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A tiny maniraptoran dinosaur in the Lower Cretaceous Hastings Group: Evidence from a new vertebrate-bearing locality in south-east England

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ABSTRACT

In contrast to the Barremian Wessex Formation on the Isle of Wight, the remains of small theropods are rare in the Berriasian–Valanginian Hastings Group of the English mainland. Both units are part of the dinosaur-rich Wealden Supergroup (Berriasian–Aptian) of southern Britain. Here we report the cervical vertebra of a small dinosaur from the Pevensey Pit at Ashdown Brickworks, a site located northwest of Bexhill, East Sussex. The pit yields a rich assemblage of vertebrate fossils from the Valanginian Wadhurst Clay Formation of the Hastings Group. The new specimen, a near-complete but water-worn posterior cervical vertebra, is tiny (total centrum length = 7.1 mm) but evidently from an adult theropod. Its large hypapophysis, X-shaped neural arch and amphicoelous centrum suggest referral to Maniraptora, and the subparallel anterior and posterior articular surfaces imply that it does not belong to a deinonychosaur. The X-shaped neural arch recalls a similar condition seen in oviraptorosaurs while the high neural canal/articular surface ratio (0.70) is bird-like. The specimen is significant in representing the first maniraptoran to be reported from the Hastings Group but is otherwise indeterminate. By comparing the specimen to better known maniraptorans and estimating the proportions of the animal to which it belongs, we suggest that the total skeletal length of this maniraptoran was somewhere between 16 and 40 cm. It may therefore have been among the smallest of known Mesozoic dinosaurs.

1. Introduction

Theropod dinosaur remains are rare in the Lower Cretaceous Hastings Group (Berriasian–Valanginian) of south-east England. This contrasts with the Weald Clay Group (Hauterivian–Barremian or Aptian) of mainland Britain and the Wealden Group (Barremian–Aptian) of the Isle of Wight (Fig. 1), where numerous theropod specimens have been discovered. Weald Clay Group theropods include the holotypes of *Wyleyia valdensis* Harrison and Walker, 1973 and *Baryonyx walkeri* Charig and Milner, 1986 while Wealden Group theropods include the holotypes of *Aristosuchus pusillus* (Owen, 1876), *Thecocoelurus daviesi* (Seeley, 1888), *Ornithodesmus cluniculus* Seeley, 1887, *Calamosaurus foxi* (Lydekker, 1889), *Neovenator salerii* Hutt et al., 1996 and *Eotyrannus lengi* Hutt et al., 2001. Several additional remains have been reported and variously represent baryonychine spinosaurids, indeterminate non-coelurosaurian tetanurans, maniraptoran coelurosaurs and others (Martill and Hutt, 1996; Naish et al., 2001; Hutt and Newbery, 2004; Sweetman, 2004, 2006; Naish and Martill, 2007; Benson et al., 2009).

1.1. Institutional abbreviations

BEXHM, Bexhill Museum, Bexhill, East Sussex; HASMG, Hastings Museum and Art Galery, Hastings, Kent; MIWG, Museum of Isle of Wight Geology, Sandown, Isle of Wight; NHMUK, the Natural History Museum, London.

To date, the only described Hastings Group theropod specimens are the holotypes of *Becklespinax altispinax* (Paul, 1988) and *Valdoraptor oweni* (Lydekker, 1889), the indeterminate tetanuran tibia NHMUK 9385 (Naish, 1999), and the allosauroid tibia HASMG G.378 (Naish, 2003). In addition, a number of undescribed, isolated vertebrae, metatarsals and other elements have been referred to the 'waste-basket' taxon *Megalosaurus dunkeri* Dames, 1884 (Lydekker, 1888). All of these specimens represent large or 'mid-sized' theropods (that is, animals estimated to have been 3 m long or more), and until recently the remains of small theropods were unknown. Two specimens, both from the same locality, have now been recovered and informally recorded (Austen et al., 2010). One, a cervical vertebral centrum (BEXHM: 2010.3), has been tentatively identified as that of the paravian maniraptoran *Ornithodesmus cluniculus* Seeley, 1887. This referral cannot be substantiated given that *Ornithodesmus cluniculus* was named for sacral vertebrae. The

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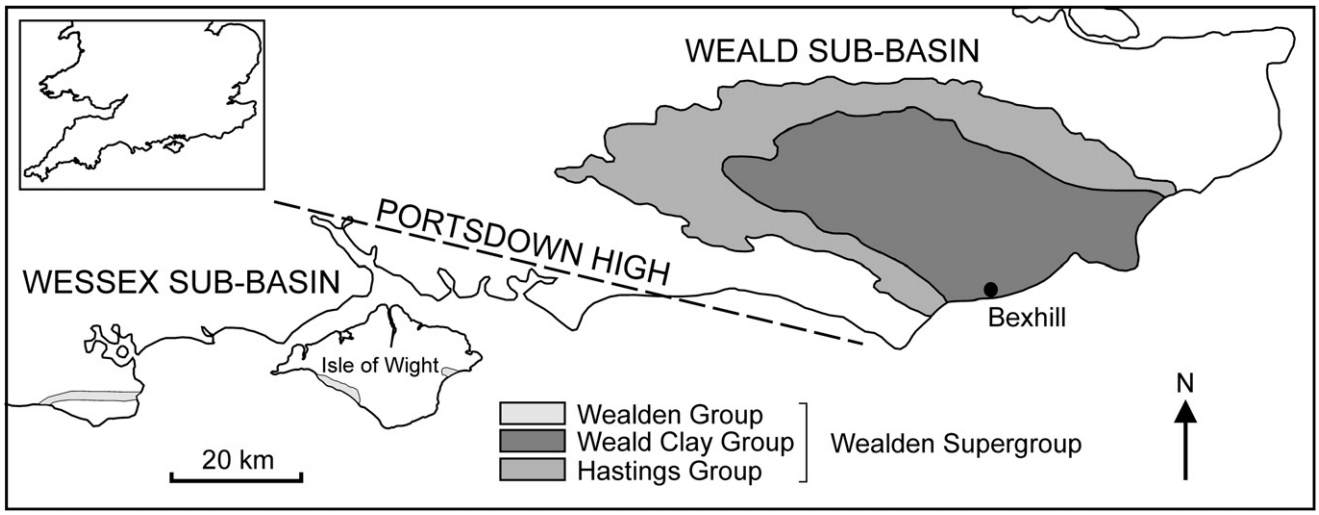

Fig. 1. Location and outline geological maps showing Wealden Supergroup outcrop areas in south-east England and the locations of the Weald and Wessex sub-basins.

second specimen, BEXHM: 2008.14.1, is the substantially complete specimen described here.

The rarity of small theropod remains in the Hastings Group contrasts with the better known assemblage of the Barremian Wessex Formation of the Isle of Wight, where small theropods are represented by numerous remains. These include cervical vertebrae (NHMUK R 901, holotype of *Calamosaurus foxi* and NHMUK R181, holotype of *Thecocoelurus daviesi*), sacral vertebrae (NHMUK R187, holotype of the paravian *Ornithodesmus cluniculus*), pelvic elements (NHMUK R178, holotype of *Aristosuchus pusillus*), hind limb elements (e.g., the femora NHMUK R5194 and MIWG.6214 and the tibiae MIWG.5137 and NHMUK R186) and isolated teeth and other remains. The skull roof of the alleged pachycephalosaur *Yaverlandia bitholus* is also probably from a small theropod (Naish, 2006).

2. Locality, stratigraphy and palaeontological context

The Ashdown Brickworks is situated northwest of Bexhill, East Sussex, at National Grid Reference TQ 720 095 (Fig. 2). It has been in constant operation since the 1890s and is currently owned by Ibstock Brick Limited. It comprises two pits: Crowborough Pit and the more northerly Pevensey Pit. Both exploit primarily argillaceous horizons within the Valanginian part of the Hastings Group. A significant east–west trending fault, the Whydown Fault, traverses the pit complex. The extent of the southerly down throw on this fault has yet to be determined but only lower beds of the Tunbridge Wells Sand Formation are exposed in Crowborough Pit and no vertebrate remains have yet been recorded here. In contrast, Pevensey Pit is in the lowest part of the Tunbridge Wells Sand Formation and the upper part of the underlying Wadhurst Clay Formation (Fig. 3). The latter comprises two argillaceous units known locally as the upper and lower clays and are separated by an arenaceous unit, the Northiam Sandstone. Several Wadhurst Clay Formation horizons within this pit have yielded both aquatic and terrestrial vertebrate assemblages but their palaeontological significance has only recently been recognized. An enthusiastic private collector and employee at the brickworks, David Brockhurst, first observed vertebrate fossils in clays from the Pevensey pit some 20 years ago. Since then he has made an extensive collection, most of which is accessioned in the collections of Bexhill Museum.

Within the upper clay only one horizon – the so called '*Polacanthus* bed' (Fig. 3) – has proved to be significantly productive with regard to identifiable tetrapod remains, though vertebrate remains have also been recorded from a channel fill (Hayward, 1996) (Fig. 3). The '*Polacanthus* bed' is between 45 and 60 cm thick and, as its name reflects, has yielded a partial skeleton referred to the ankylosaur *Polacanthus* (Austen et al., 2010), otherwise known from the Barremian Wessex Formation of the Isle of Wight (see Naish and Martill, 2001 for a review). It has also yielded the partial skeleton of an iguanodontian ornithopod, isolated teeth representing one or more allosauroid theropods, a single dromaeosaurid tooth probably representing a velociraptorine, and crocodilian remains (Austen et al., 2010; SCS pers. obs.). Unfortunately this horizon has now been obscured by a roadway.

The lower clay contains two conglomeratic horizons (Fig. 3). Within current exposures these are of variable lateral extent and thickness but both are a rich source of vertebrate fossils. In contrast to vertebrate remains obtained from the '*Polacanthus* bed', those from the conglomerates are invariably polished or more substantially abraded as a result of transport processes in an aqueous environment. The uppermost of these, known locally as the 'conglomerate bed', is generally between 5–6 cm thick and provides the greatest diversity of vertebrate fossils. The bulk of these are relatively small elements including bones and bone fragments, and isolated teeth representing chondrichthyan and osteichthyan fishes, salamanders, aquatic lizards, turtles, crocodilians and dinosaurs (Austen et al., 2010). It is from this bed that the cervical vertebra described here – BEXHM: 2008.14.1 – was obtained. Immediately below the conglomerate and probably associated with the same depositional event is a sandy clay. This is also of variable lateral extent and thickness and has produced a substantially complete but (due to its water-worn state of preservation) indeterminate scincomorph dentary, an isolated tooth of an ornithocheiroid pterosaur, an allosauroid theropod tooth, and a vertebral centrum apparently representing a plesiosaur (Austen et al., 2010). About 30–40 cm above the conglomerate there is an intermittent black band about 2 cm thick which has produced theropod remains. These include isolated teeth attributable to *Baryonyx walkeri* Charig and Milner, 1986 and the abraded vertebral centrum BEXHM: 2010.3, compared (as noted above) to those comprising the synsacrum of the paravian *Ornithodesmus cluniculus* Seeley, 1887 (Austen et al., 2010). Immediately