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Squillites spinosus (Syncarida, Malacostraca) and a New Unnamed Crustacean from the Mississippian of Central Montana

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Squillites spinosus (Syncarida, Malacostraca)
and a New Unnamed Crustacean From the
Mississippian of Central Montana

Presented by

Joan Matthews Rumore

a candidate for the degree of Master of Science in Zoology and certify that it is acceptable to them.

Squillites spinosus (Syncarida, Malacostraca) and a New Unnamed Crustacean From the Mississippian of Central Montana

(TITLE)

BY

Joan Matthews Rumore

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Master of Science in Zoology

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

1972
YEAR

I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
THIS PART OF THE GRADUATE DEGREE CITED ABOVE

July 31, 1972
DATE

31 July 1972
DATE

Squillites spinosus (Syncarida, Malacostraca) and a New Unnamed Crustacean From the Mississippian of Central Montana

Abstract

A Mississippian syncarid from the Heath shale, Squillites spinosus Scott, 1938, is redescribed and a discussion of some aspects of Syncarid phylogeny is given. Modern Syncarid biogeographical distribution is discussed and an analysis of these zoogeographical patterns is provided. A strange animal, Crustacea (incerta sedis) from the Heath shale is described in as far as is possible.

In 1971, Dr. Richard Lund of the University of Pittsburgh while searching for fossil fish in the Upper Mississippian Heath Shale of Montana found the associated remains of fossil crustaceans. Two locations were involved, T14 N R20E sec. 28, Fergus County, Montana, 2 miles south and 6 miles east of Heath, and 2¼ miles south of Heath, Fergus County, Montana. The crustacean fossils were found in a black paper shale horizon which averaged about 8 inches in thickness above which was non-fossiliferous limestone grading within inches into salt-clast lime. Below the black shale was a sequence of non-fossiliferous limestones about 4 feet thick which were followed by a conodont horizon which was very fossiliferous.

The black shale in which the crustaceans were found contained many fish, some marine, some fresh water, and most of uncertain habitat. Also present were conchostracans, unidentifiable ostracods and *Spirorbis sp.* (Lund, personal communication).

Scott (1935) states that the Heath Formation forms the upper beds of the Big Snowy Group, Chesterian, Upper Mississippian. He found in the basal zone of the Heath Formation the index brachiopod *Leiorhyncus carboniferum* along with an abundance of conodonts. Other fossils he lists as found in the Heath Formation are the brachiopods *Productus ovatus*, *Productus inflatus*, *Echinochoncus sp.*, *Spirifer sp.*, *Chonetes chesteriensis*, *Composita subquadrata*, *Lingula sp.* and *Orviculoidea sp.* The molluscs are represented by *Cypricardella sp.*, *Trepospira sp.* and *Aviculipecten sp.* Also found is the Ostracod *Cytherella sp.* as well as many conodont assemblages. Scott (1938) described *Squillites spinosus* as a "strange stomatopod" which he found in the black Heath Shale. This animal was later reassigned by Brooks (1962b) to the Superorder Syncarida. Another Syncarid found in the Heath is *Paleosyncaris dakotensis* Brooks, 1962b, found in the Heath Formation of North Dakota.

This paper will present the results of study of two of the crustaceans of the Heath shale. A redescription of *Squillites spinosus* Scott, 1938, will be given and a new crustacean will be described in as far as it is known.

Systematics

Superorder Syncarida Packard, 1885

Order Paleocaridacea Brooks, 1962b

First thoracic somite not incorporated into the cephalon: compound eyes stalked: caudal furcae lacking. (U. Miss-Perm)

Family Palaeocarididae Meek and Worthen, 1865

No thoracic endopods modified as raptorial appendages: rami of uropods lobate: telson spatulate.(U. Miss-Perm)

Genus Squillites Scott, 1938

Diagnosis

First thoracic tergite reduced: uropods with narrow spatulate rami: telson wedge shaped.(U. Miss)

Remarks

H. K. Brooks (1962b) in his reorganization of the Paleozoic Eumalacostraca placed Squillites in the family Paleocarididae which includes the two genera Paleosyncaris and Squillites. His description was based on the one specimen available at that time and made anatomical assumptions based on that specimen which proved false with this discovery of new and better material. For this study the type specimen of Squillites spinosus, X-1219 in the University of Illinois Paleontological collection, was re-examined as well as 128 new specimens now deposited in the Field Museum of Natural History in Chicago and the Carnegie Museum of Natural History in Pittsburgh. In this paper PE and CM are abbreviations used on specimen numbers..

Squillites spinosus Scott, 1938 Table 1, Pl. 1,2, Fig 1,2.

Squillites spinosus Scott, 1938 p. 508, 2 figs.
Squillites spinosus Berry, 1939 p. 467.
Squillites spinosus Brooks, 1962a p. 229 pl.56 figs 1,2.
Squillites spinosus Brooks, 1962b p. 163 pl.1 figs 10-14.
Squillites spinosus Secretan, 1967 p. 173, fig .8.
Squillites spinosus Brooks, 1969 p. 254 pl. 53 figs 1, 2. text pl. 14 fig. 10.
Squillites spinosus Schram, 1969 p. 216 Table 1.

Diagnosis

Same as Genus.

Holotype

X-1219 in the University of Illinois Paleontological Collection. See pl. 1, fig. 3.

Type locality

H. W. Scott collected the specimen ½ mile south of Heath, Fergus County, Big Snowy Mountains, Montana.

Description

The specimens studied were preserved fo the most part as dorsal-ventral compressions; only two specimens were lateral preservations.

Squillites spinosus measurements are in Table 1. These measurments are rough because of poor preservation and were made with a microscope scaled eyepiece.

The cephalon has a cephalic shield which extends anteriorly as a falciform projection (PE18350, pl.1 fig. 2). At the posterior end of the cephalic shield to each side just off the dorsal midline is a crescent-shaped ridge. The whole shield has a sub-triangular shape.

The stalked compound eye is spherical in shape.

The first antenna has two flagella with a peduncle of three joints. The rami are equal and quite long (PE18362, pl.1 fig.4). The long second antenna rises from a peduncle of 3 large joints. A long narrow setiferous antennal scale is present on the first joint.

Mouthparts are not clearly discernable. A mandible is apparently present on PE18362, pl.1 fig.4, but the cephalic region is flattened and twiated severely enough as to preclude any real conclusion as to mouthparts and their shape and structure.

All eight thoracic segments are free and are approximately the same width. Each segment has a crescent-shaped ridge on either side close to the dorsal midline. The first four thoracomeres have medially pointed pleurites while the next four thoracomeres have medially blunt pleurites. The first thoracomere differs in having a shorter pleurite and the crescent-shaped ridges are slightly closer to the midline than in the other thoracic segments. Each thoracic appendage has an endopod of five segments and an annulate exopod (PE18355, pl. 2 fig.3).

There are six abdominal segments. The first two are similar in form to the thoracic segments. The next three segments are slightly wider and are topped by heavy, raised, ventrally directed spines instead of crescent shaped ridges. The pleurites have a sharp tooth-like spine directed posteriorly. Smaller, more delicate tooth-like spines continue along the posterior margin of the pleomeres changing into fine setae in the middle of the segment posterior margin (PE18354, pl.2 fig.2).

The first five abdominal segments have annulate pleopods fringed with setae (PE18356, pl. 2 fig.5). The sixth abdominal segment is large and longer than any of the preceding segments, but on several specimens a slight vertical mid-dorsal depression as well as a slight horizontal median depression was observed.

The telson is large with a median keel and the margin is armed with spines or heavy setae (PE18362, pl.2, fig.6). No furcal structures are present. The uropods consist of a large single segment prtopod and long spatulate endopods and exopods with long, fine, marginal setae.

A reconstruction of S. spinosus is given in Fig. 1 and Fig.2.

Commentary

The preservation of the fossils indicates that the pleura and tail region were heavily sclerotized. These easily recognizable parts were frequently found separate from whole animals..The crescentshaped ridges are almost always visible and are present in raised position on several specimens indicating heavy sclerotization (PE18369 pl.2 fig.4). These crescent shaped ridges are distinguishing features of this animal as Scott (1938) noted. They are not sternite impressions as Brooks (1962) thought.

There was a heavy predominance of dorsal-ventral preservations, only two lateral preservations being found. This perhaps implies a flattened animal dorsoventrally or that the animals were buried upright in the ooze, either because they lived in it and died in position, or unknown circumstances at these two preservation sites favored preservation in the dorso-ventral position.

The fauna associated with S. spinosus contains fish (both fresh and saline forms), conchostracans, ostracods, and Spirorbis sp. and is interpreted here as a brackish water assemblage. Paleosyncaris dakotensis, another Heath shale syncarid, is found with a similar fauna of estherian conchostracans, Anthraconia-like pelecypods, and fresh water ostracods which seems to be a fresh water fauna, although Brooks (1962b) would cast doubt on the validity of estherians as fresh water environment indicators. Thus it would seem that these Mississippian Syncarida were adapted to transitional environments or had already colonized fresh water.

Discussion

In describing S. spinosus one is struck immediately by the similarities in structure with the extant species Anaspides tasmaniae Thomson, 1892. The similarities are several. The total length of the thoracic segments is about equal to that of the abdominal segments. The first five abdominal segments are narrower dorsally than at the ventral pleurite edge and the thoracic pleurites are narrower than the abdominal pleurites. The unmodified thoracic appendages consist of a segmented endopod and an annulate exopod. The pleopods are annulate, setiferous appendages.

Differences between these two genera are distinctive. *Anaspides* has epipods on the thoracic appendages but it is possible that *Squillites* also possessed such epipodites but that these lightly sclerotized structures were not preserved. *Anaspides* incorporates the first thoracic segment into the cephalon with modification of the first thoracic appendage as a maxilliped. One of the rami of the first antenna is shortened in *Anaspides* but not in *Squillites*. *Squillites* was highly decorated with ridges and spines. *Anaspides* lacks decorations and has a smooth exoskeleton.

The similarities in thoracic and abdominal appendage structure between *Squillites* and *Anaspides* is very interesting. Most Paleozoic syncarids such as *Acanthotelson stimpsoni* Meek and Worthen, 1865, *Uronectes fimbriatus* Jordan, 1847, and *Paleocaris typus* Meek and Worthen, 1865, have the thoracic appendages with spatulate exopods and swimmerets consisting of a sympod with two spatulate rami. Thoracic endopodites of the Paleozoic syncarids exhibit various specializations. *S. spinosus* and *P. dakotensis* also from the Heath shale, have segmented endopods which appear to be relatively unmodified. Brooks (1962b), however, believed the third thoracic endopod of *P. dakotensis* was incipiently modified as a raptorial appendage. *A. stimpsoni* had the second and third thoracic endopod and *U. fimbriatus* the second thoracic endopod modified as raptorial appendages. *P. typus* had the first thoracic appendage reduced and no endopodites were modified as raptorial appendages. The appendage variation among the Paleozoic Paleocaridacea implies a long history of radiation and specialization prior to the late carboniferous.

Appendage structure would seem to place *S. spinosus* near the line of evolution leading to *Anaspides tasmaniae*. An alternate explanation would be that these similarities are examples of occupation of similar niches. Manton (1930) states that *Anaspides* crawls on the bottom of streams on algal covered rocks among the weeds. They swim, but usually only to another rock or weed surface or if frightened, to escape. Both the thoracic endopodites and abdominal pleopods are used in walking and swimming. The thoracic exopodites and epipodites function in respiration. Manton states that the use of both the abdomen and thorax appendages together in locomotion is unusual in extant

Malacostraca and probably represents a primitive condition. *Anaspides* feeds on algae and detritus covering weeds and stones. Adults also feed on smaller animals such as tadpoles and worms. As a hunter it is extremely inefficient; the eyes are placed in such a way that the animal is apparently unable to see the substratum. Apparently no chemical sense organs are present, since *Anaspides* digs in the mud with the endopodites of the second through fifth thoracic segments and literally stumbles over its prey. Similarity in appendage structure might indicate that *Squillites* may have lived in much the same way as *Anaspides*.

The Superorder Syncarida is divided into the orders Paleocaridacea Brooks, 1962b, Anaspidacea Calman, 1904, Stygocaridacea Noodt, 1964, and Bathynellacea Chappuis, 1915. The Order Paleocaridacea is characterized by eight free thoracic segments and consists of four families, all fossil, from the Carboniferous to the Permian. The Order Anaspidacea contains syncarids with the first thoracic segment incorporated into the cephalon and has one fossil species *Anaspidites antiquus* Chilton, 1929, from the Triassic of Australia. The other species are all extant and found in Australia or Tasmania. The extant stygocaridaceans are specialized for interstitial living. They are characterized by a furcal rudiment on the telson and the first thoracic segment fused to the head. One fossil species, *Clarkecaris brazilicus* Clarke, 1920, from the Permian of Brazil has been placed in this group. The largest order, the Bathynellacea, consists of many extant species which are highly specialized elements of the interstitial, ground water fauna (Noodt, 1964). All possess furcae on the telson and have the last abdominal somite fused with the telson to form a pleotelson.

Brooks (1962a) states that the order Anaspidacea evolved in the southern hemisphere from the Upper Paleozoic syncarids. Brooks cites *C. brazilicus* as a transition stage between the Paleozoic paleocaridaceans and the anaspidaceans. *C. brazilicus* has a vestige of a suture between the head and first thoracic segment as a transverse sulcus indicating the remains of the fused first thoracic segment. In the anaspidaceans the first thoracic segment is wholly incorporated into the cephalon. The extant stygocaridaceans, found only in South America, are specialized, however, for interstitial living and have completely incorporated the first segment into the cephalon.

The bathynellaceans are members of the ground water fauna and have the last abdominal segment fused with the telson as well as caudal furcae. Noodt (1964) believes that the bathynellaceans have an ancient origin. They may have arose early from the main syncarid line possibly before the Paleocaridacea which do not possess a furca. The presence of caudal furcae is believed to be a very ancient characteristic shared presumably with the ancestral malacostracan and is found in modern forms only in some euphausiaceans and in larval stages of Eucarida. A furca combined with the extreme specializations for interstitial life would seem to indicate a very ancient origin for the bathynellaceans.

The Mississippian syncarids *Paleosyncaris* and *Squillites* have no furca although they do retain eight free thoracic somites which is also a primitive condition. As the associated fauna can be interpreted as fresh or brackish water forms, these paleocaridacean genera, as well as the bathynellaceans could have made the transition from saline to fresh water conditions in the Carboniferous. Other Paleozoic paleocaridaceans such as *Paleocaris* and *Acanthotelson* are found in marine or near marine situations (Brooks, 1962b). A conclusion is reached that the syncarids were a widespread group during the Late Carboniferous including both fresh water and saline forms. The syncarids probably evolved in the early Mississippian or earlier since by the late Mississippian they are of diverse form and are adapted to fresh or near-fresh water habitats. Structure comparisons between the bathynellaceans and the paleocaridaceans indicates that the bathynellaceans split off from the main syncarid line at a very early time possibly early Mississippian or earlier. The anaspidaceans evolved from paleocaridacean stock similar to S. spinosus. The primary physical change was incorporation of the first thoracic segment into the cephalon. Anaspidites antiquus, a Triassic fossil, is the earliest anaspidacean known and incorporation of the first thoracic segment into the cephalon is complete in this animal.

The extant forms with the exclusion of the bathynellaceans which are nearly cosmopolitan forms are found in South America, Australia, and Tasmania (a Gondwana distribution). The problem then arises of reconciling the Carboniferous distribution of the paleocaridaceans with that of their presumed descendants the anaspidaceans. Two answers are possible. First, it is possible that the fossil record is incomplete. Crustaceans are not often preserved. If this is the case then only new finds of syncarid fossils will prove or disprove this hypothesis. Second, it is possible that the Syncarida originated during the early Carboniferous in Laurasia and radiated out from this origin point into Gondwanaland areas while later more efficient eucarid and peracarid forms eliminated them from their northern habitats during the Mesozoic, leaving in the present day species in South America, Australia, and Tasmania only. Thus these are essentially relict populations of a once much larger and widespread group. Evidence for this view is that the anaspidaceans are all found in Australia or Tasmania, two areas long split off from the Gondwanaland mass and noted for their relict populations of many animal groups. Manton (1930) states that *Anaspides* has survived only because of lack of predators and apparently lack of competition, while *Paranaspides* Smith, 1908, a similar syncarid, survives by hiding among the weeds of its habitat. The bathynellaceans have survived because of their extreme specialization for interstitial life.

Noodt (1965) suggests that the Paleocaridacea were specialized warm water forms of the Carboniferous tropical zone. It is possible as the land mass of Pangea broke apart and Laurasia drifted further to the North, the Syncarida were pushed South by their climatic requirements.

It seems probable that the Syncarida evolved early in the warm continental seas of the early Carboniferous. By the late Mississippian they were widespread both in the sea and fresh water habitats as well as specialized interstitial lifestyles. Competition by the evolving Eucarida and Peracarida, as well as climatic changes are possible factors for the elimination of the generalized forms of Syncarida from all but their Gondwana refugia.

A new and strange arthropod tentatively placed in the subphylum Crustacea has been recognized from the Heath Shale materials collected from the same two localities as S. spinosus. The forty-three specimens identified as this animal are now deposited in the Field Museum of Natural History in Chicago.

Crusteacean, incerta sedis

The characteristics are as follows: a punctate carapace; carapace followed by five large, lightly sclerotized segments, and beyond those an indeterminate number of smaller segments; long legs on at least four of the five large segments; the region of five large segments approximately equal in length to the region of the smaller segments.

Description

The specimens were not distinguished for their clarity. Apparently the animal was not heavily sclerotized, especially so in the abdominal region where the exact number of segments cannot be certified at this time.

Measurements of measurable animals are in Table 2.

The carapace is punctate and in lateral view rectangular. Headparts may be indicated on PE18383, Pl.3 fig. 3. The last third of the carapace is subtly divided from the first two-thirds by a faint groove on several specimens (PE18314). In the region of large segments the first four segments successively increase in size while the fifth is noticeably smaller. These segments are characterized by heavy mineral deposits in the region of the pleurites somewhat in the shape of a Greek omega (PE18373, pl.3 fig. 2). The pleura have blunted almost squared ends and are smooth.

The appendages present on the first four free segments and possibly on the fifth are composed of seven elements with the fifth element highly elongated (PE18382, pl.3 fig. 4). There are no appendages visible under the carapace or associated with the posterior segments.

The posterior segments are uncountable on the material at hand, The total length of these segments is about equal to that of the five large segments immediately behind the carapace.

The tail is subject to two interpretations due to preservational distortion. On specimens PE18383 and PE18309 the tail appears to consist of a telson and two single-lobed uropods. Specimens PE18323 and PE18377 appear to have no telson, merely a last segment with with curved uropods fringed with setae. A reconstruction of the animal is given in Fig. 3, and a reconstruction of both tail interpretaions is given in Fig. 4.

Comments

The animal was very lightly sclerotized except for the strange omega shaped deposits on the first five segments behind the carapace. These segments are also the most frequently fossilized since many specimens consisted entirely of these five segments.

The fossils are all lateral preservations. The shape of the body behind the carapace is of a rather sharp convex curve dorsally and a straight line ventrally. The concave dorsal line straightens out in the region of the posterior uncountable segments. These uncountable, lightly sclerotized segments appear to have been twisted and distorted by preservation while the first five post-carapace segments consistently hold a characteristic shape.

Discussion

This animal is impossible to place taxonomically at this time. At first glance the general shape is that of a hoplocarid. The stilt-like appendages are stomatopod-like, reminiscent of the appendages of the free thoracic segments of some extant stomatopods. The number of post-carapace segments and their shape corresponds, however, to no known hoplocarid pattern. If the first five post-carapace segments are considered as thoracic segments the shape and number fits into no presently recognized pattern. If these segments are considered abdominal in nature one is left with the apparently impossible situation of an abdomen of up to ten segments and it is an abdomen differentiated into two distinct regions.

It is possible that the omega shaped mineral masses characteristic of the first five post-carapace segments are muscle masses. The omega masses are reminiscent of muscle masses in living forms. Such an interpretation is purely speculative however.

The lack of appendages other than the long stilt-like ones on the first five post-carapace segments effectively precludes any analysis on the mode of locomotion and feeding, or taxonomic position.

It is hoped that Prof. Lund will be able to collect more and better material in the field this summer. A complete study and analysis awaits this material.

Summary

A redescription of S. spinosus is given. The phylogenetic position of S. spinosus is found to be near the line of evolution leading to the anaspidaceans. The Gondwana distribution of some extant syncarids was attributed to pressure from the more efficient crustaceans which evolved after the syncarids. Climatic needs of the syncarids may have also been a factor. A new arthropod (Crustacea, incerta sedis) was described in as far as was possible.

Acknowledgements

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Explanation of Plate 1

Scales indicate 1 mm.

Figure

1. *Squillites spinosus* Scott, PE18350. Headshield with arrow pointing to crescent-shaped ridges.

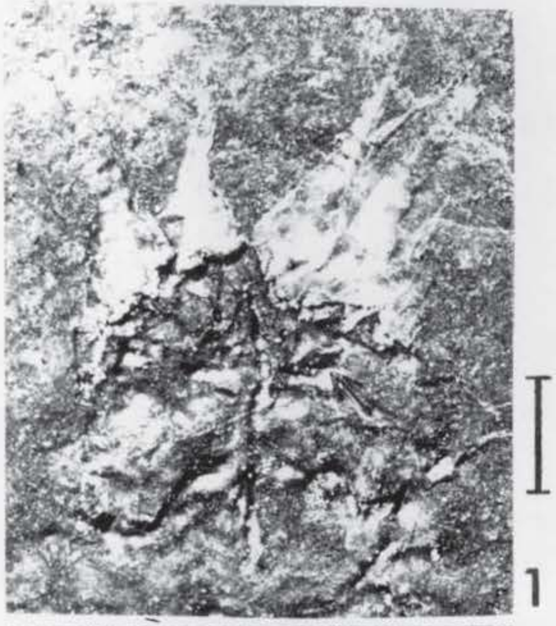
2. *Squillites spinosus* Scott, PE18350. Counterpart Fig. 1. Headshield with arrow pointing to falciform projection.

3. *Squillites spinosus* Scott, Holotype x-1219, in the collection of the University of Illinois.

4. *Squillites spinosus* Scott, PE18362. Cephalic area and anterior thorax with arrows pointing to anntennules (a_1) and antenna (a_{11}).

5. *Squillites spinosus* Scott, PE18354. Cephalic area with arrow pointing to the flagellum of the antenna.

6. *Squillites spinosus* Scott, PE18355. Cephalic area with arrow pointing to the headshield margin.



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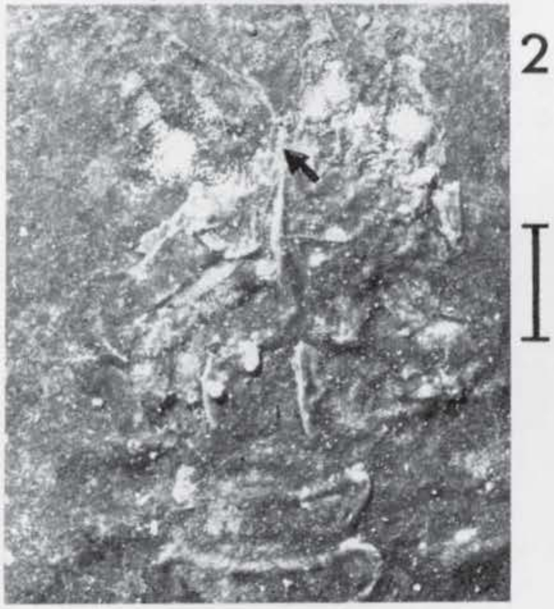

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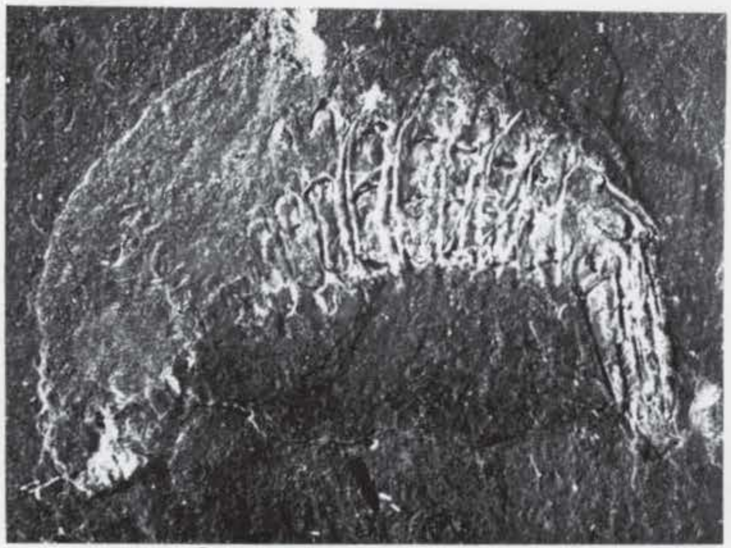

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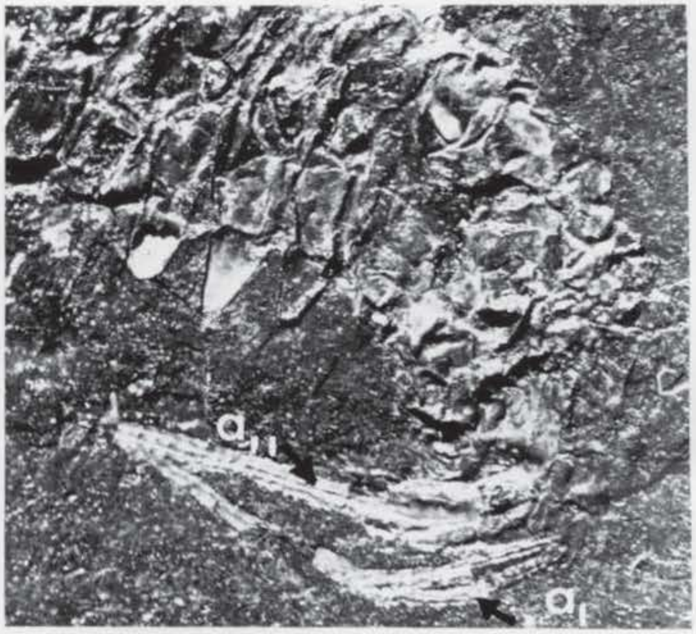

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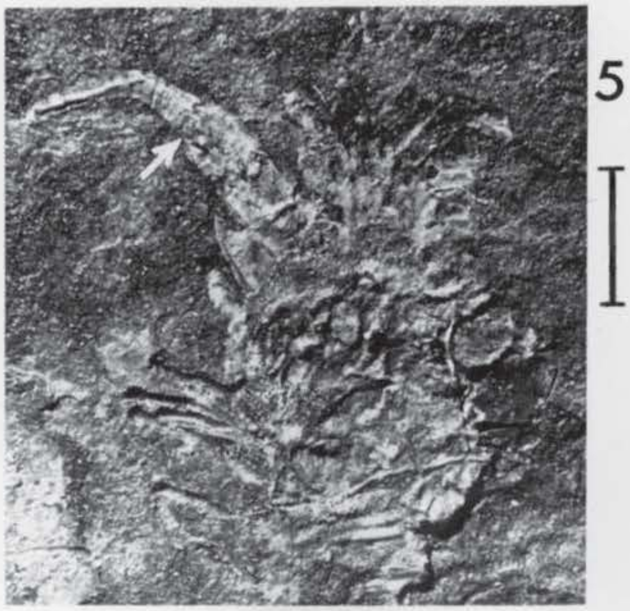

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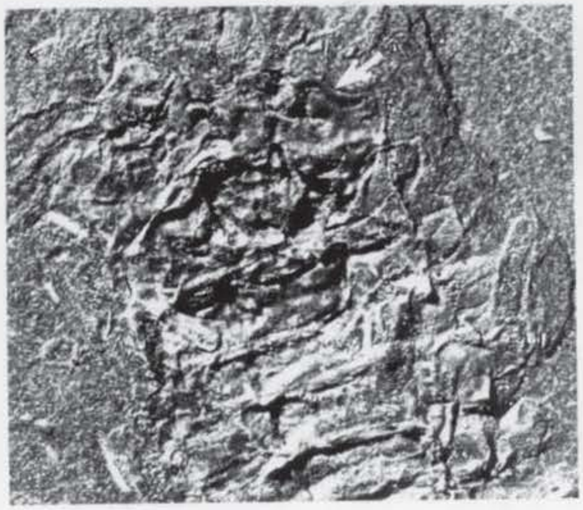

6

Explanation of Plate 2

Scales indicate 1 mm.

Figure

1. *Squillites spinosus* Scott, CM33798. With crescent-shaped ridges on thorax.

2. *Squillites spinosus* Scott, PE18354. Posteriorly directed spines on abdominal pleurites.

3. *Squillites spinosus* Scott, PE18355. Thoracic exopods.

4. *Squillites spinosus* Scott, PE18369. Displayin the thoracic crescent-shaped ridges (c) changing to posteriorly directed spines (s) at the second abdominal segment.

5. *Squillites spinosus* Scott, PE18357. Displaying a pleopod on an abdominal segment.

6. *Squillites spinosus* Scott, PE18362. Telson and uropods with setae.


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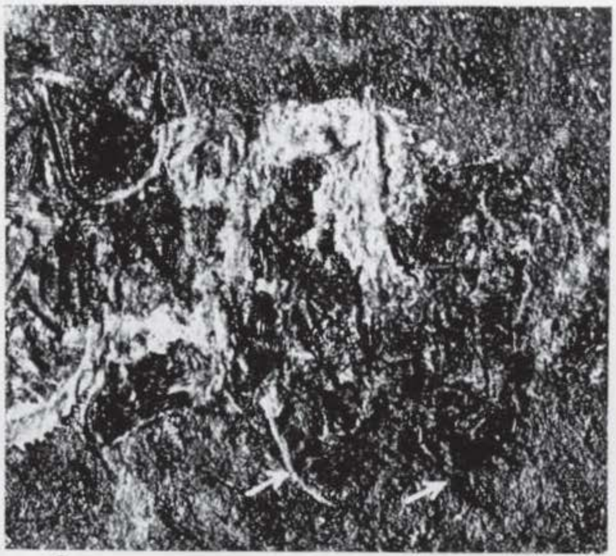
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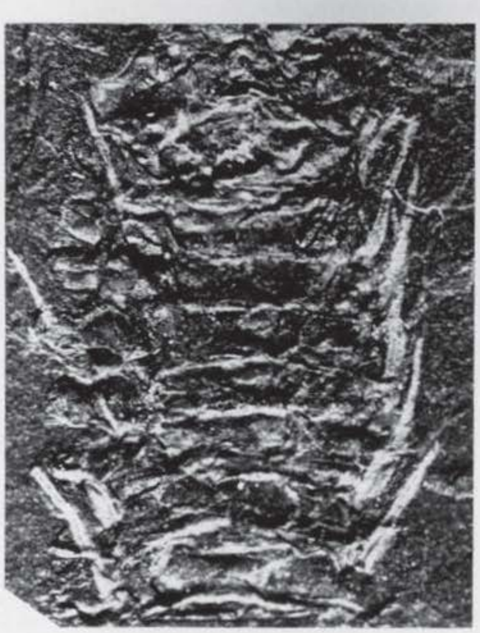
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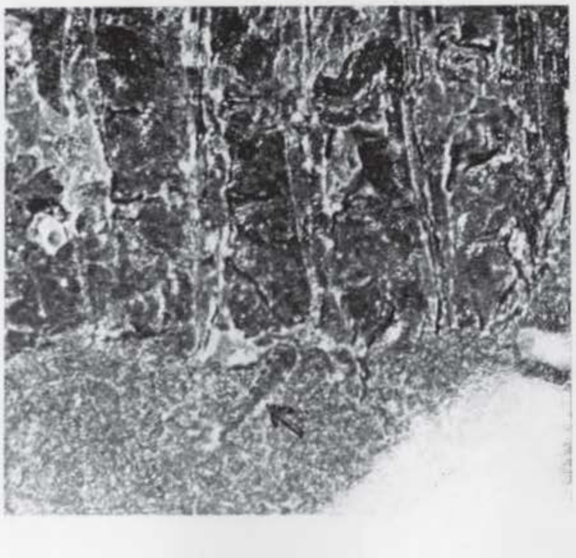
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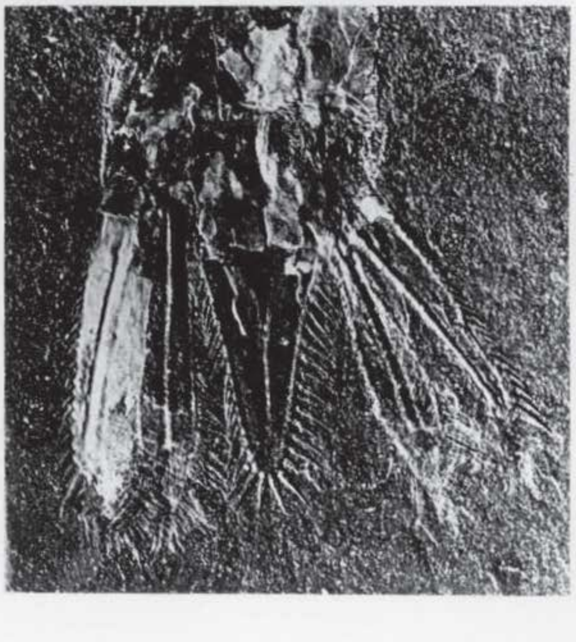
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Explanation of Plate 3

Scales indicate 1 mm.

Figure

1. Crustacea, incerta cedis, PE18379. Punctate carapace and the five post-carapace segments.
2. Crustacea, incerta sedis, PE18373. The five post-carapace segments illustrating the omega shaped masses in the pleurites.
3. Crustacea, incerta sedis, PE18383. Whole animal with arrow pointing to the carapace.
4. Crustacea, incerta sedis, PE18382. Region of the first five post-carapace segments, arrow pointing to leg segments.

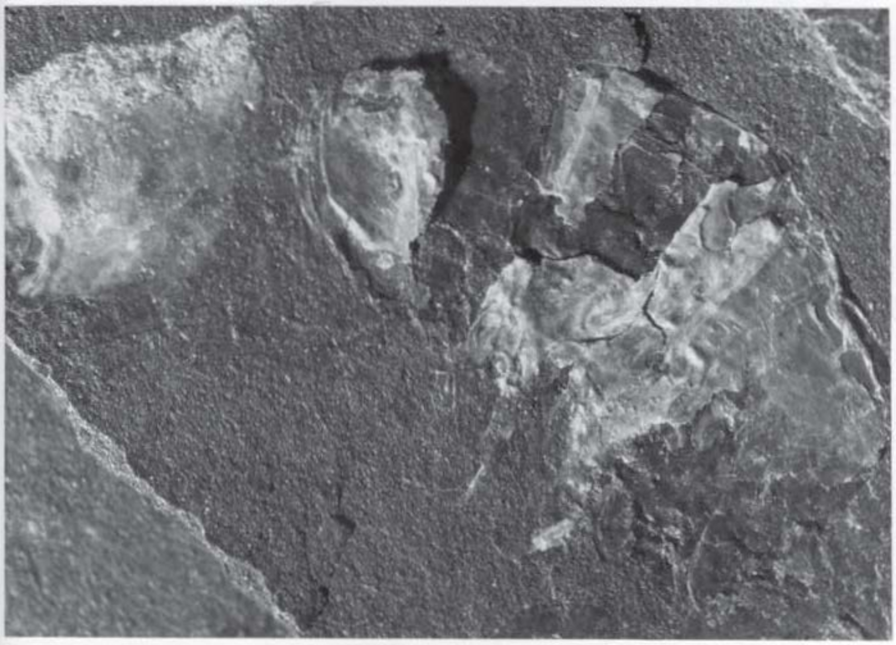

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Table 1

Measurements of selected specimens of *Squillites spinosus* given in millimeters.

Specimen	Total Length	Headshield	Thorax	Abdomen	Telson
PE18356	13.2	1.4	4.6	4.6	2.6
PE18357	-	-	3.9	3.4	-
PE18360	-	-	4.2	5.2	2.6
CM33797	-	.8	4.2	4.9	2.3
PE18355	-	.7	4.4	-	-
PE18362	12.7	1.0	4.3	4.5	2.5

Table 2

Measurements of selected specimens of Crustacea, incerta sedis given in millimeters.

Specimen	Carapace	First Five Post-carapace Segments	Total Length
PE18383	2.9	6.5	13.7
PE18314	2.9	5.5	-
PE18373	2.0	4.4	-
PE18380	2.9	-	-
PE18379	2.0	4.6	-
PE18382	3.6	4.6	-

Explanation of Figure 1

Squillites spinosus Scott. A lateral reconstruction.

Explanation of Figure 2

Squillites spinosus Scott. A dorsal reconstruction.

Explanation of Figure 3

Crustacea, incerta sedis. A lateral reconstruction in as far as was possible.

Explanation of Figure 4

Crustacea, incerta sedis. The two possible tail interpretations, dorsal and lateral views.

Figure 1

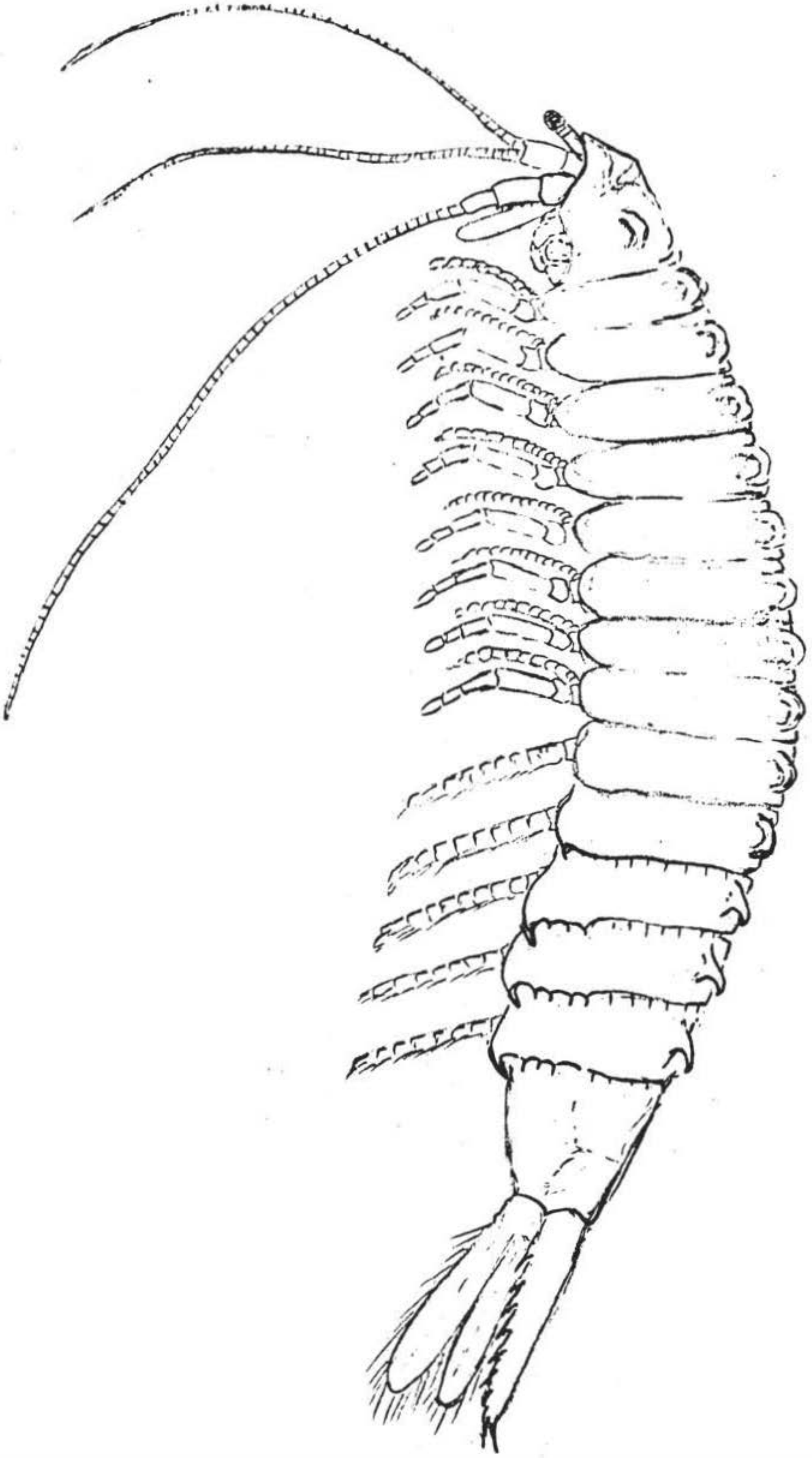

Figure 2

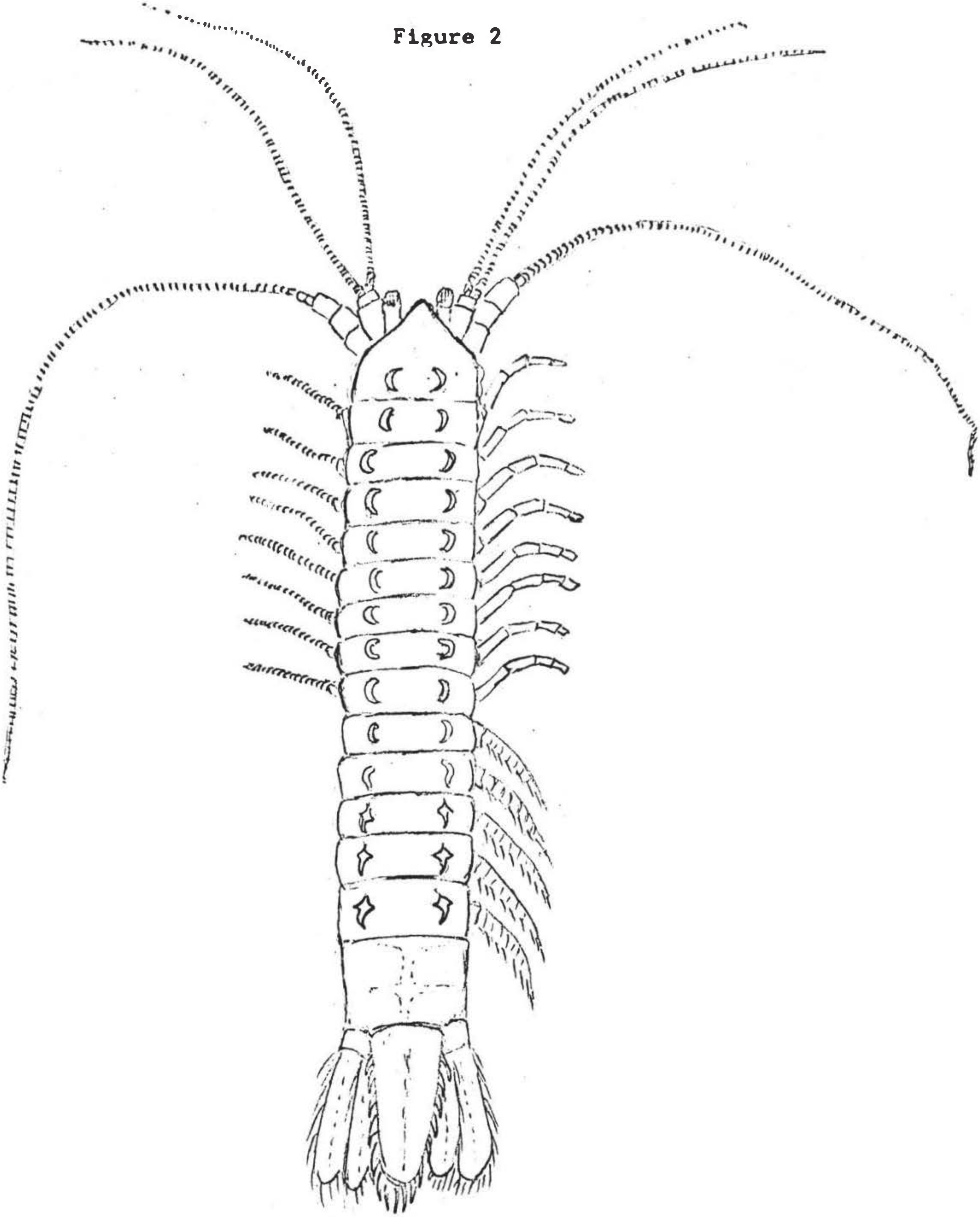

Figure 3

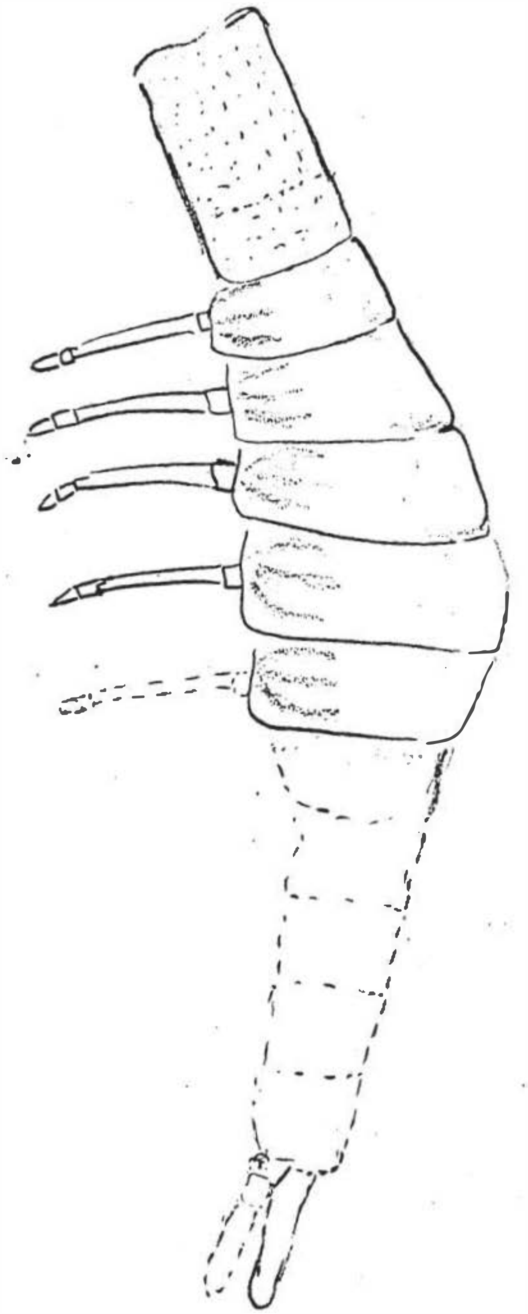

Figure 4

Tail structure, dorsal view.

Tail structure, lateral view.