LEDBURY CUTTING

OS Grid Reference: SO712385

Highlights

This Downtonian (lower PÍídolí) site in Herefordshire has yielded abundant collections of acanthodians and ostracoderms. Some of the specimens are complete with the body and tail still attached, which is unusual and represents exceptional preservation for Welsh Borders Old Red Sandstone sites. This is the type locality for *Auchenaspis egertoni* and *Didymaspis grindrodi*, two genera that are frequently illustrated as examples of early osteostracans.

Introduction

During the digging of the railway cutting and tunnel at Ledbury in 1858–1860, a complete section from below the Aymestry Limestone to the Old Red Sandstone was exposed. A measured section given by Piper (1890, 1898) indicates that it totalled some 1142 ft (342.5 m) of which the majority was unfossiliferous. Downtonian strata were exposed in the station yard and were actively collected during the digging of the tunnel and during the expansion of the station yard in 1898 (Symonds, 1860; Piper, 1890, 1898). The resulting large museum collections of eurypterids and osteostracans include many well-preserved headshields, plus more complete (i.e. head, body and tail) specimens of *Hemicyclaspis*. These have frequently been figured and described (e.g. Lankester, 1867, 1870; Woodward, 1891a; Stensiö, 1932, 1964; White and Toombs, 1948; Denison, 1951a, 1951b; Janvier, 1985a, 1985b). The complete *Hemicyclaspis* from the site is frequently figured as an example of the (supposedly) typical cephalaspid body and tail (e.g. Stensiö, 1932; Moy-Thomas and Miles, 1971).

Description

The section originally exposed at Ledbury dipped steeply, 71° N/NW (Symonds, 1860). The so-called ‘Passage Beds' (Downtonian), predominantly grey sandstones and siltstones, were exposed in the station yard. In 1898 this cutting was dug back farther, putting the entrance to the tunnel farther back and to the east. At the time, this was regarded as the finest and most complete section through this group of rocks (Symonds, 1859a, 1860, 1861, 1872; Figure 3.13).

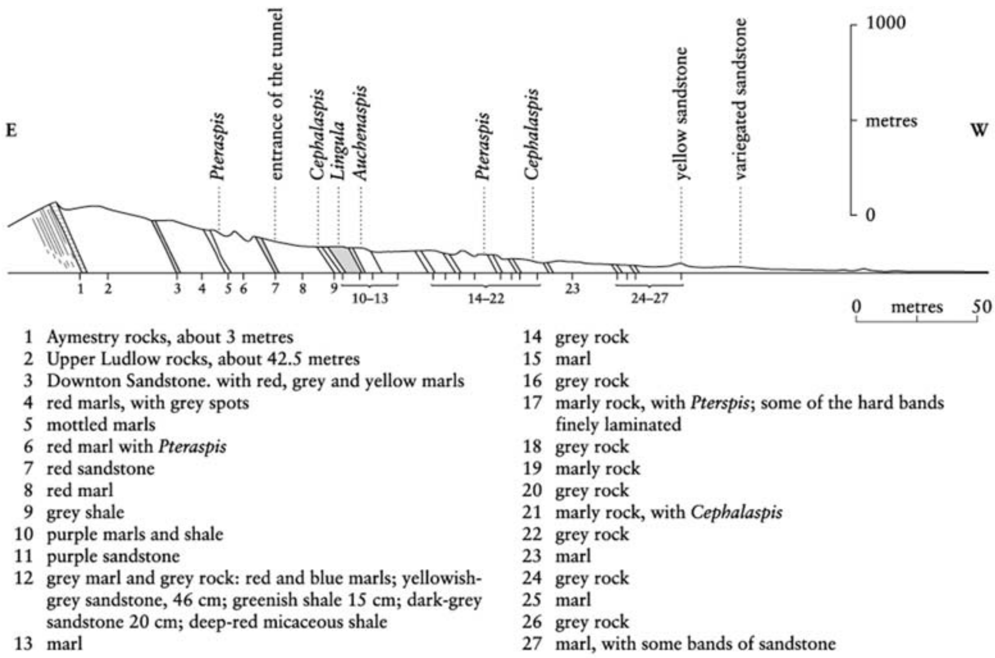

Figure 3.13: Section at Ledbury railway cutting recorded by Symonds (1860). Even more than 100 years later much of this section was still visible; recently, however, much of the western end has become obscured.

Symonds' (1872) section differs from that measured by Piper (1898), but unfortunately subsequent workers have followed Symonds' section. Piper had been able to delimit the various fish beds, each of which differed in faunal assemblage and preservation. Symonds' section totals 9 ft (2.7 m) for the Downton Sandstones and 272 ft (83 m) for the Temeside Beds, while Piper measured 58 ft (180 m) for the Downton Sandstones and 400 ft for the Temeside Beds. Piper's section is of greater thickness than that of Symonds, so it is conceivable that faulting may have repeated parts of the total sequence. This section is the type example of the Ledbury Group, described as 225 m of alternating thick red mudstones and red to purple micaceous sandstones with abundant vertebrates in the lowest 120 m. It is correlated with the Ledbury Formation of the Clee Hills area which overlies the Temeside Formation (Allen, *in* House *et al.*, 1977). The section, based on Piper (1898) is given in Table 3.1.

The Ludlow Bone Bed was not seen in this section, but it was discovered nearby, in a small cutting linking the station yard with a quarry (Piper, 1890).

The existing section, some tens of metres thick, is exposed at the entrance to the present tunnel (Allen and Tarlo, 1963). Each cyclothem has a lower part of sandstone with an erosive base, and an upper part of fine-grained material. A fine-grained well-sorted sandstone in the middle of the section shows cross-bedding and flat-bedding, and has basal siltstone clasts above a sharp erosional base that cuts into a burrowed siltstone. It is interpreted as a channel on a tidal flat and contains broken, well-sorted faunal remains, including fishes, thought to have been deposited in channels which were swept by the tide. Presumably this is the source of the fossils listed as 'small ostracoderm shields, fish spines and *Lingula cornea*' (Lawson, 1955), and of a *Thelodont parvidens* thelodont assemblage (S. Turner, pers. comm., 1982).

Fauna

AGNATHA

Osteostraci: Tremataspiformes: Didymaspididae

Didymaspis grindrodi Lankester, 1867

Osteostraci: Thyestiformes: Thyestiidae

Auchenaspis egertoni Lankester, 1870

Osteostraci: Ateleaspiformes: Ateleaspididae

Hemicyclaspis murchisoni (Egerton, 1857)

H. lightbodii (Lankester, 1870)

Heterostraci: Eriptychiformes: Tesseraspididae

Kallostrakon sp.

GNATHOSTOMATA

Acanthodii: Climatiiformes: Climatiidae

Onchus sp.

Acanthodii *incertae sedis*

Plectrodus sp.

Auchenaspis heads were first found here in 1858, at almost the same time as they were discovered at Ludlow. The body was unknown (Symonds, 1872) until March 1882, when Piper discovered the first articulated specimens in the Ledbury cutting, and subsequently found complete specimens in beds beneath the '*Auchenaspis*' Grits where *Auchenaspis* headshields had first been found in profusion (Piper, 1890). These remain the only articulated material of *Auchenaspis*. Heads of fishes within the *Auchenaspis* Grits were said by Symonds (1872) to be 'so abundant that as many as four heads were found upon a small slab a foot in diameter'. Further, Symonds (1861) described the site at the western end of Ledbury Tunnel as 'the grey curtain of rock, charged with the relics of long extinct fish, that stood so boldly out with the red shales in the foreground ...'.

Auchenaspis egertoni was described by Lankester (1870) as a second species of the genus that had been described first from Ludlow Railway Cutting as *Auchenaspis salteri* Egerton, 1857. Woodward (1891a) synonymized *Auchenaspis* with *Thyestes*, a view followed by Stensiö (1932, 1964). Stensiö (1932) based his understanding of *Auchenaspis* on 40 specimens of *A. egertoni*, including articulated remains showing the trunk region, from Ledbury. Subsequent workers (e.g. Janvier, 1985a) have also based their assumptions about the genus on an examination of the better preserved and more numerous material from Ledbury, and ignored the rarer original material of *A. salteri* from Ludlow.

Stensiö (1932) noted that the trunk of *Auchenaspis* decreased in width rapidly backwards, so was probably short (Figure 3.14; reconstruction of *A. egertoni* in Stensiö, 1932). There is no anterior dorsal fin, or dorsal ridge scutes as in cephalaspids and *Hemicyclaspis*. *A. egertoni* is slightly larger than *A. salteri*, being at most 50 mm long (Stensiö, 1932), and it has longer cornua than *A. salteri*.

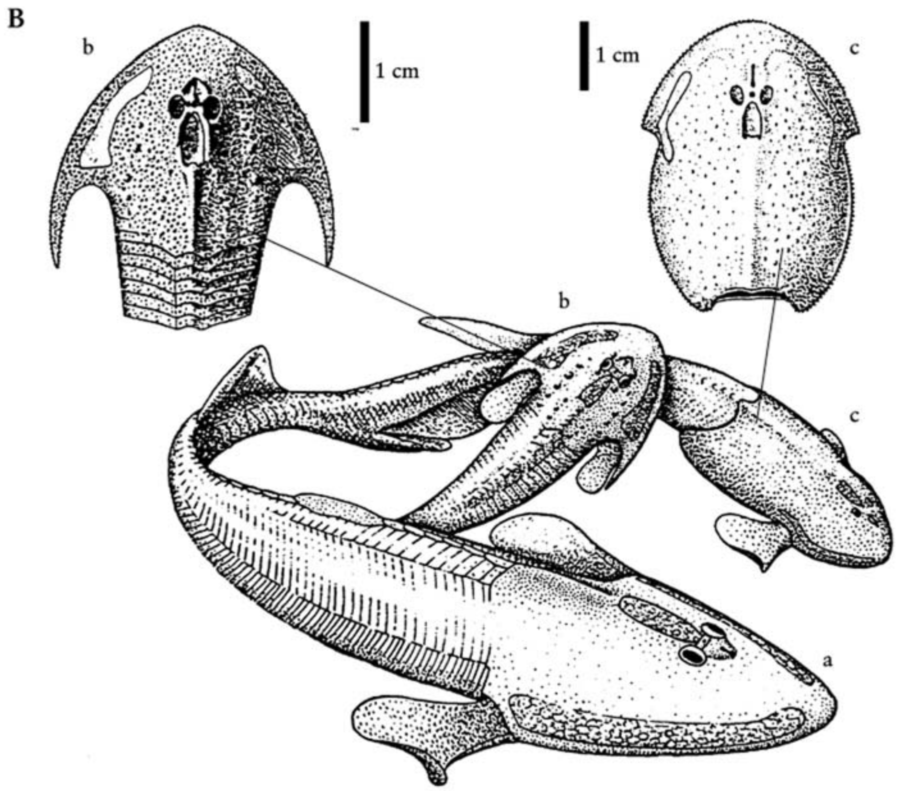

Figure 3.14: Osteostracans from the Ledbury cutting. (A) Hemicyclaspis murchisoni Egerton in rare preservation, one of many such slabs collected over 100 years ago, c. × 0.25, (photograph courtesy The Natural History Museum,London, T05398/A). (B)

Restoration of vertebrates found at Ledbury: a, Hemicyclaspis murchisoni; b, Auchenaspis egertoni Lankester; c, Didymaspis grindrodi Lankester (from Blieck and Janvier, in press).

Janvier (1985a) accepted that *Auchenaspis* is distinct from *Thyestes*, but he found no shared characteristics between the two species. He (Janvier, 1985b) attributed all the material to a single species, *Auchenaspis salteri*, arguing that they were considered to be separate species largely because of the difference in size. However, re-examination of all the material may confirm that the size ranges of the two species do not overlap, that the cornua have different size and shape, and that *A. egertoni* has a longer abdominal region. The species of *Auchenaspis* are basal forms in a phylogenetic series of 'pro-thyestids', from *Procephalaspis oeselensis*, *A. salteri*, *A. egertoni*, *Witaaspis schrenki* to *Thyestes verrucosus* (Janvier, 1985a, fig. 65).

A single small specimen of *Didymaspis grindrodi* was found in beds immediately overlying the *Auchenaspis* Grits by Dr J. Grindrod in the 1860s. This long-carapaced form was recognized as cephalaspid in character by Lankester (1867), who named and subsequently illustrated it (Lankester, 1870). Stensiö (1932) redescribed the species (Figure 3.14), having 16 specimens available to him, not only from Ledbury Cutting but also from Man Brook, Trimpley, and Bush Pitch, Ledbury. The Man Brook site yielded further specimens in the 1950s. *Didymaspis grindrodi* is the single representative of the genus, and has been found at several sites in the Downtonian of the Welsh Borders, and also (possibly) in Russia (Janvier, 1985b).

The shield is very long, and the cornua project laterally, but are short and indistinct, superficially resembling those of tremataspids. The headshield bears an obtuse dorsal median crest (Stensiö, 1932), whereas the ventral surface is flat. The rostral margin is rounded. The nasohypophysial opening is a long notch at the bottom of a hollow, which is unlike any comparable osteostracan. The dorsal field is short, and the external openings of the endolymphatic duct are situated within it. There is no independent pineal plate. The lateral fields are continuous, unlike those of tremataspids, and they have a distinctive shape, not extending very far forward, and rather than extending onto the cornua, as in other cephalaspids, bending along the lateral margin posterior to the cornua.

Unlike tremataspidids, a pectoral fin was present, which is evidenced by very clear areas of attachment for the fins in the shallow pectoral sinuses (Janvier, 1985a, 1985b). Endoskeletal bone is well developed, such that details of internal cranial structures are seen. The long-carapaced forms, such as the tremataspids generally, had endoskeletal support for the posterior part of the shield, which in Tremataspididae took the shape of a short ventro-lateral prolongation in the scapular region (Janvier, 1985a). *Didymaspis* had a greater development of this support which, unlike tremataspids, consisted of a relatively long blade of endoskeleton strengthening the ventro-lateral edge of the abdominal division (Janvier, 1985a).

The relationships of *Didymaspis* are unclear. Denison (1961) believed it was a tremataspidid since the long headshield resembled that of *Tremataspis* from Estonia. However, Janvier (1985a) suggested that *Didymaspis* may show affinities with kiaeraspids because of the absence of a pineal plate, the shape of the lateral fields and the ornamentation, but decided that *Didymaspis* has no thyestid or tremataspid characters (Janvier, 1985b).

Complete specimens (head, body and tail) of *Hemicyclaspis murchisoni* from Ledbury have been figured as an example of the general pattern of the cephalaspid body (e.g. Stensiö, 1932; Janvier, 1985a). A block with 12 articulated or complete animals (NHM P6023; Piper collection) has provided most of the data for the reconstructions (Figure 3.15) made by Stensiö (1932), and provided casts that can be seen in several museums. The pectoral fins were well developed, the anterior dorsal fin was reduced to a high dorsal crest made up of imbricating scutes, and situated well back on the body there was a small posterior dorsal fin, which was supported on its anterior edge by a thick spine. The tail was heterocercal, and the fin membrane was divided into three lobes. A full description is given in the Temeside report, the type locality of this species.

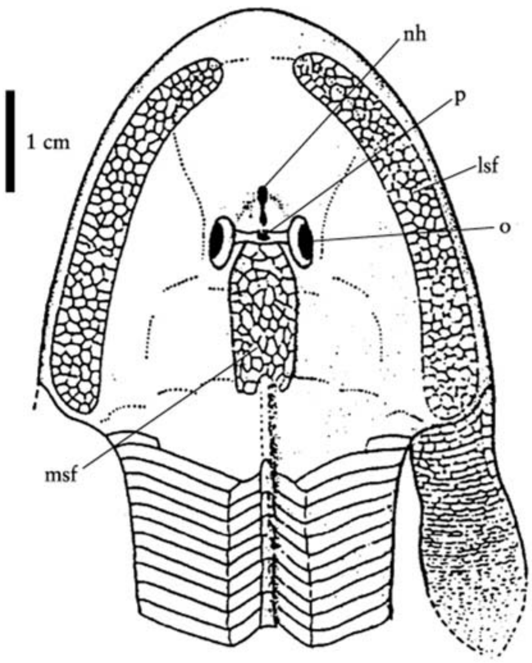

Figure 3.15: Hemicyclaspis murchisoni Lankester, detail of the dorsal surface of the headshield: p, pineal foramen; o, orbits; nh, nasal hypophysis; lsf, lateral sensory field; msf, median sensory field (after Stensiö, 1932).

Specimens labelled *Pteraspis* n. sp. in OUM are all *Kallostrakon* (White and Toombs, 1948), an enigmatic heterostracan. Remains of the acanthodians *Onchus* sp. and *Plectrodus* sp. consist of isolated fin spines.

Interpretation

The faunal assemblage from Ledbury is interesting when compared with those from Ludlow railway cutting and from Temeside (q.v.), which are all of very similar age. All three sites have been important and rich sources of specimens of early fishes which are generally rare and more fragmentary elsewhere. At these three sites, specimens are apparently concentrated in abundance within ‘fragment' bone beds. The material from these three sites is compared in Table 3.2.

The bone bed at Ludlow railway cutting has been described as ‘dark micaceous shales' (Egerton, 1857, and as a ‘grit band with fishes' (Murchison, unpublished sections in Ludlow Museum, *c*. 1852; see Antia, 1981, pp. 164–5). Two lithologies are represented by specimens in the NHM, one is a grey-green rippled siltstone packed with fragments of *Hemicyclaspis*, and arthropods plus *Lingula cornea*, the second is a buff to greenish grey grit with *L. cornea*. The Temeside Bone Bed has been described as a grey calcareous grit containing large fragments of bone with some carbonaceous matter (Elles and Slater, 1906). The bone bed has been regarded as lying some way stratigraphically above the Ludlow railway cutting, but Turner (1973) claimed that it lay in the railway cutting. It lies in the upper part of the Temeside Formation (Elles and Slater, 1906; House *et al*., 1977). The Ledbury Beds, on the other hand, are in the Ledbury Group, equivalent to the Ledbury Formation, which overlies the Temeside Formation (Allen, *in* House *et al*., 1977). However, the great similarity between the sites has been recognised (Salter, 1851; Roberts, 1861; Symonds, 1860, 1861). The Ledbury Grits of Piper's (1898) section are remarkably similar in lithology to the fragment beds near Ludlow, whereas all the lower fish beds of the Ledbury section have similar faunal assemblages to the Temeside Group fish beds of the Ludlow area. The exception is the upper part of the Ledbury section, described as red marls and sandstones, which bear *Kallostrakon* and *Didymaspis*. Similarly, in the Clee Hills area, higher Downtonian beds within the Ledbury Formation yield these two genera, together with *Hemicyclaspis murchisoni* and *Auchenaspis* (Allen, *in* House *et al*., 1977). However, the two do not occur in the Temeside Bone Beds, which may conform to a facies change (Allen and Tarlo, 1963) from intertidal and subtidal sediments that contain brackish-water *Hemicyclaspis* and acanthodians, to fluviatile and intercalated tidal sediments which hold probably freshwater *Kallostrakon* and *Didymaspis* (Allen and Tarlo, 1963), together with the brackish-water forms. Differences between the assemblages, in particular the similar species (e.g. *Auchenaspis salteri* from Ludlow, which is very similar to *A. egertoni* from Ledbury) may represent different environments or time horizons.

Conclusions

The Ledbury site is of particular palaeontological importance and conservation value because two of the fish-bearing horizons yielded complete specimens of *Auchenaspis* and *Hemicyclaspis*. This is the only site for complete *Auchenaspis*, whereas complete *Hemicyclaspis* has also been found in the Downton Castle Sandstone Formation at Gornal in the West Midlands (Wills, 1948; Ball, 1951; Allen and Tarlo, 1963). Articulated and whole specimens of cephalaspids are extremely rare in the Welsh Borders, and complete cephalaspids elsewhere in Britain are only known from later Old Red Sandstone sites. Ledbury is also the type locality of the only known species of the enigmatic osteostracan *Didymaspis*. The total fossil assemblages from Ledbury and two other coeval sites suggest different habitats.

Nowadays only a few metres of rock are seen at the entrance to the railway tunnel at Ledbury. Fishes may still be collected from red marls and siltstones here which yield ‘small ostracoderm shields, fish spines and *Lingula cornea*' (Lawson, 1955), and a *Thelodus parvidens* thelodont fauna (S. Turner, pers. comm., 1982).

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