

Scorpion fragments from the Silurian of Powys, Wales

Jason A. Dunlop

Museum für Naturkunde,
Leibniz Institute for Research on Evolution and
Biodiversity at the Humboldt University Berlin,
Invalidenstraße 43, D-10115 Berlin, Germany
email: Jason.Dunlop@mfn-berlin.de

Paul A. Selden

Paleontological Institute and Department of Geology,
University of Kansas, 1475 Jayhawk Boulevard,
Lawrence, Kansas 66049, USA
email: selden@ku.edu

Summary

Fragments of a fossil scorpion collected from Silurian (Ludfordian, *c.* 420 Ma) strata near Trecastle in Powys, Wales, are described. They represent one of the oldest records of Scorpiones, of which only five other species are known from the Silurian. Given the incomplete nature of the new material, which includes a largely complete carapace with anteriorly positioned median eyes, we cannot assign it to any particular family or genus. However, the pustulate carapace ornament and preserved pattern of sulci are reminiscent of certain, much larger, fossil scorpions such as the Devonian *Praearcturus gigas* Woodward, 1871 and the Carboniferous *Gigantoscrapio willsi* Störmer, 1963.

Introduction

Scorpions are the oldest known arachnids (reviewed by Dunlop 2010), the earliest of which are a handful of records from the Silurian of Europe and North America (Fig. 1) (Dunlop & Penney 2012). *Dolichophonus loudonensis* (Laurie, 1899) from the Gutterford Burn Eurypterid Bed, in the Pentland Hills of Scotland can be dated to the upper Llandovery (Telychian) (Lamsdell 2011), which translates to an age of around 433–438 Ma. Unfortunately, the fossil itself lacks details and is recognisable as a scorpion only in outline. A near contemporary, and better preserved, Scottish scorpion is *Allopalaeophonus caledonicus* (Hunter, 1886) from Dunside, Logan Water, Lesmahagow. This important fossil was redescribed by Pocock (1901). The Logan Water site spans the *c.* 433 Ma Llandovery/Wenlock boundary (Fig. 1), but it is unclear exactly which formation, and thus which side of the boundary, incorporates the Dunside locality (J. Lamsdell, pers. comm.).

Another well preserved find is *Palaeophonus nunciatus* Thorell & Lindström, 1884 from the Lower Wenlock (*c.* 430–433 Ma) of Visby on the island of Gotland, Sweden. A more detailed description of this spectacular specimen can be found in Thorell & Lindström (1885). We should also draw attention to the comments of Petrunkevitch (1955: P69), and the subsequent editorial notes on the same page, regarding authorship and the correct spelling of the genus name. Confusion was caused by an incorrect name *Palaeophoneus* being previously used in a letter to Milne-Edwards, formally published by Lindström (1884). The species *Proscorpius osborni* (Whitfield, 1885) is a slightly younger record from the Pridoli (*c.* 416–419 Ma) Phelps

Member of the Fiddlers Green Formation, which is part of the Bertie Group (the so-called Bertie Waterlime) at Waterville (= Forge Hollow), Oneida County, New York, USA. This species, together with a number of taxa regarded as its junior synonyms, was recently redescribed by Dunlop, Tetlie & Prendini (2008), and numerous examples of this early scorpion are now known. From the Pridoli there is a further scorpion species, *?Palaeophonus lightbodyi* Kjellesvig-Waering, 1954, from Ludford Lane in Shropshire, England. However, this species was erected for an isolated pedipalpal claw which cannot be compared meaningfully to other taxa.

Here, we report a new record of a fossil scorpion from the Silurian of Powys in Wales. This is only the sixth locality to yield a scorpion from this time period, and its Ludlow age (*c.* 425 Ma) puts it in a gap between the older Wenlock/Llandovery and younger Pridoli records (Fig. 1). Although incomplete, at least the ornamented carapace (Fig. 2) can be assigned with some confidence to Scorpiones (see below) and, interestingly, this carapace shows similarities to the morphology of some of the huge Palaeozoic scorpion species from the later Devonian and Carboniferous.

Material and methods

The fossils were collected by Paul Whalley (formerly of the Natural History Museum, London) from Capel Horeb Quarry near Halfway, about 5 km west of Trecastle, Powys, Wales. They were originally labelled as ‘scorpion or eurypterid’ and the age given as ‘Ludlovian–Whitecliffian’ [sic]. In Britain, the Ludlow epoch of the Silurian was previously divided into four regional stages (from oldest to youngest): Eltonian, Bringewoodian, Leintwardian, and Whitcliffian. These traditional names have now largely been abandoned – see Cramer *et al.* (2011) for a modern correlation of the Silurian across different continents – and the fossils described here are thus of early Ludfordian age, which forms the later part of the Ludlow epoch, and corresponds to *c.* 422.5–425.6 Ma in age (Fig. 1). Capel Horeb Quarry is world famous as the site where the oldest unequivocal evidence of vascular plants (*Cooksonia*) has been found (Cleal & Thomas 1995; Aldridge *et al.* 2000). Whether this impacts on the original habitat of the scorpion fossils is a moot point. The evidence for early Palaeozoic scorpions having been aquatic, as assumed by e.g. Pocock (1901) and Kjellesvig-Waering (1986) has, in recent years, been increasingly challenged (reviewed by Köhl *et al.* 2012).

The present material is deposited in the Natural History Museum, London (NHM) under the repository numbers IA178–185. The most informative of these is a fairly complete carapace fragment (IA178), which is unequivocally a scorpion, as well as a series of isolated sclerites and other cuticle fragments (IA179–182) which may be scorpion in nature, but which do not reveal enough distinctive features in their shape and/or ornament to confirm whether they belong to the same taxon as the isolated carapace. Three further fossils (IA183–185) from the same locality are poorly preserved fragments with only hints of segmentation, and may not actually be arthropod in nature. Fossils were compared to the literature, in particular the monograph of Kjellesvig-Waering (1986) and references

SYSTEM	SERIES	STAGE	AGE Ma	FOSSIL SCORPION	LOCALITY
SILURIAN	PRIDOLI		419.2	? <i>Palaeophonus lightbodyi</i> Kjellesvig-Waering, 1954 <i>Proscorpius osborni</i> (Whitfield, 1885)	Ludford Lane, Shropshire, England Waterville, Oneida Co., New York
	LUDLOW	LUDFORDIAN	423.0	<i>Scorpiones incertae sedis</i> (this paper)	Capel Horeb, Trecastle, Powys, Wales
		GORSTIAN	425.6		
	WENLOCK	HOMERIAN	427.4	<i>Palaeophonus nuncius</i> Thorell & Lindström, 1884	Visby, Gotland, Sweden
		SHEINWOODIAN	430.5		
	LLANDOVERY		433.4	<i>Allopalaeophonus caledonicus</i> (Hunter, 1886)	Dunside, Logan Water, Lesmahagow, Scotland
		TELYCHIAN		<i>Dolichophonus loudonensis</i> (Laurie, 1899)	Gutterford Burn, Pentland Hills, Scotland
		AERONIAN	438.5		
			440.8		
		RHUDDANIAN			
			443.4		

Fig. 1: Chronostratigraphic chart of the Silurian period showing approximate ages in millions of years (Ma, after International Commission on Stratigraphy 2012), and the positions of the four fossil scorpion genera previously recorded from this time period, together with the new material described here.

therein. Specimens were photographed using a Canon EOS 5D MkIII digital camera mounted on a Leica MZ12.5 stereomicroscope, both dry (Figs. 2, 3C,D) and under ethanol (Fig. 3A,B). Ethanol immersion is used to enhance contrast between the organic matter and the rock matrix. Drawings were prepared using a camera lucida attachment on the same microscope. All measurements are in mm.

Scorpiones incertae sedis (Figs. 2–3)

Material: NHM IA178–185. Upper Roman Camp Bed Formation, Capel Horeb Quarry, 5 km west of Trecastle, Powys, Wales, United Kingdom (SN 8444 3238), leg. P. Whalley. Silurian (Ludlow: Ludfordian).

Description: NHM IA178, largely complete carapace (Fig. 2), subrectangular and tapering slightly anteriorly. Maximum length 22.0, maximum width 19.1. Anterior margin slightly procurved and narrowly rebordered. Median eyes positioned *c.* 3 mm from anterior margin; paired and distinctly recessed with a raised median region between the lenses. Eye region slightly raised and demarcated. Posterior to eyes, carapace divided by a distinct median sulcus, length *c.* 6, which apparently bifurcates into two curving sulci (better seen on right side) extending towards the lateral margins. Posterior half of carapace ornamented with scattering of pustules; diameter *c.* 0.6. A row of smaller pustules follows the posterior boundary of the lateral sulcus. Lateral eyes and any appendages equivocal.

IA179, somewhat amorphous cuticle fragment (Fig. 3A,E); conceivably the last mesosomal segment (i.e. tergite or sternite 7) of a scorpion, based on its subtriangular tapering form and indented posterior margin. Length *c.* 15, maximum width *c.* 33. Details and ornament equivocal.

IA180, cuticle fragment (Fig. 3B,F), possibly a distorted carapace (as per the original specimen label), maximum length *c.* 19, maximum width *c.* 17. Parts of specimen with clearly demarcated (?posterior) margins, but details and ornament equivocal.

IA181, partial sclerite (?tergite or sternite) (Fig. 3C,H), length 11.5, maximum preserved width 22.7, with a straight anterior margin and a more smoothly rounded posterolateral margin.

IA182, three-dimensional, somewhat spindle-shaped cuticle fragment (Fig. 3D,G), possibly a limb article of some description, but details obscure. Maximum length 19.5, maximum width 5.8.

Remarks: The anteriorly positioned median eyes on the best preserved carapace (NHM IA178, Fig. 2) are the key character here. This morphology is much more consistent with a (Palaeozoic) scorpion than, for example, with a eurypterid (Chelicerata: Eurypterida) in which the median eyes tend to be far more central. For recent illustrations of some contemporary Silurian eurypterids see Lamsdell (2011). Indeed, the preserved morphology, with a carapace tapering slightly anteriorly, a distinct medial sulcus behind the eyes curving round into lateral sulci, and a pustulate cuticle ornament has notable parallels with the carapace of the large fossil scorpion *Gigantoscrapio willsi* Störmer, 1963 from the Early Carboniferous of Scotland; see especially Kjellesvig-Waering (1986) (Fig. 4). The fragmentary, but enormous, Devonian scorpion *Praearcturus gigas* Woodward, 1871 from England also has a strongly pustulate and medially divided carapace with laterally extending sulci (Fig 5). *Praearcturus gigas* had a carapace width of about 10 cm and thus may have approached nearly a metre in body length; indeed, it was originally misinterpreted as a (large) crustacean. With its *c.* 2 cm long carapace, our Welsh fossil

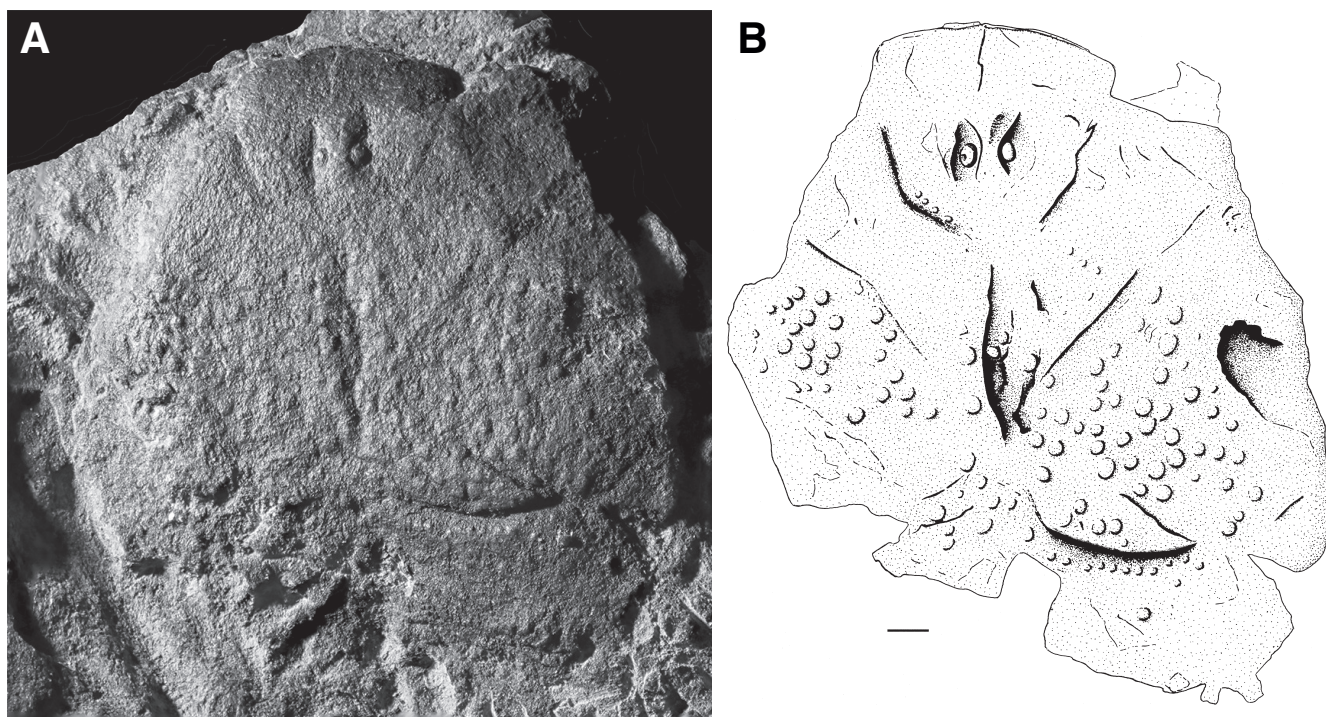


Fig. 2: *Scorpiones incertae sedis*, specimen NHM IA178; partially complete scorpion carapace from the Silurian (Ludlow: Ludfordian) Upper Roman Camp Bed Formation, Capel Horeb Quarry, 5 km west of Trecastle, Powys, Wales. **A** Photograph of the specimen; **B** camera lucida drawing of the same. Scale bar = 1 mm.

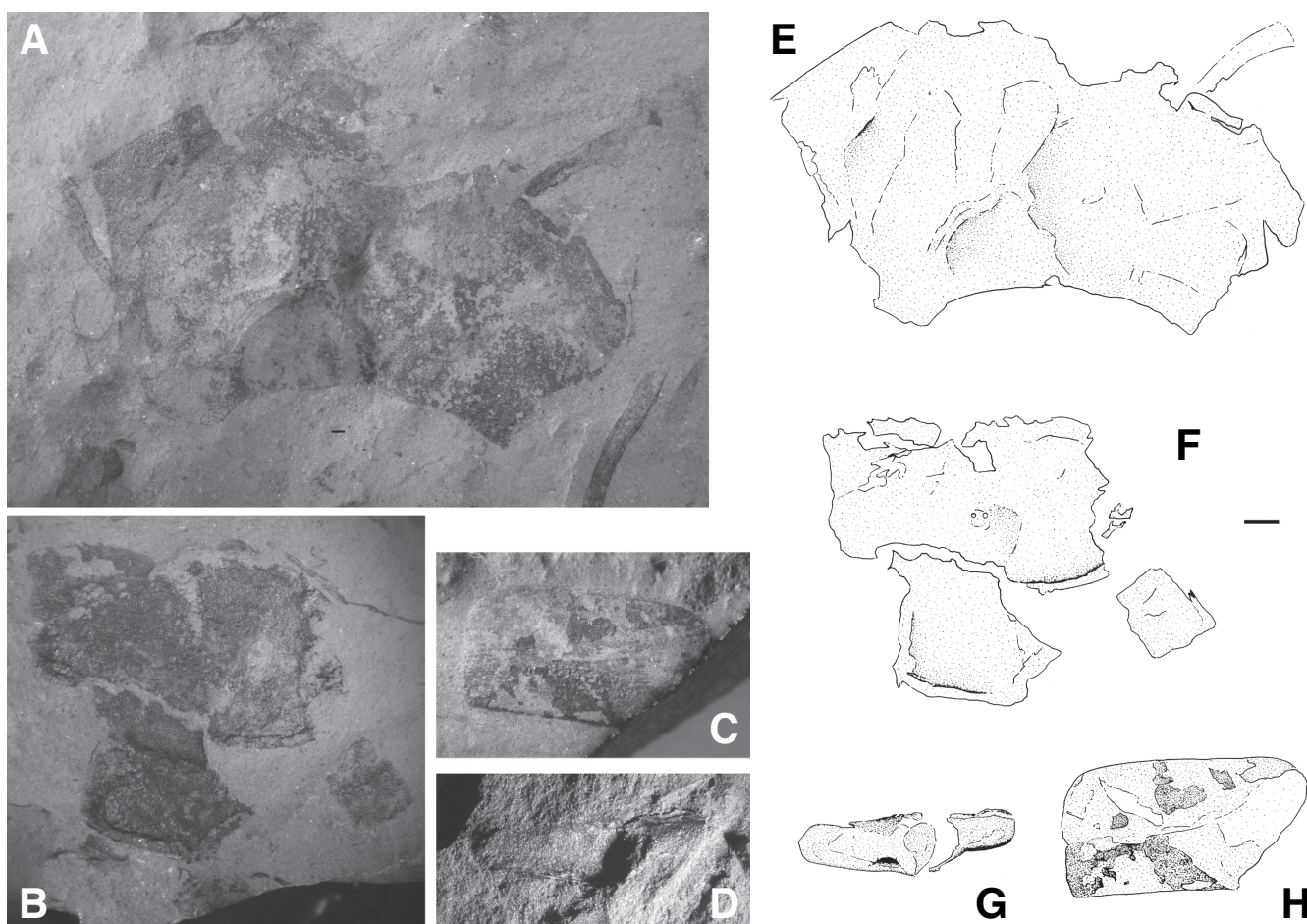


Fig. 3: Additional putative scorpion fragments collected from the same locality near Trecastle. **A** NHM IA179, last mesosomal segment with procurved posterior margin? under ethanol; **B** IA180, carapace with posterior rebordering? under ethanol; **C** IA181 partially complete tergite or sternite with curved posterolateral margin; **D** IA182, limb fragment? **E–H** Camera lucida drawings of the specimens shown in the photographs. **E** NHM IA179; **F** IA180; **G** IA182; **H** IA181. Scale bar = 1 mm.

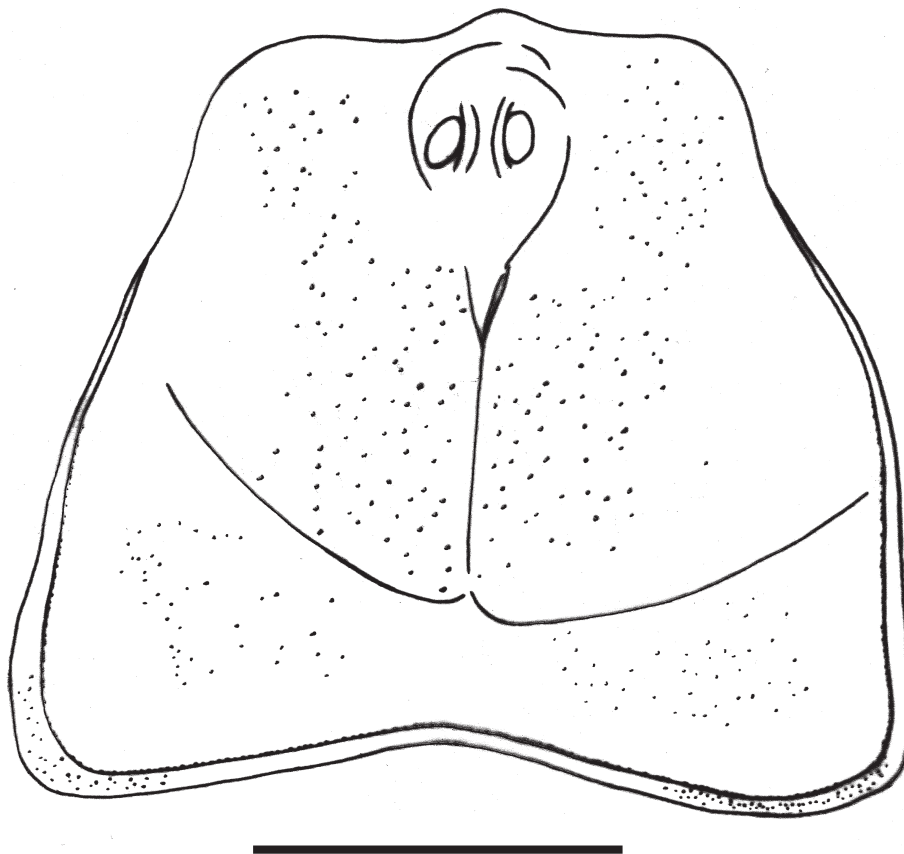


Fig. 4: Carapace of *Gigantoscorpio willsi* Störmer, 1963 from the Early Carboniferous of Glencartholm, Scotland; redrawn from Kjellesvig-Waering (1986: fig. 27D). Note the similar outline shape and sulcus pattern as compared to the specimen shown in Fig. 2. Scale bar = 1 cm.

would probably scale up to an animal about 15–20 cm long. This is towards the larger end of the scale, yet still within the size range of modern scorpions. That said, if some of the other fragments – such as the more than 30 mm wide cuticle fragment IA179 (Fig. 3A), or the nearly 12 mm long sclerite IA181 (Fig. 3C) – also belong to the same scorpion species, we could theoretically be looking at an animal towards the 30 cm body length range.

Among the other Silurian records, a similarly bilobed carapace is observed in the Swedish species *Palaeophonus nuncius*, although this specimen has a smoother and more quadrate carapace, without the ornament seen in the Welsh fossil (*cf.* Thorell & Lindström 1885). The carapace of *Proscorpius osborni* is completely smooth, without sulci or pustules (Dunlop, Tetlie & Prendini 2008), while the carapace morphology in *Dolichophonus loudonensis* and *Allopalaeophonus caledonicus* remains largely equivocal due to the poor preservation of the former (Laurie 1899) and the superimposition of dorsal and ventral features in the latter (Pocock 1901).

Given such uncertainties, we are reluctant to place our incomplete Welsh specimen into any particular family or genus. As noted elsewhere (e.g. Dunlop, Tetlie & Prendini 2008) the higher systematic scheme for Palaeozoic fossil scorpions proposed by Kjellesvig-Waering (1986) is problematic, with numerous poorly defined and often monotypic families and superfamilies. Pending a thorough revision of these fossils we prefer to leave the position of our new material open, but stress again its significance as one of only a very few scorpions from the Silurian (Fig. 1). It provides

further evidence that these animals were already established in a recognisable form by at least 430 million years ago.

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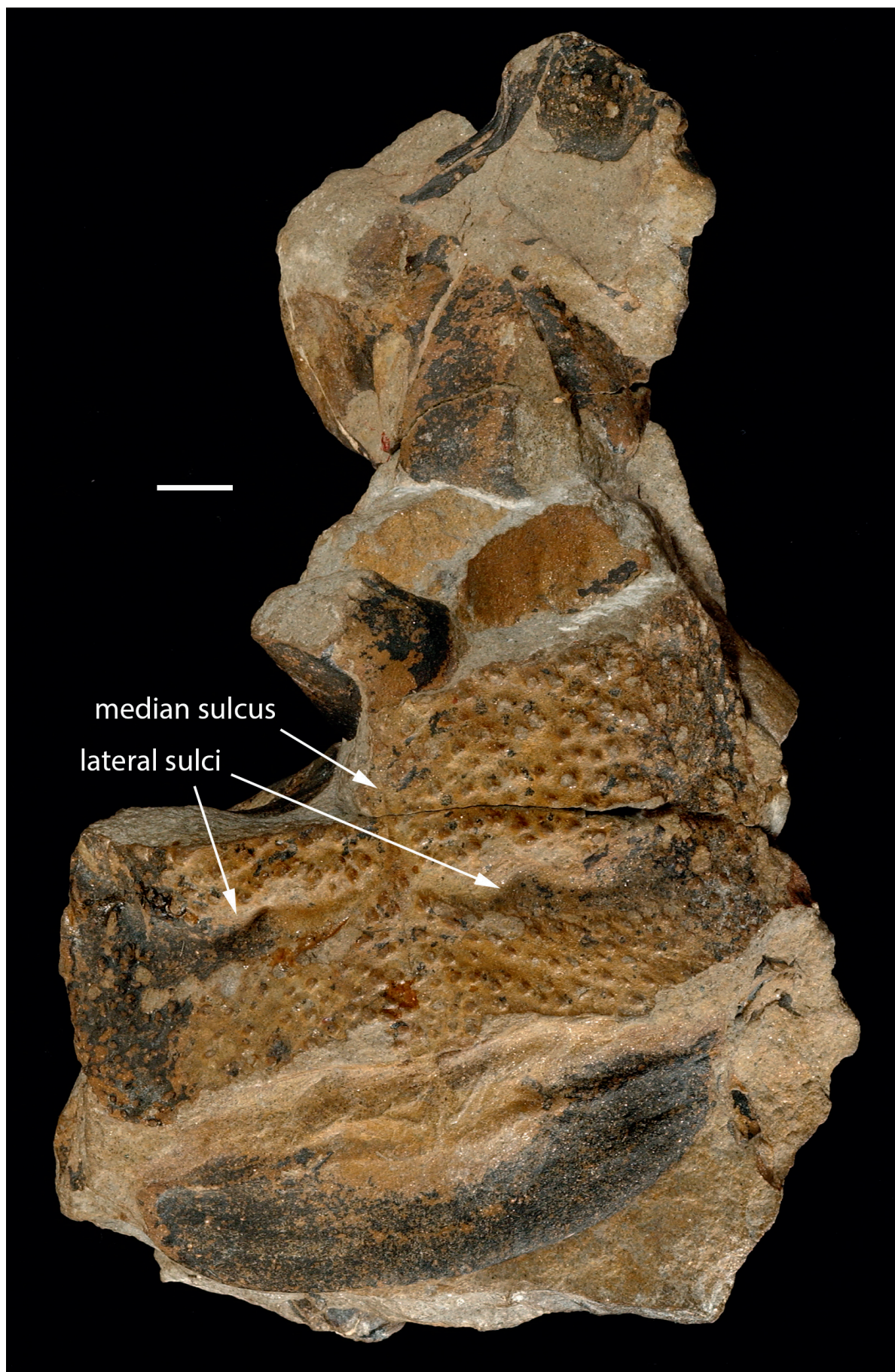


Fig. 5: Fragment of the posterior carapace region of *Praearturus gigas* Woodward, 1871 (NHM I.534) from the Early Devonian of Rowlestone, Herefordshire, England. The central, pustulose area is part of the carapace, crossed by median and lateral sulci. Note the size of this enormous fossil scorpion, which had a carapace about 10 cm across, and the similar pattern of strong pustulation and bifurcating sulci compared to our new Silurian material. Scale bar = 1 cm. © Natural History Museum, London.

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