p. 488, fig. 2a. Fritsch, Pal. Arachn., 1904, p. 41, text fig. 51.
 - M. celticus* Pocock, Carb. Arachn., 1911, p. 60, text fig. 29.

From the Coal Measures of Ty'nybedw, Rhondda Valley, South Wales.

Genus *Eotrogulus* Thevenin 1901.

Genotype and only species

1. *E. fayoli* Thevenin, Bull. Soc. France, 1901, p. 607. Fritsch, Pal. Arachn., 1904, p. 43, text fig. 55.
- From the Coal Measures of Commentry, France.

Family Eophrynidae.

Genus *Anthracosiro* Pocock 1903.Genotype *A. woodwardi* Pocock.

1. *A. woodwardi* Pocock, Geol. Mag., (4), Vol. X, 1903, pp. 246-250, 405-408.
 - = *A. latipes* Gill, Nat. Hist. Soc. Northumb., Durham, Vol. III, 1909, pp. 510-522, pl. XIII.
 - A. woodwardi* Fritsch, Pal. Arachn., 1904, p. 43, text fig. 53.
 - Pocock, Carb. Arachn. 1911, p. 70, text figs. 35, 36.

From the Coal Measures of Coseley, Sparth and Crowcock, England.
 2. *A. fritschi* Pocock, Geol. Mag., (4), Vol. X, 1903, pp. 405-408, fig. Fritsch, Pal. Arachn., 1904, p. 43, text fig. 54. Pocock, Carb. Arachn., 1911, p. 73, text fig. 37.
- From the Coal Measures of Coseley, near Dudley, England.

Genus *Pleurolycosa* Fritsch 1904.

Genotype and only species

1. *P. prolifera* (Fritsch)
 - = *Arthrolycosa prolifera* Fritsch, Fauna d. Gaskohle, Vol. IV, 1901, p. 61, pl. 153, figs. 1, 3.
 - P. prolifera* Id., Pal. Arachn., 1904, p. 23, text fig. 29.

(Position of both genus and species uncertain).

From the Coal Measures (Gaskohle) of Bohemia.

Genus *Brachylycosa* Fritsch 1901.

Genotype and only species

1. *B. carcionides* (Fritsch)
= *Arthrolycosa carcinoides* Fritsch, Fauna d. Gaskohle, Vol. IV, 1901, p. 62, text fig. 367.
B. carcinoides Id., Pal. Arachn., 1904, p. 24, fig. 30.
(Position of both genus and species uncertain).
From the Coal Measures (Gaskohle) of Nyřan, Bohemia.

Genus *Hemiphrynus* Fritsch 1901.Genotype—*H. longipes* Fritsch

1. *H. longipes* Fritsch, Fauna d. Gaskohle, Vol. IV, 1901, p. 57. Id., Pal. Arachn., 1904, p. 17, text fig. 17.
From the Coal Measures (Gaskohle) of Nyřan, Bohemia.
2. *H. hofmanni* Fritsch, Fauna d. Gaskohle, Vol. IV, 1901, p. 58. Id., Pal. Arachn., 1904, p. 18, text figs. 18, 19.
From the Coal Measures (Gaskohle) of Bohemia.

Genus *Vratislavia* Fritsch 1904.

Genotype and only species

1. *V. silesiaca* (F. Römer)
= *Architarbus silesiacus* F. Römer, Jahresb. schles. Gesell. Breslau 1878, pp. 54–55.
V. silesiaca Fritsch, Pal. Arachn., 1904, p. 44, pl. 13, figs. 5, 6, text fig. 56.
From the Coal Measures near Glatz, Silesia, Germany.

Genus *Eophrynus* Woodward 1871.

Genotype and only species

1. *E. prestvici* (Buckland)
= *Curculiodes prestvici* Buckland, Bridgewater Treatise (2d ed.), Vol. II, 1837, p. 76.
E. prestvici Woodward, Geol. Mag., (2), Vol. VIII, 1871, p. 86, pl. XI. Fritsch, Pal. Arachn., 1904, p. 46, pl. 14, figs. 3, 4, text figs. 57–60. Pocock, Carb. Arachn., 1911, p. 77, text fig. 339.
From the Coal Measures of Shropshire and Coseley, England.

Genus *Stenotrogulus* Fritsch 1904.

Genotype and only species

1. *S. salmii* (Stur)
= *Eophrynus salmii* Stur, Die Culmflora, 1877, p. V, text fig. *S. salmii* Fritsch, Pal. Arachn., 1904, p. 48, pl. 14, fig. 2, text fig. 62.
From the Coal Measures of Mährisch Ostrau, Silesia, Germany.

Genus *Cyclotrogulus* Fritsch 1904.

Genotype and only species

1. *C. sturii* (Haase)
= *Eophrynus sturii* Haase, Beiträge z. Kenntniss d. foss. Arachn., 1890, p. 642.
- C. sturii* Fritsch, Pal. Arachn., 1904, p. 49, pl. 14, fig. 1.
From the Coal Measures of Mährisch Ostrau, Silesia, Germany.

Genus *Kreischeria* Geinitz 1882.Genotype *K. wiedei* Geinitz.

1. *K. wiedei* Geinitz, Zeits. d. geol. Gesell., Vol. XXXIV, 1882, p. 238, pl. XIV. Haase, Ibid., Vol. XLII, 1890, p. 642, pl. XXX, fig. 6. Fritsch, Pal. Arachn., 1904, p. 50, text figs. 63, 64.
From the Coal Measures (Sigillaria zone) of Zwickau, Germany.
2. *K. verrucosa* Pocock, Carb. Arachn., 1911, p. 78, text fig. 40, pl. III, fig. 5.
From the Coal Measures of South Wales.

Genus *Hemikreischeria* Fritsch 1904.

Genotype and only species

1. *H. geinitzi* (Thevenin)
= *Kreischeria geinitzi* Thevenin, Proc. Verb. Soc. d'Hist. Nat. d'Autun, Vol. XV, 1902, p. 195.
= *H. thevenini* Fritsch, Pal. Arachn., 1904, p. 51, text figs. 65 A.—C.
From the Coal Measures (Westphalian) of Valenciennes, France.

Genus *Petrovicia* Fritsch 1904.

Genotype and only species

1. *P. proditoria* Fritsch
= *Eophrynus* n. sp. Kusta, Sitz. k. b. Gesell. Wiss., 1885, p. 7.
= *Anthracomartus* sp. Id., Ibid., 1888, p. 207.
P. proditoria Fritsch, Pal. Arachn., 1904, p. 52, pl. 5, figs. 1, 2, text figs. 66 A, B; 67, 68.

Genus *Adelocaris* Packard 1889.

Genotype and only species

1. *A. peruvianus* Packard, Proc. Boston Soc. Nat. Hist., 1889, p. 209. (Position of genus very doubtful).
From Peru.

Genus *Trigonotarbus* Pocock 1911.Genotype *T. johnsoni* Pocock.

1. *T. johnsoni* Pocock, Carb. Arachn., 1911, p. 74, pl. III, fig. 4, text fig. 38.
From the Coal Measures of Coseley, near Dudley, England.

2. *T. schucherti* n. sp.

From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

3. *T. carbonarius* n. sp.

From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

Genus *Aphantomartus* Pocock 1911.

Genotype and only species

1. *A. areolatus* Pocock, Carb. Arachn., 1911, p. 81, pl. III, fig. 6, text fig. 41.

From the Coal Measures of South Wales.

Areomartus new genus

Genotype and only species

1. *A. ovatus* n. sp.

From the Carboniferous of Fayette Co., West Virginia.

Trigonomartus n. gen.

Genotype and only species

1. *T. pustulatus* (Scudder)

= *Anthracomartus pustulatus* Scudder, Proc. Amer. Acad. Arts Sci., Vol. XX, 1884, p. 18. Id., Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 452, pl. 40, figs. 5, 8.

From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

It is probable that the arachnid from Bohemia, described by Fritsch under the name of *Promygale rotundata* (Pal. Arachn., 1904, p. 20, text figs. 23–25) also belongs to the family Eophrynidae of this order.

DESCRIPTION OF NORTH AMERICAN CARBONIFEROUS ANTHRACOMARTI

Family Anthracomartidae.

Genus *Anthracomartus* Karsch (Pocock 1911).

Pleural laminae divided, not emarginate. Abdomen rounded. Pedipalpi pediform. Genotype *A. voelkelianus* Karsch.

Key to North American Species of Anthracomartus.

1. Cephalothorax almost rectangular, wider than long

A. trilobitus

+ Cephalothorax triangular

A. triangularis

Anthracomartus trilobitus Scudder.

Plate XI, fig. 60, text fig. 57.

A. trilobitus Scudder, Proc. Amer. Acad. Arts Sci., Vol. XX, 1884, p. 17. Id., C. R. Soc. Ent. Belgique, (3), 1885, p. 85, with fig. Id., Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 451, pl. 39, figs. 7-10.

Altogether twenty-two specimens, all from the same locality. Of these eighteen in the U. S. National Museum and four, including

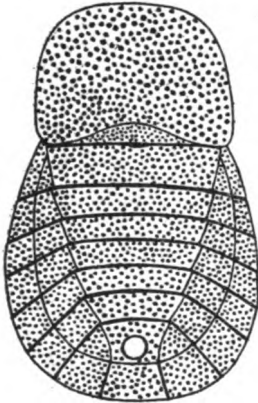


Fig. 57.

Figure 57.—*Anthracomartus trilobitus* Scudder, from the Pennsylvanian (Upper Pottsville) near Fayetteville, Arkansas, U. S. N. M. No. 1753 d (Lacoe collection). $\times \frac{4}{1}$

the type, No. 136, in the Museum of Comparative Zoology at Harvard University. None of the specimens shows either the ventral surface or legs, so that our knowledge of the species is based entirely on the characters of the cephalothorax and the dorsal surface of the abdomen. All are on dark grey carbonaceous shale, together with ferns. Although their size differs, all specimens have the same structure and same proportions. All appear punctate or granulate. As for the anal operculum, it must be stated that it is missing in some of the specimens and present in others, thus giving confirmation to the assumption, that it was pressed through the body from the ventral to the dorsal surface. The posterior edge of the cephalothorax is always strongly procurved. Behind it is the first abdominal tergite, partly covered by the cephalothorax and devoid of pleural laminae. The anal

operculum appears perfectly round, imprinted on the eighth abdominal tergite. Measurements of type specimen: cephalothorax, 5.25 mm. long; 7.5 mm. wide; total length, 15.0 mm.

Specimen No. 1753 d of the Lacoe collection in the U. S. National Museum. Length of cephalothorax in median line, 4.0 mm.; width, 6.5 mm. Length of abdomen in median line, 9.3 mm.; width in the region of the sixth tergite, 8.3 mm.

Found in the Upper Pottsville series, near Fayetteville, Washington County, Arkansas.

Anthracomartus triangularis n. sp.

Plate XI, fig. 61; text fig. 58.

The type and only specimen of this species, No. 37968 of the U. S. National Museum, shows like the preceding species only the dorsal surface on the obverse and its mould on the reverse. The specimen is black, but in some places the black color is gone so that it appears mottled with yellow. On the same rock are impressions of ferns. The body is much flatter than in *A. trilobitus*. Total size 18.6 mm. Cephalothorax distinctly triangular, 6.5 mm. long, 7.5 mm. wide at posterior edge. Maximum width of abdomen 11.3 mm. Lines of separation heavy, black. The first tergite completely covered by the cephalothorax. An interesting feature represents the shape of the seventh and eighth (sixth and seventh visible) tergites.

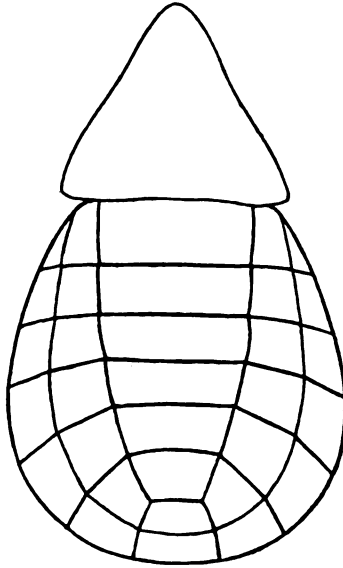


Fig. 58.

Figure 58.—*Anthracomartus triangularis* n. sp., from the Upper Coal Measures, Joggins Mines, Nova Scotia, holotype, U. S. N. M. No. 37968, dorsal surface. $\times \frac{4}{1}$

Family Eophrynidae.

Key to North American Genera of Eophrynidae.

1. Cephalothorax triangular, elevated in the middle, sloping gradually in all directions, not sculptured *Trigonotarbus* Pocock
 + Cephalothorax sculptured 2
2. Cephalothorax triangular, wider than long, its surface divided into hexagonal fields. Abdominal tergites 9
Areomartus n. gen.
 + Cephalothorax triangular, longer than wide, with a median longitudinal crest in its posterior half. Abdominal tergites 8
Trigonomartus n. gen.

Areomartus n. gen.

With the characters given in the key. Genotype *A. ovatus* n. sp.

Areomartus ovatus n. sp.

Plate X, fig. 58; text fig. 59.

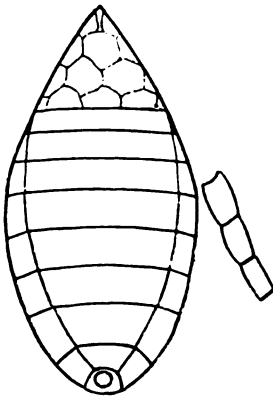


Fig. 59.

Figure 59. — *Areomartus ovatus* n. sp., from the Pennsylvanic (Lower Kanawha), Cottonhill, West Virginia, holotype, U. S. N. M. No. 1196, showing the dorsal surface. $\times \frac{5}{1}$

The type and only specimen of this species is in the U. S. National Museum under No. 1196. Only the obverse is in existence and that shows the cephalothorax with abdomen and three joints of one leg.

Total length 9.75 mm. Cephalothorax remarkably small for the size of the abdomen, 2.5 mm. long, 3.25 mm. wide, beautifully triangular with scarcely curved margins and the surface divided into hexagonal areas which appear as slight depressions. Pleurae entire. Nine tergites can be counted with the anal operculum impressed on the ninth. The fragment of the leg, which probably belonged to the fourth pair, shows that the legs were short and stout.

Found in the Pennsylvanic (lower Kanawha), Cotton Hill, Fayette County, West Virginia.

Trigonomartus n. gen.

Cephalothorax triangular with a median crest in the posterior half, covered with irregular polygonal depressions. Visible abdominal tergites eight. Sternum very large. Posterior coxae by far the heaviest and much closer together than the preceding pair. Eyes absent. Genotype *T. pustulatus* (Scudder).

Trigonomartus pustulatus (Scudder)

Plate IX, figs. 47–51; text figs. 60–62.

= *Anthracomartus pustulatus* Scudder, Proc. Amer. Acad. Arts Sci., Vol. XX, 1884, p. 18. Id., Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 452, pl. 40, figs. 5, 8.

This species is represented by three excellently preserved specimens. The holotype, No. 1752 of the Lacoë collection, is in the U. S. National Museum under No. 37984. The second specimen

is in the Peabody Museum, No. 168, and is from Bucks cral pit at Marris, Illinois. The third and best is in the collection of Mr. L. E. Daniels. All specimens are from the same region, are almost of the same size and agree completely in the details of structure.

Type specimen, Plate IX, figs. 47, 48. Total length 15.0 mm. Cephalothorax, length 6.0 mm. ; it is somewhat pressed out of shape and the width given by Scudder as 7.0 mm. is excessive.

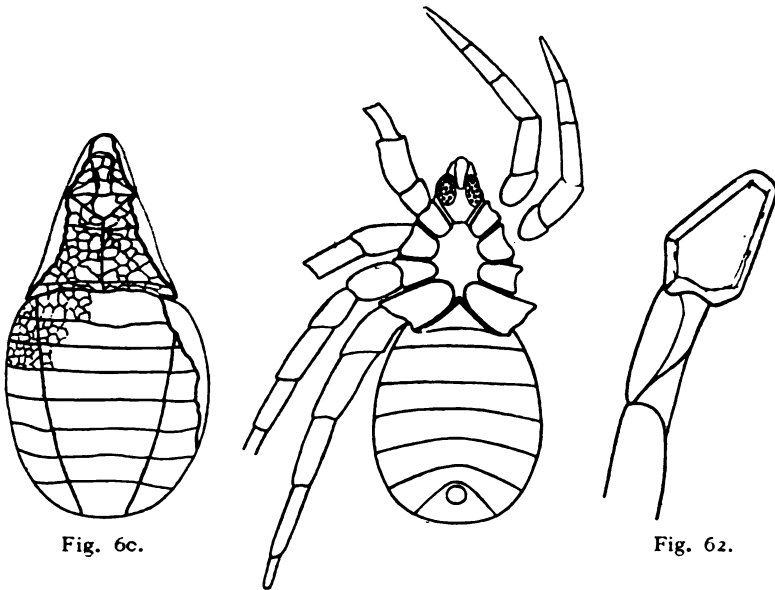


Fig. 60.

Fig. 61.

Fig. 62.

Figure 60.—*Trigonmartus pustulatus* (Scudder), specimen in the collection of Mr. L. E. Daniels, dorsal view of body. Figure 61.—Same, reverse, showing the whole specimen as it appears on the nodule. $\times \frac{3}{1}$. Figure 62.—Hind leg of the specimen from the Pennsylvanic, Morris, Illinois, Peabody Museum No. 168. $\times \frac{6}{1}$

Specimen in the Peabody Museum, No. 168. Total length 16.3 mm. Of interest is the right hind leg represented in text figure 62. It is preserved not as a mould, but is actually the petrified limb. Lying on the side, it shows the shape and thickness of the coxa, represented by the inner fine lines on the figure. The trochanter has an unusual shape, its dorsal surface being much longer than the ventral one, so that this joint is articulated with the femur in a manner similar

to the patella of spiders, with this difference, however, that it is the distal end of the trochanter.

Specimen in the Daniels collection. Plate IX, figs. 49, 50; text figs. 60, 61. Total length 16.5 mm. Cephalothorax 7.0 mm. long, its probable width 5.1 mm. It has a distinct triangular shape, and together with the abdomen and limbs, represents the *mould* of the actual specimen. This interpretation may seem strange to one who examines the obverse alone, since the specimen on the obverse stands out bodily to a considerable height and gives the impression of a petrified specimen. But a comparison with the reverse of the same specimen shows at once what has happened to this as to the other two specimens. Under pressure of the drying mud the dorsal surface of the abdomen of the specimen caught in it was pressed in until it became concave instead of remaining convex, coming in contact with the ventral surface. Why this happened to the dorsal surface and not to the ventral one, is not clear, but presumably the dorsal surface was less chitinized and therefore softer. The cephalothorax being much harder, kept more or less its shape, and what appears on it as the median crest was in reality a deep groove. The irregular, polygonal depressions appearing as such both on the abdomen and cephalothorax were evidently thickened areas of the chitin and formed in life low elevations. The abdomen covers in the specimen the posterior edge of the cephalothorax. Consequently we may assume that it had in life a segment anterior to the first visible tergite, consequently, if the anal operculum represents the last tergite the abdomen must have been composed of eleven segments as in *Anthracomartus*. The plate surrounding the anal operculum represents the fused tergite and sternite of the tenth segment and since in front of this plate may be counted only seven sternites, the first visible sternite which has the shape of a triangle corresponds to the first, second and third abdominal segments. The dorsal surface of the abdomen was a little displaced laterally and shows on the left the sternites. Bearing all this in mind we may give the following description of the specimen as it must have appeared in life.

Cephalothorax triangular, high, covered with irregular polygonal thickenings. A deep transverse groove in the middle, another a little in front of it and a third close to the posterior margin which is covered by the abdomen. Two almost parallel grooves run from the anterior transverse groove to the anterior end of the cephalothorax. Two oblique ridges run from the sides of the anterior groove backward uniting a little in front of the median transverse

groove. A median longitudinal groove runs from this point backward to the posterior margin. Eyes absent. Abdomen sphaeroidal, longer than wide, and wider than high, with the anal operculum placed ventrally and surrounded by a plate composed of the fused tergite and sternite of the tenth segment. Dorsal surface of abdomen covered with irregular polygonal thickenings similar to those of the cephalothorax, ventral surface smooth. Two deep grooves separate the tergites from the sclerites of the pleura in all segments except the tenth and eleventh and probably the first.

Their sternum is very large, being 3.3 mm. long and 2.4 mm. wide between the coxae of the second and third pair of legs. It is truncated in front, has three pairs of lateral projections and a posterior bifid lobe. Legs robust and moderately long, patella completely fused with tibia, tarsi longer than metatarsi. Length of legs in order 4312.

Two structures visible on the reverse require special mention. They are: a beak-like median process directed backward, and two oval deeply punctate areas. The first may be the end of the cephalothorax turned downward. Another interpretation would be that this process represents the chelicera. The punctate oval areas undoubtedly are parts of the pedipalpi, perhaps a stridulatory organ on the coxae.

Found in the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

Trigonomartus woodruffi (Scudder).

Plate IX, fig. 52.

= *Anthracomartus woodruffi* Scudder, Bull. U. S. Geol. Surv., No. 101, 1893, p. 9, pl. I, figs.

The type and only specimen of this species is a mere fragment of the dorsal surface of the abdomen. From its likeness with the preceding species I have placed it in the same genus, since it certainly does not belong to the genus *Anthracomartus*. The surface of the tergites is considerably smoother than in *T. pustulatus* and the abdomen much flatter.

Found in the Pennsylvanic (? Pottsville), of Rhode Island.

Genus *Trigonotarbus* Pocock 1911.

Cephalothorax triangular, elevated in the middle, sloping gradually in all directions, not sculptured. Legs with patella. Anal operculum ventral in position. Genotype *T. johnsoni* Pocock.

Key to the Species of *Trigonotarbus*.

1. Coxae of pedipalpi contiguous in median line almost their entire length. Coxae of first pair of legs touching each other
T. schucherti n. sp.
 - + Coxae of pedipalpi not contiguous their entire length, coxae of first pair of legs separated by the sternum 2
2. The segment surrounding the anal operculum wider than long. Abdominal sternites moderately recurved
T. carbonarius n. sp.
 - + Segment surrounding the anal operculum much longer than wide. Three adjoining abdominal sternites strongly recurved
T. johnsoni.

Trigonotarbus schucherti n. sp.

Plate X, figs. 53, 54; text figs. 63, 64.

The type and only specimen of this species is in the collection of Peabody Museum under No. 169. The reverse shows an almost complete specimen. The obverse shows besides the dorsal surface the superimposed impression of the reverse. This is especially clear if one examines the position of the anal operculum. On the ventral surface it is median in position, whereas on the obverse it is lateral, showing that the two surfaces were laterally dislocated.

Total length 19.0 mm. Cephalothorax triangular, with slightly recurved posterior edge and curved sides, produced anteriorly into a blunt lobe; length in median line 7.5 mm., width at posterior edge 7.0 mm.; high, gradually sloping in all directions. Abdomen oval. Pleural sclerites not subdivided. Visible on the dorsal surface are eight tergites. Anal operculum ventral in position. The plate surrounding it is considerably wider than long, representing probably the fused sternite and tergite of the tenth segment. In front of it are seven sternites with moderately recurved edges. In two places the sternites were evidently separated from each other by the pressure of the drying mud in which the specimen was imbedded, exposing the anterior margin of the sternites of the fourth and sixth segments (second and fourth visible sternites). Sternum long and narrow, reaching to base of first coxae, with lateral projections between each consecutive pair of coxae and a narrow process separating the fourth coxae. Coxae of pedipalpi triangular, contiguous their entire length with exception of a small distal space. Chelicera missing. Pedipalpi

pediform, slender, 9.0 mm. long, with subequal joints. Of the first pair of legs only the trochanter, femur and fraction of the patella preserved. In the second and third pair of legs is missing the metatarsus and tarsus. Left fourth leg complete, 19.2 mm. long. Patella

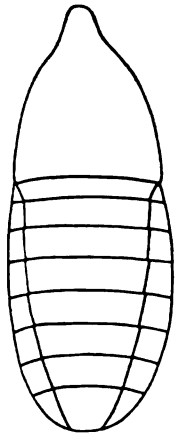


Fig. 63.

Figure 63.—*Trigonotarbus schucherti* n. sp., holotype, Peabody Mus. No. 169, dorsal surface of cephalothorax and abdomen. $\times \frac{3}{1}$

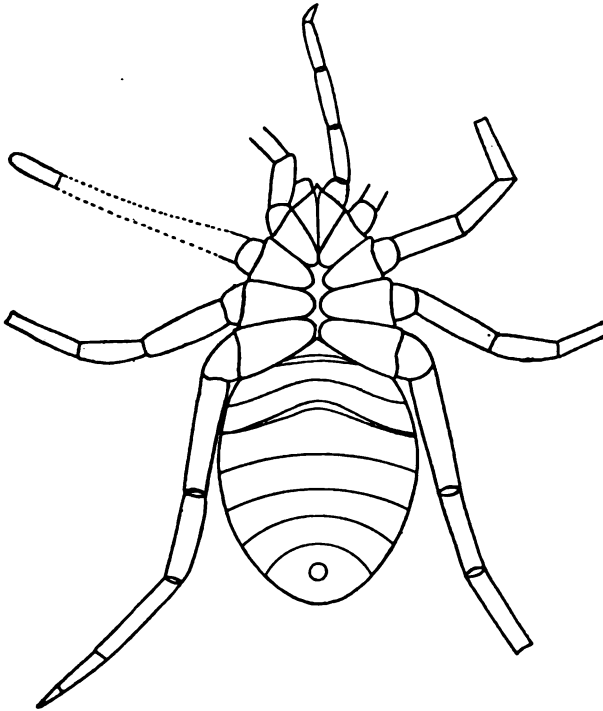


Fig. 64.

Figure 64.—Same, reverse as it appears on nodule. $\times \frac{3}{1}$

present in all legs. Femur I, 2.3 mm.; II, 3.0 mm.; III, 4.0 mm.; IV, 5.1 mm. Tarsus of fourth leg shorter than metatarsus.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Trigonotarbus carbonarius n. sp.

Plate X, fig. 55; text fig. 65.

The type and only specimen of this species is in the U. S. National Museum under No. 37978. The obverse is missing.

Total size 15.5 mm. Abdomen 10.0 mm. long, 8.0 mm. wide in middle. The small coxae of the pedipalpi touch each other only at

their proximal end. Between them two triangular plates, probably chelicera. Sternum long and narrow, with three pairs of lateral processes, an anterior median, trifid lobe and a posterior bifid lobe. Trochanters one-jointed. Pedipalpi missing. Faint impressions of the third left and second and third right legs. Femur of fourth pair of legs 4.6 mm. long. Anal operculum round. The segment surrounding it much wider than long. Abdominal sternites recurved,

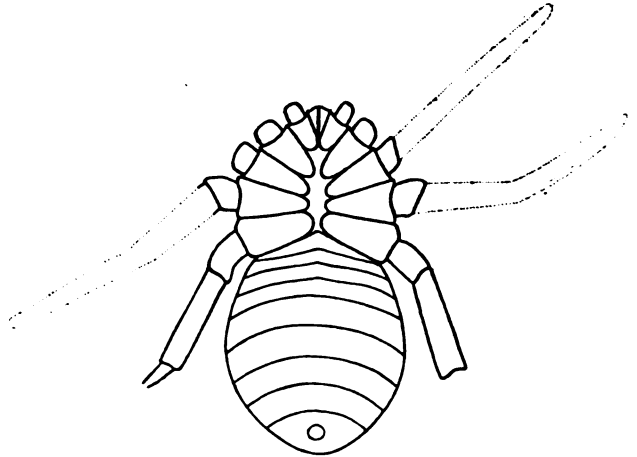


Fig. 65.

Figure 65.—*Trigonotarbus carbonarius* n. sp., holotype, U. S. N. M. No. 37978, ventral surface as it appears on the nodule. $\times \frac{8}{1}$

eight in number. Abdomen almost hemispherical in a transverse section, probably spherical in life.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

ORDER OPILIONES

Head completely fused with thorax. Abdomen broadly joined with cephalothorax, composed of ten segments; the anal operculum placed ventrally represents the tergite of the tenth segment. One pair of eyes, sometimes eyes absent. Chelicera three-jointed, chelate. Pedipalpi pediform. Trochanter usually one-jointed. Patella present in all legs. Coxae of first pair of legs and often of the second and third with maxillary lobes. Respiratory organs in the form of tracheal tubes with one pair of spiracles either on the second

ventral segment, or behind the fourth coxae. In the family Phalangioidea the position of the spiracles is varying, in some species there is a spiracle on each tibia. Genital organs opening with a penis or ovipositor on the first abdominal sternite. Oviparous.

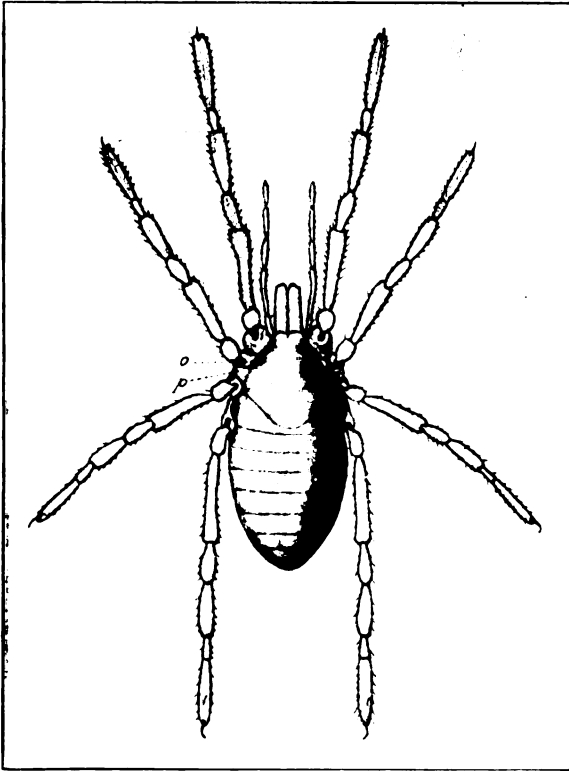


Fig. 66.

Figure 66. — *Stylocellus beccarii* Thorell, from Sumatra ; male viewed from above.
(From Hansen and Sørensen, On two Orders of Arachnida, 1904.)

This order shows close relation to Haptopoda and Phalangiotarbi. To facilitate the understanding of the species belonging to the last named order, I reproduce here two figures showing the skeletal structures of an Opilionid belonging to the family Sironoidae of the sub-order Cyphophthalmi.

To this order belong probably the following Carboniferous arachnids from Europe :

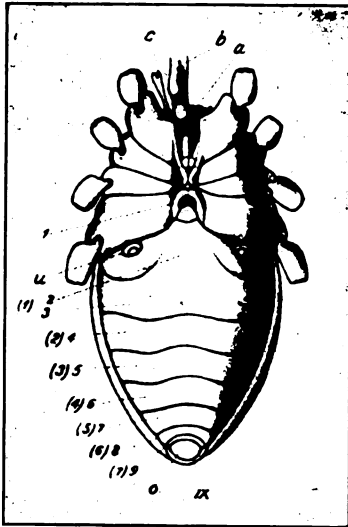
Genus *Nemastomoides* Thevenin 1902.

Fig. 67.

Figure 67.—*Stylocellus beccarii* Th., Same, ventral surface. (From Hansen and Sørensen, On two Orders of Arachnida, 1904.)

- i. *N. elaveris* Thev., Bull. Soc. Geol. France, (4), Vol. I, 1902, p. 609 pl. XIII, fig. 2. Fritsch, Pal. Arachn., 1904, p. 29, text fig. 34 Pocock, Carb. Arachn., 1911 p. 83, text fig. 42.

From the Coal Measures of Commentry, France, and Ellismuir, Scotland.

Genus *Dinopilio* Fritsch 1904.

- i. *D. gigas* Fritsch, Pal. Arachn., 1904, p. 30, pl. 5, figs. 3–5, text fig. 35.

From the Coal Measures of Rakonitz, Bohemia.

I refer also to this order the two imperfectly preserved specimens from North America, representing two new species of the new genus *Protopilio*, although they are far from being typical Opilionids.

Protopilio n. gen.

Coxae of all legs without maxillary lobes, those of the fourth pair fully twice as long as first coxae. Sternum oval. Trochanters one-jointed. Legs long and slender. Genotype *P. longipes* n. sp.

Protopilio longipes n. sp.

Plate X, fig. 57; text fig. 68.

The type and only specimen of this species, No. 171 of the Peabody Museum, unfortunately presents on both halves of the nodule the ventral surface alone. It is therefore impossible to say anything about the cephalothorax and the abdominal tergites. If judged by the appearance of the ventral surface, the abdomen is broadly joined to the cephalothorax. The number of visible sternites is nine. The first sternite is small, triangular. The second sternite is by far the largest with a recurved anterior edge. The following two sternites are almost as long as the second. The remaining sternites are very short, with parallel edges with exception of the ninth which is triangular. Ster-

num oval. In front of it two heavy chelicera, evidently bent downward, so that their distal end reaches the sternum. At the sides of the chelicera are the coxae of the pedipalpi. The coxae of the legs are radiating from the sternum. The fourth coxae are fully twice as long as the first. All trochanters are one-jointed. Of the legs are preserved only the femora of the second right and fourth left leg. They are very long and slender and from their appearance it is prob-

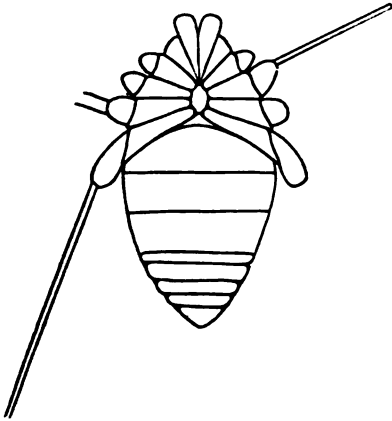


Fig. 68.

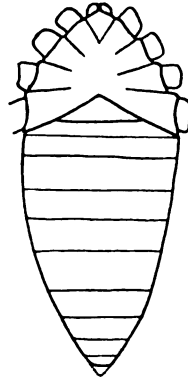


Fig. 69.

Figure 68.—*Protopilio longipes* n. sp., holotype, Peabody Mus. No. 171, ventral surface. Figure 69.—*Protopilio depressus* n. sp., holotype, U. S. N. M. No. 37974, ventral surface. $\times \frac{4}{1}$

able that all legs were long and slender. The whole body is quite flat. Total size with chelicera 10.5 mm.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek Illinois.

Protopilio depressus n. sp.

Plate X, fig. 56; text fig. 69.

A very imperfectly preserved specimen in the U. S. National Museum under No. 37974. The nodule presents both the obverse and reverse, but the detail of the structures cannot be seen. Abdomen chipped off at its extreme end. Probable length of the body 24.5 mm. Width of abdomen on the level of the posterior edge of the second sternite 10.0 mm. In the anterior part of the abdomen several heavy transverse folds which make the counting of sternites in this region very uncertain. Beginning with the fourth sternite represented in

text figure 69, the demarcation lines are quite clear, but beyond the seventh sternite they become faint. Probable number of sternites eleven. Coxae visible only at their distal ends. Sternum obliterated.

Found in the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

ORDER HAPTOPODA

Head completely fused with thorax. Abdomen broadly joined with cephalothorax, composed of eleven segments. Pedipalpi short, pediform. Terminal segment of the first pair of legs seven-jointed, modified into a tactile organ. Coxae without maxillary lobes.

This order is so closely related to the Phalangiotarbi, that it seems to have been more reasonable to place the only genus and species known in a separate family under the latter order. The segmentation of the first tarsus is about the only character of importance separating the two Orders. Yet we must not forget that in the order of Solifugids for example the tarsus shows a different number of joints in closely related genera. That the seven-jointed tarsus of *Plesiosiro madeleyi* is a tactile organ is a hypothesis which can be neither substantiated nor disproved. However, since I have not seen any specimen of the only known species, I have retained Pocock's order and refer the reader for details to his Monograph.

Family Plesiosironidae.

Genus *Plesiosiro* Pocock 1911.

1. *P. madeleyi* Pocock, Carb. Arachn., 1911, p. 44, pl. II, fig. 5, text figs. 15, 16.

Found in the Coal Measures of Coseley, near Dudley, England.

ORDER PHALANGIOTARBI

Head completely fused with thorax. Abdomen broadly joined to the cephalothorax. Pleurae soft, without sclerites, not segmented. Several anterior abdominal tergites very short, with a thickened posterior edge. Chelicera not known. Pedipalpi short, pediform. Coxae without maxillary lobes. All trochanters one-jointed. Patella always developed. Anus subapical or ventral in position, closed by an operculum. Abdomen composed of ten to twelve segments. Eyes, when present, in the number of two on the cephalothorax.

Key to the Families of Phalangiotarbi.

1. Third and 4th pair of coxae elongated, meeting in the median line.
First pair of legs slender and long
Heterotarbidæ
- + All coxae triangular. All legs short and stout 2
2. Coxae of first pair of legs contiguous throughout their entire length
Architarbidæ
- + Coxae of first pair of legs contiguous only at their proximal end.
Between them are the coxae of the pedipalpi
Phalangiotarbidæ.

LIST OF DESCRIBED SPECIES OF PHALANGIOTARBI

Family Phalangiotarbidæ.

Genus *Phalangiotarbus* Haase 1890.

1. *P. subovalis* (H. Woodward)
= *Architarbus subovalis* H. Woodward, Geol. Mag. Vol. IX, 1872,
p. 385, pl. IX, fig. 1.
P. subovalis Haase, Zeits. d. g. Gesell., Vol. XLII, 1890, pp. 638,
650, pl. XXX, fig. 3.
= *Architarbus subovalis* Fritsch, Pal. Arachn., 1904, p. 35, text
fig. 39.
P. subovalis Pocock, Carb. Arachn., 1911, p. 46, text fig. 17.
From the Coal Measures of Lancashire, England.

Genus *Geratarbus* Scudder 1890.

1. *G. acoei* Scudder, Mem. Boston Soc. Nat. Hist., Vol. IV, 1890,
p. 448, pl. 40, fig. 11.
From the Pennsylvanic (Lower Allegheny) of Mazon Creek,
Illinois.
2. *G. minutus* n. sp.
From the Pennsylvanic (Lower Allegheny) of Mazon Creek,
Illinois.

Discotarbus n. gen.

1. *D. deplanatus* n. sp.
From the Pennsylvanic (Lower Allegheny) of Mazon Creek,
Illinois.

Metatarbus n. gen.

1. *M. triangularis* n. sp.
From the Pennsylvanic (Lower Allegheny) of Mazon Creek,
Illinois.

Family Architarbidae.

Genus *Architarbus* Scudder 1868.

1. *A. rotundatus* Scudder, Geol. Surv. Illinois, Vol. III, 1868, p. 568, fig. 4.
= *Geraphrynus carbonarius* Scudder, Proc. Amer. Acad. Arts Sci., Vol. XX, 1884, p. 16. Id., Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 446, pl. 40, figs. 1, 9, 10, 12.
From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.
2. *A. horribilis* (Melander)
= *Hadrachne horribilis* Melander, Journ. Geol., Vol. XI, 1903, p. 180, pl. V, fig. 1; pl. VII, fig. 1.
From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.
3. *A. angulatus* (Pocock)
= *Geraphrynus angulatus* Pocock, Carb. Arachn., 1911, p. 49, pl. III, fig. 2, text figs. 19, 20.
From the Coal Measures of Coseley, near Dudley, England.
4. *A. hindi* (Pocock)
= *Geraphrynus hindi* Pocock, loc. cit., p. 51, text figs. 20, 21.
From the Coal Measures of Coseley, near Dudley, England.
5. *A. eggintoni* (Pocock)
= *Geraphrynus eggintoni* Pocock, loc. cit., p. 53, text figs. 24, 25.
From the Coal Measures of Coseley, near Dudley, England.
6. *A. torpedo* (Pocock)
= *Geraphrynus torpedo* Pocock, loc. cit., p. 54, text figs. 26, 27; pl. III, fig. 1.
From the Coal Measures of Coseley, near Dudley, England.
7. *A. angustus* (Pocock)
= *Geraphrynus angustus* Pocock, loc. cit. p. 55.
From the Coal Measures of Coseley, near Dudley, England.
8. *A. minor* n. sp.
From the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

Genus *Opiliotarbus* Pocock 1910.

1. *O. elongatus* (Scudder)
= *Architarbus elongatus* Scudder, Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 449, pl. 40, fig. 4.
= *Geraphrynus elongatus* Fritsch, Pal. Arachn., 1904, p. 33, text fig. 37.
O. elongatus Pocock, Geol. Mag., (V), Vol. VII, 1910, p. 511.

From the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Family Heterotarbidae.

Heterotarbus n. gen.

1. *H. ovatus* n. sp.

From the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

DESCRIPTION OF NORTH AMERICAN SPECIES OF
PHALANGIOTARBI.

Heterotarbidae n. family.

Coxae of first pair of legs separated by the coxae of the pedipalpi. Coxae of the third and fourth pair of legs elongated meeting in the median line. First pair of legs long and slender, the other legs short and stout. Chelicera small, chelate. Pedipalpi not known, their trochanter large. Cephalothorax triangular. Abdominal tergites ten, the first five much shorter and typical of the order.

Heterotarbus n. gen.

With the characters of the family. Genotype *H. ovatus* n. sp.

Heterotarbus ovatus n. sp.

Plate X, fig. 59; text fig. 70.

The type and only specimen of this interesting species is in the collection of Mr. L. E. Daniels. The dorsal and ventral surface are superimposed both on the obverse and reverse of the nodule. The demarcation lines between the sternites being considerably fainter than those between the tergites, especially in the anterior region of the abdomen where the narrow tergites have a thickened poster or edge, the sternites cannot be counted safely. The first sternite is the only one clearly visible and is large and distinctly triangular. For the same reason the posterior edge of the cephalothorax is not clearly defined.

Total length probably 14.0 mm., but the end of the abdomen is broken off, so that the actual length cannot be given. Cephalothorax triangular, 7.3 mm. wide in the region of the first tergite; its probable length 4.8 mm. The anterior five abdominal tergites very short, the first and second slightly procurved, the third with a straight posterior edge, the fourth and fifth slightly recurved. Each of these tergites has a median ridge. The following tergites are much longer,

straight. The tenth tergite was probably the last. On the edges of the abdomen are visible the pleurae. They are not segmented, and were probably soft. Chelicera very small, turned downward, with a line dividing them half-way into two parts probably representing the fingers of a chela. At the sides of the chelicera are visible the trochanters of the pedipalpi separating the legs of the first pair. The

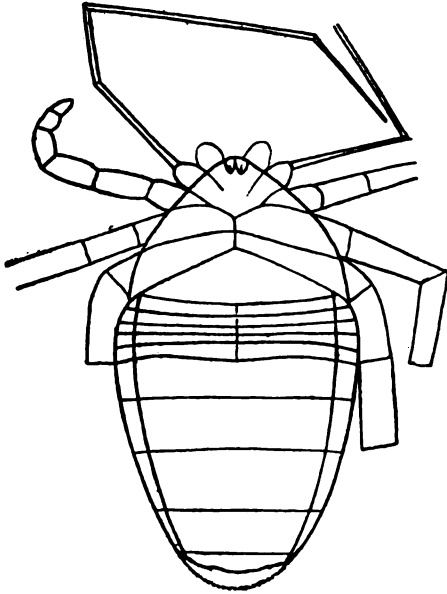


Fig. 70.

Figure 70.—*Heterotarbus ovatus* n. sp., holotype, Daniels coll., dorsal surface, with the coxae and chelicera superimposed on the cephalothorax. $\times \frac{4}{1}$

outlines of the coxae of the first pair cannot be traced all the way backward. The coxae of the second pair are triangular and widely separate. The coxae of the third and fourth pair are very long, contiguous, meeting in a median line. All trochanters one-jointed. Trochanter of the first pair of legs conical, the others rectangular. The first leg is slender and long, its femur measures 3.85 mm., patella 2.66 mm., tibia 7.8 mm., metatarsus 2.7 mm., tarsus missing. Second leg is the shortest; it is heavy, its femur and patella of the same length, tibia somewhat shorter, metatarsus shorter than the width of the patella, tarsus conical. The third leg is heavier and longer than the second.

but its three distal joints are missing. The fourth leg is still heavier and longer, but only trochanter and part of femur preserved. The whole body is smooth.

The species is of great interest since it combines characters of two orders: Opiliones and Phalangiotarbi. The arrangement of the coxae and the chelate chelicera remind of the former, while the segmentation of the abdomen is typical of the latter.

Found in the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

Family Phalangiotarbitidae.

New definition. Coxae of pedipalpi wedged in between the coxae of the first pair of legs, narrow and long, contiguous throughout their entire length. Sternum oval or elongated, with the coxae of the legs radiating from it and increasing in length from the first to the fourth. Trochanters of the first and second leg always one-jointed. Patella developed. Legs all short and stout. Abdominal tergites, not counting the ventrally placed operculum anale, ten. The first five or four tergites very short with heavily thickened posterior edge appearing in the specimens as a deep groove. Genital opening on the first sternite. Pleurae soft, not segmented.

Key to the Genera of Phalangiotarbitidae.

1. Posterior edge of the cephalothorax straight or very slightly procurved. The first 5 abdominal tergites straight or almost straight 2
 - + posterior edge of the cephalothorax strongly procurved. The first 2 or 3 tergites strongly procurved 3
2. Coxae of the 1st pair of legs completely separated by the coxae of the pedipalpi. Coxae of the 4th pair far apart
 - Phalangiotarbus*
 - + Coxae of the 1st pair of legs contiguous at their base. Coxae of the 4th pair approximated
 - Geratarbus*
3. Abdomen disc-shaped, quite flat. Posterior corners of the cephalothorax angular
 - Discotarbus*
 - + Abdomen oval. Posterior corners of the cephalothorax rounded
 - Metatarbus*.

Genus *Geratarbus* Scudder.

New definition. Coxae of pedipalpi wedge-shaped, coxae of first pair of legs contiguous at base. Posterior edge of cephalothorax almost or quite straight. Anterior five abdominal tergites straight, the following very slightly recurved. Sternum oval. Abdominal sternites divided into three fields by longitudinal lines. Genotype *G. lacoiei* Scudder.

Key to the Species of *Geratarbus*.

1. Cephalothorax with parallel sides and broad anterior edge
 - G. lacoiei*
 - + Cephalothorax with rounded sides converging anteriorly to a sharp point
 - G. minutus*.

Geratarbus lacoei Scudder.

Plate XI, fig. 68; text figs. 71, 72.

G. lacoei Scudder, Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 448, pl. 40, fig. 11.

The type and only specimen of this species, No. 1765 of the Lacoe collection, is in the U. S. National Museum under No. 37966. The obverse shows the dorsal surface with the impressions of the coxae superimposed over the cephalothorax, the reverse shows the ventral surface clear; but abdominal sternites are totally obliterated on both

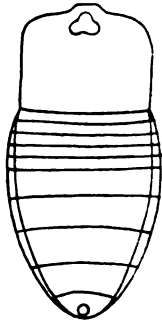


Fig. 71.

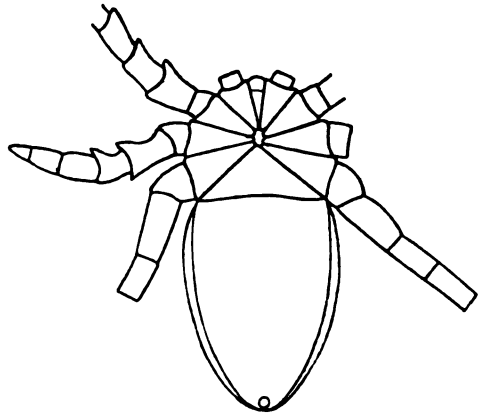


Fig. 72.

Figure 71.—*Geratarbus lacoei* Scud., holotype, U. S. N. M. No. 37966, dorsal surface. Figure 72.—Same, ventral surface. $\times \frac{4}{1}$

the obverse and reverse. The description given by Scudder is incorrect in many points, he having omitted to clean the kaolin off the specimen.

Total length 10.5 mm. Cephalothorax 3.6 mm. long, 4.2 mm. wide. Its posterior edge very slightly procurved, almost straight. The sides are parallel, the anterior corners rounded. The anterior edge presents a broad projection in the middle with sloping sides and truncated front. Immediately behind this projection is a more or less triangular depression with rounded angles and emarginate sides, representing probably the eye tubercle. Abdomen oval. The anal operculum appears on both the ventral and dorsal surfaces, but must have been ventral in position. Of the ten tergites, the anterior five are short, with heavily thickened posterior edge, typical of the order. The pleura is not segmented and was evidently soft. Chelicera

missing; of the pedipalpi preserved only the coxae which are wedge-shaped and apparently completely fused together, forming one triangular plate. Sternum small, oval. Radiating from it are the triangular coxae of the legs. The first coxae are contiguous at their base (apex of the triangle); the fourth coxae are $1\frac{1}{2}$ times as long as the first. The first sternite, the only one visible, is large, triangular. Trochanters one-jointed. The third left leg is complete, its femur and patella with an anterior apical process. The second leg shows similar processes in the same joints and in the tibia; its metatarsus and tarsus are missing. The joints of the fourth leg are without the apical process, metatarsus and tarsus also missing. The body is smooth, the legs are coarsely and distinctly punctate.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Geratarbus minutus n. sp.

Plate XI, fig. 69; text figs. 73, 74.

There are altogether six specimens of this species in the Peabody Museum. Their numbers are 176 (type), and 177—181.

All are approximately of the same size, their length varying from 9.1 to 10.6 mm. Some are of course better preserved than others, yet all show the same structure. No. 176 being the best preserved specimen, I chose it for holotype.

Body flat. Total length 9.1 mm. Cephalothorax 3.1 mm. long, 3.5 mm. wide at posterior edge which is perfectly straight. The sides of the cephalothorax are rounded, converging in front to a sharp point. Its surface perfectly smooth; eyes absent. The anal operculum round, impressed on both the dorsal and ventral surfaces. Abdominal tergites ten. The anterior five short, with heavily thickened posterior edge and a median ridge, straight. The following tergites longer, slightly recurved. Pleura not segmented, forming a heavy ridge alongside the abdomen on its ventral surface, anteriorly chipped off exposing the ends of the sternites. Five abdominal sternites in front of the last sternite divided by two longitudinal lines into three fields. The triangular area between the hind coxae with an almost round genital operculum divided by a transverse line. Chelicera missing. Coxae of pedipalpi wedge-shaped, contiguous throughout their length. Sternum large, longer than wide, with three pairs of lateral projections and a median posterior lobe separating the hind coxae. All coxae with rounded base. Coxae of first pair twice as short as those of the fourth pair, contiguous at base. Trochanters one-jointed. Legs short, but not as heavy as in *G. lacoei*, femora and

patellae without apical process. Text figure 74 shows all legs as they appear on the reverse. The majority of specimens have only fragments of legs. Dorsal surface of abdomen appearing also on the reverse. Abdomen smooth. Legs and distal ends of coxae distinctly punctate.

Found in the Pennsylvanic (Lower Allegheny) of Mazon Creek, Illinois.

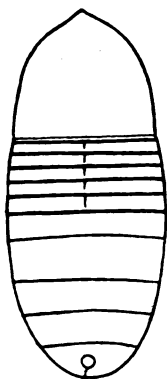


Fig. 73.

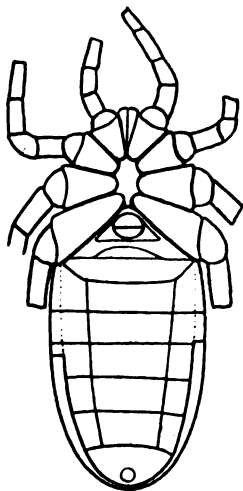


Fig. 74.

Figure 73.—*Geratarbus minutus* n. sp., holotype, Peabody Mus. No. 176, dorsal view of cephalothorax and abdomen. Figure 74.— Same, ventral surface with legs. $\times \frac{5}{1}$

thickened edge. Sternum long, divided into three areas of which the middle one is hexagonal and the other two pentagonal. Body very flat. Genotype *D. deplanatus* n. sp.

Discotarbus deplanatus n. sp.

Plate XII, fig. 10; text figs. 75, 76.

Two specimens, Nos. 174 and 175, in the Peabody Museum. The first is twice as small as the second, but better preserved. Since the larger specimen shows the same structure there is no reason for separating it into another species. I choose the smaller specimen, No. 174, as holotype.

Type specimen. Total length 11.25 mm. Cephalothorax 4.5 mm. long, 5.12 mm. wide between the posterior corners. Posterior edge strongly procurved. Sides curved. Eyes absent. Five anterior tergites very short, with heavily thickened posterior edge. First, second and third tergites procurved; fourth, fifth and sixth straight;

the others recurved. The sixth tergite somewhat longer than the preceding, but its posterior edge not thickened. Anal operculum round, impressed clearly on the dorsal surface; the reverse does not show it because the end of the abdomen is chipped off. Sternites not visible, the tergites appearing as clearly on the ventral surface as on the dorsal, only reversed, *i. e.* what appears as a groove on the dorsal surface has a counterpart in a ridge on the ventral surface. Only the first sternite is clearly visible, small, triangular.

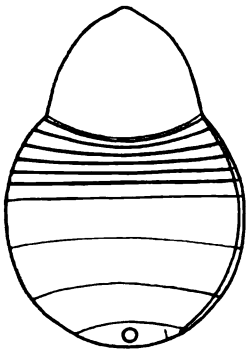


Fig. 75.

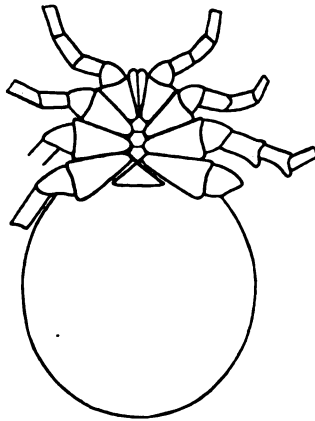


Fig. 76.

Figure 75.—*Discotarbus deplanatus* n. sp., holotype, Peabody Mus. No. 174, showing the cephalothorax and abdomen. Figure 76.—Same, ventral surface. $\times \frac{4}{1}$

Sternum long, divided into three areas of which the middle one is hexagonal, the other two pentagonal. Coxae of pedipalpi wedge-shaped, contiguous throughout their entire length. Coxae of first pair contiguous at base. Coxae of fourth pair of legs $1\frac{2}{3}$ as long as those of the first pair. Trochanters one-jointed. Legs short. Patella of first leg longer than femur. Patella and femur of third leg with a distal posterior process. Whole body quite flat and smooth, apparently covered with a thin layer of graphite.

Total size of specimen No. 175, 23.5 mm. Cephalothorax 9.0 mm. long, 11.0 mm. wide between the posterior corners.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Metatarbus n. gen.

Cephalothorax triangular, with posterior corners rounded. Posterior edge procurved. Eyes absent. Only four anterior abdominal

segments with a heavily thickened posterior edge. The first, second, and third tergites procurved, the fourth with a procurved anterior and recurved posterior edge. The following tergites slightly recurved. Sternum elongated, divided into three areas of which the middle one is hexagonal and the two others pentagonal. Abdomen oval, with ten tergites and seven sternites. Genotype *M. triangularis* n. sp.

Metatarbus triangularis n. sp.

Plate XI, figs. 66, 67; text figs. 77, 78.

The type specimen of this species is in the Peabody Museum, No. 182. It is somewhat deformed, so that the left half is narrower

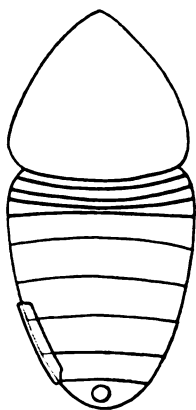


Fig. 77.

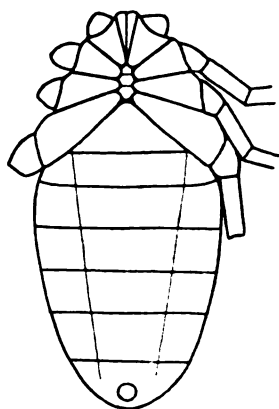


Fig. 78.

Figure 77.—*Metatarbus triangularis* n. sp., holotype, Peabody Mus. No. 182, dorsal surface. Figure 78.—Same, ventral surface. $\times \frac{3}{1}$

than the right half, but otherwise well preserved. Total length 17.5 mm. Cephalothorax triangular, posterior edge procurved, posterior corners rounded, sides curved. Length in median line 7.5 mm. Maximum width 8.0 mm. Eyes absent. Abdominal tergites ten. Only four anterior tergites short and with heavily thickened posterior edge. First, second and third tergites procurved, fourth with a procurved anterior and recurved posterior edge. The following tergites slightly recurved. Sternites seven. The first sternite triangular. Two converging lines divide the ventral surface of the abdomen into three fields. Anus round, ventral in position, its operculum impressed on both the dorsal and ventral surfaces. Sternum long, divided into three areas of which the middle one is hexagonal.

the other two pentagonal. Coxae of pedipalpi wedge-shaped, contiguous throughout their entire length. Coxae of first pair contiguous at base. Coxae of fourth pair more than twice as long as those of first pair. Trochanters one-jointed. Of the legs preserved only the femora of the second, third and fourth leg. Pleura not segmented, probably soft, appearing as heavy ridge at one side of the abdomen. Body quite smooth.

Specimen in the Museum of Comparative Zoology, Harvard University, not numbered, but accompanied by a label which reads: *Libellula carbonaria* Scudder, AAAS, Vol. XXIV, B, 1875. In every respect similar to the type specimen, but not as well preserved. Of the cephalothorax preserved the proximal end only. Length of abdomen 9.2 mm.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Family Architarbidae.

(New definition.) Cephalothorax broadly joined to the abdomen. Pedipalpi short, pediform. Coxae of first pair of legs contiguous throughout their entire length. Eyes, when present, in the number of two, on the cephalothorax. Anal operculum ventral in position. Abdominal tergites nine to eleven, the anterior five or six much shorter than the following, with a heavily thickened posterior edge, typical of the order. Abdominal sternites seven or eight. Pleura not segmented, soft.

Key to the Genera of Architarbidae.

1. Cephalothorax produced posteriorly, with curved sides converging to a point. Five or 6 anterior tergites distinctly procurved. Sternum well developed

Architarbus

+ Cephalothorax with a straight posterior edge, broadly rounded in front. Anterior abdominal tergites straight. Sternum reduced to a line

Opiliotarbus.

Genus *Architarbus*¹ Scudder 1868.

New definition. Cephalothorax produced posteriorly or at least with a very strongly procurved posterior edge. Anteriorly it is

¹ *Geraphrynus* is a synonym of *Architarbus*. See Introduction and the description of *Architarbus rotundatus*.

drawn out to a sharp point, almost having the appearance of a spine. Anterior five or six tergites procurved, with heavily thickened posterior edge. Pedipalpi short, pediform. Sternum long, divided into three areas of which the middle one is hexagonal, the other two pentagonal. Ventral surface of abdomen divided into three fields by two longitudinal lines. Genotype *A. rotundatus* Scudder.

Key to North American Species of *Architarbus*.

1. Cephalothorax slightly produced posteriorly. Size very large
A. horribilis
 + cephalothorax produced posteriorly into a long lobe. Size much smaller 2
2. Anterior 6 tergites very short in the middle. Abdomen broadly rounded
A. minor n. sp.
 + 4th, 5th and 6th tergites not conspicuously short in middle, with almost parallel edges. Abdomen oval, widest in front
A. rotundatus.

The specimens of *Architarbus*, like all other Phalangiotarbi, have certain peculiarities of structure which one must bear in mind to avoid false interpretation. Both surfaces are usually superimposed, the ventral over the dorsal on the obverse and the dorsal over the ventral on the reverse. What is a ridge on the obverse appears as a groove on the reverse. This and the fact that the demarcation lines between the tergites and sternites do not coincide, help to recognize the structures belonging to the dorsal surface from those belonging to the ventral. Even Pocock seems not to have escaped an error in drawing the tergites divided by two longitudinal lines into three fields in some of his species. These lines belong undoubtedly to the ventral surface. Thus in some specimens of *A. rotundatus*, where a superimposition of the surfaces for some reason did not take place, the lines appear only on the ventral surface. The anal operculum is always better visible on the dorsal surface than on the ventral where it belongs. The reason for this may be sought in an internal ring-shaped thickening of the opercular edge, or still more probably in an internal thickening of the wall of the anus itself. The anus itself being placed ventrally, the internal ring-shaped thickening would naturally be better visible on the dorsal surface after the two surfaces came in contact with each other under the pressure of the drying mud in which the specimen was imbedded.

Architarbus rotundatus Scudder.

Plate VII, figs. 74—79, 81—83; text figs. 79, 80.

A. rotundatus Scudder, Geol. Surv. Illinois, Vol. III, 1868, p. 568.

= *Geraphrynus carbonarius* Idem, Mem. Boston Soc. Nat. Hist., 1890, p. 446, pl. 40, figs. 1, 9, 10, 12.

A. rotundatus Melander, Jour. Geol., Vol. XI, 1903, p. 181, pl. V, fig. 2; pl. VII, fig. 2.

= *Geraphrynus carbonarius* Idem, Ibid., p. 181, pl. V, fig. 3; pl. VII, fig. 3.

There are altogether seventeen more or less well preserved specimens of this species distributed as follows:

One specimen, No. 1116, the type specimen of *A. rotundatus*, in the collection of the University of Illinois.

Nine specimens, Nos. 1116, 37961, 37962, 37979, 37980, of which several are under the same numbers, in the collection of the U. S. National Museum. Of these No. 37961 was originally No. 1701 ab of the Lacoë collection and is the type of *Geraphrynus carbonarius*.

Two specimens in the Daniels collection.

Two specimens in the Walker Museum of the University of Chicago. Of these Nr. 9234 was identified by Melander as *A. rotundatus*, and No. 9233 as *Geraphrynus carbonarius*.

Three specimens, Nos. 185, 186, 187 in the collection of the Peabody Museum of Yale University.

All specimens come from the same locality and have the same structure, although their size varies from 12 to 24 mm. Hansen and Sørensen are decidedly wrong when they suggest that the three specimens of *Geraphrynus carbonarius* represented by Scudder in plate 40, figs. 1, 10, and 12 "belong to at least two different genera, perhaps even to different families or orders" (p. 139). Scudder has correctly recognized the specimens as belonging to the same species and if he had cleaned the type specimen of *A. rotundatus* of the heavy layer of kaolin with which it was covered he would have undoubtedly recognized the identity of his two types.

A photograph of the type specimen of *Architarbus rotundatus* after I have carefully cleaned it, is given on plate XII, fig. 74. Photographs of the obverse and reverse of the type specimen of *Geraphrynus carbonarius* are given on plate XIII, fig. 80. There is no difference whatever in the proportions or the details of structure. The first is 20.0 mm. long, the second 19.0 mm. Specimen No. 37979 of the U. S. National Museum is reproduced on plate XII, fig. 72. It is 12.0 mm. long. The better specimen in the Daniels collection is

reproduced on plate XII, fig. 73. Both specimens of the University of Chicago are in an excellent state of preservation. Specimen No. 9233 is reproduced on plate XIII, fig. 76 and 77. It shows only few traces of the anterior tergites superimposed over the sternites, especially visible on the right edge of the abdomen. Specimen No. 9234 is reproduced on plate XII, fig. 75. The apparently larger width of its abdomen is due to greater flattening under pressure of the drying mud, and consequently both surfaces are clearly superimposed. This specimen measures 24.0 mm. The best preserved specimen is the one in the Peabody Museum, No. 185, reproduced on plate XIII, figs. 78, 79. Unfortunately the photographs did not come out as well as they should. This specimen was very little compressed dorsoventrally; consequently the obverse shows only the dorsal surface, while on the reverse are visible the impressions of the abdominal anterior tergites on the sides only of the abdomen. Omitting further discussion of other specimens I shall now give a detailed description of the last mentioned.

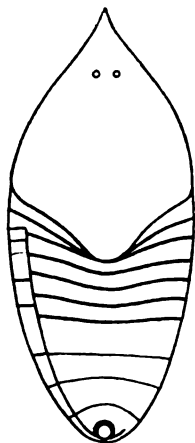


Fig. 79.

Fig. 79.--*Architarbus rotundatus* Scudder, specimen No. 185 of the Peabody Museum; dorsal surface of cephalothorax and abdomen. $\times \frac{2.5}{1}$

Specimen No. 185 of the Peabody Museum. Total length 21.75 mm. Cephalothorax 12.7 mm. long in middle line, 9.1 mm. wide. It has rounded latero-posterior corners and is posteriorly produced into a median lobe with rounded end and concave sides. Anteriorly the cephalothorax forms a sharp spine-like projection. The cephalothorax is high, sloping gradually to the sides and front. Two small,

round eyes, 3.25 mm. from anterior end, about double their diameter apart. The posterior lobe of the cephalothorax reaches as far as the anterior edge of the third tergite. It is impossible to decide whether the first and second tergites are each composed of two sclerites, or whether the lobe of the cephalothorax merely covers the short median part of these tergites. The following four tergites are short, but with more or less parallel procurved edges. The posterior edge of all six tergites is heavily thickened and appears in the specimen as a deep groove. The demarcation lines between the following four tergites are also clearly visible, but appear in the specimen as narrow, low ridges, which proves that the edge of these

segments was not thickened. The pleura appears as a heavy ridge along the sides of the abdomen. In life it must have been soft and not segmented, the cross lines being due to folding. In places the pleura is chipped off and under it is exposed the edge of the abdomen. The anus is visible on both the reverse and obverse. In

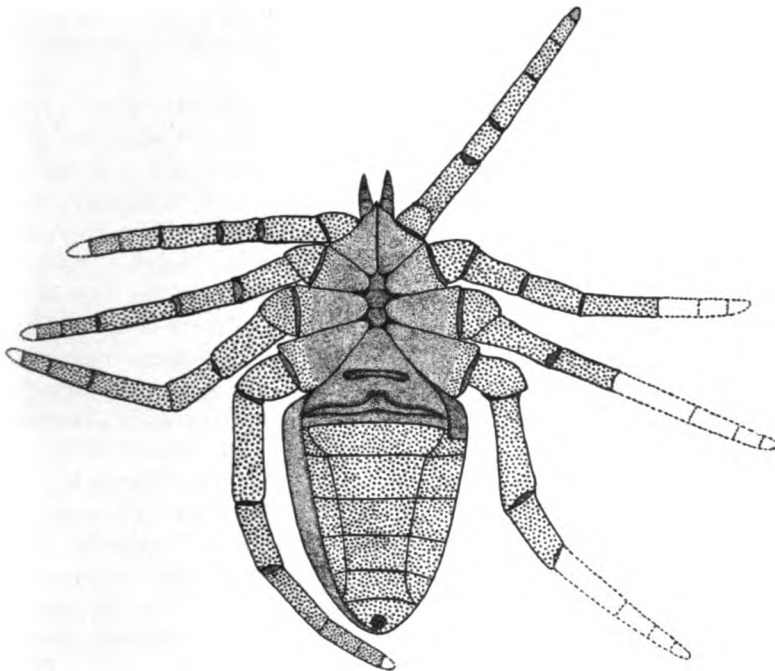


Fig. 80.

Figure 80.—*Architarbus rotundatus* Scudder, specimen No. 185 ventral surface as it appears on the nodule with this difference, that the left fourth leg in the specimen is curved inwardly and lies under the abdomen. $\times \frac{2.5}{1}$

the latter it appears in the tenth tergite close to the pleura, and is surrounded by a heavy wall. The surface leaves no doubt that the anus was protected by a round operculum, placed ventrally. The cephalothorax is smooth, but the abdominal tergites are clearly punctate.

The number of sternites is apparently only seven. The first sternite is very large, triangular, smooth. It has a deep transverse groove representing probably the mould of a ridge or movable plate

protecting the genital opening. Behind this groove is another transverse depression of singular form, extending across the whole sternite and represented in the text figure. The meaning of this structure is not at all clear. It may be part of the external genital apparatus, or the cover of the organs of respiration, or it may have had both functions. The following five sternites are divided into three fields by two longitudinal lines, appearing in the specimen as very low ridges. These sternites and the last or seventh are clearly punctate.

The chelicera are missing. The pedipalpi are very short, pediform, only three last joints visible. The sternum is long and typically composed of three areas of which the middle one is hexagonal and the other two pentagonal. The coxae are triangular, with rounded base (apex of the triangle). The coxae of the first pair of legs are contiguous throughout their entire length, produced anteriorly into a sharp process. Whether this process represents a maxillary lobe is very difficult to decide, since there is no evidence to either prove or disprove the assumption that these coxae are immovable. The coxae of the fourth pair are not quite twice as long as those of the first. All coxae are smooth with exception of their distal end which is punctate. Legs all preserved. Those of the left side complete but for the tarsus. The fourth left leg is, however, in reality bent under the abdomen where it lies on one surface with a fern. The first right leg is quite complete, while the other legs of the right side are broken off at the patella-tibia articulation line. The trochanters are one-jointed. Patella shorter than femur. The tarsus of the first leg is two-jointed, and so was probably the tarsus of all legs. The legs are in order 4321. First leg 14.0 mm., second (without last tarsal joint) 15.75 mm., third (same way) 17.0 mm., fourth (same way) 19.25 mm. Length of fourth femur 5.5 mm.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Architarbus minor n. sp.

Plate XIII, figs. 81, 82; text figs. 81, 82.

The type and only specimen of this species is in the Peabody Museum, No. 189. The dorsal and ventral surface are superimposed on both the obverse and reverse of the nodule, but the structures are quite clear. Total length 15.0 mm. Cephalothorax 10.0 mm. long in the median line, 6.6 mm. wide. Posteriorly it is produced into a lobe rounded at its end and with concave sides. Anteriorly

the cephalothorax forms a long, pointed process. The eyes are very small, almost four times their diameter apart. The six anterior tergites have a rather peculiar shape, being strongly procurved, very short in the middle and much longer at the sides. Their posterior edge is heavily thickened. The lobe of the cephalothorax extends as far as the anterior edge of the second tergite. The demarcation lines between the last four tergites are light, but

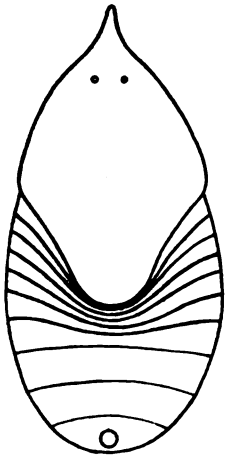


Fig. 81.

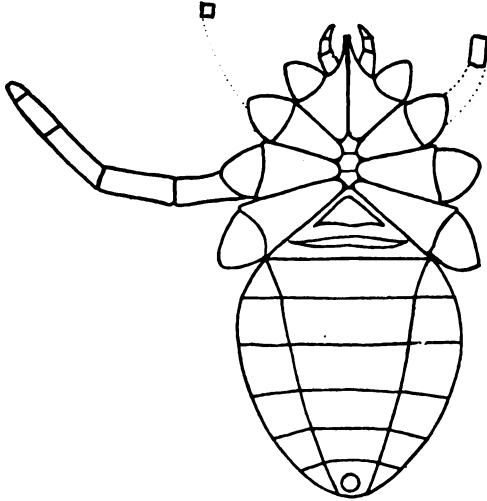


Fig. 82.

Figure 81.—*Architarbus minor* n. sp., holotype, Peabody Mus. No. 189, dorsal view of cephalothorax and abdomen. Figure 82.—Same, ventral surface. $\times \frac{4}{1}$

clear. Anal opercle appears on both surfaces. The abdominal sternites very much like those in the preceding species, but the converging lines divide the last sternite also. Instead of a transverse groove, a triangular depression in the first sternite. Sternum typical. The coxae of the first pair of legs with a very pronounced apical process. Pedipalpi small, pediform, only three terminal joints visible. Trochanters one-jointed. Of the legs the left third is alone preserved. The patella of this leg is longer than the femur. The tarsus is apparently one-jointed.

Abdomen and legs punctate above and below. The greater part of the cephalothorax smooth, but a punctate area occupies the space between the eyes, extending backward to the middle of the cephalothorax and reaching anteriorly its end.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Architarbus horribilis (Melander).

Plate XII, fig. 71; text figs. 83, 84.

= *Hadrachne horribilis* Melander, Jour. Geol., Vol. XI, 1903, p. 180, pl. V, fig. 1; pl. VII, fig. 1.

The type and only specimen of this species, No. 9232 of the Walker Museum of the University of Chicago, presents only the

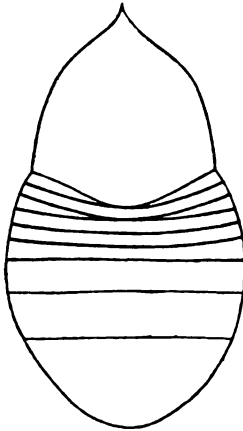


Fig. 83.

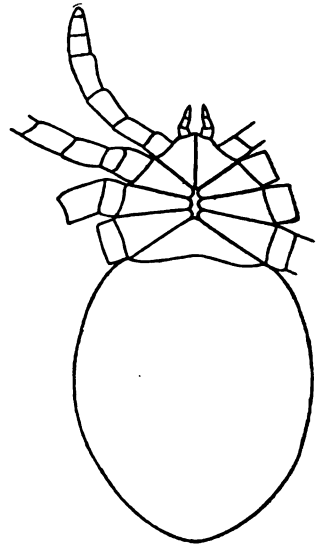


Fig. 84.

Figure 83.—*Architarbus horribilis* (Melander), holotype, Univ. of Chicago Mus. No. 9232, dorsal surface showing cephalothorax and abdomen.

Figure 84.—Same, showing the ventral surface. Both surfaces appear in the specimen superimposed, and since the reverse is missing the sternites

are not visible. $\times \frac{1.5}{1}$

obverse with the ventral surface superimposed on the dorsal. Partly owing to this, partly to the fact that the specimen was not sufficiently cleaned, the description of Melander is incorrect in several respects. Moreover, he committed the same error as Scudder in two instances, by assuming the legs of the first pair to be the pedipalpi.

Total length 38.0 mm. Cephalothorax 18.3 mm. long in middle line, 16.3 mm. wide at posterior corners which are not rounded.

but form an angle with the strongly procurved posterior edge. The sides of the cephalothorax converge anteriorly to a sharp point, forming an almost spine-like projection. The whole surface of the cephalothorax is smooth. Eyes apparently absent. Six anterior tergites with heavily thickened posterior edge. Behind the sixth tergite are visible only two lines, but it seems probable that the abdomen had ten tergites and that the line separating the ninth from the tenth tergite became obliterated. Anal operculum not visible. Sternum badly deformed but apparently typical. Pedipalpi small, pediform, only the terminal three joints visible. Coxae of the first pair of legs contiguous throughout their entire length, with an internal distal lobe. Trochanters one-jointed. The trochanter of the second leg appears to be two-jointed, but the distal joint represents apparently the soft membrane connecting the trochanter with the femur and distended because the leg lies on its dorsal surface. Tarsus of first leg two-jointed. Patella longer than femur.

Found in the Pennsylvanian (Lower Allegheny) of Mazon Creek, Illinois.

Genus *Opiliotarbus* Pocock 1900.

New definition. Cephalothorax with a straight posterior edge, perfectly rounded anteriorly. Anterior six tergites very short, straight, with a heavily thickened posterior edge. Number of tergites eleven. Sternum very narrow, almost reduced to a narrow ridge. Number of sternites seven. Anal operculum ventral. Coxae of the first pair of legs contiguous throughout their entire length, without internal apical process. Trochanter of the first and second pair of legs one-jointed, of the third and fourth pair two-jointed. Eyes absent. Genotype *O. elongatus* (Scudder).

Opiliotarbus elongatus (Scudder).

Plate XI, figs. 62–65; text figs. 85–88.

= *Architarbus elongatus* Scudder, Mem. Boston Soc. Nat. Hist., Vol. IV, 1890, p. 449, pl. 40, fig. 4.

O. elongatus Pocock, Geol. Mag., (V), Vol. VII, 1910, p. 511.

Two specimens in the collection of the U. S. National Museum. Specimen No. 37975 from Mazon Creek is not as well preserved as the type specimen; but the end of the abdomen is not broken off and the details of the structure are sufficiently clear. The proportions of the body are somewhat different from the type, but not sufficient, in my mind, to constitute a different species. The text figures being carefully drawn to scale reveal no tangible

difference. Total size 12.17 mm. Cephalothorax 4.0 mm. long, 5.6 mm. wide at posterior edge. Trochanter of the third and fourth

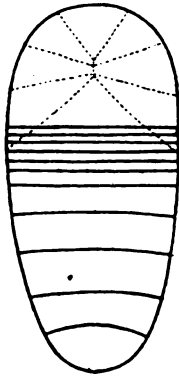


Fig. 85.

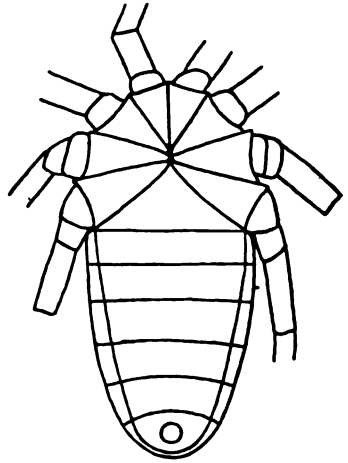


Fig. 86.

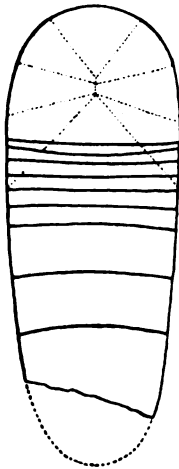


Fig. 87.

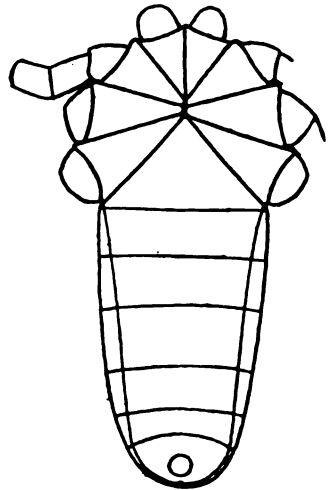


Fig. 88.

Figure 85.—*Opiliotarbys elongatus* (Scudder), U. S. N. M. No. 37975, dorsal surface. Figure 86.—Same, ventral surface. Figure 87.—*Opiliotarbys elongatus*, from the Pennsylvanian (Lower Allegheny), Braidwood, Illinois, holotype, U. S. N. M. No. 37970, dorsal surface. Figure 88.—Same, ventral surface. $\times \frac{4}{1}$

leg two-jointed. Specimen No. 37970 was originally No. 1702 of the Lacoë collection. It is Scudder's type and is indeed excellently preserved but for the end of the abdomen which is missing in the observe. Total size 15.3 mm. Cephalothorax 4.5 mm. long, 5.6 mm. wide at posterior edge which is so little procurved that it appears almost to be straight. Anteriorly the cephalothorax is broadly rounded. Eyes absent. Six anterior tergites practically straight, with heavily thickened posterior edge, very short. The following tergites much longer, slightly recurved. Since the other specimen has eleven tergites is it fair to assume that the type had also eleven tergites. The number of sternites seven, the first sternite triangular, large. Chelicera and pedipalpi missing. Coxae of the first pair of legs contiguous throughout their length, without internal apical process. Sternum reduced to a narrow ridge. Pleura probably soft, not segmented. Anal operculum round, ventral in position. Body quite smooth. The "moderately coarse punctuation" mentioned by Scudder was due to extraneous matter which was cleaned without difficulty.

Found in the Pennsylvanian (Lower Allegheny) of Braidwood, Illinois.

EXPLANATION OF PLATES

Correct size of specimens given in the text.

Plate I.

- Fig. 1. *Eoscorpium typicus* n. sp., Peabody Mus. No. 126.
2. *Eoscorpium typicus* n. sp., holotype, U. S. N. M. No. 37986, obverse.
3. *Eoscorpium typicus* n. sp., same, reverse.
4. *Eoscorpium typicus* n. sp., U. S. N. M. No. 37987, comb.
5. *Palaeobuthus* n. gen. *distinctus* n. sp., holotype, Peabody Mus. No. 133, reverse.

Plate II

- Fig. 6. *Eoscorpium carbonarius* M. & W., Univ. of Illinois coll., obverse. Holotype.
7. *Palaeopisthacanthus* n. gen. *mazonensis* n. sp., holotype, U. S. N. M. No. 37977, obverse.
8. *Palaeopisthacanthus* n. gen. *schucherti* n. sp., holotype, Peabody Mus. No. 140, obverse.
9. *Palaeopisthacanthus* n. gen. *schucherti* n. sp., same, reverse.
10. *Eoscorpium granulatus* n. sp., holotype, Peabody Mus. No. 128, obverse.

Plate III.

- Fig. 11. *Eoscorpium granulatus* n. sp., Peabody Mus. No. 129, reverse.
12. *Eoscorpium granulatus* n. sp., same, obverse.
13. *Mazonia woodiana* M. & W., holotype, Univ. of Illinois coll.
14. *Eoctonus* n. gen., *miniatus* n. sp. holotype, Peabody Mus. No. 131, obverse.
15. *Eoctonus* n. gen. *miniatus* n. sp., Peabody Mus. No. 132, obverse.

Plate IV.

- Fig. 16. *Eoscorpium danielsi* n. sp., holotype, Daniels coll., obverse.
17. *Trigonoscorpium* n. gen. *americanus* n. sp., holotype, Daniels coll., obverse.
18. *Trigonoscorpium* n. gen. *americanus* n. sp., same, reverse

- Fig. 19. *Geralinura similis* n. sp., holotype, U. S. N. M. No. 37985 (1754 c), obverse.
 20. *Geralinura similis* n. sp., same, reverse.
 21. *Geralinura carbonaria* Scud., holotype, U. S. N. M. No. 37985 (1754a and b), obverse.
 22. *Geralinura carbonaria* Scud., same, reverse.

Plate V.

- Fig. 23. *Geralinura gigantea* n. sp., holotype, U. S. N. M. No. 37976, obverse.
 24. *Geralinura gigantea* n. sp., same, reverse.
 25. *Geralinura gigantea* n. sp., paratype, Peabody Mus. No. 147, reverse.
 26. *Thelyphrynus* n. gen. *elongatus* n. sp., holotype, Daniels coll.
 27. *Graeophonus carbonarius* (Scud.), holotype, U. S. N. M. No. 37969, obverse.
 28. *Graeophonus carbonarius* (Scud.), same, reverse.
 29. *Graeophonus carbonarius* (Scud.), U. S. N. M. No. 37964, obverse.

Plate VI.

- Fig. 30. *Protosphrynus* n. gen. *carbonarius* n. sp., holotype, Daniels coll., obverse.
 31. *Protosphrynus* n. gen. *carbonarius* n. sp., same, reverse.
 32. *Protosolpuga* n. gen. *carbonaria* n. sp., holotype, Peabody Mus. No. 155, obverse.
 33. *Kustarachne tenuipes* Scud., holotype, U. S. N. M. No. 37967, reverse.
 34. *Kustarachne tenuipes* Scud., same, obverse.
 35. *Kustarachne conica* n. sp., holotype, Daniels coll., reverse.

Plate VII.

- Fig. 36. *Curculioides scaber* (Scud.), holotype, U. S. N. M. No. 37965, reverse.
 37. *Curculioides scaber* (Scud.), same, obverse.
 38. *Curculioides sulcatus* (Mel.), holotype, Univ. of Chicago No. 9235, obverse.
 39. *Polyochera glabra* n. sp., holotype, U. S. N. M. No. 37981, obverse.
 40. *Polyochera glabra* n. sp., same, reverse.

Plate VIII.

- Fig. 41. *Polyochera punctulata* Scud., holotype, U. S. N. M. No. 37971, obverse.
 42. *Polyochera punctulata* Scud., same, reverse.
 43. *Arthrolycosa antiqua* Harger, Peabody Mus. No. 162, obverse.
 44. *Arthrolycosa antiqua* Harger, holotype, Peabody Mus. No. 161, obverse.
 45. *Arthrolycosa danielsi* n. sp., holotype, Daniels coll., obverse.
 46. *Arthrolycosa danielsi* n. sp., same, reverse.

Plate IX.

- Fig. 47. *Trigonomartus pustulatus* (Scud.), holotype, U. S. N. M. No. 37984, obverse.
 48. *Trigonomartus pustulatus* (Scud.), same, reverse.
 49. *Trigonomartus pustulatus* (Scud.), Daniels coll., obverse.
 50. *Trigonomartus pustulatus* (Scud.), same, reverse.
 51. *Trigonomartus pustulatus* (Scud.), Peabody Mus. No. 168, obverse.
 52. *Trigonomartus woodruffi* (Scud.), holotype, Brown Univ. coll.

Plate X.

- Fig. 53. *Trigonotarbus schucherti* n. sp., holotype, Peabody Mus. No. 169, reverse.
 54. *Trigonotarbus schucherti* n. sp., same, obverse.
 55. *Trigonotarbus carbonarius* n. sp., holotype, U. S. N. M. No. 37978, reverse.
 56. *Protopilio* n. gen. *depressus* n. sp., holotype, U. S. N. M. No. 37974, reverse.
 57. *Protopilio* n. gen. *longipes* n. sp., holotype, Peabody Mus. No. 171, reverse.
 58. *Areomartus* n. gen. *ovatus* n. sp., holotype, U. S. N. M. No. 1196, obverse.
 59. *Heterotarbus* n. gen. *ovatus* n. sp., holotype, Daniels coll., obverse.

Plate XI.

- Fig. 60. *Anthracomartus trilobitus* Scud., U. S. N. M., Lacoë coll. No. 1753d, obverse.

- Fig. 61. *Anthracomarthus triangularis* n. sp., holotype, U. S. N. M. No. 37968, obverse.
62. *Opiliotarbus elongatus* (Scud.), U. S. N. M. No. 3790, reverse.
63. *Opiliotarbus elongatus* (Scud.), same, obverse.
64. *Opiliotarbus elongatus* (Scud.), holotype, U. S. N. M. No. 37970, reverse.
65. *Opiliotarbus elongatus* (Scud.), same, obverse.
66. *Metatarbus* n. gen. *triangularis* n. sp., holotype, Peabody Mus. No. 182, reverse.
67. *Metatarbus* n. gen. *triangularis* n. sp., same, obverse.
68. *Geratarbus lacoeyi* Scud., holotype, U. S. N. M. No. 37966, obverse.
69. *Geratarbus minutus* n. sp., holotype, Peabody Mus. No. 176, obverse and reverse.

Plate XII.

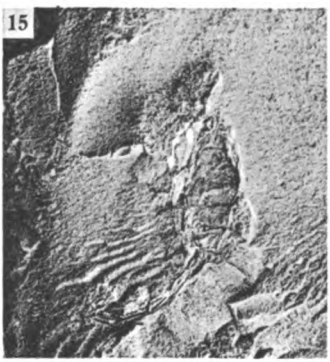
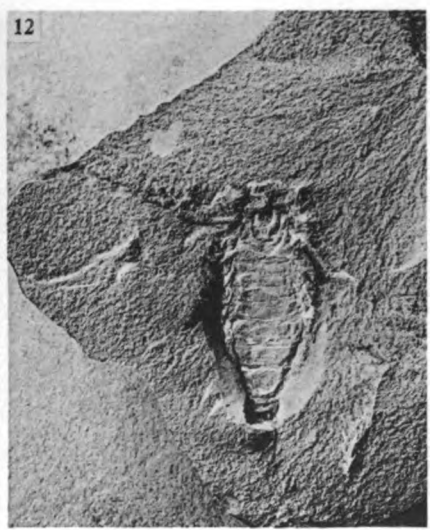
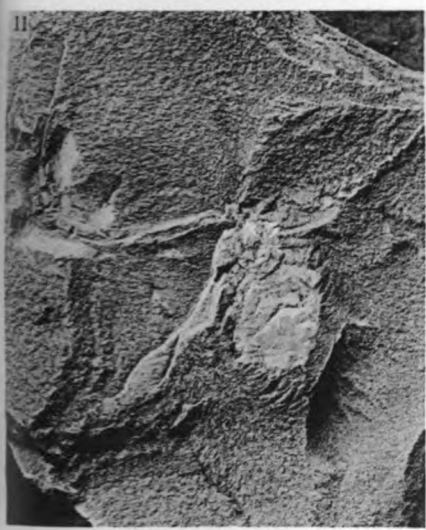
- Fig. 70. *Discotarbus* n. gen. *deplanatus* n. sp., holotype, Peabody Mus. No. 174, obverse.
71. *Architarbus horribilis* (Mel.), holotype, Univ. of Chicago coll. No. 9322, obverse.
72. *Architarbus rotundatus* Scud., U. S. N. M. No. 37979, obverse.
73. *Architarbus rotundatus* Scud., Daniels coll., reverse.
74. *Architarbus rotundatus* Scud., holotype, Univ. of Illinois coll. No. 1116.
75. *Architarbus rotundatus* Scud., Univ. of Chicago coll. No. 9234, reverse.

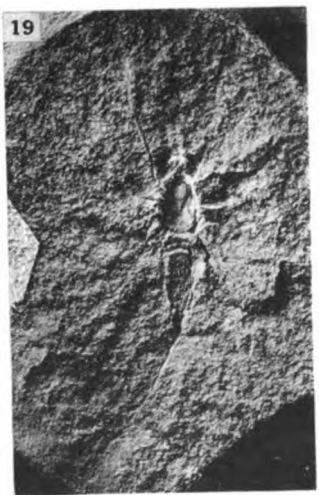
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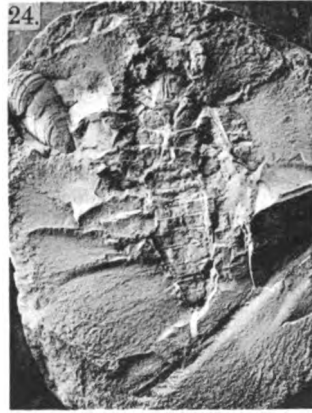
- Fig. 76. *Architarbus rotundatus* Scud., Univ. of Chicago No. 9233, reverse.
77. *Architarbus rotundatus* Scud., same, obverse.
78. *Architarbus rotundatus* Scud., Peabody Mus. No. 185, reverse.
79. *Architarbus rotundatus* Scud., same, obverse.
80. *Architarbus rotundatus* Scud., holotype of *Geraphrynus carbonarius* Scud., U. S. N. M. No. 37961 (Lacoe coll. No. 1701 a b), obverse and reverse.
81. *Architarbus minor* n. sp., holotype, Peabody Mus. No. 189, reverse.
82. *Architarbus minor* n. sp., same, obverse.

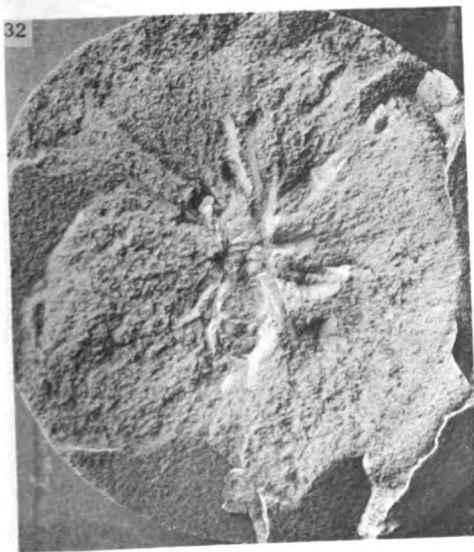












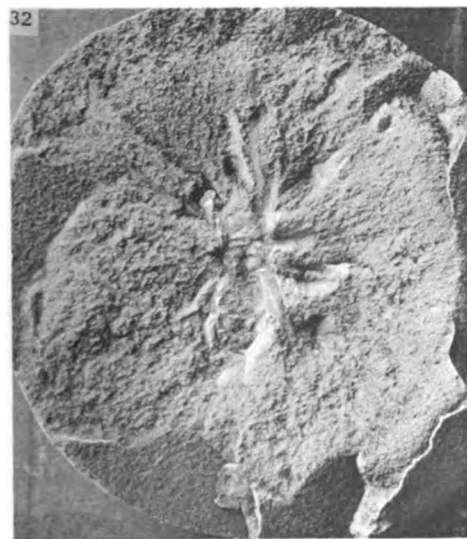
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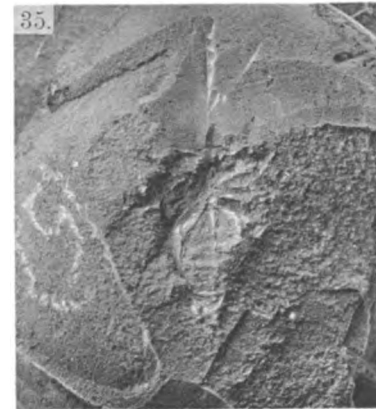
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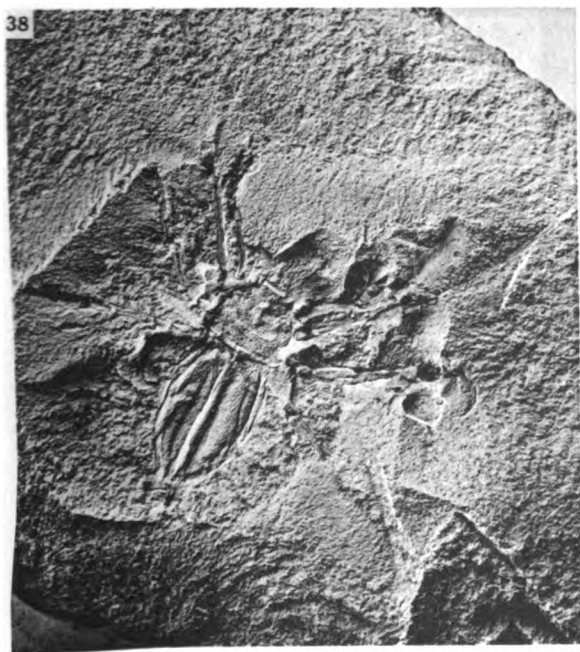
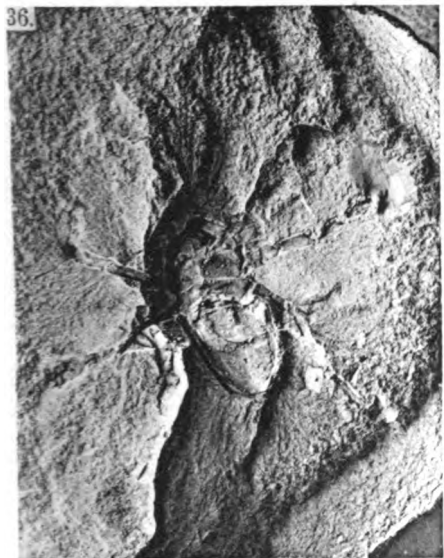


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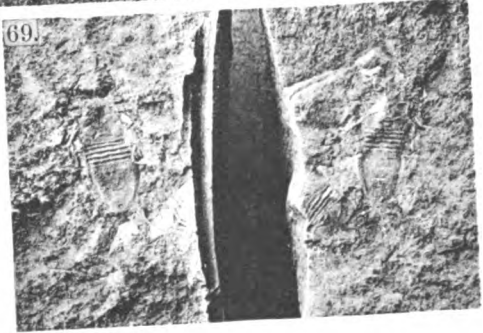


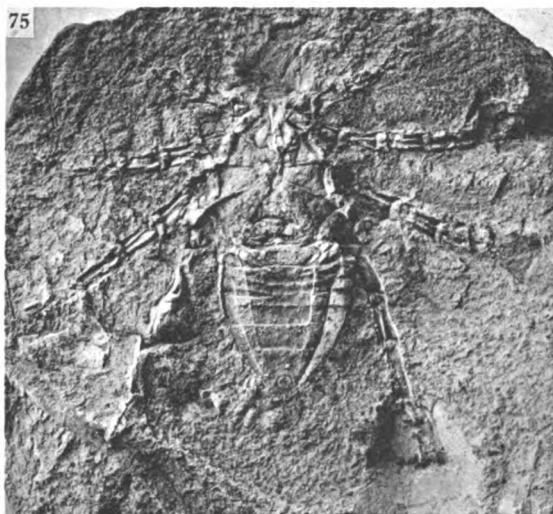


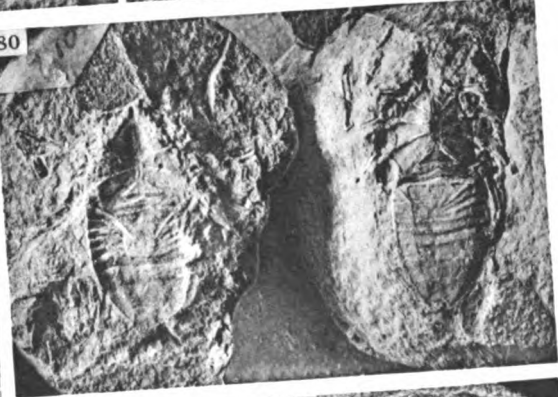












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