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Title

**A Reexamination of a Middle Jurassic sauropod limb bone
from the Bathonian of the Isle of Skye.**

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REVISITING THE SKYE SAUROPOD LIMB BONE

Abstract

A limb bone from the Bathonian of the Isle of Skye, previously identified as a possible femur of the sauropod dinosaur *Cetiosaurus*, is reassessed in light of comparisons with other sauropod material, including the lectotype of *Cetiosaurus oxoniensis*. Although the closest match for the Skye bone is found to be a left humerus identified as *Cetiosaurus oxoniensis* by Phillips (1871), the identification of the Skye bone as cetiosaurid is unsafe, given the poor diagnostic power of long bones in most sauropod taxa.

Introduction

Dinosaur remains are rare in Scotland. The material described by von Huene (1910) (Huene 1910) as *Saltopus elginensis*, and proposed by Benton and Walker (1985) as related to *Procompsognathus*, is not clearly dinosaurian in nature, and may represent a more basal member of the Dinosauromorpha (Benton 1997). In 1982, a single footprint (then identified as theropod, now regarded as ornithopod – (Delair & Sarjeant 1985)) was collected by S. P. Wood from the Lonfearn Member of the Lealt Shale Formation (Middle Jurassic, Bathonian) of Skye (Andrews & Hudson 1984) for the Hunterian Museum, University of Glasgow, where it remains on display. The first dinosaur skeletal material to be recovered from the Isle of Skye was collected in 1992 from the Broadford Beds Formation (Lower Jurassic, Hettangian) by Herr Matthias Metz, and following donation to the National Museums of Scotland was described as the partial right tibia of a ceratosaurian theropod (Benton *et al.* 1995).

In 1994, three separate groups of collectors discovered a dinosaur bone on the eastern shore of the Trotternish Peninsula of Skye (Clark *et al.* 1995). Too heavy to

move intact, each group removed a different portion. The proximal and distal portions were quickly reunited (SM 1977.1994.1), but it was not until the description of the bone was going to press that the middle portion was delivered to the Hunterian Museum. It was accompanied by an apologetic letter from an anonymous collector, who had mistaken it as merely being a part of a fossilised tree. As a sheath of matrix had been found that formed a bridge between the distal and proximal fragments, preserving a mould of approximately half of the missing middle section of the bone, it had already been possible to partially reconstruct the middle portion prior to this donation. There was considerable uncertainty regarding the identification of the bone as a cetiosaurid femur, and this was not aided by the absence of the mid-section prior to publication. With the arrival of the mid section, Clark *et al.* (1995) noted in an addendum to the manuscript that the bone lacked an (unspecified) trochanter that would be expected to be present near the proximal end of many sauropod femora, but did not discuss the identification of the bone further.

Other finds attributed to dinosaurs include trackways (Liston 1999; Clark 2001) and a sauropod mid-caudal vertebra. This bone (SM 1977.1996.1) was found loose extremely close to the site of the original limb bone and appears to be from the same stratum.

Materials/Methods

A scientific reconstruction of the Isle of Skye sauropod, based on the limb bone, was planned for display in the Hunterian Museum, and to finalise dimensions, it was decided to compare a cast of the bone (GLAHM 109385) and a cast of the undescribed caudal vertebra (GLAHM 109384) with the *Cetiosaurus* and other

sauropod material in Leicester City Council's New Walk Museum, the Natural History Museum (London), and the Oxford University Natural History Museum. This last repository is of particular interest, as it contains the original material used by Phillips (1871) in his description, including the newly-designated lectotype material for *Cetiosaurus oxoniensis*, and is therefore of special significance for any identification of bone elements as belonging to *Cetiosaurus* sp..

Figures 1 and 2 here

Results

A cast of the Skye specimen (GLAHM 109385) was compared with the femora, tibiae, and humeri of *Cetiosaurus* sp. and several other sauropods. Although in outline it resembles the anteroposterior view of a sauropod tibia, the three dimensional structure of the bone rules out a lower limb origin for this specimen: specifically, the absence of a fourth trochanter precludes it from being a femur, and the lack of a cnemial crest indicates that it is not a tibia. The Skye specimen most closely resembles the left humerus (OUM J.13690) (Phillips 1871, fig. CII on page 274) of *Cetiosaurus oxoniensis* (fide Phillips) donated by Earl Ducie, from Smith's Quarry near Chipping Norton, Oxfordshire (Figs.1 and 2). The Skye specimen has a deltopectoral crest for the attachment of the pectoralis muscle, lying above the mid-shaft level. A broad area medially adjacent to this corresponds to the inferior part of the site for attachment of the coracobrachialis. The rest of the area proximal to this has been lost through erosion, extending as far on the medial side as the attachment site of the supracoracoideus. At the inferior end of the bone, a broken surface plane proceeding ventromedially from the lateral surface to the middle of the distal end of

the bone indicates where a large section of the bone has been lost from around the level of the supinator muscle attachment ventrally (Romer 1956).

Despite inferolateral and proximal portions of the bone having been lost, the preservation of the material compares well with that of the holotype, which has suffered antero-dorsal crushing over its proximal and distal areas due to compaction.

Discussion

The Skye limb bone suggests a fairly gracile sauropod of some 11-13 metres in length (Buffetaut, pers. comm.). Although the element is clearly a sauropod left humerus, its referral to *Cetiosaurus* sp. cannot be supported, based as it was upon interpretation of features on the bone as being those of a femur. Although there are not a large number of individual humeri of *Cetiosaurus* to compare with this specimen in terms of variation within a genus, there seem to be a number of differences between it as a humerus and other representatives to make a tentative assignation to Cetiosauridae unsafe. Long bones are not usually diagnostic to genus/family level in sauropods (Upchurch, pers. comm.), and so more diagnostic material would need to be recovered before Cetiosauridae can confidently be reported from Scotland. Recent work (Upchurch & Martin, 2002; Upchurch & Martin, 2003) has indicated that the Cetiosauridae were far from the only sauropod family represented in the Middle Jurassic of Britain, with Brachiosauridae and Diplodocoidea also present. [they have also indicated that no diagnostic characters for humerus in *Cetiosaurus*, and none of Wilson's characters represented][add photos of actual specimens at Staffin Museum? Or *Vulcanodon* in (Cooper 1984) Jpegs 427

for vertebra, noting new part to restore; 410 for specimen without proximal end; 416 for tibia cast;]

It is worth noting, in this respect, that the caudal vertebra (SM 1977.1996.1) found at the same site in Skye appears quite distinct from any of the vertebrae of *Cetiosaurus* held in Leicester City Museums (Leicester), the Natural History Museum (London) or Oxford University Natural History Museum, in both overall morphology (in which it more closely resembles *Diplodocus carnegii*), and specifically in bearing, as it does, a well-defined narrow longitudinal groove on its ventral surface (Fig.3). This groove appears considerably more prominent than the feature noted by Upchurch & Martin (2003) as a shallow midline groove on caudal centrum OUMNH J13696 as well as on the caudal centra of the Rutland *Cetiosaurus* (LCM G468.1968) at Leicester City Museum. However, Upchurch (pers. Comm.) notes that this character may well have become overprinted during development by a deep wide hollow, and therefore have little taxonomic or diagnostic significance. Wilson (Wilson, 2002) also notes the presence of a similar character (number 132, Appendix 2) in several taxa.

Figure 3 here

Conclusions

Although SM 1977.1994.1 represents a well-preserved sauropod humerus, more material is required before a particular sauropod family group can confidently be stated to have been found on Skye.

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Abbreviations used

GLAHM = Hunterian Museum, University of Glasgow; SM = Staffin Museum, Isle of Skye; OUM=Oxford University Museum of Natural History; BMNH = Natural History Museum (London); LCM = Leicester City Museums, Leicester.

Captions to illustrations

Figure 1: Anterior views of (to left) left humerus of *Cetiosaurus oxoniensis*, OUMNH J13690 (scale bar to left represents 100mm), and (to right) cast (GLAHM 109385) of the Skye limb bone, SM 1977.1994.1 (scale bar to left represents 100mm). The objects have been scaled to similar sizes for ease of comparison, and missing components outlined.

Figure 2: Medial views of (to left) left humerus (OUMNH J.13690), and (to right) cast (GLAHM 109385) of the Skye limb bone, SM 1977.1994.1 (scale bar to left represents 100mm). The objects have been scaled to similar sizes for ease of comparison, and missing components outlined.

Figure 3: Ventral view of GLAHM 109384, cast of vertebra SM 1977.1996.1, showing the prominent ventral groove (scale bar below represents 100mm).

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