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Two worm-like organisms from the Hunsrück Slate (Lower Devonian), southern Germany

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With 8 figures

Kurzfassung: Das Röntgenbild einer Platte aus dem Hunsrück-Schiefer zeigt einen tropfenförmigen „Wurm“, der an einen acoelen Platyhelminthen erinnert, da er anscheinend eine ausstülpbare Pharynxstruktur besitzt. Die sichere Bestimmung ist jedoch nicht möglich, da keine Spur des komplizierten Fortpflanzungsapparats der Platyhelminthen zu sehen ist. Ein anderes Bild zeigt einen mehr länglichen, wurmartigen Organismus mit Öffnungen im vorderen Bereich, die in einen Verdauungstrakt führen. Diese Eigenschaft weist in Richtung der tunikaten Chordaten. Ähnliche Individuen in nächster Nachbarschaft erwecken den Eindruck von Kolonie-Bildung und bestärken die Deutung als Tunikaten. Obwohl dies offenbar der erste bekanntgewordene paläozoische Vertreter dieses Unterstamms ist, erlaubt das vorliegende Material keine generische Zuordnung.

Abstract: One radiograph of Hunsrück slate shows the presence of a drop-shaped “worm”. This image resembles an acoel platyhelminth in the presence of an apparently eversible pharyngeal structure, but no trace can be found of the complex reproductive structures of platyhelminths, making full identification impossible. Another more elongate worm-like image shows the presence of anterior perforations into a digestive tract. This feature is consistent with identification of the individual as a tunicate Chordata. Similar organisms, adjacent to the first suggest coloniality, and reinforce the identification as a tunicate. Even though this is apparently the first known Paleozoic fossil of the subphylum, the material does not warrant assignment of a generic name.

Introduction

The Hunsrück Slate is well known for preservation of rare fossils which have soft tissue replaced by pyrite. As a consequence, radiographic methods have been employed in its investigation. It is fundamental to note that slate slabs were collected by quarry workers because they showed fossils on the surface. When quarrying was done specifically for the purpose of radiographic investigation, again slabs were selected which showed some irregularity on the surface, indicative of a hard skeleton within (STÜRMER, STÜRMER & YOCHELSON 1986: A45).

Recovery of soft-bodied organisms is governed both by their chance preservation, and by their lying near specimens which might then be radiographed. It is impossible to determine how abundant such soft-bodied creatures were in the Hunsrück Sea. We report on two unique “worms”. Each is significant in extending the range of marine organisms which have essentially no fossil record. A search by STÜRMER & YOCHELSON through negatives during May 1986 revealed no additional images of these organisms.

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A "flat" worm

A single specimen (WS 13100) is illustrated at natural size in stereo (Fig. 1) and enlarged (Figs. 2, 3). The image shows a flattened leaf-shaped organism, about 25 mm long and 10 mm wide, lying near the arms of a starfish. That fossil is instructive for interpretation of pyritized fossils of the formation, for one observes on it that the areas rich in organic matter, not the calcareous skeleton, are those which are most prominent on the radiograph. The implication is that faint areas which extend the outline of an animal, as at the anterior of the worm, may be interpreted as regions that are thinner and contain less organic matter.

As preserved, the organism is not quite bilaterally symmetrical and our interpretation is that the left side has been slightly infolded. Along the right side there is a slight indentation which may have been a constriction in life, but all one can state with confidence is that the outline was roughly tear drop-shaped. The body must have been quite flat for the stereoview shows virtually no relief, apart from a little upward curvature. Presumably the organism was slightly thicker near or at the anterior end than in the posterior.

The wide end, judged to be the anterior, is obscured in part by a relatively large lump of pyrite. This is interpreted as a mass of digestive tissue, squeezed out during compaction of the soft tissue. This material has been more strongly pyritized than the other tissues. From the position of this pyrite lump, it may have been squeezed through an opening which lay a short distance behind the anterior end; it seems to connect with a darker stain within the body of the animal.

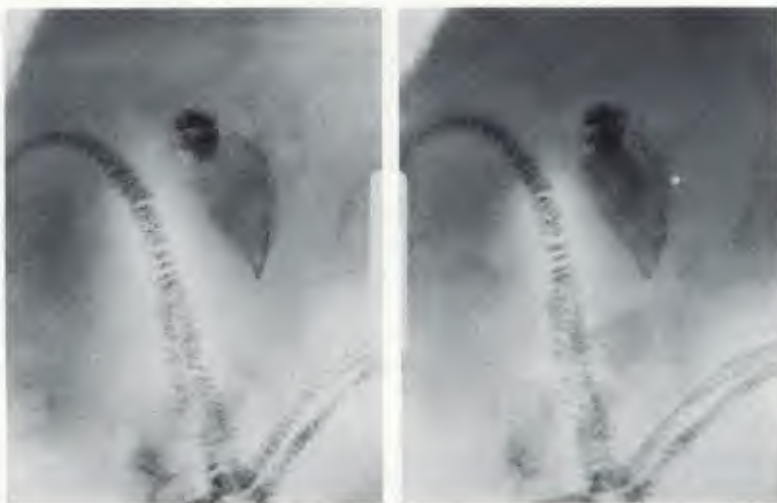


Fig. 1. Radiograph WS 13100 showing a small flattened worm-like organism adjacent to a starfish. Natural size.



Fig. 2. Enlargement $\times 8$ of the same organism.

A set of narrow tubes are present along the edges of the organism. The longest occupies nearly one quarter of the animal length and extends to the pointed posterior. At least two other smaller structures appear prominently on the right end, posteriorward of the possible constriction. Whether they extend into the anterior half of the animal is uncertain, but seems unlikely. These probably are not preservation phenomena for two reasons. First is the pairing of long tubes on both the right and left half of the posterior. Second, along the right margin, a curved pyrite stain exists, suggesting that a fluid filled cavity was crushed and the fluid then pyritized. It is possible that these tubes continued to the anterior, but were ripped apart when the anterior end was squeezed during compaction.

About halfway between anterior and posterior, a small structure occurs. It is to the left, but if our assumption on original flattening of the organism is correct, this would have been essentially mid-ventral in position. A light pyritization stain is adjacent, suggesting that this also may have been an opening from which some fluid or tissue was squeezed out.

Finally, near and at the anterior end streaks of light and dark-colored material overlie the pyritic mass. The margins appear rod-like and outline a structure circular in cross-section (Fig. 3); towards the posterior lefthand end of this mass is a star-shaped structure, perhaps a radially symmetrical eversible pharynx. The pharyngeal apparatus may have been pushed aside as the digestive mass burst through the mouth-opening.

Nothing further is to be observed within the anterior half of the animal. The relatively good preservation of the posterior tubes and the absence of any detail in this part of the animal lead us to postulate that most of the body must have been filled by digestive glands, for these would not produce any distinctive pattern. We see no evidence of pyritization of a complete digestive tract.

The general shape reminds one strongly of a turbellarian. HYMAN (1951) reproduces a drawing of *Provortex* which is useful for interpreting the lateral structures as fluid-filled cavities. However, this specimen is twice as large as the largest known living turbellarian with similar body form; for that reason we would rule out such a class placement.

At best we can say from shape and general level of complexity that this animal resembles members of the phylum Platyhelminthes. Nevertheless, the organism cannot be assigned to that phylum since key features, such as the complex reproductive structures are not observed. Even though the process of pyritization is poorly understood, the fact that ducts are visible in the posterior end, suggests if that complex and well organized features, like the platyhelminth reproductive system had been present, we should see at least traces of them. Platyhelminthes is currently defined as containing forms with complex, hermaphroditic reproductive systems. Because such systems are not present in the image at hand, we leave the fossil unassigned.

An "elongate worm"

Another specimen, recovered in radiograph WS 13058, is illustrated at natural size (Fig. 4), in enlarged stereoview (Fig. 5) and selectively further enlarged (Figs. 6-7). This soft-bodied creature is curved (Fig. 4) and has an elongate head region distinguished from the body by a constriction. The body is evenly wide through approximately half its length and abruptly tapers to a slender, posterior end. The greatest width is about 2 mm; the total length is about 55 mm.

The individual lies adjacent to two crinoid stems, and disruption of one stem which lies cross the anterior region of the specimen indicates that this part of the body was firm under compaction, in contrast to the fossil described above. Below the two crinoid stems is another individual, oriented in the same general fashion, but less well preserved (Fig. 5). To the right of the crinoid stems are at least two additional individuals in slightly different orientation (Fig. 7). The individual below the stems seems attached at its tip to the best preserved specimen.



Fig. 3. Enlargment about $\times 15$ of the anterior portion of the same organism.

Proximity of the other individuals suggests that they were all associated and that this fossil organism was colonial in nature.

The head has a tapering, possibly conical snout; there is no evidence of a mouth, but we are unable to assess whether this is due to the contact between the specimen and the crinoid stem (Fig. 7). Posterior to the snout the head is expanded in width, giving an overall wedge shape. The head surface in this wider region bears a series of discrete pyrite circles, best shown to the left of a center line along the head. We interpret these circles as a series of perforations in the



Fig. 4. Radiograph WS 13058 showing two crinoids with an elongate organism lying adjacent to the stems. Natural size. In other views, the orientation is changed.

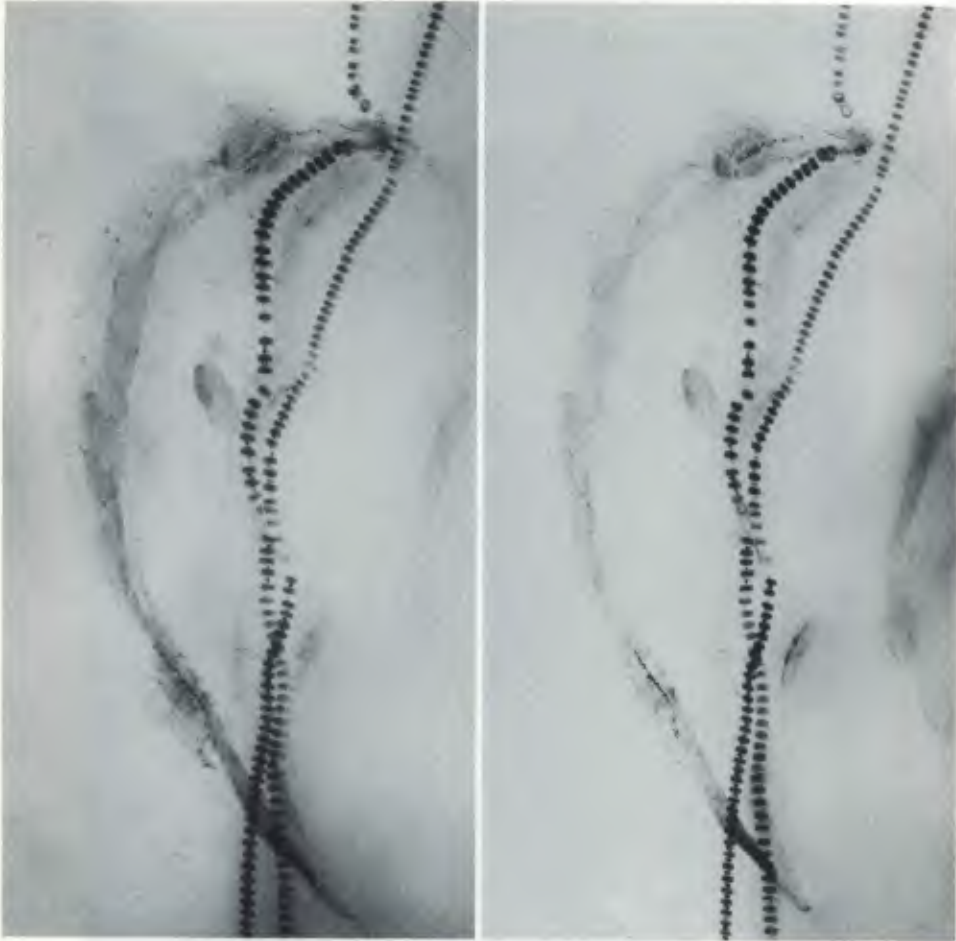


Fig. 5. Stereoview of Fig. 4, $\times 2$.

outer body-surface. Internally, a central structure is darker as a result of more intense pyritization; the replacement is not uniform but shows signs of a periodicity, best interpreted as small circles. These periodical pyritizations may also represent a series of perforations that open into the gut.

The animal has a series of superficial, vaguely defined pyritized zones encircling the body (Fig. 6). We can identify at least four of these zones, the highest being marked by a line of pyrite just posterior to the head and the lowest being roughly midway on the body. Internally a long, gut-like structure is visible, in part slightly folded. The folding is seen vaguely on the left side of the organism as a more sinuous line. The gut tapers towards the posterior end where it fades into the surface layers. Near the posterior end an irregularity in the surface on the left side may indicate the presence of a penetration of the body-wall, possibly during compression, but alternatively might represent a posterior body opening.



Fig. 6. Enlargement, $\times 3$. A second specimen shows the head just to the left of the left crinoid stem and the tip to the right of the stems; near the crossing of the stems, a series of pyrite dots outline a ring strengthening the body. The head of a third specimen is seen just to the right of where the stems cross. Two other specimens occur further to the right.



Fig. 7. Enlargement, $\times 12$, of the head region of the best preserved specimen. The individual crinoid ossicles are turned on end in the immediate vicinity of the snout.

Below the two crinoid stems and paralleling them is the second organism (Fig. 5). It is more strongly pyritized towards the anterior, but no more details can be seen. It tapers posteriorward and is definitely connected to the better preserved specimen; the point of connection mentioned lies to the right of the crinoid stems (Fig. 6).

To the right of the crinoid stem is a vaguely defined specimen, oriented in the same fashion as two specimens mentioned above; the anterior end shows the same taeniform outline and indications of the pyritized circles are also present.

Further to the right are two additional specimens (Fig. 8). Neither of these specimens shows clear preservation of the body. Computer enhanced enlargement of each head, not il-



Fig. 8. Computer enhanced enlargement, about $\times 6$, of the specimens to the far right. The image has been reversed.

lustrated, indicates that these specimens have the same circles of pyrite as present in the anterior end of the best preserved specimen. Three of the specimens forms a cluster; the other two specimens may have been torn off.

The structure of this organism shows none of the hallmarks of the annelids, nor is it a tube-dwelling form such as *Sphenothallus* (FAUCHALD, STÜRMER & YOCHELSON 1986). The features are consistent with those of stalked tunicates. We interpret the relation between these specimens as showing a colonial life form similar in kind to the one present in Recent tunicates, such as *Clavelina*. Even though we are convinced that this organism is a tunicate, the structures present are only the general features that identify it as such; there is not sufficient detail preserved to warrant a generic name for this tunicate.

Discussion

In spite of the paucity of the material, we want to make two points. First, even though there has been various reports of fossil tunicates in the literature, we believe that this material is authentic, not only because of the presence of the perforation but also because of the coloniality of the form. Secondly, it would appear that a diverse fauna of soft-bodied organisms was well established living within the crinoid thickets in the Hunsrück Sea. The organisms are of the same general kinds that would be expected to live in shallow, warm seas today.

Literature

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