Wainlode Cliff, Gloucestershire

[SO 845 257]

Introduction

Wainlode Cliff exposes a good section through uppermost Triassic rocks, and is an important fossil locality. The rocks exposed include the Mercia Mudstone Group and the overlying Penarth Group. Wainlode Cliff is the type locality for the crustacean *Euestheria minuta* var. *brodieana* (Jones, 1863), and is historically important for the evidence this fossil provides about the relative age of the Penarth Group.

The Wainlode Cliff section has been investigated by geologists since at least the early years of the 19th century. References include Strickland (1841), Brodie (1845, 1858), Wright (1860), Etheridge (1865), Richardson (1903a,b, 1947), Reynolds and Vaughan (1904), and Sykes (1977).

Description

The Wainlode Cliff section is on the east bank of the River Severn, near the village of Norton, between Tewkesbury and Gloucester. The section is good, although the beds towards the top of the cliff are virtually inaccessible (Swift, 1995).

Sedimentology

Wainlode Cliff exposes a sequence of Upper Triassic sediments, including the Twyning Mudstone and Blue Anchor formations of the Mercia Mudstone Group, the Westbury and Lilstock formations of the Penarth Group, and the Lower Lias at the top of the section (Figure 4.9). Several accounts have been published detailing the sedimentary sequence. The following is modified from Richardson (1903a, table 1) and Sykes (1977, pp. 205–6):

	Thickness (m)
Lias	
Hard blue limestone	0.10
Penarth Group	
Lilstock Formation ('Upper Rhaetic' of Richardson, 1903a):	
Shales, brown and grey, finely laminated, with a discontinuous limestone at the base	0.38
'Insect Limestone': hard, dark grey and blue	0.13
Shales, blue and brown, laminated, weathering to marly clay	1.57
'*Euestheria* Bed': hard, yellow, nodular limestone, dendritic markings, irregular fracture	0.15
Shales, pale greenish-yellow, coarsely laminated, marly	1.83
Westbury Formation ('Lower Rhaetic' of Richardson, 1903a):	
Shales and limestone:	
(a) Shales, black, coarsely laminated, slightly calcareous	0.91
(b) Limestone, very hard, grey, slightly pyritic; an irregular but continuous band	0.03
Shales, black, imperfectly laminated	0.25
Pecten limestone, grey to black, with fibrous layers of limestone, shelly	0.025
Shale, black and fissile, with bivalves	1.5
Sandstone, discontinuous, pyritic	0.03
Shales, black, clayey, laminated	0.15
Sandstone, micaceous, pyritic, in one or two seams	0.03

Shales, black, firm, coarsely laminated	0.30
Interbedded sandstone and clay:	
(a) sandstone, hard, calcareous, micaceous, pyritic	0.03
(b) clayey parting, selenitic, variable	0.03
(c) sandstone, hard, calcareous, micaceous, pyritic	0.01
Shale, black and fissile, with some thin, calcareous siltstone lenses that have sporadic minute fossils	0.35
Sandstone and siltstone, calcareous, divided into six units: (a) black shales with thin calcareous sandstone (b) fine, calcareous, pyritic sandstone with some medium sandstone concentrations associated with bony fossils (c) fine, calcareous, sandstone and siltstone with scattered fine bone remains (d) fine, calcareous, micaceous, light-grey sandstone, pyritic in part (e) fine, calcareous, light grey sandstone with much pyrite. Some small vertebrate fossils and occasional larger specimens and coprolites (f) light grey silt, calcareous, micaceous and unfossiliferous	0.17
Shale, black and fissile, with occasional silts	0.5
Mudstone, black, poorly bedded, with some clay and some silt layers	0.1
Mercia Mudstone Group	
Slue Anchor Formation ('Upper Keuper' of Richardson, 1903a):	
Light greenish-grey marls, weathering bluish-grey. Conspicuous green layer at the top	7.00
Twyning Mudstone Formation (former 'undifferentiated red mudstone')	
Red mudstones; variegated red marls, with zones of grey and greenish-grey marl; angular and conchiodal fractures	22.86

The Twyning Mudstone Formation at the base of the cliff comprises mainly red clays and marls, with patches of grey, green, and blue sediment. Gypsum is occasionally present in these beds (Richardson, 1903a). Overlying these red beds are the paler greenish-grey, fine-grained sediments of the Blue Anchor Formation. Although poorly consolidated, argillaceous lithologies dominate, a band of hard, yellowish or white marl is seen in this formation close to the boundary with the Penarth Group (Richardson, 1903a).

Most of the Westbury Formation comprises dark shales with thin sandstones. Above the base of the formation is the 'bone bed'; an indurated calcareous and pyritic sandstone with abundant vertebrate remains, often occurring as three or four discrete beds separated by clay units. Although well developed, the bone-bearing facies frequently merges laterally with a thick (0.3 m) sandy, micaceous and non-calcareous sandstone that does not contain any fossils. The bone bed is best seen towards the north-east end of the exposure (Richardson, 1903a,b). One, and occasionally two, prominent grey sandstone beds occur some 0.2 to 0.3 m above the bone bed, and are associated with minerals such as barite and selenite (Richardson, 1903a).

Towards the top of the cliff, the Lilstock Formation, composed of alternations of pale limestone and shale, is exposed. At the top of the section, the Cotham Member is overlain by pale-coloured limestones, which show certain affinities to the Langport Member, but this unit has not been formally recognized at this locality (Swift, 1995).

Palaeontology

Many of the horizons in the Penarth Group at Wainlode Cliff have yielded remains of invertebrates and vertebrates, and the site is the type locality (Brodie, 1845, 1858; Jones, 1863) for the branchiopod crustacean *Euestheria minuta* var. *brodieana.* Vertebrate finds include fishes, for example *Gyrolepis, Hybodus,* and *Acrodus* (see Dineley and Metcalfe, 1999). Invertebrates are also present, often in large numbers, and include species of the bivalves *Protocardium, Ostrea,* and *Pecten,* all from the Westbury Formation. The fauna from the Cotham Member is significantly different, and includes insects, the crustacean *Euestheria minuta* var. *brodieana,* ostracods such as *Darwinula liassica,* bivalves, and plant remains (Richardson, 1903a). The Cotham Member at a neighbouring locality has yielded a marine microflora (Barclay *et al.,* 1997, p. 72).

The record of *Euestheria minuta* var. *brodieana* is historically important, since the taxon was named in the first report of this characteristic Rhaetian fossil from the Penarth Group (Jones, 1863), hence confirming for the first time direct equivalence with the Rhät of Germany, from which *Euestheria minuta* had already been described, in 1832. The variety *brodieana* was established to take account of the fact that the British form was smaller and had a finer network pattern on its outer surface, but is otherwise identical to the German form (Boomer *et al.,* 1999).

Interpretation

As with all late Triassic exposures in south-west Britain, the section at Wainlode Cliff shows the palaeoenvironmental change from terrestrial to marine conditions associated with the Late Triassic marine transgression. The oldest beds, the Twyning Mudstone Formation, record a dominantly terrestrial environment characterized by low-lying, supratidal plains with shallow hypersaline lakes. The overlying Blue Anchor Formation is marked by a change in colour, produced by a change in the geochemical environment. These sediments are also terrestrial in origin, although they show evidence of an increasing marine influence.

The Westbury Formation marks the beginning of marine conditions, with the transgression and the development of shallow seas and marginal marine conditions. The 'bone bed', as elsewhere, may represent a storm-driven process, with winnowing of sediment from among accumulated bones associated with the transgres■

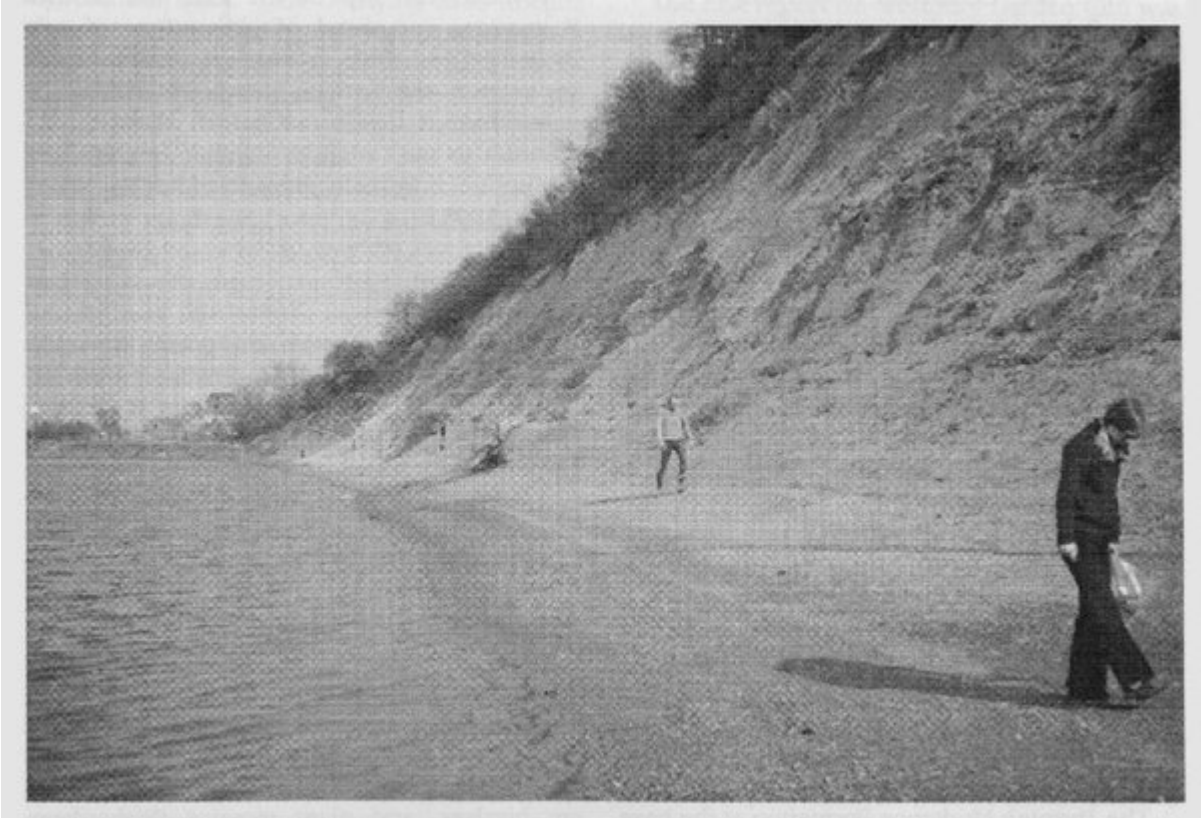
sion. Succeeding beds in the WestburyFormation are characteristic of low-energy conditions, probably associated with shallow seas. The overlying Cotham Member of the Lilstock Formation includes sediments characteristic of marine and terrestrial environments with shallow, probably marine, lagoons.

Conclusions

Wainlode Cliff exposes a sequence of sedimentary rocks that range in age from Late Triassic to Early Jurassic. The sediments record a change in environmental conditions from terrestrial with hypersaline lakes (the Mercia Mudstone Group),

through marine transgressive and shallow marine (Westbury Formation) and lagoonal–terrestrial (Cotham Member), to more fully marine conditions associated with the start of the Jurassic Period. It has historic importance, having been studied since at least 1841, and having provided the first evidence, from specimens of the crustacean *Euestheria minuta* var. *brodieana,* of direct correlation with the German Rhät.

References



(Figure 4.9) The Penarth Group in Wainlode Cliff, looking upstream (northwards). (Photo: K. A. Kermack.)