Writhlington, Avon

[ST 703 553]

Introduction

The Radstock coal basin of the Bristol–Somerset Coalfield in south-west England (Figure 3.16) has been long recognized (Woodward 1729; von Sternberg 1820–1838; Brongniart 1828–1838) for the exceptional preservation of its Upper Carboniferous plant fossils. Numerous holotypes and important illustrations of fossil plants were chosen from Radstock basin examples (see Thomas and Cleal, 1994). The last mines closed in the 1970s, but reworking of the tips for coal from 1984 to 1986 exposed fresh Roof Shale (mainly mudstone) and attracted the interest of fossil collectors.

Through co-operation between the site owner, local geological and conservation groups and the enthusiasm of palaeontological societies and individuals, some 3000 tons of spoil from the old colliery tip was set aside in a fenced conservation area and in 1987 the site became a geological nature reserve — the Writhlington GCR site (Figure 3.17). The result has been one of the most successful and innovative, palaeontological site-based conservation initiatives of recent years.

Particularly through the efforts of Dr E. Jarzembowski and the many volunteers, both professional and amateur, a vast fossil fauna was assembled from the site Oarzembowski, 1989) including vascular plants, arthropods (insects, arachnids, xiphosurans, conchostracans, giant millipedes and a eurypterid), nematodes, bivalves, fishes and reptiles in order of descending abundance. The collection includes the largest collection of fossil insects in the UK, more than 1200 specimens, including the oldest known damselfly (Jarzembowski and Nel, 2002), and the greatest number of phalangiotarbid arachnids in Britain. The fossil material is derived from Farringdon Formation shales of late Westphalian D age (*Dicksonites plueckeneti* Subzone), some 307 million years old (Todd, 1991).

These Upper Carboniferous coals and associated sediments accumulated close to the palaeoequator and are therefore deposits of some of the world's first tropical forest ecosystems. Their fossils provide insights into these ecosystems in which the only flying animals were insects whose diversity included the first dragonflies as top aerial predators.

The scientific importance of the site results from (a) the vast number of Coal Measure insects recovered from the locality; (b) earliest records of some insect fossils; (c) the large collection of unusual phalangiotarbid arachnids; and (d) the total fauna and flora which, together, provides a unique insight into Upper Carboniferous terrestrial life on a delta plain (forested floodplain with freshwater wetland and waterways) in Britain (Todd, 1991).

Description

Writhlington lies in the southern part of the Bristol–Somerset Coalfield. Upper Carboniferous strata in this part of the coalfield form a broad structural basin known as the 'Radstock Syncline', which is truncated on the north side by the Farmborough Fault that was activated during the Hercynian (Variscan) orogeny. Apart from some exposure near Paulton, and in the Nettlebridge Valley, Upper Carboniferous rocks are concealed below a maximum of 150 m of Mesozoic cover (mainly Triassic and Middle Jurassic in age). Consequently, most of what is known of the geology of these strata is based on old mining records (e.g. Moore, 1937; Kellaway and Welch, 1948; Kellaway, 1970; Green, 1992).

Strata in the Radstock Syncline is mainly of Westphalian age, probably lying unconformably on Viséan Carboniferous Limestone. The interval can be divided into three main units (Figure 3.18). The lowest (Langsettian to middle Bolsovian) consists of about 1700 m of mudstones, thin sandstones and coals of the Vobster and New Rock groups (Moore and Trueman, 1937, 1942). These are overlain by some 3600 m of Pennant-like sandstones (upper Bolsovian to lower Westphalian D), which Kellaway (1970) referred to as the Downend and Mangotsfield groups. These sandstones are, in turn, overlain by about 2500 m of mudstones and thin sandstones, which include most of the coals exploited in the Radstock area.

These supra-Pennant beds have been assigned to three formations: in ascending order the Farrington, Barren Red and Radstock formations. Much of the early mining in the area concentrated on the stratigraphically higher coals of the Radstock Formation, but these were largely worked out by the' early twentieth century and the collieries thus had to delve

deeper to the Farrington coals. Lower Writhlington Pit reflects this history well: between 1829 and 1894, it only worked coals in the Radstock Formation; from 1894 to about 1925, it worked both Radstock and Farrington coals; and from about 1925 to its closure in 1973, only Farrington coals were exploited (Jarzembowski, 1989b). According to Jarzembowski, all the presently available material on the Lower Writhlington tip is from the Farrington Formation of late Westphalian D age (*Dicksonites plueckeneti* subzone). At Lower Writhlington the lower two seams have coalesced to form what was known locally as the No. 10 or New Coal. The fossiliferous shales on the Lower Writhlington tip were probably derived mainly from the roof of this No. 10 Coal but included a small amount of distinctive Rock Coal Roof Shale as well.

It is difficult to assess the sedimentology because the Upper Carboniferous geology at Radstock can no longer be seen *in situ.* The best that can be done is to compare the fossiliferous lithologies with those in the exposed sections lower in the Westphalian of northern England, and which have been the subject of sedimento-logical investigation (e.g. Haszeldine and Anderton, 1980; Haszeldine, 1983, 1984; Fielding, 1984a,b, 1986; Guion and Fielding, 1988).

British coal-bearing sequences similar to the Radstock and Farrington formations were formed in large fluvial plains traversed by levee-bounded distributary channels. Between the channels were low-lying flood basins, which were normally densely vegetated, forming back-swamps. For most of the time, the main deposits formed in the flood basins were peats generated by the swamp vegetation, and these were eventually transformed into coals. Periodically, however, the levee banks bounding a flood basin were breached, causing river water to flood the area and destroy most of the swamp vegetation. The inflowing water brought with it muds and silts, forming crevasse-splay and small-scale delta deposits. These sediments would progressively cause the floodplain lake to silt up, until eventually the swamp vegetation could return.

It has been estimated that a 1 m thickness of clastic deposits caused by crevasse-splay flooding could have been generated in as little as five years (Broadhurst *et al.,* 1980). In contrast, Broadhurst and France (1986) estimated that it took some 7000 years to generate the same thickness (1 m) of coal. Applying these figures to the thicknesses of coals and inter-seam sediments of the Farrington Formation given by Moore (1937), it appears that, despite the immediate impression given by the relative stratigraphical thicknesses, the area was covered by swamp vegetation for at least 97% of the time, and was only cleared by flooding for very short periods (Thomas and Cleal, 1994). According to Jarzembowski (1989), the fossil-bearing mudstones at Lower Writhlington contained entombed lycopsid stumps, from which he concluded that sedimentation had been rapid. These mudstones were thus probably deposited as part of a crevasse splay caused by a flood event which destroyed the swamp vegetation that formed the No. 10 Coal. The resulting lake may have lasted for some centuries before it silted up, but this pales into insignificance compared with the 10 000 years duration of the replacement swamp.

Todd (1991) described four sublithologies at the Writhlington site. More than 90% of the fauna is associated with sublithology A, a medium to dark grey, laminated, silty mudstone with subordinate clayey siltstone. He interpreted this sublithology as belonging to Scott's (1979) Facies Association 1A: pro-delta lake clays; that is. the animals were washed into the site of deposition together with lycopod debris during flooding episodes.

The arthropod fauna

(Figure 3.19) shows that by far the majority of the animal fossils found at Writhlington are Blattodea (cockroaches), with over 700 specimens accounted for. Since cockroaches are a common component of coal measure terrestrial faunas this finding should not be surprising; however, the lesser number of other insects, and hence the extreme abundance of blattodeans, is most unusual. Also, the cockroach entomofauna is dominated by archimylacrids (and not mylacrids) unlike many other late Westphalian faunas (Jarzembowski and Schneider, in press).

Similarly, amongst Carboniferous arachnids, which in any case are rare, phalangiotarbids are not normally the commonest; normally it is trigonotarbids which turn up most often. However, Beall (1991) has pointed out that where phalangiotarbids do occur (Writhlington, UK, and Mazon Creek, USA), they do supercede all others in number of specimths. The second commonest insect in Writhlington, one-tenth as numerous as the cockroaches, is Protorthoptera; and the second commonest arachnid group, with one-quarter the number of specimens as Phalangiotarbida, is the Trigonotarbida (Figure 3.20).

Phylum ARTHROPODA

Subphylum Chelicerata

Class Xiphosura

Euproops danae (Meek & Worthen, 1865) (Ambrose and Romano, 1972; Anderson, 1994)

Class Eurypterida

Adelophthalmus imhofi (Proctor, 1999)

Class Arachnida

Order Phalangiotarbida

Phalangiotarbids (Beall 1991)

Bornatarbus mayasii (Pollitt *et al.,* 2004)

Order Trigonotarbida

Pleophrynus verrucosa (Pocock, 1911) (Dunlop, 1994b)

Order Amblypygi

Protophrynus carbonarius? Petrunkevitch, 1913 (Dunlop,1994a)

Order Araneae

Undescribed mesothele spider (Selden and Siveter 2001)

Subphylum Hexapoda

Order Odonatoptera

Bechlya ericrobinsoni Jarzembowski & Nel, 2002

Order Blattodea (Jarzembowski, 1989b)

Archimylacris sp. nov. Jarzembowski & Schneider, in press

Sooblatta spp. Jarzembowski & Schneider, in press

Phyloblatta? sp. Jarzembowski & Schneider, in press

Order Protorthoptera (Jarzembowski, 1989b)

Order Palaeodictyoptera (Jarzembowski, 1989b)

Mazonopterum? sp. nov. Prokop *et al.,* in press [Kilmersdon]

There is also evidence of plant damage by insects, such as the ichnofossil

Phagophytichnus ekowskii.

Other arthropod remains

Ostracode traces (Pollard and Hardy, 1991) unnamed

Xiphosuran traces (Pollard and Hardy, 1991)

Kouphichnium aff. *variabilis*

Conchostracan traces (Pollard and Hardy, 1991) unnamed + body fossil: *Anomalonema reumauxi* (Jarzembowski, 2004)

Nematode traces (Pollard & Hardy 1991)

Cochlichnus sp.

Arthropleura armata (jarzembowski 1989) (Proctor, 1998)

trace fossil: *Diplichnites* cf. *cuithensis* (Jarzembowski, 2004)

Arthropod coprolites Oarzembowski, 1989b)

Molluscs (bivalves)

Anthraconaia species *Anthraconauta tenuis*

Vertebrates

Shark: *Palaeoxyris* cf. *carbonaria* (jarzembovvski, 1989b)

Reptile: cf. *Pseudobradypus* sp. (pelycosaur ichnofossil, Milner, 1994) (Pollard and Hardy (1991) also record cf. *Lunichnium.*

Interpretation

There are many Coal Measure arthropods known from Britain, but mostly from isolated localities yielding a handful of specimens each; most of the old localities are now destroyed. Writhlington is one of the few to still be reasonably accessible and also to yield an abundance of fossils. Work done so far on the arthropod faunas is as follows.

Ambrose and Romano (1972) described a xiphosuran and a trigonotarbid from the mine tip of Kilmersdon Colliery in the Radstock Coalfield. They named the new xiphosuran taxon *Euproops kilmersdonensis.* Following discovery of additional xiphosuran remains from the Writhlington site, Anderson (1994) described the Writhlington material in conjunction with a review of the Kilmersdon xiphosuran. He concluded that the animals were con-specific and could be accommodated in the well-known *Euproops danae* (Meek & Worthen, 1865, (Figure 3.21)). This is not surprising as Kilmersdon and Writhlington deposits are adjoined underground and both mines were working the No. 10 Coal (Jarzembowski, 1989b). The Somerset specimens differed from the type of E. *danae* simply due to taphonomic and tectonic distortion.

The phalangiotarbid arachnids were discussed, but not formally described, by Beall (1991) who distributed the morphologies through three genera. Selden and Siveter (2001) indicated that there is probably only a single species of phalangiotarbid at Writhlington and that the variety of morphologies could be explained by tectonic distortion. Most recently, Pollitt *et al.* (2004) agreed with this conclusion in their redescription of the Writhlington phalangiotarbid fauna and referred the animal to *Bornatarbus mayasii,* a genus and species previously recorded from Germany (Figure 3.21)a.

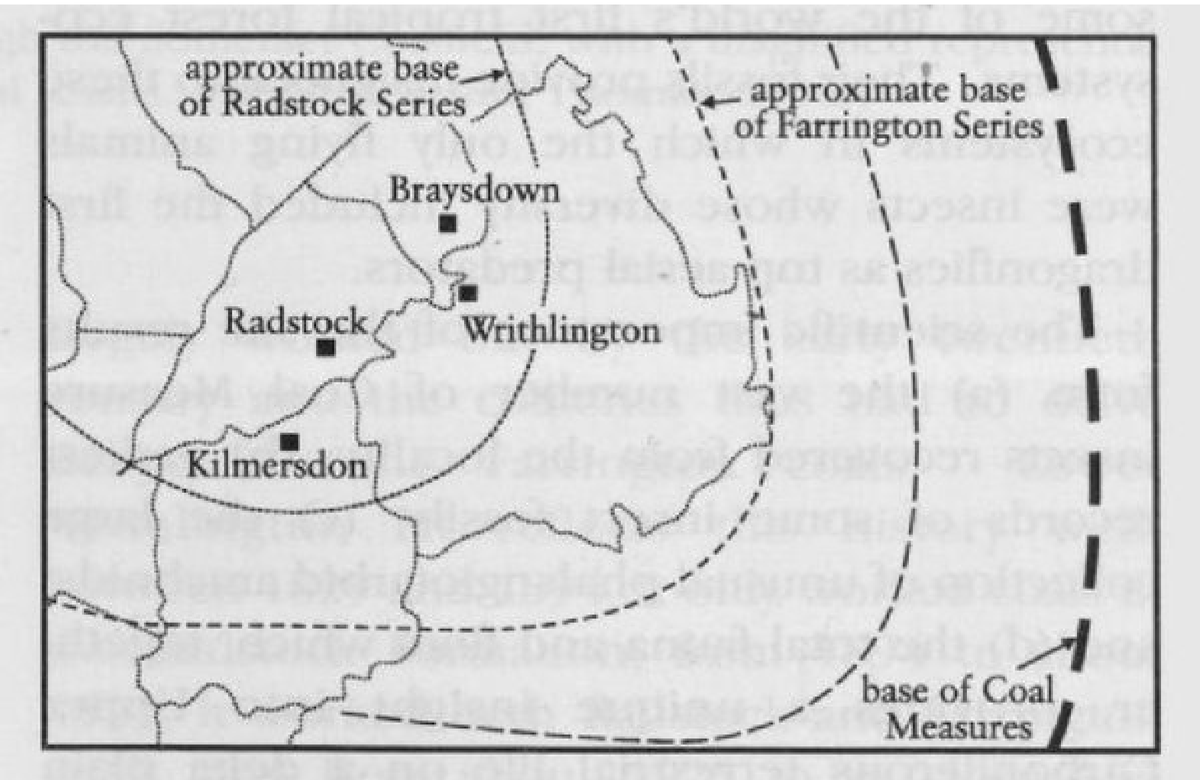
Other arachnids known from Writhlington include one poorly preserved amblypygid (Dunlop 1994a), undescribed spiders carapaces (Selden and Siveter, 2001), and some trigonorbid specimens. The last were described by Dunlop (1994b) as *Pleophrynus verrucosa* (Pocock, 1911). In this paper, he reviewed the specimens of *Eophrynus jugatus* Ambrose & Romano (1972) from Kilmersdon Colliery tip, and concluded that they were conspecific with *Pleophrynus verrucosa* of Writhlington).

General conclusions from these works are that there is much less diversity among Coal Measure arthropod faunas than has hitherto been thought. Previously, each new arthropod locality has produced a new taxon; perhaps it was assumed that new localities should always preserve different species. Critical comparative studies on arthropods from a variety of sites in Britain and the USA have shown that commonly differences in the specimens from these localities can be attributed to different tapho-nomic histories rather than true morphological dissimilarity. Low diversity of arthropod faunas in the stable environment of the Euramerican Carboniferous coal swamps fits in well with a similar hypothesis put forward by Milner and Panchen (1973) for vertebrates (Dunlop, 1994b).

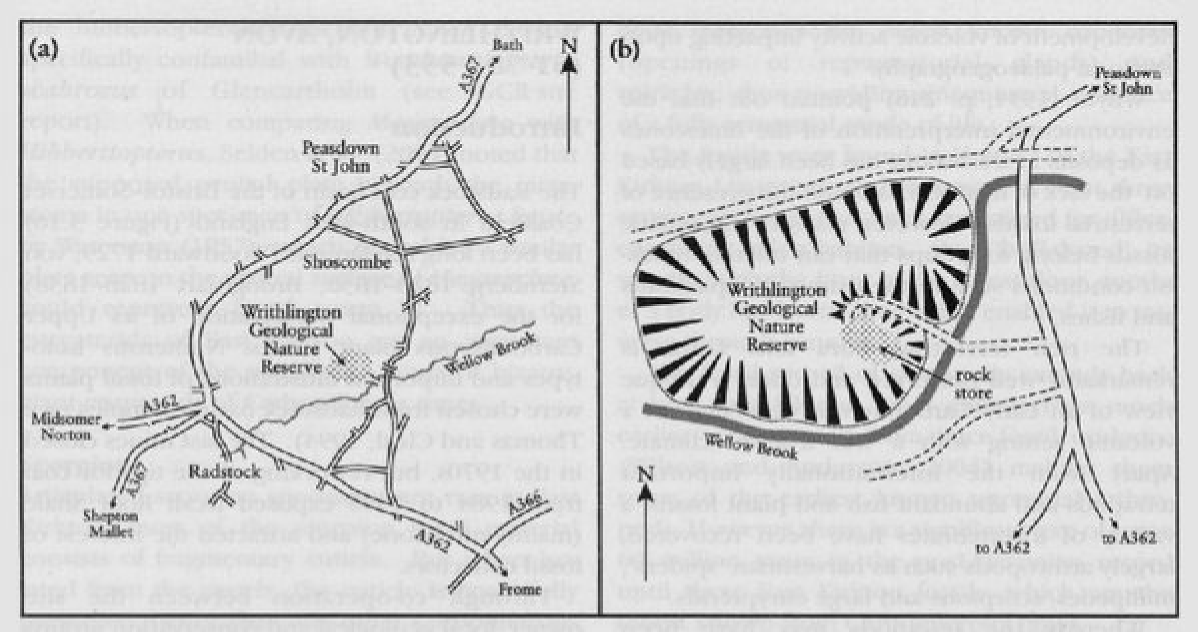
Conclusions

The Geological Nature Reserve at Writhlington is an exceptional resource for the study of Upper Carboniferous terrestrial life in Britain. The sheer numbers of fossil cockroaches and the unusual, extinct arachnids called phalangiotarbids, makes this site unique in the world. It can be compared to the other well-known Upper Carboniferous Lagerstätten of Mazon Creek (USA), Montceau-les-Mines (France), and Coseley (UK: now unavailable). Few Upper Carboniferous sites yielding arthropods are still available in Britain, and the saving of Writhlington in 1987 made this the best site for the study of Coal Measures arthropods and their association with other biota, especially the plants, and environments.

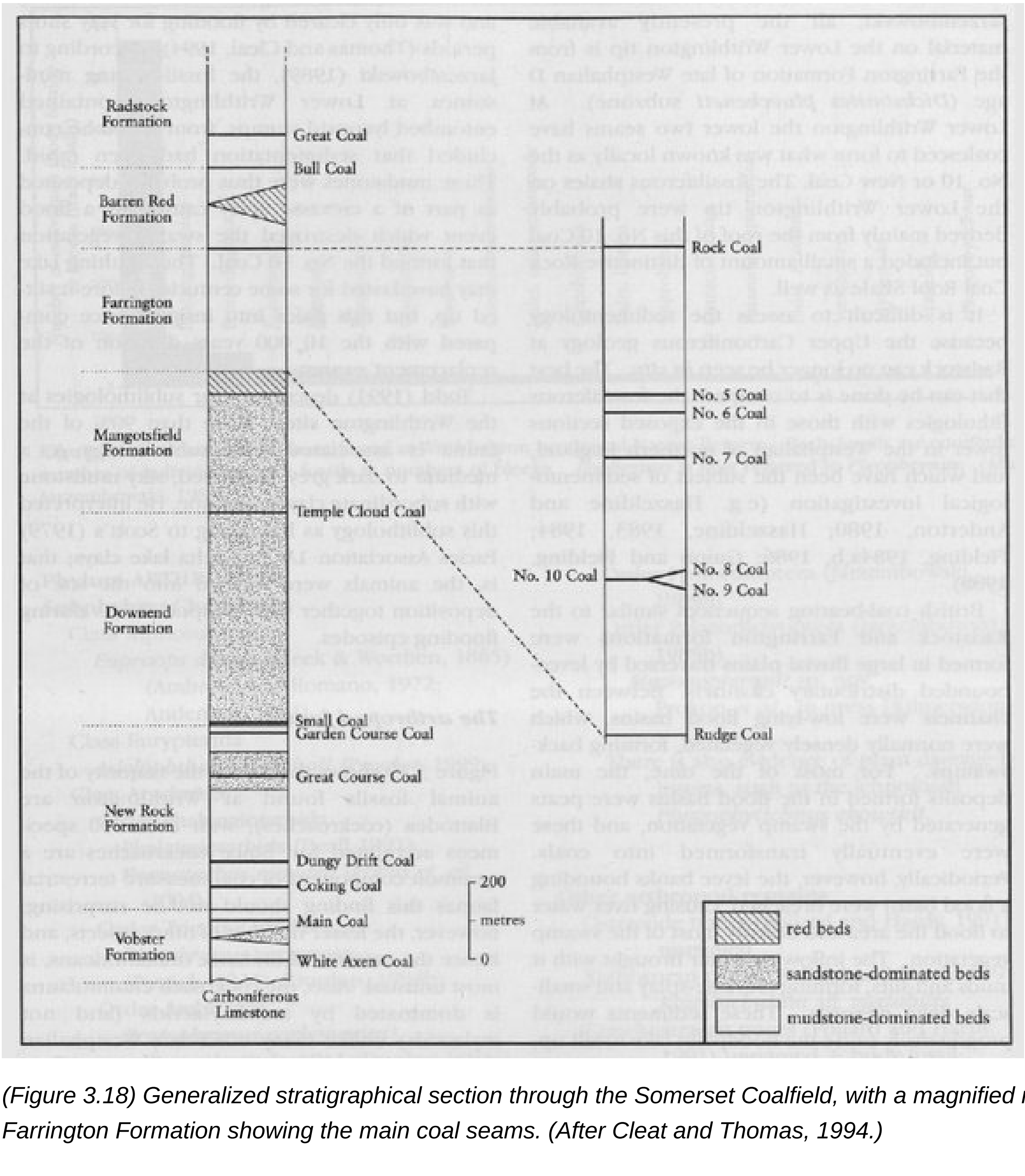
References



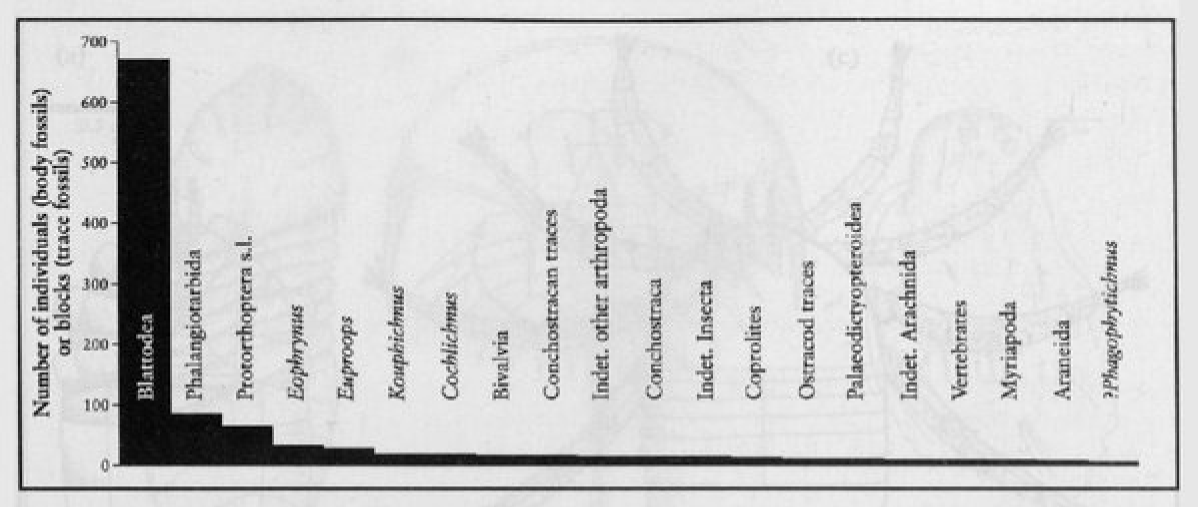
(Figure 3.16) The Radstock Coal Basin of the Bristol–Somerset Coalfield, sketch map.



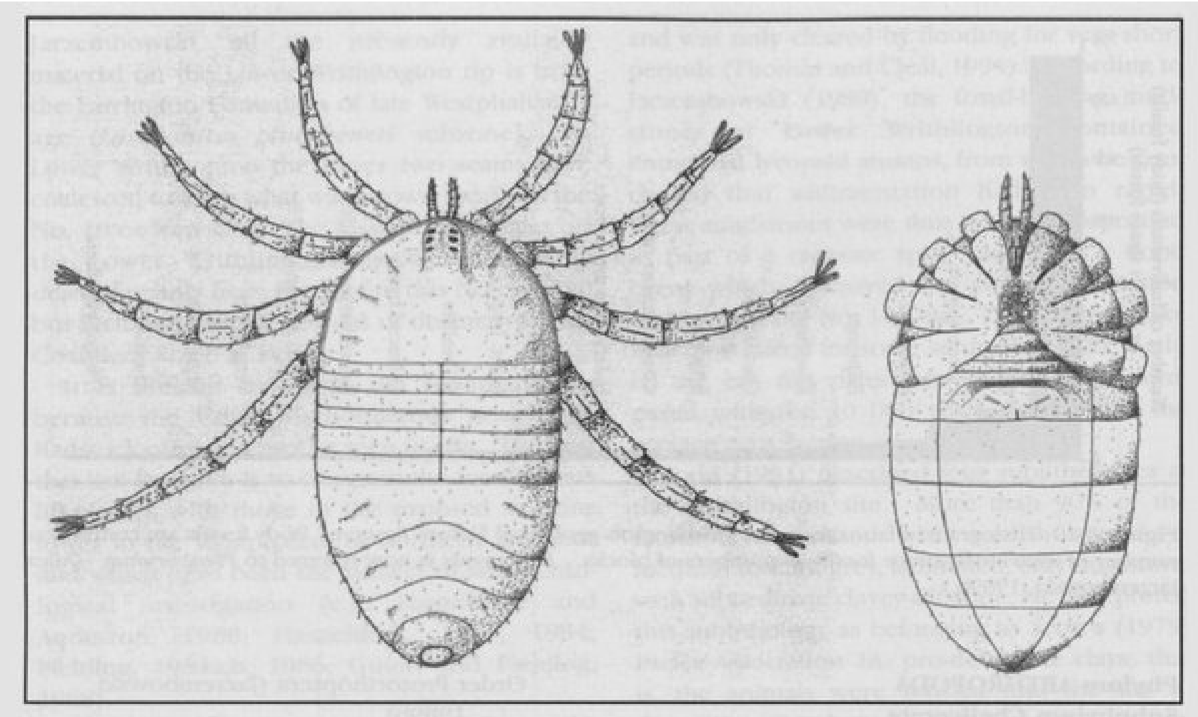
(Figure 3.17) Sketch maps showing the location of the Writhlington geological nature reserve and the rock store. (After Jarzembowski1989b)



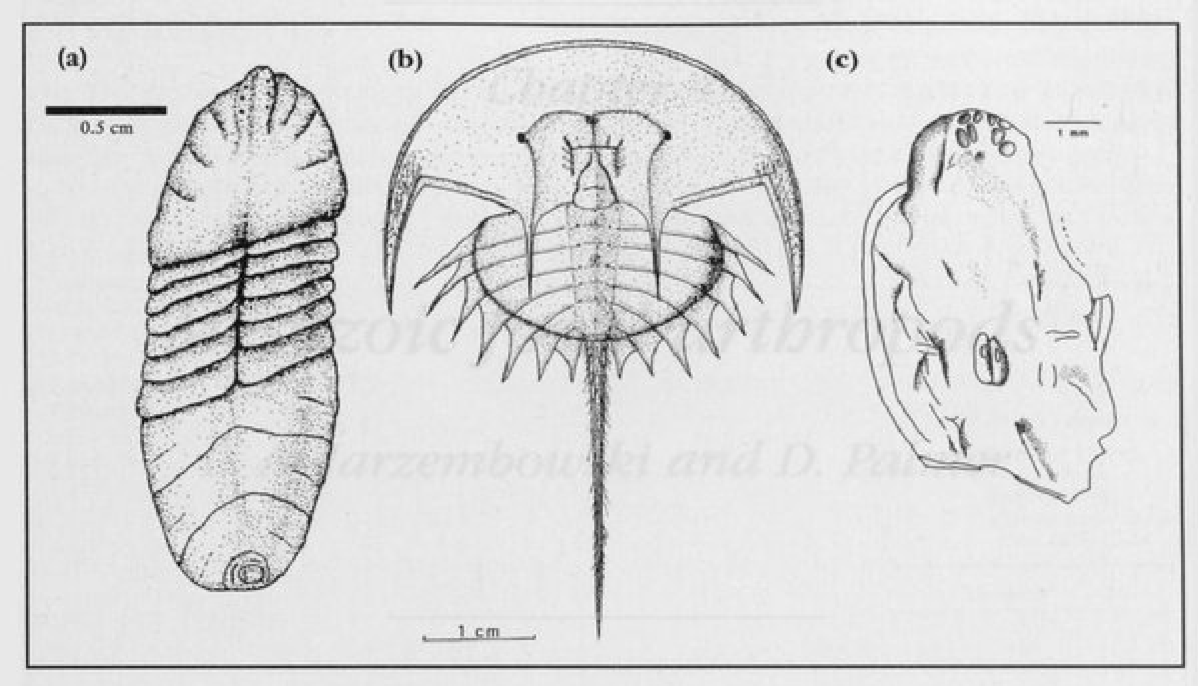
(Figure 3.18) Generalized stratigraphical section through the Somerset Coalfield, with a magnified representation of the Farrington Formation showing the main coal seams. (After Cleat and Thomas, 1994.)



(Figure 3.19) Histogram of fauna found at Writhlington geological Nature Reserve. Body fossils are counted as number of individuals; trace fossils as numbers of blocks. Eophrynus is now referred to Pleophrynus. (After Jarzembowski, 1989b.)



(Figure 3.20) Reconstruction of Pleophrynus verrucosa (Pocock, 1911) dorsal and ventral views (see Dunlop, 1994b).



(Figure 3.21) Some Writhlington arthropods. (a) A reconstruction of the phalangiotarbid arachnid Bornatarbus mayasii (from Pollitt et al., 2004); (b) Euproops dance reconstruction, (from Anderson, 1994). (c) carapace of an undescribed spider (original drawing by the author). Note the tectonic distortion shown by the natural specimens (a) and (c).