Carl, bestwishes, Lyall.

N. Jb. Geol. Paläont. Mh.	**1995**, H. 11	647–658	Stuttgart, Nov. 1995

Valloisella lievinensis RACHEBOEUF, 1992 (Chelicerata; Xiphosura) from the Westphalian B of England

By **Lyall I. Anderson** and **Carl Horrocks**, Manchester

With 3 figures in the text

ANDERSON, L. I. & HORROCKS, C. (1995): *Valloisella lievinensis* RACHEBOUEF, 1992 (Chelicerata; Xiphosura) from the Westphalian B of England. – N. Jb. Geol. Paläont. Mh., **1995** (11): 647–658; Stuttgart.

Abstract: Two small xiphosurans are described from geographically separate Westphalian B sites in England and assigned to *Valloisella lievinensis* RACHEBOEUF, 1992. *Valloisella* is removed from Euproopidae ELLER, 1938 and placed in Paleolimulidae RAYMOND, 1944.

Zusammenfassung: Zwei kleine Xiphosuren aus geographisch getrennten Fundorten in England (Alter: Westfal B) werden beschrieben und der Art *Valloisella lievinensis* RACHEBOEUF 1992 zugeordnet. *Valloisella* wird von den Euproopidae ELLER, 1938 in die Paleolimulidae RAYMOND, 1994 übertragen.

Introduction

DIX & JONES (1932) reported a small arthropod from the roof shales of the Little Vein coal in the lower part of the *A. pulchra* zone (Westphalian B) from Blaina Colliery, Pantyffynon, South Wales. The specimen was illustrated by way of a line drawing and was reported to have been deposited in the collections of the University College of Swansea under the acquisition number A. 152. The arthropod was found associated with non-marine bivalves and the other, more commonly encountered, Coal Measures xiphosuran, *Bellinurus* PICTET, 1846. The tripartite division of the fossil into a prosoma, opisthosoma and tail spine led DIX & JONES (1932) to compare their specimen with the extant xiphosuran *Limulus polyphemus*. They concluded that it was a post-larval, but immature, stage of an aquatic chelicerate but did not formally assign it a name.

STORMER (1955) copied DIX & JONES's line drawing for the „Treatise of Invertebrate Paleontology" (p. 19, fig. 13, 2) and placed the form in superfamily and family uncertain, genus undetermined. He also gave incorrect locality details for the fossil, stating that it was from England and not from Wales. BERGSTRÖM (1975: 296.) briefly mentioned the specimen

 0028-3630/95/1995-0647 $ 3.00

described by DIX & JONES (1932) and remarked that it was probably the oldest limulacean (Superfamily Limulacea ZITTEL 1885) known at that time. He suggested that it may belong in *Paleolimulus* DUNBAR, 1923. Since 1975, the stratigraphically older limulaceans *Xaniopyramis* SIVETER & SELDEN, 1987 and *Rolfeia* WATERSTON, 1985 have been described. STÜRMER & BERGSTRÖM (1981) pictured the same specimen in a diagram of the evolutionary relationship (p. 253, fig. 8) between the different groups of the Xiphosura. FISHER (1984) did not mention the specimen in his text but placed it at the same stratigraphic level as *Euproops anthrax* (PRESTWICH, 1840) which is Westphalian B in age, in a phylogenetic tree (p. 199, fig. 2), referring to it as *Paleolimulus* sp. WATERSTON (1985) also mentioned the specimen, considering it to be a possible *Paleolimulus*.

After an extensive search of all of the British museums housing xiphosuran fossils and the remaining Swansea collection now housed in the National Museum of Wales, Cardiff, the original specimen described by DIX & JONES (1932) could not be found and must be considered lost (S. HOWE, pers. commun.). However, the fossils described herein are virtually identical to that figured by DIX & JONES and in some respects are more informative, allowing their tentative placement in *Valloisella* RACHEBOEUF, 1992.

Preservation and taphonomic history

The Dudley specimen (BU 2464)

The xiphosuran is preserved as a mould of the dorsal surface in dorsal aspect in a small, sideritic nodule. Part and counterpart were available for study. The specimen is part of the Hollier-Tilley Collection, Lapworth Museum (University of Birmingham) BU 2464. The accompanying documentation states that it was collected from a Coal Measures site near Dudley, Worcs. The Coal Measures strata in this area are Westphalian B in age (Upper Carboniferous) but unfortunately, this is the only stratigraphic detail available. The nearby site of Coseley (Westphalian B) has yielded *Bellinurus koenigianus* WOODWARD, 1872, *Bellinurus bellulus* KÖNIG 1851 (see SCHULTKA 1994: 347), and *Pringlia birtwelli* (WOODWARD, 1872). The mode of preservation of these forms is very similar to the specimen described here: patchy kaolinite and pyrite in siderite nodules.

The sideritic nodule enclosing the xiphosuran is ellipsoid in shape with a long axis (corresponding to the long axis of the fossil) of 25 mm and a width of 20 mm suggesting that the nodule was constrained in size by the fossil remains which it enclosed. The nodule has a light red-brown weathered outer surface, but is a much darker grey colour on the freshly exposed broken surface. The nodule is much darker in colour than any other sideritic nodules studied by the authors, perhaps suggesting a

higher organic carbon or clay content. Both patchy kaolinite and an unidentified sulphide mineral (probably pyrite or chalcopyrite) form a natural cast of the cuticle in much the same way as was described for the replacement of cuticle in fossil ricinuleids by SELDEN (1992). The prosoma, opisthosoma and tail spine are still articulated and lie in the same horizontal plane, suggesting minimal disturbance of the carcass prior to burial.

Since the fossil is three-dimensionally preserved in a sideritic nodule, it has been shielded from severe compactional compression, as detailed by ANDERSON (1994). It is unusual, therefore, to see cracks in what used to be the cuticle. Generally, compactional deformation of three-dimensional xiphosuran exoskeletons results in the formation of wrinkles and creases of the cuticle without breakage (PICKETT 1984). This is due to the pliable nature of the cuticle once it has passed the rigor mortis stage (BABCOCK 1994). Cracking of the cuticle may indicate dessication of the carcass prior to burial (L. BABCOCK, pers. commun.) and this may be as a result of subaerial strand-line exposure. Alternatively, the cracking in this instance, may simply result from fracture of the replacing mineral rather than any original feature of the cuticle.

The Bickershawe specimen (LL 11133)

During the course of examination of the Birmingham fossil, a second and better preserved fossil (LL 11133) was found by one of us (C. H.) at the Bickershawe Complex colliery tip near Leigh, Wigan. Both *Bellinurus* and *Pringlia* have recently been collected from the site further strengthening comparisons with Coseley and suggesting a Westphalian B age. Two cockroach wings, a uropygid arachnid and a few small fragments of scorpion cuticle have also been recovered from the site to date along with abundant plant material including *Annularia, Neuropteris* and *Mariopteris*. The bivalve *Naiadites* occurs frequently, however only one specimen has been found which can be attributed to *Anthraconaia* sp. These are all preserved in sideritic nodules with variable degrees of pyritisation. Unfortunately, the material is not preserved in situ, however all of the material listed above comes from a single, constrainable area of the spoil tip, and as such is likely to reflect original association.

LL 11133 is also preserved as a cast of the dorsal surface in dorsal aspect in a small, sideritic nodule. Again, part and counterpart were available for study. However, pyritisation of the cast is minimal and kaolinite appears to be absent. Instead, some of the holes in the siderite have been filled by sparry calcite. The carapace shows marked creasing of the cuticle and as a result of the degree of creasing, no detail of the cardiophthalmic topography can be discerned apart from the posterior of the cardiac lobe.

The small, movable, lateral, opisthosomal spines are preserved as dark stains on the siderite and are best observed under high magnification with the specimen immersed in 70% alcohol. The mode of preservation of the spines as thin films suggests that they were originally rather delicate structures and as a result, may not always be preserved.

It is worthy of note that the carapace of the holotype specimen of *Valloisella* and LL 11133 show marked creasing of the cuticle indicating pliability of the cuticular exoskeleton. The apparent absence of lateral spines in the holotype can be explained if minor disarticulation of the carcass, evinced by the lack of a tail spine, had taken place prior to burial. The lateral movable spines of *Limulus* are amongst the first items lost during transport and/or disarticulation of the carcass (L. BABCOCK, pers. commun.).

Systematic palaeontology

Class Xiphosura LATREILLE, 1802
Order Xiphosurida LATREILLE, 1802
Suborder Limulina RICHTER & RICHTER, 1929
Infraorder Limulicina RICHTER & RICHTER, 1929
Superfamily Limulacea ZITTEL, 1885
Family Paleolimulidae RAYMOND, 1944
Valloisella RACHEBOEUF, 1992

Holotype: MGL 5067 in the collections of the Musée Gosselet, Lille.

Emended diagnosis: Paleolimulidae lacking longitudinal opisthosomal ridges and inter-tergal ridge nodes. Carapace (prosoma) elongate and fingernail shaped with long genal spines. Opisthosomal axis pinched in half-way along its length. Carinate medial ridge runs the length of the opisthosomal axis. Opisthosoma possesses six pairs of movable spines.

Remarks: *Valloisella* is placed in the Paleolimulidae on the basis of the recognition of the opercular tergite (somite VIII of SELDEN & SIVETER 1987) forming a free lobe, with the axial portion of the tergite being encephalised. Additionally, the axial ridge of the opisthosoma still shows vestiges of the original segmentation. The lack of an associated movable spine with the free lobe negates placement in *Limulitella*. The lack of longitudinal opisthosomal ridges and intertergal ridges, and quadriradiate intertergal ridge nodes differentiates *Valloisella* from *Paleolimulus*. We agree with WATERSTON (1985) that the movable spines of the limulaceans are not homologous with the tips of the fixed tergal spines in *Euproops* or *Bellinurus*. The fixed spines identified in *Valloisella* are the sharp cuticular projections flanking the embayments in the opisthosomal flange in which the movable spines are positioned.

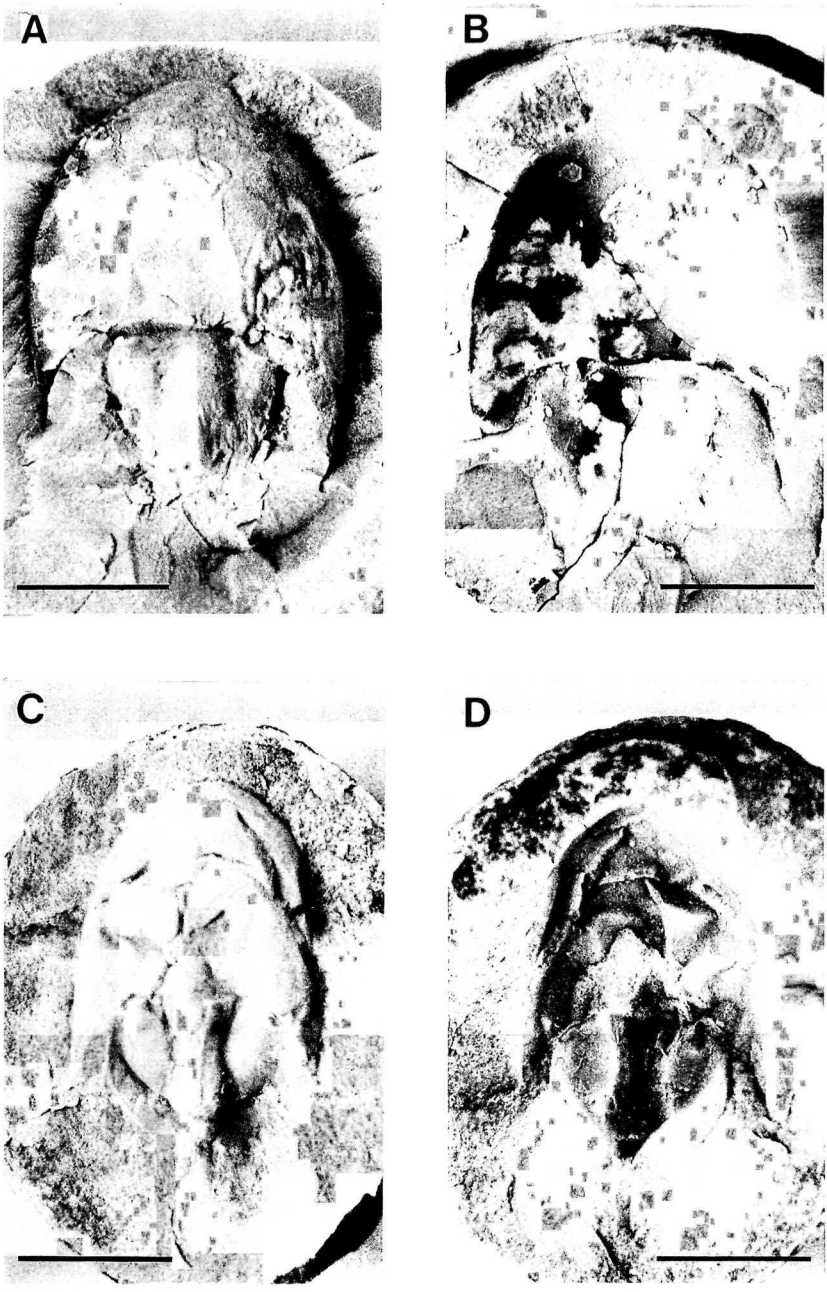

Fig. 1. *Valloisella lievinensis*. A, B: BU 2464 (part and counterpart); C, D: *Valloisella lievinensis*, LL 11133 (part and counterpart) (scale bar = 5 mm).

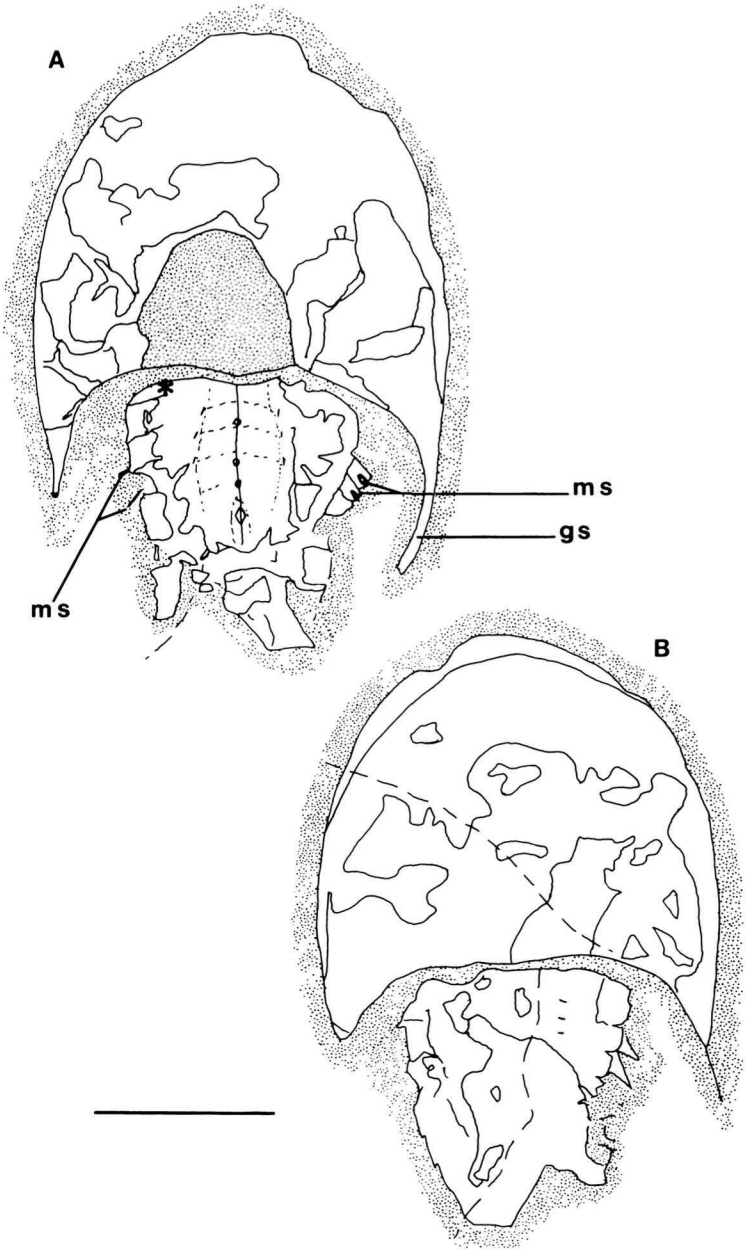

Fig. 2. A, B: Camera lucida drawing of BU 2464; ms: movable spines; gs: genal spine, * indicates position of opisthosomal somite VIII (scale = 5 mm).

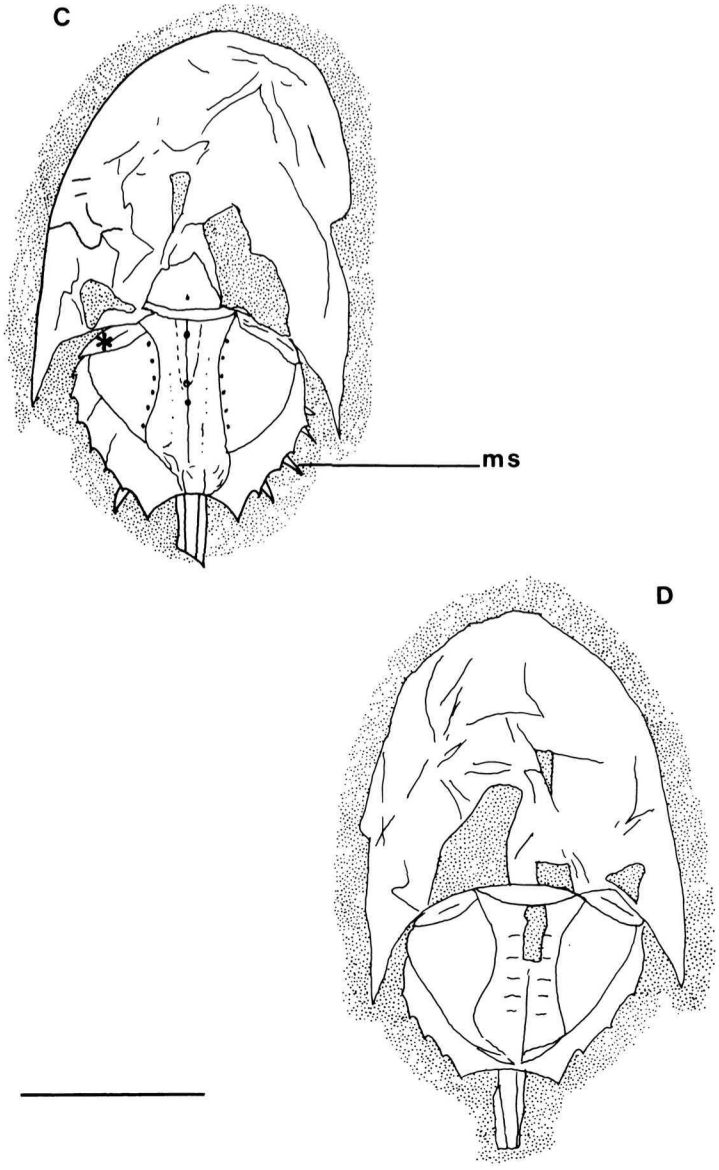

Fig. 2. C, D: Camera lucida drawing of LL 11133; ms: movable spines; * indicates position of opisthosomal somite VIII (scale = 5 mm).

RACHEBOEUF (1992) placed *Valloisella* in Euproopidae ELLER, 1938 on account of its fused opisthosoma of seven segments and the form of the cardiophthalmic region. However, he noted that it shared many characteristics with the liomesaspid *Pringlia,* such as the absence of opisthosomal spines, well-developed genal spines, and a similary shaped opisthosoma. He stated that the form of the ophthalmic ridges in his reconstruction were hypothetical. Re-examination of his plates, particularly Fig. 2A–C indicates that the ophthalmic ridges of this form are distinctly non-euproopid in morphology; they are closer in form to those of *Bellinurus* or *Paleolimulus.* The posterio-lateral branches of the ophthalmic ridges (posterior to the lateral eyes) of *Euproops* are concave in nature and swing inwards towards the cardiac lobe. The course of the ophthalmic ridges figured in RACHEBOEUF's (1992) reconstruction was probably based on an artefact of the wrinkling of the prosomal cuticle seen on the right-hand side of the carapace in his Fig. 2A–B.

Valloisella lievinensis RACHEBOEUF, 1992

1932 Unnamed. – DIX & JONES, p. 275–277, fig. 1.
1955 Genus indet. – STORMER, p. 19, fig. 13, 2, p. 23.
1975 ? *Paleolimulus* sp. – BERGSTRÖM, p. 296.
1992 *Valloisella lievinensis.* – RACHEBOEUF, p. 336–342, p. 337, fig. 1., p. 339, fig. 2.

Material: BU 2464 (Lapworth Museum, University of Birmingham); LL 11133 (Manchester Museum, University of Manchester).

Description: BU 2464 Carapace fingernail shaped, axial length 8 mm, maximum width at point of production of genal spines 10 mm (Fig. 2A, B).

Genal spines approximately 2 mm long, extending beyond posterior margin of the opisthosoma. Genal spines produced down into sideritic nodule forming holes in the matrix. Dorsal surface of the carapace featureless, therefore no indication of cardiophthalmic topography. Prosomal appendages not preserved.

Opisthosoma broadly trapezoidal, tapering posteriorly and fully fused. Carinate longitudinal medial ridge runs full length of opisthosoma. Small, poorly defined spine tubercles present on medial ridge on segments ?3, 4, 5 and 6. Axial region of opisthosoma slightly raised above lateral fields. Segmentation of axial lobe poorly defined. Lateral fields smooth, with only vestiges of original tergite boundaries. Opisthosomal flange forms lateral margin of opisthosoma. Vague intertergal ridges run across opisthosomal flange. Six slit-like structures lateral to the axial region of the opisthosoma are interpreted as apodeme attachment points. On the right-hand lateral margin of the counterpart,

towards the anterior of the opisthosoma, are two lateral opisthosomal spines. These are poorly preserved and form a hollow mould at their distal ends. On the part, additional spines are seen on the right and left hand side of the lateral margins of the opisthosoma. The spines appear to be produced from the posterior of the opisthosomal flange but not directly from the inter-tergal ridge. This observation along with the single, disarticulated spine lying posterior to the rest of the fossil, suggests that these small spines were movable. Opisthosomal appendages not seen.

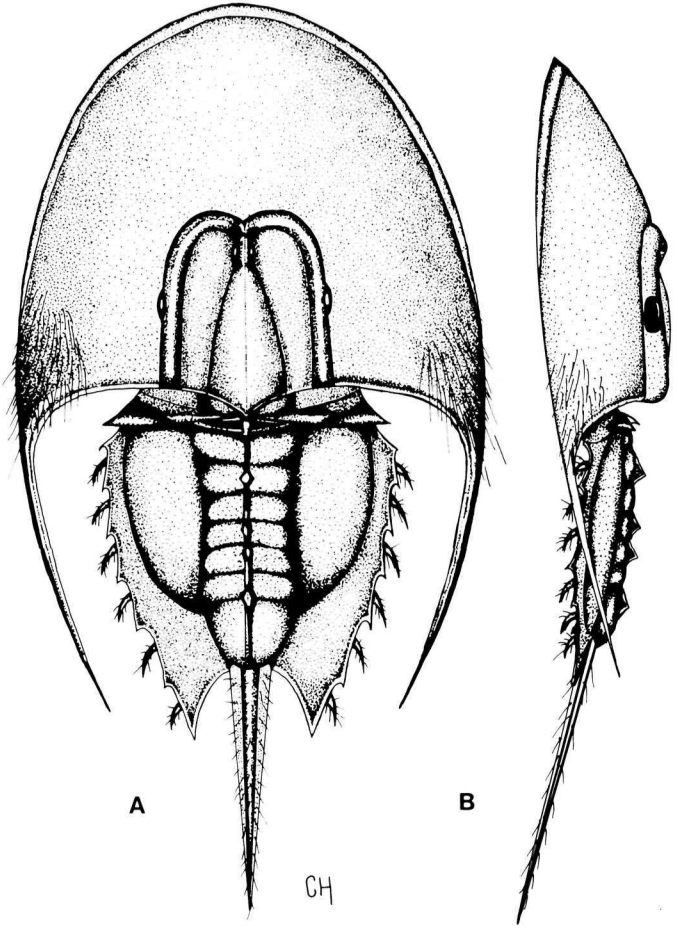

Fig. 3. Reconstruction of *Valloisella* by Carl Horrocks. A: dorsal view; B: lateral view (scale = approx. 5 mm).

Tail spine articulated but lies only partially along the plane of fracture of the nodule. Remainder of tail spine extends down into the nodule below the fracture surface. Full length of tail spine probably not preserved within the confines of the nodule.

LL 11133: Carapace fingernail shaped, axial length 6.5 mm, maximum width at point of production of genal spines 7 mm (Fig. 2C, D). Genal spines poorly preserved. Posterior portion of the triangular cardiac lobe preserved on dorsal surface of the carapace. Prosomal appendages not seen.

Opisthosoma broadly similar to BU 2464 but with more obvious movable, opisthosomal spines. Opisthosomal appendages not seen. Tail spine articulated, but with the majority of its length lying outside the bounds of the nodule. Tail spine possesses a median dorsal ridge running along its length.

Remarks: There are, at present, six recorded genera of Upper Carboniferous xiphosurans: *Bellinurus* PICTET, 1846, *Euproops* MEEK, 1868, *Paleolimulus* DUNBAR, 1923, *Pringlia* RAYMOND, 1944, *Liomesapsis* RAYMOND, 1944 and *Valloisella* RACHEBOEUF, 1992. BERGSTRÖM (1975) suggested that *Anacontium* RAYMOND, 1944 was a junior synonym of *Pringlia* RAYMOND, 1944, a view with which we agree. The characters RAYMOND (1944) used to diagnose *Liomesaspis* and *Pringlia* are of dubious value when taphonomic effects are taken into consideration and as such these genera probably require clarification of diagnostic features and taxonomic revision. The possibility that the specimen described here represents a post-larval or juvenile form of *Euproops, Bellinurus,* or *Pringlia* is ruled out because juvenile specimens of all three genera have been examined by the authors and, in all cases, the juveniles are merely miniatures of the adult forms.

Diagnoses of *Pringlia, Liomesaspis,* and *Valloisella* all include the lack of lateral, fixed, opisthosomal spines. The specimens described here show evidence of lateral spines on the margin of the opisthosoma associated with the opisthosomal flange, thus precluding them from placement in Liomesaspidae RAYMOND, 1944. Presence of movable spines on the opisthosoma is an autapomorphy of Limulina RICHTER & RICHTER, 1929 and their presence here is of diagnostic use, discounting both *Bellinurus* and *Euproops*. The carinate longitudinal axial ridge is a structure identified in *Valloisella* RACHEBOEUF, 1992 and also in the Upper Triassic *Paleolimulus fuchsbergensis* HAUSCHKE & WILDE, 1987. Due to the overall morphological similarity of these specimens to the holotype described by RACHEBOEUF (1992), they are placed in that genus until new or better preserved material comes to light which may allow further refinement of the systematics.

Acknowledgements

We thank Mr. S. Howe of the National Museum of Wales, Cardiff for aiding in the search for the missing specimen and Dr. P. Smith (Lapworth Museum, University of Birmingham) for the loan of a specimen. Dr. J. Dunlop and Dr. P. Selden are thanked for reading the manuscript and providing useful comments on the final version. We also wish to thank Mr. P. Horrocks for his help in the field and Dr. F. Broadhurst for his continuing encouragment. Dr. L. E. Babcock (Ohio State University, Ohio) provided useful discussions of the taphonomy of modern *Limulus*. L. I. A. acknowledges funding by the W. & E. Alkins Memorial Scholarship for Palaeontology (University of Manchester).

References

Anderson, L. I. (1994): Xiphosurans from the Westphalian D of the Radstock Basin, Somerset Coalfield, the South Wales Coalfield and Mazon Creek, Illinois. - Proc. Geol. Assoc., **105:** 265-275, 4 figs.

Babcock, L. E. (1994): Taphonomy of *Limulus:* implications for the fossil record of horseshoe crabs and trilobites. - Geol. Soc. America, Abstracts with Programs, **26:** 3.

Bergström, J. (1975): Functional morphology and evolution of the xiphosurids. - Fossils and Strata, **4:** 291-305.

Dix E. & Jones, S. H. (1932): A note on an arthropod from the South Wales coalfield. - Geol. Mag., **69:** 275-277.

Dunbar, C. O. (1923): Kansas Permian insects. Part 2. *Paleolimulus,* a new genus of Paleozoic Xiphosura, with notes on other genera. - Amer. J. Sci., **5:** 443-454.

Eller, E. R. (1938): A new xiphosuran, *Euproops morani,* from the Upper Devonian of Pennsylvania. - Ann. Carnegie Mus., **17:** 152-153.

Fisher, D. C. (1984): The Xiphosurida: archetypes of bradytely? Pp. 106-212. - [In:] Eldredge, N. & Stanley, S. M. (eds.): Living fossils: 196-213, 3 figs. Springer, New York.

Hauschke, N. & Wilde, V. (1987): *Paleolimulus fuchsbergensis* n. sp. (Xiphosura, Merostomata) aus der oberen Trias von Nordwestdeutschland, mit einer Übersicht zur Systematik und Verbreitung rezenter Limuliden. - Paläont. Z., **61:** 87-108; Stuttgart.

König, C. [n. d.] (c. 1851): Icones Fossilium sectiles. pls. 9-19. [? London].

Latreille, P. A. (1802): Histoire naturelle, generale et particuliere, des Crustaces et des Insectes, **3,** 467 pp. Dufart, Paris.

Meek, F. B. (1867): Note on *Bellinurus danae,* from the Illinois Coal Measures. - Amer. J. Sci. and Arts, (2), **43:** 257-258.

Pickett, J. W. (1984): A new freshwater limuloid from the mid Triassic of New South Wales. - Palaeontology, **27:** 609-621.

Pictet, F. J. (1846): Traité élémentaire de Paléontologie, **4,** 458 pp, 20 pls.; Paris.

Prestwich, J. (1840): Memoir on the Geology of Coalbrook Dale. - Trans. Geol. Soc. London, **5:** 413-495.

Racheboeuf, P. R. (1992): *Valloisella lievinensis* n. g. n. sp.: nouveau Xiphosure carbonifère du nord de la France. - N. Jb. Geol. Paläont. Mh., **1992** (6): 336-342; Stuttgart.

Raymond, P. E. (1944): Late Paleozoic xiphosurans. - Bull. Mus. Comp. Zool., Harvard Univ., **94:** 475-508.

RICHTER, R. & RICHTER, E. (1929): *Weinbergina opitzi* n. g. n. sp., ein Schwertträger (Merost. Xiphos.) aus dem Devon (Rheinland). - Senckenbergiana, **11:** 193-209.

SCHULTKA, S. (1994): *Bellinurus* cf. *truemanni* (Merostomata) aus dem tiefen Oberkarbon (Namur B/C) von Frondenberg (Nordrhein-Westfalen, Deutschland). - Paläont. Z., **68:** 339-349.

SELDEN, P. A. (1992): Revision of the fossil ricinuleids. - Trans. Royal Soc. Edinburgh: Earth Sci., **83:** 595-634; Edinburgh.

SIVETER, D. J. & SELDEN, P. A. (1987): A new, giant xiphosurid from the lower Namurian of Weardale, County Durham. - Proc. Yorkshire Geol. Soc., **46:** 153-168.

STORMER, L. (1952): Phylogeny and taxonomy of fossil horseshoe crabs. J. Paleont., **261** (4): 630-639, 3 Abb.; Tulsa.

- (1955): Merostomata. [In:] MOORE, R. C. (ed.): Treatise on Invertebrate Paleontology, Part P, Arthropoda 2, P4-P41. Univ. Kansas and Geol. Soc. America, Lawrence, Kansas.

STÜRMER, W. & BERGSTRÖM, J. (1981): *Weinbergina,* a xiphosuran arthropod from the Devonian Hunsrück Slate. - Paläont. Z. **55:** 237-255; Stuttgart.

WATERSTON, C. D. (1985): Chelicerata from the Dinantian of Foulden, Berwickshire, Scotland. - Trans. Royal Soc. Edinburgh: Earth Sci., **76:** 25-33; Edinburgh.

WOODWARD, H. (1872): Notes on some British Palaeozoic Crustacea belonging to the order Merostomata. Geol. Mag., **9:** 433-441; London.

ZITTEL, K. A. VON (1885): Handbuch der Paläontologie, Paläozoologie, **2:** Munich and Leipzig.

Bei der Tübinger Schriftleitung eingegangen am 30. Januar 1995.

Anschrift der Verfasser:

LYALL I. ANDERSON and CARL HORROCKS, Department of Earth Sciences, University of Manchester, Manchester, M13 9PL, Großbritannien.