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English Wealden fossils: an update

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ABSTRACT

The non-marine Wealden succession of southern England contains a great variety of fossils, new finds of which continue to reveal novel insights into the animals and plants that inhabited this part of the world during much of the Early Cretaceous. Although seldom common, careful searching during the past few years has yielded megafossils that add to previous knowledge of occurrences of taxa and palaeoenvironmental conditions. Particularly significant in this respect has been the recovery of a large number of new insect species, but there have also been numerous finds of vertebrate bones and other body parts, such as teeth, skulls, a claw and a cranial endocast. In addition, the taxonomy of some of these groups and, in the case of dinosaurs, the ichnotaxonomy of their footprints and trackways, has been reviewed and/or reassessed. In this paper, we provide an illustrated account of the research that has been published on Wealden geology and the fossils that have been recovered from the succession since a field guide to English Wealden fossils was issued by the Palaeontological Association in 2011. It is aimed at providing the reader with a document of first resort for fossil identification purposes and a lead into the literature for further information.

1. Introduction

A field guide to English Wealden fossils was published by the Palaeontological Association, London in 2011 (Batten, 2011a). It contains descriptions and illustrations of all of the fossils that there is a reasonable chance of finding in Wealden rocks without spending an inordinate amount of time searching for them, and many more besides. Since publication, a number of new specimens of a range of taxa have been discovered and described, and others renamed. The aim of our paper is to bring this work up to date by providing an illustrated record of these additions and changes, together with new references and some older items not included in the original publication, so that those who wish to identify their finds may refer to it as a first resort and will know where to look in the literature for further information. Hence, it is a supplement to the field guide but not a new, multi-authored, fully documented work in the field-guide style. It is too soon for such an endeavour. Work in progress is also noted.

2. Wealden geology

One of the most important contributions on Wealden geology to have been published since Batten's (2011b, Chapter 2) review was a special issue of the Proceedings of the Geologists' Association (PGA) containing five papers by Dr. J. Radley and the late Professor P. Allen (1917–2008). This volume was the latest in the Geological Conservation Review (GCR) series, previously published as books on behalf of, and latterly by, the JNCC (Joint Nature Conservation Committee). When funding for the book series ran into difficulty, Elsevier stepped in with a commitment to publish the remaining GCR volumes as special parts of the PGA. The GCR series aimed to assess and document the most important geological sites in the UK, and provide the scientific basis for the legal protection of those sites under the Wildlife & Countryside Act. Entitled "The non-marine Lower Cretaceous Wealden strata of southern England", this special issue was regarded as a summation of Prof. Allen's lifelong Wealden studies (Radley, 2012). It included a discussion of sites that were crucial to his interpretation of the Wealden succession (Fig. 1), many now no longer accessible. The collection of papers consists of a review of the strata and depositional model (Radley and Allen, 2012a), discussion of the Weald and Wessex sub-basins (2012b,c) and the marginal Wealden between Wiltshire and Buckinghamshire (2012d), and a summary of palaeoenvironments and palaeoecology (2012e). Prof. Allen's lifelong research into Wealden sedimentology and palaeoenvironments was also summarized in Radley (2014), together with a previously unpublished report written by Allen of an excursion to Philpots Quarry, West Sussex in 1990 to celebrate the bicentenary of the birth of Gideon Mantell (1790–1852).

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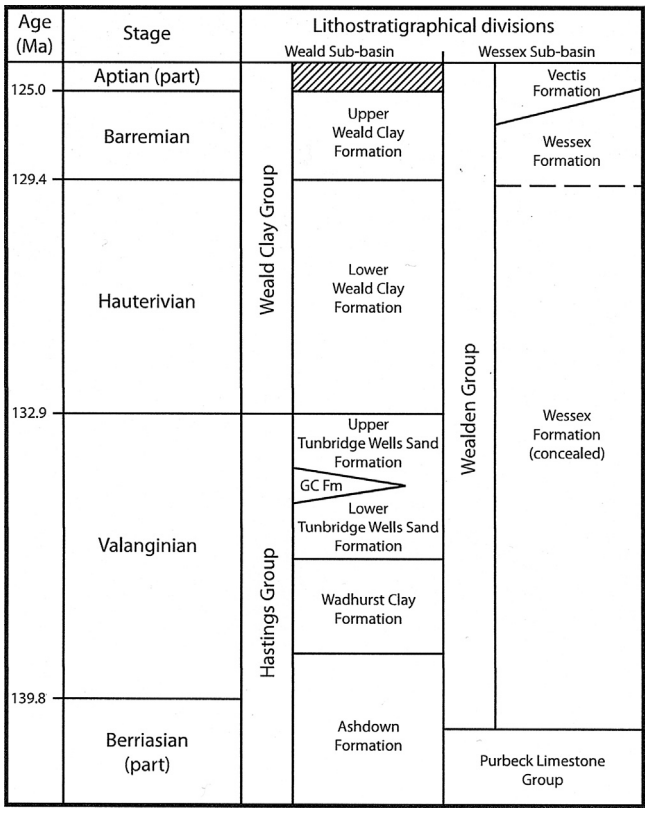

Fig. 1. Stratigraphy of the Wealden Supergroup of southern England. Time scale from Cohen et al. (2013; updated 2017). Modified after Batten (2011b, text-fig. 2.1, to which reference should be made for formation thicknesses and other observations).

Other publications on Wealden geology include those of Bouch (2005) and Kemp et al. (2012). Bouch reported on SEM (scanning electron microscope) petrography of Wealden samples from the Wessex Formation of Hanover Point and Brighstone Holiday Park on the Isle of Wight, and Lulworth Cove and Swanage in Dorset; the Weald Clay Group exposed in quarries associated with the South Holmwood (Beare Green) Brickworks and Smokejacks Brickworks in Surrey, the Laybrook Brickworks in West Sussex, and the Chailey Brickworks in South Chailey, East Sussex; and the Wadhurst Clay Formation at Bexhill, East Sussex. Kemp et al. (2012) discussed the mineralogy and geochemistry of samples from the same localities. These two projects were undertaken to investigate the shrink-swell properties of Wealden Supergroup mudstones in England. Recent work by Akinlotan (2015) on the sedimentology of the Ashdown and Wadhurst Clay formations of south-east England has formed the basis of several papers aimed at interpreting depositional environments based on geochemical analyses (Akinlotan, 2017a); the importance of using mineralogy for both palaeoenvironmental reconstructions (2017b) and interpretation of conditions of deposition in sedimentary basins (2017c); and determining the porosity and permeability of Wealden sandstones (Akinlotan, 2016).

3. Wealden localities in south-east England

Of the working quarries discussed by Batten and Austen (2011, Chapter 3: Figs. 2 and 3, herein) a number are no longer accessible, and some significant discoveries have been made in others.

3.1. Hastings Group: inland localities

In August 2013, some scattered bones were discovered in a newly cut face in the Pevensey Pit of the Ashdown Brickworks, Bexhill (TQ 720095). Excavations into this face in the Wadhurst Clay Formation over the following three years revealed around 300 bones. They are thought to come from two iguanodonts, a juvenile and a sub-adult, most likely *Hypselospinus fittoni*. All the remains have been donated to Bexhill Museum, and Dr. D. Norman (University of Cambridge) is currently studying the material (Austen and Austen, 2013, 2014, 2015: Fig. 4 herein). An ankylosaur bone was also found in the same deposit.

Blows and Honeysett (2014a) reported three new nodosaurid teeth from the Ashdown Brickworks site which, along with one tooth from the Wessex Formation of the Isle of Wight, are the first to be recovered from the Lower Cretaceous of the UK. They also documented the earliest recorded *Polacanthus* (Blows and Honeysett, 2014b). This was found at Ashdown and is the first from Valanginian deposits. As noted in Batten and Austen (2011), access to this site is restricted. Its main purpose is for research, with all material being donated to Bexhill Museum.

Access to the other inland sites described in the field guide, all in West Sussex (Philpots and Hook quarries: TQ 355323 and TQ 355313, respectively; Sharpthorne Brickworks: TQ 374329; Freshfield Lane Brickworks, Danehill: TQ 383264), cannot be guaranteed as permission to visit can be difficult to obtain.

3.2. Weald Clay localities

Quarrying at Langhurstwood, Warnham, West Sussex (TQ 180352) continued throughout the economic recession. Batten and Austen (2011) reported that this locality is important for the discovery of Wealden fish otoliths (ear stones). It is now the only available Wealden site where these have been recorded, the other location, Clockhouse Brickworks in Surrey, having closed down (see below). A large collection of these otoliths has recently formed the basis of a paper by Flannery Sutherland et al. (2017).

Batten and Austen (2011) reported that owing to the recession, brick-making operations at Smokejacks Brickworks, Ockley, Surrey (TQ 112374) had been reduced, and that the main plant had been "mothballed". However, in 2014/15, an upturn in the economy and an increase in house building led to full production again, which since then has provided fresh exposures in which to search for fossils. This has proved extremely rewarding because representatives of several new groups of insects not previously encountered in Wealden deposits have been discovered. These include an archaic earwig, a rove beetle, a ground beetle, a water beetle, a weevil, mayfly larvae and a 'stick insect' (Jarzembowski et al., 2015a; E.A. Jarzembowski et al., 2016a; Austen et al., 2017). A new estheriellid clam shrimp was also found (previously recorded only from the Southern Hemisphere) (Liao et al., 2017), as well as amber, the first record from the site (E.A. Jarzembowski et al., 2016a). Other finds at Smokejacks include a small theropod claw, a tooth of a large theropod (not *Baryonyx*) (Austen et al., 2017), and a distal caudal vertebra of a small ornithopod dinosaur (not iguanodont). These suggest a greater diversity of vertebrates at Smokejacks than previously recognized.

Since the publication of a detailed lithostratigraphical log from four different parts of the pit at Smokejacks (Ross and Cook, 1995, pp. 708–710, figs. 3, 4), a modified version with numbered beds for each face has been distributed to participants in organized Geologists' Association and other geological society field trips to the site and used to identify the exact horizon of fossil finds. Although not formally published hitherto, i.e., in a peer-reviewed journal, it has recently been referred to by various authors, and is therefore reproduced here (Fig. 5). It should be noted that Ross and Cook's "log 2 NW face" has been used as a basis for the north-east face where the majority of the recent discoveries have been made. The north-west (NW) face is now mostly obscured by dumped spoil. However, although the beds

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