CWM MILL

OS Grid Reference: SO311156

Highlights

Cwm Mill in Gwent has yielded two exceptional specimens of *Rhinopteraspis crouchi*, as well as several cephalaspids, to provide important information about the body, tail, armour and mouth parts. Complete specimens of this age (earliest Devonian) are very rare, and the site has potential for more such excellent finds.

Introduction

A small stream section in the Ditton Group at Cwm Mill, near Abergavenny, has yielded rare complete articulated specimens of cephalaspids, including the body and tail region, which is unusual since most finds in the Welsh Borders are headshields alone. These came from a lens of grey-green siltstone, which has yielded some 50 articulated specimens (White and Toombs, 1983). The geology of the site is mentioned in papers by Allen and Tarlo (1963), Allen (1964), White (1973) and White and Toombs (1983), and the fish fauna by White (1935, 1950b, 1958b, 1961), Westoll (1945, 1958), Denison (1951a, 1956, 1967b, 1970), Novitkskaya (1975), Goujet and Blieck (1979), Blieck (1980) and Janvier (1980, 1981, 1985a).

Description

Allen (1964) scrutinized the cyclothem (Figure 4.13) which contains the fossil fishes within a conglomerate unit and which rests on a scoured surface of siltstone. The horizon that yielded the complete articulated cephalaspid specimens lies ‘a little below' a fossiliferous intraformational conglomerate. It is a lens of siltstone passing laterally into a coarser, vertebrate-bearing, grey-green sandstone (Allen and Tarlo, 1963). White and Toombs (1983) described the lens that yielded the cephalaspids as being part of the ‘Darker Bed' (p. 166), which is found in Unit 2 or 3 of the cyclothem (Allen, 1964, fig. 11).

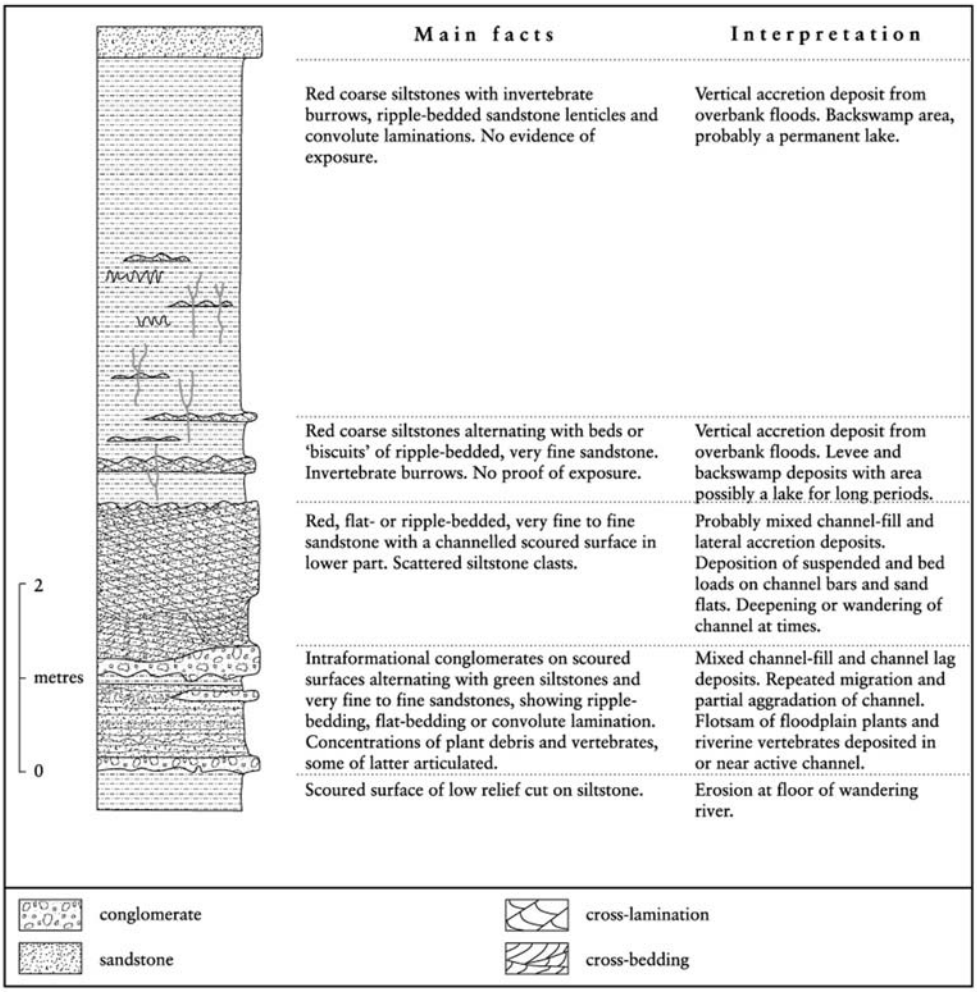

Figure 4.13: The succession at Cwm Mill, Abergavenny (after Allen, 1964).

A mudstone layer near the base has yielded complete cephalaspids, but the only other specimens present within the whole section were 'half a dozen broken head shields here and there of similar animals' plus *Rhinopteraspis crouchi* plates, either alone or with plant and/or eurypterid remains. This *Rhinopteraspis* debris is from individuals of all sizes found together (Allen and Tarlo, 1963).

There are differences between the mode of preservation and the faunal assemblages of the 'Darker Bed' and the siltstone lens. The 'Darker Bed' contains well-separated undeformed large pieces of fossil fishes; these comprise bodies (with one exception) but tails are completely absent. The siltstone lenticle contains many fossils, all massed together, which are complete but flattened, and the intraformational conglomerate is 'crowded with large plant fragments, pellets of wood, *Pachytheca*, eurypterid skins, and pteraspid and cephalaspid scales, plates and discs.' (Allen, 1964, p. 186).

Fauna

AGNATHA

Osteostraci: Cephalaspidiformes: Cephalaspididae

Cephalaspis abergavenniensis White and Toombs, 1983

'*C.*' *cwmmillensis* White and Toombs, 1983

'*C.*' *cradleyensis* Stensiö, 1932

Cwmaspis billcrofti White and Toombs, 1983 Heterostraci: Pteraspidiformes: Pteraspididae

Rhinopteraspis crouchi (Lankester, 1868)

Thelodonti: Phlebolepidiformes: Phlebolepididae

Goniporus alatus (Gross, 1947)

Rhinopteraspis crouchi (Figure 4.15) was originally distinguished by Lankester as *Pteraspis crouchi*, and has been described subsequently by White (1935, 1950b, 1961, 1973), Denison (1967b, 1970), Novitskaya (1975), Goujet and Blieck (1979) and Blieck (1980). The majority of the plates of *Rhinopteraspis* from this site are from half-grown small animals, and include examples of the youngest state of development. The dorsal and ventral discs of *Rhinopteraspis* vary in length from 20 to 70 mm (large adult). This site has yielded two exceptional specimens of articulated pieces of almost the whole of the body armour including the mouth parts (White, 1973). However, it is unclear whether the specimens came from the siltstone lenticle or the 'Darker Bed'. These pteraspids show the configuration and relationship of the tooth plates, orbital plates and branchial plates, and allow the identification of isolated plates found elsewhere in the Welsh Borders. Using this material, White (1973) was able to define the body armour of this species for the first time, and Blieck (1980) gave a

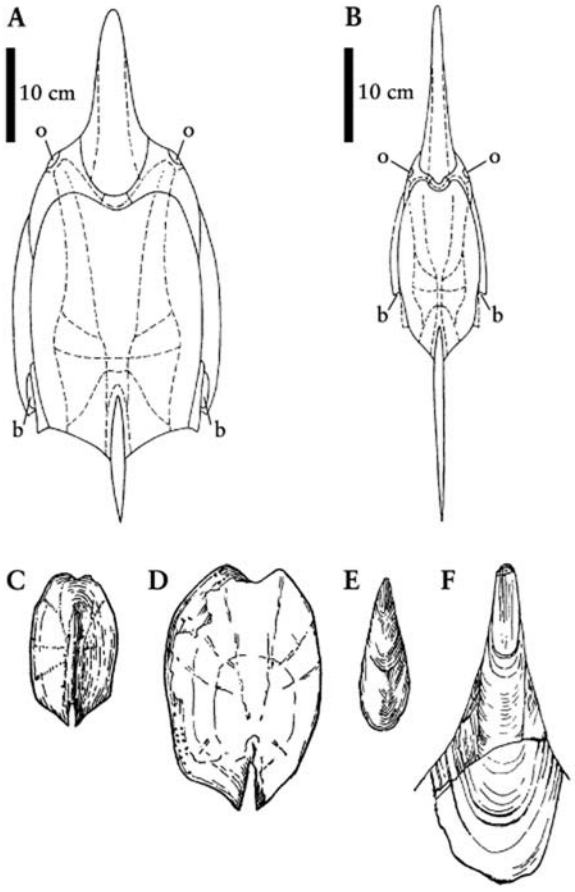

Figure 4.15: Rhinopteraspis crouchi (Lankester) from Cwm Mill (after White, 1973; Blieck, 1980). (A) R. crouchi carapace in dorsal view with sensory canal system shown by broken lines: b, branchial openings; o, orbits; (B) R. dunensis (Roemer) carapace in dorsal view, the extreme elongated form found in the higher Dittonian strata: (C), (D) dorsal discs; (E), (F) rostral plates.

reconstruction based on White's (1973) description.

White and Toombs (1983) reported on the fifty articulated specimens of 'cephalaspid' material collected by Croft at this site in the mid-1930s, all but three of which are '*Cephalaspis*' *cradleyensis* (Figure 4.14). Each of the other three specimens represents a new species. The darker bed around the siltstone lens yielded further specimens of cephalic shields

of *C. cradleyensis* plus fragments of other species. These provided greater detail than the complete specimens from the site, and form the basis of the reconstruction of the headshield of *C. cradleyensis* (White and Toombs, 1983, fig. 6).

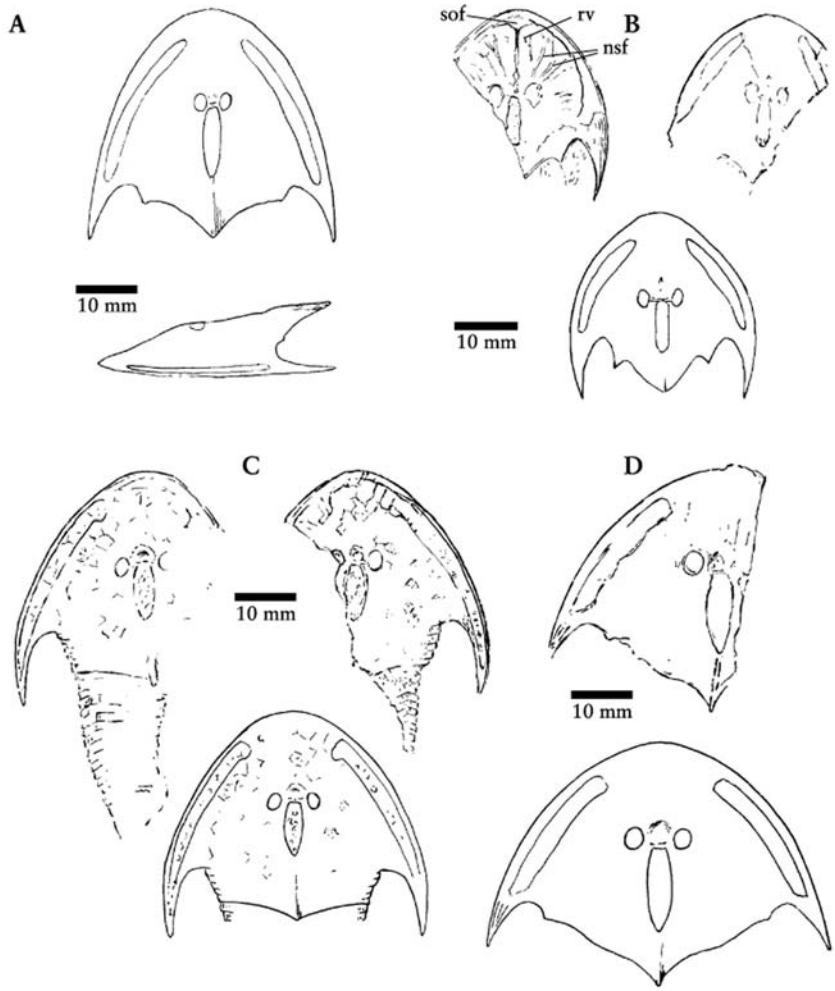

Figure 4.14: Cephalaspids from Cwm Mill (after White and Toombs, 1983). (A) Cephalaspis cradleyensis Stensiö, restoration of headshield; (B) Cephalaspis cwmmillensis White, holotype in dorsal impression and counterpart, with restoration: nsf, nerve canals to lateral sensory field; rv, rostral vein; sof, supra-oral field; (C) Cephalaspis abergavenniensis White, external dorsal aspect of the headshield and part of the thorax with counterpart and restoration; (D) Cwmaspis (Cephalaspis) billcrofti White, part of headshield in dorsal aspect, with restoration (after White, 1963).

The new material from Cwm Mill, consisting of 42 individuals, many with the squamation of the body and tail, allowed White and Toombs (1983) to produce a new description and diagnosis of this species. The total length is about 120 mm, with the median length of the head, body and tail being approximately equal at *c.* 40 mm each. The interzonal part of the headshield bears a low but distinct spine, and the species possessed shallow pectoral sinuses. The ventral surface of the headshield was similar to *Hemicyclaspis* in possessing a wide narrow mouth and an external surface covered by numerous small irregular scales. There were at least eight box-like branchial pouches on each side. The body was covered by scale rows. The pectoral fins were leaf-like in shape.

'*Cephalaspis*' *cradleyensis* was erected by Stensiö (1932) for a single small imperfect and distorted headshield, from Cradley, near Malvern, Worcestershire. The same species has been described from a single specimen from the Red Bay Series of Spitsbergen (Wängsjö, 1952), and it may have some palaeogeographical significance.

'Cephalaspis' cwmmillensis White and Toombs 1983 is based on a single small imperfect headshield from Cwm Mill, which has lost most of its associated body and tail. The outline of

the head shield is distinctively oval (Figure 4.14), with no rostral angle. The upper surface was covered with small thorn-like denticles, and the mucous canal system was enclosed in the exoskeleton.

Cephalaspis abergavenniensis White and Toombs, 1983 is based on a single small imperfect flattened cephalic shield with much of the body attached, which was complete when collected, but now lacks part of the body and tail (White and Toombs, 1983). The pectoral sinuses are narrow and deep. Ornamentation on the exoskeleton consists of numerous small well-separated stellate tubercles, which are larger and thorn-like towards the back of the shield.

Cwmaspis billcrofti White and Toombs, 1983 is another species based on a single small imperfect headshield. However, the great breadth and shortness of the headshield, together with very short cornua, and other proportions (Figure 4.14) suggested assignment to a new subgenus, *Cwmaspis*, by White and Toombs (1983), which is raised to the level of genus, because of the restriction of the genus *Cephalaspis* to *Cephalaspis lyelli* (Janvier 1980, 1981, 1985a). Although the shape of the cephalic shield is similar to *Benneviaspis*, unlike that genus, *Cwmaspis* retains the cephalaspidid sensory fields and position of orbits.

Interpretation

Allen (1964) interpreted the cyclothem as fluviatile in origin; the intraformational conglomerate containing disarticulated fossil material is interpreted as the ‘flotsam of a waning flood' that was perhaps deposited at the head of a channel bar or in the entrance to a slough where gravel from the channel floor might also be found. The disarticulated fossil material is thought to have been derived from an earlier deposit, whereas the articulated specimens may represent fishes that died catastrophically in the river as the result of flood conditions (Allen, 1964, p. 187). Allen and Halstead (1968) explained this section as a channel deposit. To White (1973) the whole section appeared to have been deposited by varying currents within a short period of time, which is supported by the restricted fauna present within the section. White and Toombs (1983) saw this event as the result of floodwaters from exceptional storms in the uplands which swept still-living or moribund animals down the rivers to be interred in the drying pools of the floodplains. These authors suggested that, if the major habitat for cephalaspids was in the fresh waters of the ‘distant uplands', this would explain their spasmodic occurrence within the floodplain deposits of the Anglo-Welsh Basin.

This *Rhinopteraspis* material consists of plates from individuals of all sizes found together and probably represents a population sample from the original life assemblage. The dorsal and ventral discs of *Rhinopteraspis* vary in size from 20 to 70 mm (large adult) in length. White (1973) produced growth series from these discs, which showed the way that the sensory canals developed as the animal grew and indicated that the basal bone layer must have been capable of resorption to allow for the growth in thickness of the plates.

Cephalaspids are normally found as fully grown adults (Westoll, 1945, 1958; Denison, 1951b, 1956; White 1958), which has led to the conclusion that they acquired their bony skeleton only when fully grown (Wängsjö, 1952): if they lived in marine or brackish waters, there would be no need for bony shields for salinity control. However, one specimen of *Cephalaspis 'cradleyensis*' apparently shows incompletely formed hard parts. White and Toombs (1983) thought this was the result of post-mortem changes, because the complete individual is associated with, and on the same surface as, another that is perfectly normal. Moreover, the unusual specimen is merely a ‘ghost', preserved as an impression only. It is also slightly smaller than the other specimens of the species. It was regarded by White and Toombs (1983) as possibly a young animal in the early stages of forming armour. Thus it would follow that the young animals may have been soft-bodied while within the fluvial environments, and that ossification took place evenly throughout the animal.

The thelodont *Goniporus alatus* (Gross, 1947) is the last recorded member of the family Phlebolepididae, the first (oldest) genus of which is of Wenlockian age.

Comparison with other localities

The locality is unique in Britain in the number of exceptionally well-preserved pteraspidids and

cephalaspids that it contains. Only at Silvington Waterfall (Ball and Dineley, 1961) has an intraclast conglomerate and sandstone yielded very numerous small specimens (seeWhite, 1961, pp. 256–7), from a horizon about 150 m above the *Psammosteus*' Limestone, but cephalaspids are rare there. The osteostracan assemblage at Cwm Mill is unique.

Conclusions

The conservation value of the site lies in the uniqueness of its fish fauna, the quality of preservation and its role in the palaeobiological interpretation of these fish. Cwm Mill has produced exceptional specimens of the heterostracan *Rhinopteraspis crouchi* and of several cephalaspid species, three unique to this site. The quality of preservation is uncommon, since most Early Devonian fossil fish sites in the Welsh Borders have yielded only fragmentary remains. Studies of ontogeny and growth of the fishes may be possible, based on Cwm Mill material, because of the range of specimen sizes preserved. This site is crucial for further palaeobiological study of heterostracans and osteostracans, but the potential for further discoveries is rather restricted without further excavation.

Reference list

Allen, J.R.L. (1964) Studies in fluviatile sedimentation: six cyclothems from the Lower Old Red Sandstone, Anglo-Welsh Basin. *Sedimentology*, **3,** 163–98.

Allen, J.R.L. and Tarlo, L.B.H. (1963) The Downtonian and Dittonian facies of the Welsh Borderland. *Geological Magazine*, **100**, 129–55.

Ball, H.W. and Dineley, D.L. (1961) The Old Red Sandstone of Brown Clee Hill and the adjacent area. I: Stratigraphy. *Bulletin of the British Museum (Natural History*), *Geology*, **5,** 178–242.

Blieck, A. (1980) Le genre *Rhinopterasis* Jaekel (Vertébrés, Hétérostracés) du Dévonien inférieur: systématique, morphologie, repartition. *Bulletin du Muséum national d'Histoire naturelle, Paris, 4 Ser.*, ZC, **1,** 25–47.

Denison, R.H. (1951a) Evolution and classification of the Osteostraci. *Fieldiana: Geology*, **11**, 156–96.

Denison, R.H. (1951b) The exoskeleton of early Osteostraci. *Fieldiana: Geology*, **11**, 198–218.

Denison, R.H. (1956) A review of the habitat of the earliest vertebrates. *Fieldiana: Geology*, **11**, 359–457.

Denison, R.H. (1967b) A new *Protaspis* from the Devonian of Utah, with notes on the classification of Pteraspididae. In *Fossil Vertebrates: papers presented to Dr. Errol I. White* (eds C. Patterson and P.H. Greenwood), Academic Press, pp. 353–413.

Denison, R.H. (1970) Revised classification of Pteraspididae with description of new forms from Wyoming. *Fieldiana: Geology*, **20**, 1–41.

Goujet, D. and Blieck, A. (1979) Les vertébrés de l'Assise des Schistes et Grès de Pernes (Dévonien de Nord de la France). *Annales de la Societé géologique du Nord*, **98**, 263–78.

Gross, W. (1947) Die Agnathen und Acanthodier des Obersilurischen Beyrichienkalks. *Palaeontographica, Abteilung A, 96*, 91–158.

Janvier, P. (1980) Osteolepid remains from the Devonian of the Middle East, with particular reference to the endoskeletal shoulder girdle. In *The Terrestrial Environment and Origin of Land Vertebrates* (ed. A.L. Panchen), Systematics Association, **15**, 223–54.

Janvier, P. (1981) The phylogeny of the Craniata, with particular reference to the significance of fossil 'agnathans'. *Journal of Vertebrate Paleontology*, **1,** 121–59.

Janvier, P. (1985a) Les céphalaspides du Spitsberg. *Cahiers de Paléontologie (Section Vertébrés*), CNRS, Paris, pp. 1–244.

Novitskaya, L.I. (1975) Revision of the Devonian pteraspids from Podolia. *Palaeontologiski Zhournal*, **4,** 72–85.

Stensiö, E.A. (1932) *The Cephalaspids of Great Britain*. British Museum (Natural History), London, 220 pp.

Wängsjö, G. (1952) The Downtonian and Devonian veterbrates of Spitsbergen, IX. Morphology and systematic studies of the Spitsbergen cephalaspids. *Norsk Polarinstitut Skrifter*, Oslo, **97**, 1–611.

Westoll, T.S. (1945) A new cephalaspid fish from the Downtonian of Scotland, with notes on the structures and classification of Ostracoderms. *Transactions of the Royal Society of Edinburgh*, **61**, 341–57.

Westoll, T.S. (1958) The lateral fin-fold theory and the pectoral fins of ostracoderms and early fishes. In *Studies on Fossil Vertebrates* (ed. T.S. Westoll), University of London Press, London, pp. 181–211.

White, E.I. (1935) The Ostracoderm *Pteraspis* Kner and the relationships of the Agnathous Vertebrates. *Philosophical Transactions of the Royal Society, London*, **B225**, 381– 457.

White, E.I. (1950b) *Pteraspis leathensis* White, a Dittonian zone-fossil. *Bulletin of the British Museum (Natural History) Geology*, **3,** 69–89.

White, E.I. (1958b) On *Cephalaspis lyelli* Agassiz. *Palaeontology*, **1,** 99–105.

White, E.I. (1961) The Old Red Sandstone of Brown Clee Hill and the adjacent area. II. Palaeontology. *Bulletin of the British Museum (Natural History) Geology*, **5,** 245–310.

White, E.I. (1973) Form and growth in *Belgicaspis* (Heterostraci). *Palaeontographi-ca, Abteilung A, 143*, 11–24.

White, E.I. and Toombs, H.A. (1983) The Cephalaspids from the Dittonian section at Cwm Hill, near Abergavenny, Gwent. *Bulletin of the British Museum (Natural History), Geology*, **37**, 149–71.