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The Rhaetian vertebrates of Chipping Sodbury, South Gloucestershire, UK, a comparative study

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ABSTRACT

Microvertebrates are common in the basal bone bed of the Westbury Formation of England, documenting a fauna dominated by fishes that existed at the time of the Rhaetian Transgression, some 206 Myr ago. Two sites near Chipping Sodbury, south Gloucestershire, Barnhill Quarry and Chipping Sodbury railway cutting, show differing faunas. Top predators are the large bony fish *Severnichthys* and the shark *Hybodus cloacinus*, which preyed on smaller sharks such as *Lissodus* and *Rhomphaiodon*. These fishes in turn may have fed on a mixed diet of other fishes and invertebrates, and *Lissodus* was a shell crusher. Comparisons of these faunas with others described recently from the Bristol region, and from Devon, indicate remarkable faunal similarities in the Rhaetian basal Westbury Formation bone bed over a wide area, based on a variety of ecological statistics that document species diversities and relative abundances. Only the fauna from the Chipping Sodbury railway cutting differs significantly.

1. Introduction

The Rhaetian was a significant stage of the Triassic, during which there were profound changes in the Earth's climate and topography, and biosphere. During this short span of time (205.7–201.3 Myr ago; Maron et al., 2015), Pangaea began to break up (de Lamotte et al., 2015), and this presumably greatly influenced the global climate system by driving cyclical extremes of climate (Trotter et al., 2015). The Rhaetian was terminated by the end-Triassic mass extinction, which saw the rapid, global extinction of ~50% of marine and terrestrial genera (Deenen et al., 2010), including the conodonts and many marine reptiles and invertebrates, as well as many archosaurs, some therapsids, and most temnospondyl amphibians.

Rhaetian outcrops in the UK, assigned to the Penarth Group, extend from Teesside in the north-east of England to Dorset on the south coast, and on both sides of the Severn Estuary, in South Wales and around Bristol (Swift and Martill, 1999). The stratigraphy of the Rhaetian follows a common pattern throughout the UK, but differs in continental European locations. However, one constant throughout all occurrences is that there is generally a basal bone bed that yields abundant bones and microfossils of bony fishes, sharks, and reptiles. A number of British Rhaetian bone bed sites have been described (Swift and Martill, 1999; Allard et al., 2015; Korneisel et al., 2015; Nordén et al., 2015) and many of them share the key elements of their faunas in common; however, there has never been a numerical comparison of the faunal lists, key taxa and relative abundances between different sites. Are they constant, representing unbiased preservation of a common fauna, or are there differences in diversity and relative abundance, perhaps reflecting palaeoenvironmental or taphonomic differences?

The aim of this paper is to explore variations in the composition of the vertebrate faunas from the Rhaetian bone beds of southern England. Here, we examine two sites, Barnhill and Chipping Sodbury railway cutting, chosen because they are located geographically adjacent to each other. Further, we analyse census data from these sites, and others, to assess the variation in faunal assemblages and relative abundances of taxa among a number of Rhaetian bone bed sites

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2. History and geological setting

2.1. Historical setting

The two sites, Barnhill Quarry (National Grid Reference [NGR] ST 72604 82620) and Chipping Sodbury railway cutting (NGR ST 71484 80904 to ST 75242 81473) are approximately 1.1 km apart, both being located towards the eastern end of Chipping Sodbury (Fig. 1). Barnhill Quarry, sometimes called Arnold's Quarry (Murray and Wright, 1971), was first mentioned on a tithe map printed in 1839, when the quarry was much smaller and shallower than it is today, and quarrying operations were small-scale. From 1844, however, the quarry was presumably a much larger undertaking, and was recruiting workers from the Sodbury Union Workhouse. In 1859, records show a specialist limestone quarry, as well as a limekiln on the site (Ridge Wood, 2015). At this time, the quarry covered 11 acres, 2 rods and 7 perches (approx. 46,719 m^2). From the 1860s, there is evidence of a railway siding leading into the quarry (Ridge Wood, 2015), built and run by the Midland Railway Company. It is likely that packhorses and mules were used to carry cut stone from the quarry to the railway line. After the First World War, quarrying became the principal source of employment in the area, as the demand for limestone increased with the growing network of roads being laid at the time.

In 1928, several small-scale West Country quarries were grouped together to form the British Quarrying Company (Hopkins, 1979), which later became the Amalgamated Roadstone Corporation (ARC); Barnhill Quarry was used as the headquarters for what was at the time the largest stone company in the world. Eventually, however, the limestone yield of the quarry began to decline, and by 1955, the quarry had been abandoned. The site was declared an SSSI for its twofold stratigraphic significance; in representing the Lower Cromhall Sandstone of the Carboniferous, which is noted for the demonstration of sedimentary structures, and in demonstrating an excellent Rhaetian section sitting directly on Carboniferous Limestone (Benton et al., 2002; Cossey et al., 2004). However, there is much ongoing debate about the future of the site. Houses and a supermarket were built (2014–2016) in the southern part of the quarry, and the remainder could become a household waste landfill site. Today, the site covers just 7.7 acres (31,160.8 m^2), but the geological sections forming the east, north and west faces of the quarry are still intact.

Chipping Sodbury railway cutting was excavated by the former Great Western Railway Company, which had been the primary railway company in the west since its establishment in 1835 (Roden, 2010). Following successful completion of the Severn Railway Tunnel in 1887 (Walker, 1888), the construction of a new railway line between Swindon and the tunnel began in November, 1897 (Robertson and Abbott, 1989). This would allow South Wales coal traffic bound for London to bypass Bristol. In order to lay a track bed across such an uneven landscape, great volumes of rock and earth were excavated to build tunnels and cuttings, and a large number of embankments and viaducts also had to be erected (Husband, 1902).

Chipping Sodbury railway cutting leads into Chipping Sodbury tunnel, which is the second longest railway tunnel in the Great Western region (4433 m), exceeded in length only by the Severn tunnel (7008 m). Construction of the former was made possible by 'shaft excavation', and at one point the tunnel had up to 40 gangs of navvies tunnelling ventilation shafts directly down into the hill, then tunnelling horizontally at the correct depth to link up with other shafts (Husband, 1902). Work on the line was completed in 1903, and by this time, excavation of the cuttings had required the work of 4000 navvies, 44 steam locomotives, 17 steam shovels, 11 steam cranes and 1800 wagons (Robertson and Abbott, 1989).

2.2. Geology of Chipping Sodbury railway cutting

Chipping Sodbury is located on low-lying Upper Triassic and Lower Jurassic sediments (Fig. 1), and the succession youngs eastwards, passing up through Lower and Middle Jurassic sediments, with outcrops all trending roughly north to south at this point. About 1 km east of the eastern limit of Chipping Sodbury, the landscape rises as a ridge formed from the Dyrham

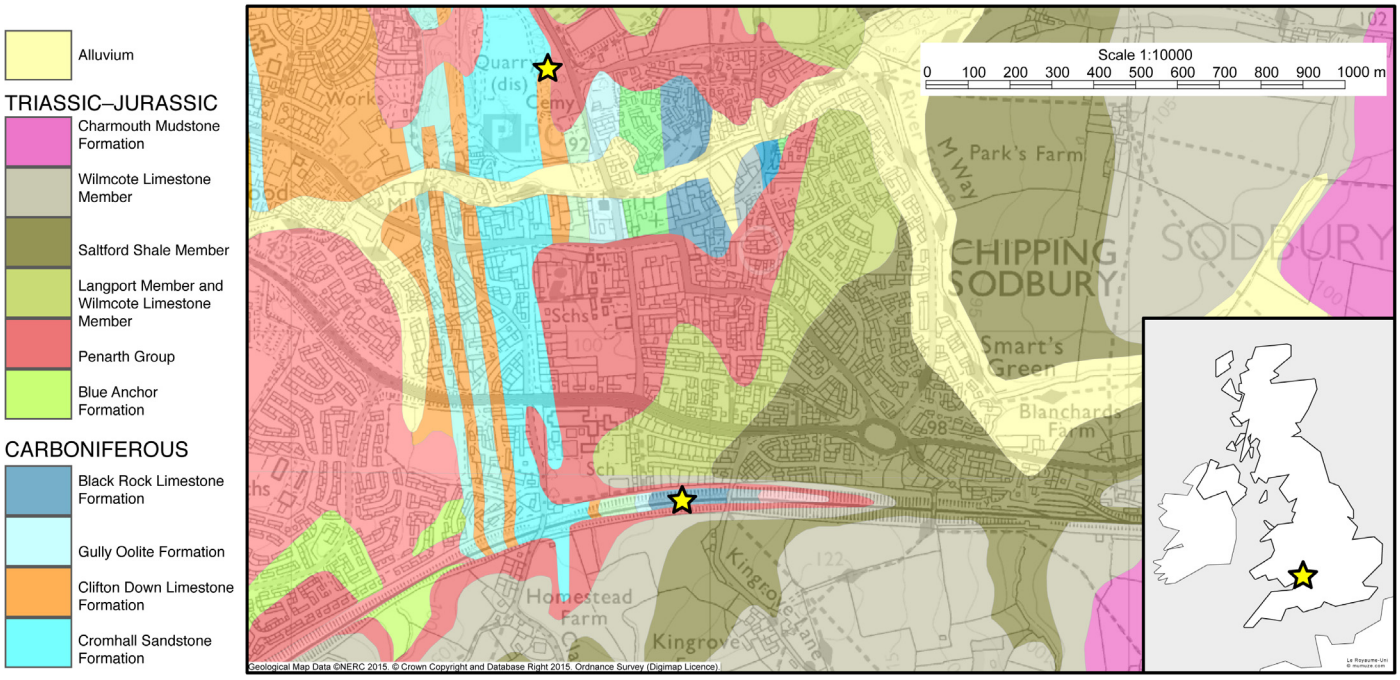

Fig. 1. Geological map of the Chipping Sodbury area, with Barnhill Quarry and the Chipping Sodbury railway cutting marked (yellow stars). Key geological formations are indicated, separated into four key Carboniferous units (bottom of column) and the key Triassic–Jurassic units above. © Crown Copyright and Database Right 2015. Ordnance Survey (Digimap Licence).