

A new specimen of the Silurian synziphosurine arthropod *Cyamocephalus*

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ANDERSON, L. I. 1998. A new specimen of the Silurian synziphosurine arthropod *Cyamocephalus*. *Proceedings of the Geologists' Association*, **110**, 211–216. The synziphosurine (Chelicerata, Xiphosura) *Cyamocephalus loganensis* Currie, 1927 is known from two specimens from the UK: one from the Lesmahagow Inlier, Scotland, and another from Leintwardine, England. A third specimen, newly identified in the collections of the Oxford University Museum, is described here, and a morphological reconstruction of *Cyamocephalus* is presented for the first time.

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1. INTRODUCTION

Xiphosurans ('horseshoe crabs') are aquatic arthropods allied with spiders, scorpions and the extinct eurypterids within the Chelicerata. Their scarcity as fossils is a reflection of the unusual conditions required to preserve their unmineralized cuticular exoskeletons which are often only met with in sites of exceptional preservation, so-called Konservat-Lagerstätten (Allison & Briggs, 1991). In this paper, a specimen of the monotypic synziphosurine (primitive xiphosuran) *Cyamocephalus loganensis* Currie, 1927, which was identified by the author whilst examining the collections of the Oxford University Museum in December 1995, is described and figured. It is of importance as it is only the third specimen of this taxon known and allows a revised diagnosis of the genus to be made in the light of recent work on this group (Anderson & Selden, 1997). A reconstruction of this synziphosurine is presented for the first time, incorporating new morphological data.

2. MATERIALS AND METHODS

This study is based on a single, relatively complete xiphosuran in the collections of the Oxford University Museum, catalogued as OUM C.20151 (Figs 1 & 2). The associated label bears the information that it was originally identified as *Hemiaspis* (= *Limuloides*) by Dr R. B. Grindrod, and formed part of an extensive collection bequeathed to the museum upon his death in 1882. Grindrod was a medical doctor and a keen amateur collector of fossils from the Malvern area. Salter in Symonds & Lambert (1861) noted that Grindrod, amongst others, had collected many well-preserved fossils from the Woolhope beds near Malvern.

The synziphosurine is preserved as a negative relief in an olive-green, micaceous siltstone. To facilitate its study, a black latex cast was prepared to produce a positive of the fossil which was whitened with ammonium chloride and

photographed under slightly oblique light to bring out surface detail. A *camera lucida* drawing was prepared using an Olympus stereomicroscope with a drawing tube attachment. A wide variety of xiphosurid and synziphosurine fossils were studied for comparison, including the holotype of *Cyamocephalus loganensis* Currie, 1927 in the Natural History Museum, London (NHM I. 16521) and the paratype (Eldredge & Plotnick 1974) (NHM I. 25). Preserved exoskeletons of the extant xiphosuran *Limulus polyphemus* were also studied for the purposes of comparative morphology. Morphological terminology follows Anderson (1996).

3. DEPOSITIONAL AND PRESERVATIONAL SETTING

Although the provenance details of OUM C.20151 are scant, the associated collections are of the same lithology as that yielding the famous Silurian starfish of Church Hill, Leintwardine. As such, it is reasonable to assume that this is the locality yielding the synziphosurine fossil. Corroborative evidence comes from other synziphosurines recorded from this site including *Limuloides limuloides* Woodward, 1865 (see Anderson *et al.* in press), *Limuloides speratus* Woodward, 1872 (probably a junior synonym of *L. limuloides*) and *Bunodes salweyi*, Woodward, 1872 (see Morris 1980), demonstrating that conditions were indeed amenable to the preservation of unmineralized arthropod cuticles there. Examination of these other synziphosurines in the collections of the Manchester Museum and the Natural History Museum, London revealed that they are in an identical lithology and do, in fact, come from Church Hill. Viewed on a regional scale, occurrences of *Limuloides limuloides* are geographically restricted to the Leintwardine area.

The distribution of these fossils is likely to represent a preservational bias exerted by unusual physio-chemical conditions in the channel fills of the submarine canyons

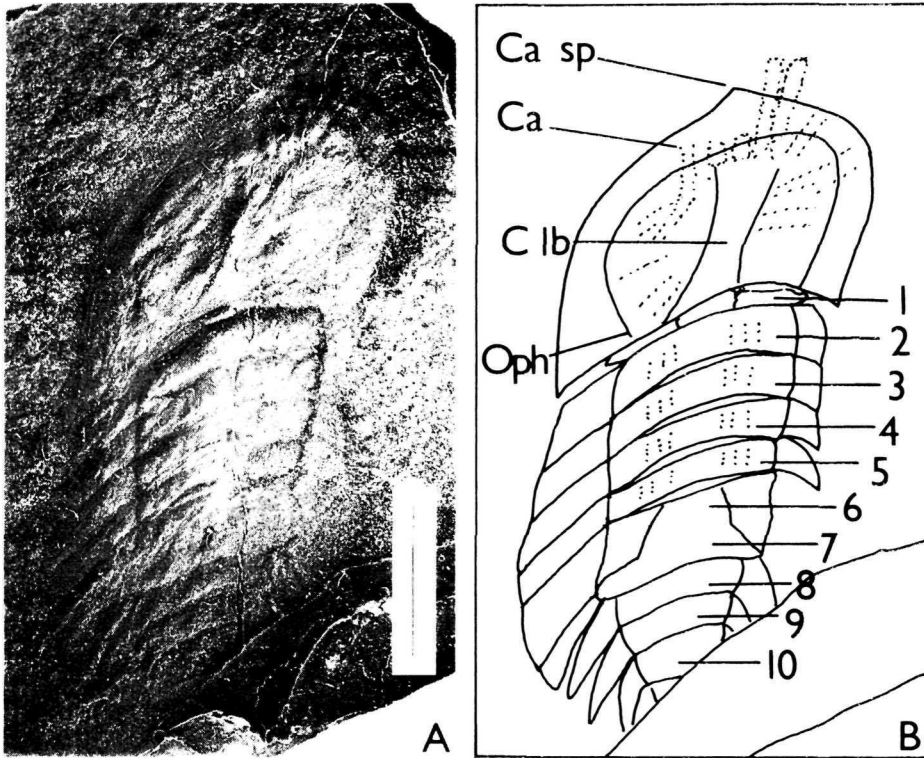


Fig. 1. (A) Photograph of cast of specimen OUM C.20151. Cast of fossil coated with ammonium chloride. Scale bar 1 cm. (B) *Camera lucida* drawing of OUM C.20151. Abbreviations as follows: Ca, carapace; Ca sp, carapace spine; C lb, cardiac lobe; Oph, ophthalmic ridge; 1–10, opisthosomal segments one to ten.

detailed by Whitaker (1962). Indeed, his reconstruction of the topography and fauna of one of these submarine channels (p. 341) included phyllocarid crustaceans, eurypterids and a xiphosuran. These biotic elements were detailed as unusual fauna concentrated within the channel, whilst current terminology would probably regard this site as a Konservat-Lagerstätte (*sensu* Allison & Briggs, 1991). Whitaker (1962: p. 340) indicated that the sediments at the base of these submarine channels contained worn and derived fossils. Additionally, sedimentary structures such as prod and groove marks, and aligned graptolite axes indicated that there was turbulent directional movement of water down slope. Sedimentation may therefore have been dominated by periods of quiescence interrupted by rapid influx of sediment in the form of muddy density flows which effectively smothered benthic elements of the indigenous fauna, concealing them from the attentions of scavengers. This would account for the relatively undisturbed arthropod exoskeletons.

The majority of synziphosurine fossils are reported from sediments of marginal marine origin where they are associated with eurypterids, in particular. Anderson *et al.* (in

press) describe such a situation for the Lower Devonian synziphosurine *Willwerathia* Störmer, 1969. However, the preservational environment of these fossils seems somewhat different, occurring as they do within a deeper water setting more akin to that described for the Lower Devonian synziphosurine *Weinbergina* Stürmer & Bergström, 1981. Although caution must be exercised in stretching analogies between living *Limulus* and these Silurian forms, primarily due to their differing morphologies, there are reports of horseshoe crabs in open marine waters. Shuster (1982) cited *Limulus* as having been trawled up from the continental shelf at depths of 246 m. Such examples of these animals in deeper water environments are rare, with most observations being made whilst they are on the spawning beaches or swimming in inter-tidal waters. However, it does point to the possibility of their presence as fossils in deep water deposited sediments given the correct preservational conditions. The association of the synziphosurines with starfish, phyllocarid crustaceans, graptolites and eurypterids does suggest that they were part of a deeper water fauna actually inhabiting the submarine channels rather than representing an allochthonous or washed-in element.

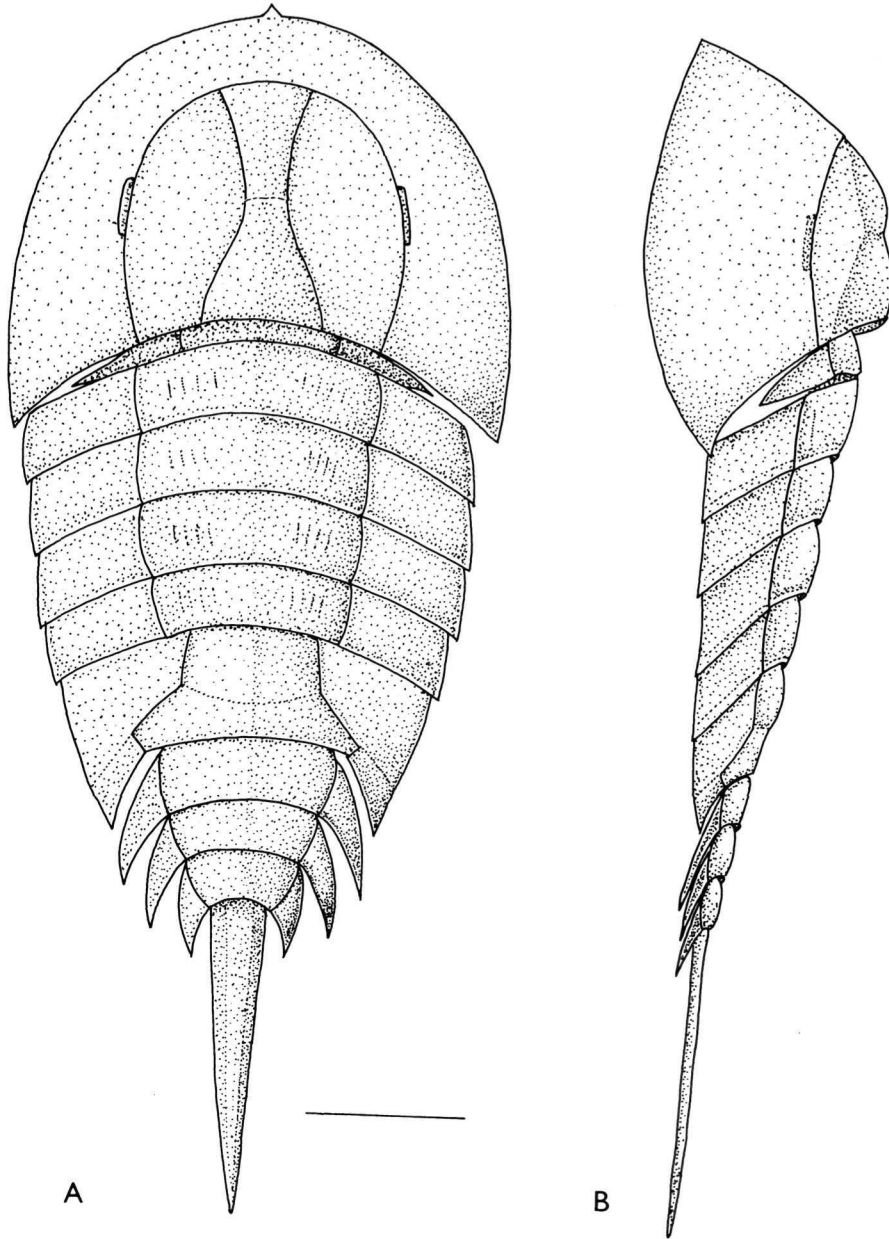


Fig. 2. Morphological reconstruction of *Cyamocephalus loganensis* Currie, 1927. (A) Dorsal view illustrating the fusion of the sixth and seventh visible tergites to form the distinctive region directly anterior to the post-abdominal tergites. (B) Lateral view illustrating the convexity of both the carapace and opisthosomal segments.

4. SYSTEMATIC PALAEOONTOLOGY

Phylum CHELICERATA Heymons, 1901

Class XIPHOSURA Latreille, 1802

Plesion (Family) PSEUDONISCIDAE Packard, 1886

Silurian, Late Wenlock Series, 'Eurypterus' Dolomite, Rootsiküla Stage, Saaremaa, Estonia. By subsequent designation.

Type genus. *Pseudoniscus* Nieszkowski, 1859; latest Lower Silurian. Other genera. *Cyamocephalus* Currie, 1927.

Familial diagnosis. Xiphosura with ten visible opisthosomal segments, the axial portions of which are equal to, or slightly narrower than the corresponding lateral portions of each segment. Opisthosomal segment one expressed as a reduced articulating microtergite. Posterior margin of carapace developed into cornua. Anterior medial carapace spine present (emended from the diagnosis of Eldredge, 1974).

Genus *Cyamocephalus* Currie, 1927

Type Species. *Cyamocephalus loganensis* Currie, 1927. By monotypy.

Diagnosis. Pseudoniscids exhibiting fusion of the sixth and seventh opisthosomal segments only (emended from Eldredge & Plotnick, 1974).

Discussion. Eldredge & Plotnick (1974) presented a diagnosis, emended from the original diagnosis of Currie (1927), for this monotypic genus based on re-examination of the holotype and an additional specimen which they elected as paratype. The dorsal fusion of tergites 6 and 7 in this form is a diagnostic autapomorphy, contrary to the opinion of Stürmer & Bergström (1981). Eldredge (1974) commented that opisthosomal segments 6 and 7 appeared to be fused in some specimens of *P. roosevelti* Clarke, 1902 although he also stated that the evidence for this was somewhat scant. Under the new diagnosis given above, it could be that some of these specimens belong in *Cyamocephalus* rather than *Pseudoniscus*. Eldredge & Plotnick (1974) also suggested that *Cyamocephalus* appeared to be the most derived pseudoniscid, a view with which I concur.

Occurrence. *Cyamocephalus* is recorded from the type locality, Lesmahagow, where it is poorly stratigraphically constrained. In addition to the type locality, *Cyamocephalus* was identified from the Upper Silurian (Ludlow Series) of Shropshire by Eldredge & Plotnick (1974) and also in this study.

Cyamocephalus loganensis Currie, 1927
(Figs 1–2.)

- 1927 *Cyamocephalus loganensis* sp. nov., Currie, p. 155, fig. 1.
 1955 *Cyamocephalus loganensis* Currie; Størmer, p. 17, fig. 11(11).
 1974 *Cyamocephalus loganensis* Currie; Eldredge, p. 32.
 1974 *Cyamocephalus loganensis* Currie; Eldredge & Plotnick, pp. 1–10, figs 1, 2, table 1.
 1974 *Cyamocephalus* cf. *Cyamocephalus loganensis* Eldredge & Plotnick, p. 7, fig. 2 A&B.
 1975 *Cyamocephalus loganensis* Currie; Bergström, p. 304.
 1987 *Cyamocephalus loganensis* Currie; Selden & Drygant, p. 541.

Holotype. A poorly preserved synziphosurine in dorsal aspect, NHM I. 16521 figured by Currie (1927; p. 155, fig. 1.) and Eldredge & Plotnick (1974; p. 5, fig. 1.).

Type stratum and locality. Lower Silurian, Upper Llandovery, Telychian, ?Patrick Burn Formation, Logan Water, Lesmahagow, Strathclyde, Scotland, UK (stratigraphic information from Selden (1993; p. 300). However, more recent palynological investigation of this site suggests an early Wenlock age (Wellman, 1995; Wellman & Richardson, 1993).

Additional material. The paratype specimen, NHM I. 25, is in the collections of the British Museum (Natural History), London, England, UK. Specimen OUM C.20151 is in the collections of the Oxford University Museum and constitutes only the third known occurrence of this species.

Diagnosis. As for the genus.

Description. Carapace spatulate with large genal cornua extending back as far as the second opisthosomal segment. Antero-medial carapace spine present. Cardiac lobe triangular, tapering rapidly anteriorly. Series of radiating ridges emanate from the cardiac lobe region and are bounded by paired ophthalmic ridges. Cuticle covered by coarse tubercles along ophthalmic ridges. Opisthosoma of ten visible segments with well-defined axial and lateral regions. First opisthosomal segment small, narrow with thin lateral spines. Segments 2–4 subequal in length; segment 5 relatively short. Three pairs of transversely running ridges cross opisthosomal segments 2–5 parallel to the long axis of the fossil. Segments 6 and 7 fused. Sixth segment short, seventh long, possibly hypertrophied. Lateral regions of segments 8–10 taper into sharp spines, whilst preceding six segments have short, blunt epimera. Tail spine triangular in cross-section. Specimen shows signs of shear deformation as well as the expected compactional deformation inherent in many unmineralized arthropod fossils. However, dimensions are as follows: carapace length 11 mm, pre-abdomen length 12 mm, post-abdomen length 6 mm (exposed). A morphological reconstruction of *Cyamocephalus loganensis* Currie, 1927 is presented in Fig. 2.

Discussion. The most recent classification of the Palaeozoic Xiphosura by Anderson & Selden (1997) recognized *Cyamocephalus* as a sister taxon to *Pseudoniscus* Nieszkowski, 1859 in an unnamed taxon. This was based on the cladistic analysis they performed. The reason for this particular classification was due to a three-taxon problem relating to *Cyamocephalus*, *Pseudoniscus* and *Kasibelinurus*. All three taxa had unique apomorphies. However, the recognition of an anterior medial carapace projection (Character 25 of Anderson & Selden, 1997) in this specimen of *Cyamocephalus*, a character previously only seen in *Pseudoniscus* and *Legrandella* gives a synapomorphy between *Cyamocephalus* and *Pseudoniscus*.

Table 1. Synziphosurine genera recorded from Silurian Konservat-Lagerstätten

Locality	Synziphosurine taxa	Stratigraphic age
Lesmahagow, Scotland	<i>Cyamocephalus</i> , <i>Pseudoniscus</i>	Early Wenlock
Saaremaa, Estonia	<i>Bunodes</i> , <i>Pseudoniscus</i>	Late Wenlock
Velyka Slobidka, Podolia, Ukraine	<i>Pasternakevia</i>	Middle Ludlow
Leintwardine, England	<i>Cyamocephalus</i> , <i>Limuloides</i>	Ludlow
Bertie Waterlime, New York State, USA	<i>Bunodes</i> , <i>Pseudoniscus</i>	Pfärdol

All of these genera apart from *Pseudoniscus* are monospecific.

The synziphosurines mentioned, but not named by Kluessendorf (1994) in a study of North American sites are not included here.

For this reason, *Cyamocephalus* and *Pseudoniscus* are reunited in the Family Pseudoniscidae.

The pattern of low diversity and narrow taxonomic categories exhibited by extant horseshoe crabs revealed by Shuster (1962) appears to hold true for the well known Carboniferous forms *Euproops*, *Bellinurus* and *Liomesapsis* (Anderson & Selden, 1997). However, the monospecific synziphosurine genera listed in Table 1 reveals that this pattern is also evident earlier back in the geological history of the Xiphosura. Perhaps this is one of the underlying reasons for the group's longevity.

Finally, there exists the possibility that further synziphosurine fossils remain undescribed within existing museum collections. The most likely cause is misidentification as, and inclusion with, eurypterid fossils primarily due to the superficial similarities in body plan (a semi-circular carapace, a body divided into a broad pre- and reduced post-abdomen and possession of a thin tail spine). However, synziphosurines differ from eurypterids in that

they possess fewer opisthosomal segments (10 as opposed to 12), the opisthosomal segments are characterized by the presence of a raised axial column in synziphosurines and the post-abdominal region consists of 3 rather than 5 segments. The close preservational association of synziphosurines and eurypterids may also contribute to this problem.

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