A C T A P A L A E O N T O L O G I C A P O L O N I C A

Vol. XII 1967 No. 4

ANDRZEJ RADWAŃSKI & PIOTR RONIEWICZ

TRACE FOSSIL *AGLASPIDICHNUS SANCTACRUCENSIS* N.GEN., N.SP., A PROBABLE RESTING PLACE OF AN AGLASPID (XIPHOSURA)

Abstract. — *Aglaspidichnus sanctacrucensis* n.gen., n.sp. is a new trace fossil from the Upper Cambrian of the Holy Cross Mountains (Góry Świętokrzyskie), Central Poland. It is considered to be the cast of the resting place of an aglaspid arthropod (Xiphosura). The origin of the trace and life activity of the animal during its formation are discussed and compared with the ecology of fossil aglaspids and recent horseshoe crabs.

INTRODUCTION

A new trace fossil has been found by the present authors in the Upper Cambrian clastics that crop out in the Wielka Wiśniówka quarry near Kielce in the Holy Cross Mountains. It is different from other trace fossils of this locality and has no analogues in the ichnologic literature. The sediments of Wielka Wiśniówka are known by their wealth of trace fossils, mostly those, related to trilobites (Radwański & Roniewicz, 1963).

Our most sincere thanks are extended to Professor A. Seilacher, University of Tübingen, West Germany, and Docent A. Urbanek, Palaeontological Department of the Warsaw University, Poland, for their constructive criticism of the manuscript and helpful suggestions.

DESCRIPTION

Aglaspidichnus sanctacrucensis n. sp.

Holotype: The specimen presented in Plate I.

Derivation of the name: The generic name, *Aglaspidichnus*, from the order Aglaspida, whose representative is believed to form the trace, and ending *ichnus*

(= *trace*) for pointing that the fossil is a trace. It follows the recommendation by Häntzschel (1962) on the creation of new ichnologic names. The specific name, *sanctacrucensis*, refers to the Holy Cross Mountains (Góry Świętokrzyskie) as the region of the find.

Type locality: Wielka Wiśniówka quarry, on the northern slopes of the Wiśniówka hill near Kielce, in the Holy Cross Mountains, Upper Cambrian.

Material. — One specimen preserved as a hieroglyph, i.e. as an infilling, by the overlying sediment, of the true trace left by the animal. The original trace was formed in clayey bottom, whereas its infilling (hieroglyph) consists of sandy material, cemented into quartzitic sandstone.

The fossil is preserved as a trace of the segmented and of the caudal, shield-shaped parts of the animal. There is no trace of anterior part (prosoma) of the animal. It was either destroyed or was not marked in sediment especially when the animal had not sealed the sediment with its anterior part.

Dimensions and morphology. — The hieroglyph (Pl. I) is 15.5 cm in length and 12.0 cm in a maximum width. It displays a ridge, running from the front, along a somewhat sinuous axis as far as the ovally triangular ending. From the axial ridge the eight single lateral ridges (numbered 1—8 in Fig. 1), curved rearwards, branch more or less symmetrically. The rear ridges are more distinct than the anterior ones, and those on the right side are shorter than those on the left. Of the left-sided ridges, the third from the rear is broken close to the axis and placed somewhat further to the front. The sixth ridge is very slightly marked. Similar irregularities are also observed in a few anterior right-sided ridges.

The anterior part of the hieroglyph is slightly deformed by two small hieroglyphs, *Rusophycus* sp. (*a'*, *a''* in Fig. 1), and by a small synaeresis crack cutting the sixth, seventh and eight right-sided ridges (*b* in Fig. 1).

TAXONOMIC POSITION OF THE ANIMAL

On the basis of the morphology of the hieroglyph, it may be concluded that the trace was left by an elongated, ovally shaped, segmented animal, whose body terminated in a shield. All these characters indicate an arthropod.

Among the arthropods, trilobites (Trilobita) and merostomes (Merostomata) have exhibited characters that might be compared with those we discuss. The general shape of the trace, its sinuous axis, as well as the dimensions of the trace, suggest merostomes. The Upper Cambrian trilobites had different shapes, did not laterally arch along their axis,

and were usually smaller. The shape of the fossil correspond to that of xiphosurans (Xiphosura). Furthermore, the presence of pygidial shield indicates a representative of the family Beckwithiidae Raasch, 1939, of the order Aglaspida Walcott, 1911, as the trace maker.

The family Beckwithiidae was erected by Raasch (1939) for aglaspids (Aglaspida) that possess a pygidial shield, formed by the coalescence of some posterior abdominal segments. This family includes only one genus, *Beckwithia* Resser, 1931, represented by one species, *Beckwithia typa* Resser, 1931, plus one form of uncertain assignation, *Beckwithia? major* (Graham, 1931), put herein by Raasch (1939) with hesitation.

The trace we describe here, on the presence of the caudal shield, may be compared to any representative of the family Beckwithiidae, and it displays similarity to *Beckwithia typa* Resser. It is, however, considerably larger, has a more distinct trilobation, and its segmental imprints are more strongly arched backwards, along with the embracing of posterior segments by the more anteriorly situated ones. All these differences are explainable and they do not contradict the assignation.

The considerable size of the trace does not exclude an aglaspid. Since the size of the part of animal that left the trace amounted to 15.5 cm, the antire animal was at least 22 cm long. This falls within the known size range of aglaspids; for instance, the length of *Beckwithia? major* (Graham), found only in fragments, is estimated as about 20 cm, while the greatest aglaspid, *Aglaspis spinifer* Raasch, must have been several times larger (Raasch, 1939). In other Xiphosura, similarly to the Eurypterida, animals of great dimension are also common.

The distinct trilobation observed in the trace, but rather unknown in aglaspids, may be explained by the fact that it was formed by the ventral side of the animal. This side is little investigated in aglaspids, but it is likely that the axial part was more convex than the lateral (pleural) parts (see Størmer, 1955, p. 10).

The arching is known in the posterior segments of *Beckwithia,* whereas in other aglaspids it is also observed in median segments, e.g. in the genera *Glypharthrus* Raasch and *Aglaspis* Hall (*vide* Raasch, 1939; Størmer, 1955). In the trace we deal with here, it is difficult to recognize which parts of grooves were left by the exoskeleton and which by appendages. In addition, the hieroglyph is somewhat load casted, i.e. deformed by the process of sinking. Thus, it is impossible to decide whether the arching is the result of the shape of segments or of the manner of digging.

Thus, the particular shape of the trace *Aglaspidichnus sanctacrucensis* n.sp. fits with aglaspids. More exact comparisons are difficult as the aglaspids are really rare fossils and most of the species are known only from single specimens, usually preserved as dorsal exoskeletons (Raasch, 1939; Størmer, 1955).

MODE OF FORMATION OF THE TRACE

The trace fossil, *Aglaspidichnus sanctacrucensis* n.sp., is the infilling (hieroglyph) of the true trace, left by an aglaspid on the sediment surface. The morphology of the trace shows that the animal was resting on the bottom (*Cubichnia* trace, after Seilacher, 1953). During the digging action, the grooves corresponding to the axis, segments and pygidial shield were formed. As we have mentioned, segmental grooves might have been formed either by the exoskeleton, or by the appendages. Presumably, both are responsible, if the aglaspid really possessed appendages at all abdominal segments.

The arching of the axial part of the trace has a primary reason. It is also indicated by the different distribution of traces of segments along both sides, and by their depth. Such an arching or wriggling was possible in live aglaspids (*vide* Raasch, 1939, Pl. 8, Figs. 8—9; Pl. 9, Figs. 1—3; Størmer, 1955, Figs. 9—10; 1956, Pl. 1, Fig. 1). The greatest depth (2 cm) of the trace at its posterior end, and a very distinctly preserved imprint of the pygidial shield show that the animal strongly dug itself into the sediment, especially with its posterior part. A very similar behaviour is characteristic of modern xiphosurans, such as the horseshoe crab, *Limulus polyphemus* (Linnaeus) (*vide* Caster, 1938, Fig. 4d), and probably of some fossil aglaspids. According to Raasch (1939), some aglaspids, e.g. those of the genus *Aglaspis* Hall, probably dug themselves into the sediment, so that only their eyes were exposed over the bottom surface (Raasch, *l.c.*, p. 109). On the other hand, the aglaspid's manner of digging into the sediment, as well as its behaviour — lateral wriggling motion and unevenness of the vertical digging along the axis — were also very similar to those, known in the trilobites living in the same environment, and this may be recognized by the analysis of their resting-place traces, hieroglyphs *Rusophycus* sp. (Radwański & Roniewicz, 1963).

A peculiar feature of the trace we deal with here is the presence, in its anterior part, of small hieroglyphs *Rusophycus* sp. — counterparts of two rest places of small trilobites. It is difficult to establish their age relationship to the aglaspid trace, but probably the trilobite traces are earlier. Their association with the trace of the aglaspid seems to be rather accidental.

A comparative analysis of the trace. Until now, no other trace fossils have been described that could be assigned to the aglaspids. In the Upper Cambrian of Wisconsin, different crawling traces (*Climactichnites, Protichnites*) of doubtful origin (Caster, 1938; Raasch, 1939; Häntzschel, 1962) have been found below the aglaspidiferous complex. Different traces, referred to merostomes, have been critically discussed by Caster (1938); mostly, they were formed by horseshoe crabs. Traces of the life activities of the latter animals (traces of moving and also of resting)

have been considered by many authors (Caster, 1938; Kolb, 1957). The resting traces of horseshoe crabs do not resemble, however, those of *Aglaspidichnus sanctacrucensis* n. sp.

ENVIRONMENTAL CONDITIONS

The sedimentary environment of the Upper Cambrian in the Holy Cross Mountains has been studied by Dżułyński & Żak (1960) and Radwański & Roniewicz (1960, 1963). Fine-grained clastic sediments cropping out in the Wielka Wiśniówka quarry represent a marine complex, formed under the influence of bottom currents and waves. From sedimentary structures the depth of the basin may be estimated as from a dozen or so to some scores of metres (Dżułyński & Żak, 1960; Radwański & Roniewicz, 1960). The organic life was favoured by the clean and well--aerated waters, but sedimentary agents (currents, waves) rendered the preservation of animals in sediments impossible. Only some traces of their life activities have been preserved. The assemblage of traces, i.e. the ichnocoenosis, includes (Radwański & Roniewicz, 1963) mainly structures assigned to trilobites (*Rusophycus* sp., *Cruziana* sp., *Diplichnites* sp., *Dimorphichnus* sp.), sea anemones (*Bergaueria perata* Prantl) and annelids (*Diplocraterion* sp.).

The discovery of an aglaspid trace in this sedimentary facies is in conformity with the supposed ecology of the aglaspids. These animals have hitherto been found, associated with trilobites and brachiopods, in the deposits of very shallow and quiet marine sedimentation (Graham, 1931; Raasch, 1939; Størmer, 1955) or, exceptionally, even in a supposed brackish environment (Chlupač & Havliček, 1965). The only specimen of *Beckwithia typa* Resser, which displays the greatest analogies to the trace dealt with here, was found in carbonate sediment in banded marly limestones of the uppermost Middle Cambrian of the Marjum formation, Utah (Resser, 1931; Raasch, 1939). The other data on the aglaspid bearing sediments (Raasch, *l.c.*) considering, it may be stated that the Upper Cambrian sedimentary enviroment of the Holy Cross Mountains was a more turbulent one. This may be the main reason why aglaspids did not live in larger numbers in this region.

Considering the environmental conditions and geographic distribution of the aglaspids, one should bear in mind that their fossil remains are very rare. Most specimens come from the Upper Cambrian Trempealeau formation in Wisconsin. In this formation, aglaspids are rather common and usually occur in thin-bedded, fine-grained sandstones and siltstones, sometimes dolomitic in character (Raasch, 1939). The only European aglaspids are from the Lower Cambrian of Sweden (Størmer, 1956) and Middle Cambrian of Bohemia (Chlupač & Havliček, 1965). It is hard to

decide whether the scarcity of aglaspids in the European Cambrian is due to facial or to zoogeographical reasons. Nevertheless, the aglaspid that has left the trace under study, may be considered to be an American faunistic element in the Cambrian sea of the Holy Cross Mountains.

Laboratory of Dynamic Geology
of the Warsaw University
Warszawa 22, Żwirki i Wigury 93
December, 1965

REFERENCES

CASTER, K. E. 1938. A restudy of the tracks of Paramphibius. — *J. Paleont.*, **12**, 1, 3-60, Tulsa.

CHLUPAČ, I. & HAVLIČEK, V. 1965. Kodymirus n.g., a new aglaspid merostome of the Cambrian of Bohemia. — *Sborn. Geol. Věd, Paleont.* ř. P., **6**, 7-20, Praha.

DŻUŁYŃSKI, S. & ŻAK, C. 1960. Środowisko sedymentacyjne piaskowców kambryjskich z Wiśniówki i ich stosunek do facji fliszowej (Sedimentary environment of the Cambrian quartzites in the Holy Cross Mts. (Central Poland) and their relationship to the flysch facies). — *Roczn. P. T. Geol.* (*Ann. Soc. Geol. Pol.*), **30**, 2, 213-241, Kraków.

GRAHAM, W. A. P. 1931. A new crustacean of the family Aglaspidae from the Upper Mississippi Valley. — *Ohio J. Sci.*, **31**, 2, 127-128, Columbus.

HÄNTZSCHEL, W. 1962. Trace fossils and problematica. *In*: R. C. Moore (Ed.), Treatise on Invertebrate Paleontology, Part *W* (Miscellanea), 177-245, Lawrence.

KOLB, A. 1957. Limulus-Spuren. — *Geol. Bl. NO-Bayern*, **7**, 4, 138—155, Erlangen.

RAASCH, G. O. 1939. Cambrian Merostomata. — *Geol. Soc. Amer., Special Paper*, **19**, 1-146, Baltimore.

RADWAŃSKI, A. & RONIEWICZ, P. 1960. Struktury na powierzchniach warstw w górnym kambrze Wielkiej Wiśniówki pod Kielcami (Ripple marks and other sedimentary structures of the Upper Cambrian at Wielka Wiśniówka, Holy Cross Mts.). — *Acta Geol. Pol.*, **10**, 3, 371-399, Warszawa.

— & — 1963. Upper Cambrian trilobite ichnocoenosis from Wielka Wiśniówka, Holy Cross Mountains, Poland (Górno-kambryjska ichnocenoza trylobitowa z Wielkiej Wiśniówki w Górach Świętokrzyskich). — *Acta Palaeont. Pol.*, **8**, 2, 259-280, Warszawa.

RESSER, C. E. 1931. A new Middle Cambrian merostome crustacean. — *Proc. U. S. Nat. Mus.*, **79**, 33, 1-4, Washington.

SEILACHER, A. 1953. Studien zur Palichnologie, I-II. — *N. Jb. Geol. Paläont. Abh.*, **96**, 421-452; **98**, 87-124, Stuttgart.

STØRMER, L. 1955. Merostomata. *In*: R. C. Moore (Ed.), Treatise on Invertebrate Paleontology, Part P (Arthropoda, 2), 4-41, Lawrence.

— 1956. A Lower Cambrian merostome from Sweden. — *Arkiv Zool.*, **9**, 6, 507-514, Stockholm.

ANDRZEJ RADWAŃSKI & PIOTR RONIEWICZ

AGLASPIDICHNUS SANCTACRUCENSIS N.GEN., N.SP., NOWY HIEROGLIF ORGANICZNY, PRZYPUSZCZALNIE ŚLAD SPOCZYNKU AGLASPIDA (XIPHOSURA)

Streszczenie

Opisano nowy hieroglif organiczny, *Aglaspidichnus sanctacrucensis* n.gen., n.sp., z kambru górnego Wielkiej Wiśniówki w Górach Świętokrzyskich. Hieroglif ten (Pl. I i schematyczny zarys na Fig. 1) jest wypełnieniem śladu spoczynku, pozostawionego przez stosunkowo dużego stawonoga (szacunkowa wielkość całego zwierzęcia minimum 22 cm). Rekonstrukcja wyglądu tego stawonoga i sposobu rozkopywania przez niego osadu, dokonana na podstawie analizy hieroglifu, prowadzi do wniosku, że stawonogiem tym był jakiś starorak (Merostomata), należący przypuszczalnie do rzędu Aglaspida w obrębie podgromady ostrogonów (Xiphosura).

W dotychczasowej literaturze nie opisywano śladów, które można by wiązać z działalnością aglaspidów. Zwierzęta te, charakterystyczne — jak się wydaje — przede wszystkim dla kambru amerykańskiej prowincji zoogeograficznej (Resser, 1931; Graham, 1931; Raasch, 1939), pojawiały się w kambrze europejskim rzadko (Størmer, 1955, 1956; Chlupač & Havliček, 1965). Ich obecność w środowisku sedymentacji, reprezentowanym przez osady z Wielkiej Wiśniówki (por. Radwański & Roniewicz, 1960, 1963), jest zgodna z danymi o wymaganiach życiowych tych zwierząt. Opisany hieroglif uzupełnia stosunkowo liczny zespół śladów rozmaitych zwierząt, głównie trylobitów, znanych dotychczas z Wielkiej Wiśniówki (Radwański & Roniewicz, 1963).

АНДРЖЕЙ РАДВАНЬСКИ & ПЁТР РОНЕВИЧ

AGLASPIDICHNUS SANCTACRUCENSIS N. GEN. N. SP., НОВЫЙ ОРГАНИЧЕСКИЙ ИЕРОГЛИФ ВЕРОЯТНО СЛЕД ПОКОЯ АГЛАСПИДА (XIPHOSURA))

Резюме

Описано новый органический иероглиф под названием *Aglaspidichnus sanctacrucensis* n. gen., n. sp. из верхнего кембрия Велькой Висьнювки в Свентокржиских Горах. Этот иероглиф (Пл. I и схематический рисунок на фиг. 1) является наполнением следа покоя, оставленного довольно большим члени-

стоногим (оценочный размер целого животного — по крайней мере 22 см). Реконструкция внешности этого членистоногого и способа раскапывания ним осадка, проведенная на основании анализа иероглифа, приводит к выводу, что этим членистоногим был какой то представитель мечехвостовых (Merostomata), принадлежащий вероятно к ряду Aglaspida.

В существовавшей до сих пор литературе не описывано следов, которые можно было бы увязывать с жизнедеятельностью агласпидов. Эти животные, характерны главным образом для кембрия американской зоогеографической провинции (Resser, 1931; Graham, 1931; Raasch, 1939), появлялись тоже изредка в европейской кембрии (Størmer, 1955, 1956; Chlupač & Havliček, 1965). Их присутствие в седиментационной среде, репрезентированной отложениями из Велькой Висьнювки (*vide* Radwański & Roniewicz, 1960, 1963),сходное с данными о жизненных требованиях этих животных.

Описанный иероглиф дополняет довольно обильный комплекс следов разных животных, главным образом трилобитов, известных до сих пор из Велькой Висьнювки (Radwański & Roniewicz, 1963).

FIGURE and PLATE

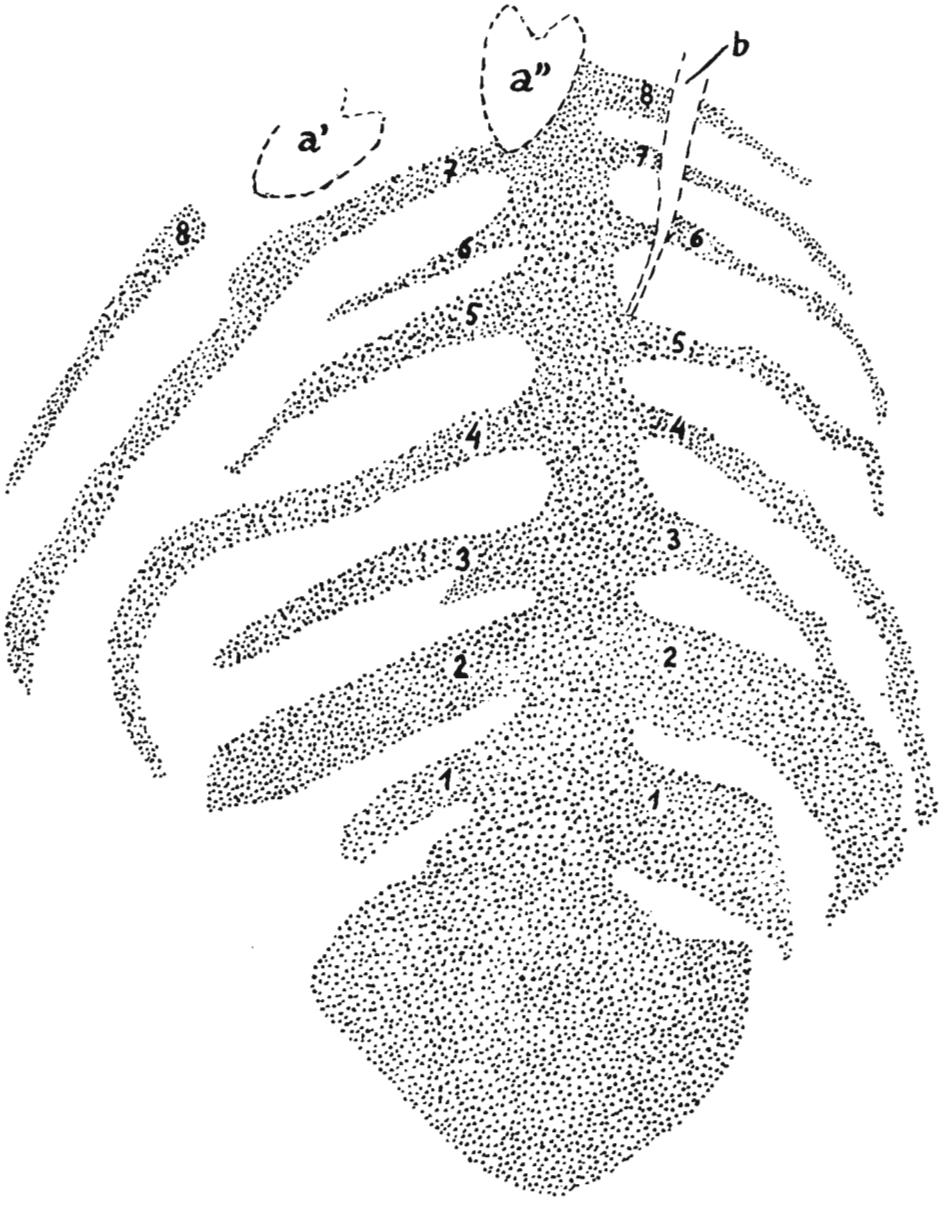
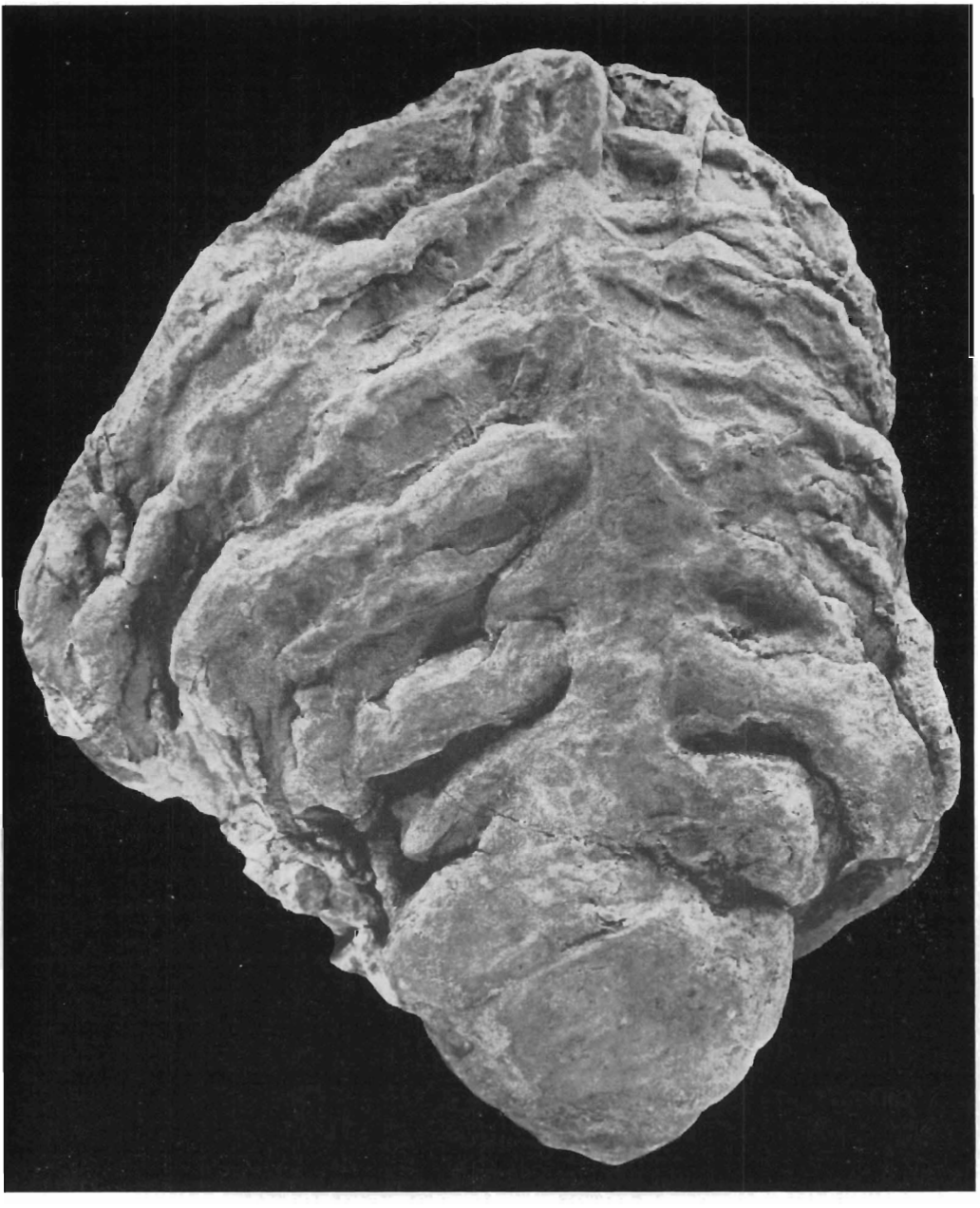


Fig. 1. — A sketch-drawing of the trace fossil presented in Plate I. Explanation in the text (p. 546); nat. size.



Aglaspidichnus sanctacrucensis n.gen., n.sp.; holotype. The trace preserved as a sandy infilling (hieroglyph) of the true trace left by an aglaspid resting on the clayey bottom. Upper Cambrian, Wielka Wiśniówka quarry, Holy Cross Mountains (Central Poland); nat. size.