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FIRST RECORD OF A MAASTRICHTIAN SAUROPOD DINOSAUR FROM EGYPT

by

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ABSTRACT

A left femur of a small sauropod dinosaur was found in the Maastrichtian part of the Ammonite Hill Member of the Dahkla Formation of southwestern Egypt. It represents the first dinosaur remains of certain Maastrichtian age from Egypt and the second record of dinosaurs from this stage within Africa. Moreover, the Egyptian specimen shows similarities to femora of brachiosaurids, possibly extending the temporal range of this family up to the very end of the Mesozoic.

KEYWORDS: Africa, Maastrichtian, Dinosauria, Sauropoda, Brachiosauridae

INTRODUCTION

Africa is the "Lost World" of the dinosaurian era (Russell 1995). In his 1990 synopsis, Weishampel listed only a few dinosaur-bearing localities of Cretaceous age on this continent. Although more have been discovered since (Jacobs *et al.* 1996), our knowledge of Cretaceous African dinosaur faunas is still rather poor. In the African dinosaur assemblages of Cretaceous age sauropods predominate. Thus, the Early Cretaceous sauropods of Africa include diplodocoids, titanosaurids, brachiosaurids and probable camarasaurids (Lavocat 1954; Lapparent 1960; Jacobs *et al.* 1993; Sereno *et al.* 1994; Wilson pers. comm.), although the supposed camarasaurid *Rebbachisaurus* probably belongs rather to the Diplodocoidea (Calvo & Salgado 1995).

The Late Cretaceous sauropod fauna of Africa seems to be less diverse, but is also even less well known than that of the Early Cretaceous. Titanosaurids are present in all African dinosaur-bearing localities of this age, e.g. the Cenomanian of Egypt (Stromer 1932) and Sudan (Werner 1994; Rauhut 1995), the Turonian-Santonian of Kenya (Arambourg & Wolff 1969; Jacobs *et al.* 1996; Harris & Russell, unpubl. data), the Coniacian-Santonian of Niger (Broin *et al.* 1974), the Santonian of South Africa (Kennedy *et al.* 1987; Buffetaut 1988) and the Maastrichtian of Niger (Greigert *et al.* 1954; Taquet 1976). In addition, sauropods are represented by dicraeosaurids in the Cenomanian of Egypt and Sudan (Stromer 1932; Rauhut 1995). For a review of dinosaur occurrences in Africa see also Jacobs *et al.* (1996).

Another titanosaurid is known from the Campanian of Madagascar (Depéret 1896), but as the breakup of Madagascar started in the Callovian (Luger et al. 1994), the specimen from Madagascar is not truly African.

Here we report on a sauropod femur from the Maastrichtian part of the Ammonite Hill Member of the Dahkla Formation of southwestern Egypt. This record provides further information on our relatively poor knowledge of Cretaceous dinosaurs of Africa.

GEOLOGICAL AND STRATIGRAPHICAL SETTING

The Dakhla Formation outcrops not only in the Dahkla Oasis, but in vast areas all over southern Egypt. This Late Cretaceous to Early Tertiary sequence includes transgressive/regressive cycles with distinct regional facies differentiation. The Ammonite Hill Member, introduced by Barthel & Herrmann-Degen (1981: 157), is geographically restricted to the westernmost margin of the Dahkla Basin. It is characterised by the interfingering of distal alluvial to deltaic shallow marine sediments (Barthel & Herrmann-Degen 1981). In the westernmost outcrops, the Ammonite Hill Member consists of highly fossiliferous siltstones, sandstones and limestones (Barthel & Herrmann-Degen 1981). The record of a dinosaur bone in the Ammonite Hill Member reflects terrestrial influence within a shallow marine environment (Figure 1).

In SW Egypt the Dahkla Formation is Middle Campanian to Middle Paleocene in age. The Ammonite Hill Member, representing the westernmost exposures of the Dakhla Formation, is subdivided into a lower Maastrichtian part and an upper Paleocene part (Barthel & Herrmann-Degen 1981). The lower part is dated at Maastrichtian on the basis of the occurrence of the ammonite *Libycoceras ismaelis* and shed loads of the oyster *Exogyra overwegi*. Above the last occurrence of *Exogyra overwegi*, the appearance of the very abundant gastropod *Turritella* defines the Cretaceous/Tertiary boundary. Vertebrates, including the sauropod femur, were found in the Maastrichtian part of the Ammonite Hill Member (Barthel & Herrmann-Degen 1981).

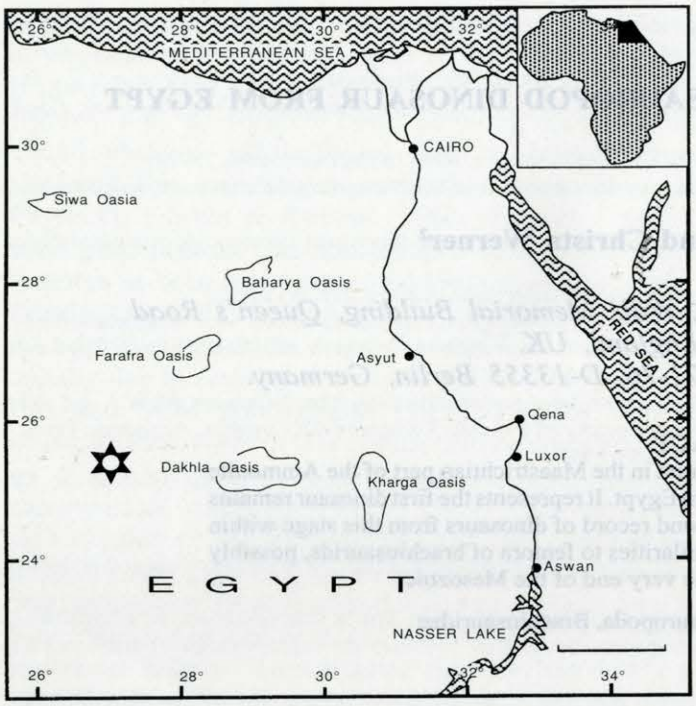

Figure 1. Locality map for the Dakhla Oasis in the Western Desert of Egypt.

VERTEBRATE ASSEMBLAGE OF THE MAASTRICHTIAN PART OF THE AMMONITE HILL MEMBER

Wanner (1902) and Quaas (1902) reported the occurrence of marine vertebrates, based on rather fragmentary remains, from the Late Cretaceous of the Ammonite Hill area. The next expeditions into the Great Sand Sea of SW Egypt took place in 1979 and 1980. In their papers on the Cretaceous stratigraphy and sedimentology, Barthel & Herrmann-Degen (1981) and Fay & Herrmann-Degen (1984) mentioned the occurrence of fishes, turtles, mosasaurs, plesiosaurs and dinosaurs in the Maastrichtian part of the Ammonite Hill Member of the Dakhla Formation. The fishes are represented by elasmobranchian teeth, including *Cretolamna*, *Squalicorax*, *Dalpiazia* and *Parapalaeobates*, and osteichthyan fragments including the genera *Enchodus* and *Stratodus*. Plesiosaurs are recorded by elasmosaurid vertebrae (Werner & Bardet 1996). Mosasaurs include a jaw fragment of *Prognathodon* and numerous vertebrae (Werner, unpubl. data). The most abundant vertebrate fossils found are fragments of marine turtles representing a diverse turtle assemblage of at least five species (Lapparent de Broin and Werner, pers. obs.).

The sauropod femur discussed here was recovered from the westernmost outcrops of the Maastrichtian part of the Ammonite Hill Member. It represents the only terrestrial element in the marine vertebrate assemblage and therefore indicates close proximity to the Maastrichtian coast line.

REPOSITORY

The sauropod femur described here was collected by K.-W. Barthel and his team (Technical University of Berlin) in the Great Sand Sea of the Western Desert of Egypt in 1980. All specimens recovered during this expedition are housed in the fossil collection of the Special Research Project 69 (= SFB 69) of the Department of Applied Geology II (formerly Department of Geology and Palaeontology) of the Technical University of Berlin. The specimen reported here bears the catalogue number Vb-646.

DESCRIPTION

Vb-646 represents a left femur of a sauropod dinosaur (Figure 2). The bone is well preserved except for slight erosion at both ends. It is almost completely straight in both lateral and anterior views. The specimen is 724 mm long, and 237 mm and 249 mm wide (transversely) at its distal and proximal ends, respectively. The shaft is strongly compressed anteroposteriorly at mid-shaft, being 118 mm wide and only 75 mm deep in its narrowest part. The minimal shaft circumference is c. 305 mm. The cross section at this point is subrectangular, with the anterior side more rounded than the posterior.

In both anterior and posterior views, the femoral head is confluent with the greater trochanter, the bone sloping slightly downwards from the middle of the head towards the lateral side of the proximal end. Medial to the centre of the head, the bone curves medio-distally. In proximal view, the femoral head is separated from the greater

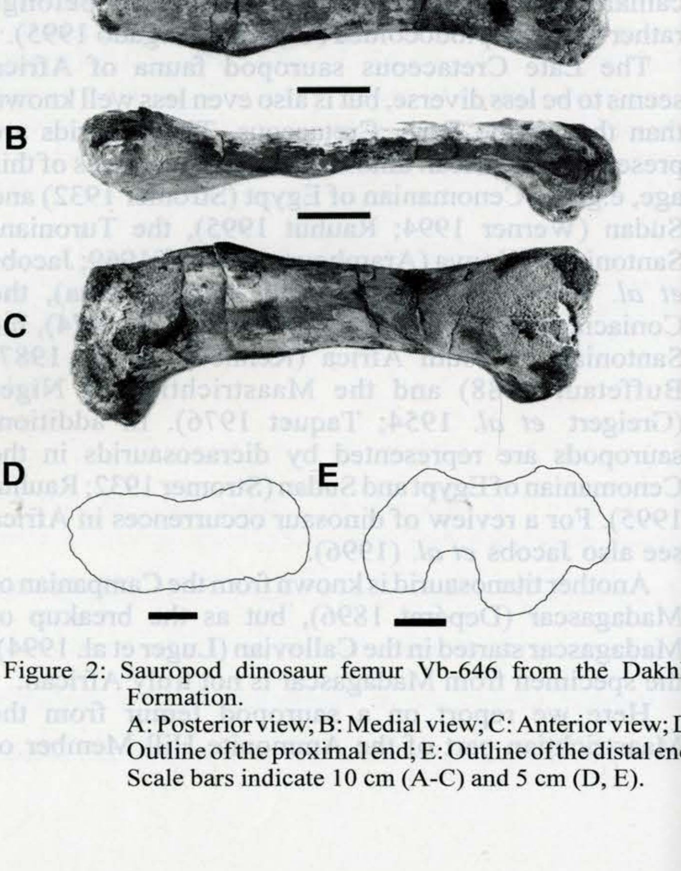

Figure 2: Sauropod dinosaur femur Vb-646 from the Dakhla Formation.
A: Posterior view; B: Medial view; C: Anterior view; D: Outline of the proximal end; E: Outline of the distal end. Scale bars indicate 10 cm (A-C) and 5 cm (D, E).

trochanter by a shallow depression on the posterior side. The distal side of the head is set at an angle of approximately 110° to the shaft of the bone, but meets the latter in a gentle slope extending downwards as far as the fourth trochanter.

While the proximal part of the anterior side is almost flat, the greater trochanter forms a striking bulge on the posterior side. This bulge ends some 190 mm below the proximal end. Distal to the greater trochanter, the posterior side is almost plain down to the distal condyles. A prominent lateral bulge is located in the upper third of the bone. It extends from the mid-point of the greater trochanter latero-distally and reaches its greatest expansion at the lower end of the latter. Its lower part is slightly directed posteriorly and a c. 50 mm long and 30 mm wide roughened area is found on the postero-lateral part, indicating the insertion of a muscle or tendon.

Slightly above the middle of the medial side of the shaft is a broad ridge which represents the fourth trochanter. It is c. 100 mm long and is directed medially and slightly posteriorly. At the mid-height of the shaft, just distal to the fourth trochanter, a 65 mm long shallow groove is situated on the medial side. The surface of the bone is significantly roughened within the groove and its surrounding area, indicating the insertion of a well developed muscle.

Distally, the shaft of the bone expands strongly transversely, more abruptly on the medial than on the lateral side. Two well developed but relatively narrow condyles are present on the posterior side. The medial condyle is situated directly at the medial margin of the bone and, in distal view, projects postero-medially. The lateral condyle is clearly offset from the lateral margin. It is slightly broader than the medial condyle at its base, but tapers significantly in its posterior expansion. The lateral expansion of the bone forms a shallow sulcus between the lateral condyle and a small ridge, which forms the lateral margin of the distal end. The intercondylar groove is broad.

The anterior side of the bone is almost plain proximally, but becomes more rounded towards the middle of the shaft. The structures of the distal part of the anterior side are eroded and therefore not visible.

DISCUSSION

A number of general characters including antero-posterior flatness, rudimentary fourth trochanter, and confluence of the femoral head with the greater trochanter, show that the specimen from the Maastrichtian part of the Ammonite Hill Member of the Dakhla Formation (Figure 2) is undoubtedly a sauropod femur.

A striking feature of this element is the strongly developed lateral bulge on the proximal half of the bone. This bulge probably represents the remainder of the lesser trochanter (McIntosh 1990). A similar development of this trochanter only occurs in brachiosaurids and titanosaurids (Figure 3; McIntosh 1990; Salgado 1993); thus the Egyptian specimen represents a member of one of these families. Since the lesser trochanter is more strongly developed in brachiosaurids and titanosaurids than it is in primitive sauropods (Jain *et al.* 1979; Cooper 1984) and prosauropods (Galton 1990), this character might represent a synapomorphy of a monophyletic group comprising the former two families (see also Salgado 1993; Calvo & Salgado 1995, although it should be noted that Upchurch (1995) did not regard these two families as closely related).

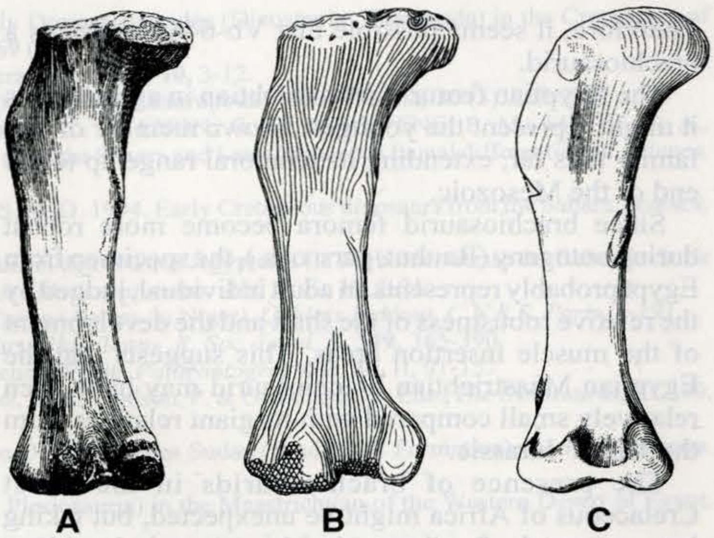

Figure 3: Comparison of sauropod femora in posterior view. A: Femur of *Brachiosaurus brancai* (from Janensch 1961, reversed); B: Vb-646 from the Maastrichtian of the Dakhla-Oasis; C: *Saltasaurus australis* (from Huene 1929). Drawn to same size for comparison; the original lengths are A: 183 cm, B: 72 cm, and C: 70 cm.

Further resolving the taxonomic position of the Egyptian femur is difficult, because of the similarities between femora of different taxa of brachiosaurids and titanosaurids (Figure 3; Huene 1929; Janensch 1961; Powell 1986). In its overall morphology, the femur from Egypt is most similar to that of *Brachiosaurus* (Janensch 1961: Beilage J) and *Saltasaurus* (Huene 1929: Lámina 14, Fig. 4). However, it differs from the femur of the latter taxon in several details, including the shape of the trochanters, the condyles and the femoral head, which is significantly more raised above the greater trochanter in all titanosaurids (Figure 3; McIntosh, pers. com., see Huene 1929: Lámina 14, Fig. 4a, c). The femur of *Brachiosaurus* differs in minor ways, such as the slightly more robust shaft and the subequal width of the distal condyles in the Egyptian specimen (Rauhut, pers. obs.; see Janensch 1961). However, in many anatomical details, including the shape and development of the lesser and greater trochanters, the outline of the distal articular surface and the contour of the femoral head, the specimen from Egypt is almost identical to the femur of *Brachiosaurus* (Figure 3; Rauhut, pers. obs. in numerous *Brachiosaurus* femora from the Late Jurassic Tendaguru Formation of Tanzania, stored in the Naturkundemuseum Berlin; see also Janensch 1961).

Therefore, it seems possible that Vb-646 represents a brachiosaurid.

The Egyptian femur is Maastrichtian in age and thus it might represent the youngest known member of this family thus far, extending its temporal range up to the end of the Mesozoic.

Since brachiosaurid femora become more robust during ontogeny (Rauhut, pers. obs.), the specimen from Egypt probably represents an adult individual, judged by the relative robustness of the shaft and the development of the muscle insertion areas. This suggests that the Egyptian Maastrichtian brachiosaurid may have been relatively small compared with its giant relatives from the Upper Jurassic.

The presence of brachiosaurids in the latest Cretaceous of Africa might be unexpected, but taking into account the fossil record of this group, it should not be too surprising. Brachiosaurids are well known from the Late Jurassic of Africa, North America and Europe (McIntosh 1990) and they are still present in all these continents in the Early Cretaceous. Brachiosaurids are represented in the Early Cretaceous of Africa by "*Brachiosaurus*" *nougaredi* from the Albian of Algeria (Lapparent 1960), and possibly in the Late Cretaceous (Cenomanian) of northern Sudan by a brachiosaurid-like caudal vertebra (Rauhut 1995). Thus Late Cretaceous brachiosaurids might have survived until the end of the Cretaceous, unnoticed so far, due to the still incomplete fossil record of African dinosaurs. However, new discoveries in recent years have already shown that Cretaceous dinosaur faunas from Africa were more complex than previously thought (Rauhut & Werner 1995; Rauhut 1995; Sereno *et al.* 1994, 1996).

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