



Anais da Academia Brasileira de Ciências

ISSN: 0001-3765

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Academia Brasileira de Ciências

Brasil

O'CONNOR, PATRICK M.; SERTICH, JOSEPH J.W.; MANTHI, FREDRICK K.
A pterodactyloid pterosaur from the Upper Cretaceous Lapurr sandstone, West Turkana, Kenya
Anais da Academia Brasileira de Ciências, vol. 83, núm. 1, marzo, 2011, pp. 309-315
Academia Brasileira de Ciências
Rio de Janeiro, Brasil

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A pterodactyloid pterosaur from the Upper Cretaceous Lapurr sandstone, West Turkana, Kenya

PATRICK M. O'CONNOR^{1,2}, JOSEPH J.W. SERTICH³ and FREDRICK K. MANTHI⁴

¹Department of Biomedical Sciences, Ohio University College of Osteopathic Medicine, Athens, OH 45701, USA

²Ohio Center for Ecology and Evolutionary Studies, Irvine Hall, Ohio University, Athens, OH 45701, USA

³Department of Anatomical Sciences, Health Sciences Center T8-040, Stony Brook University, Stony Brook NY 11794, USA

⁴Department of Earth Sciences, National Museums of Kenya, P.O. Box 40658-00100, Nairobi, 00100 Kenya

Manuscript received on January 15, 2010; accepted for publication on December 1, 2010

ABSTRACT

An isolated pterosaurian caudal cervical (~ postcervical) vertebra was recovered from the Upper Cretaceous Lapurr sandstone of West Turkana, northwestern Kenya. The vertebral centrum is short, wide, and dorsoventrally compressed. Although the specimen is lightly built similar to most pterosaurs, it is here referred to Pterodactyloidea and tentatively to the Azhdarchidae in that it lacks pneumatic features on both the centrum and neural arch. This represents one of the few pterosaurs recovered from the entirety of Afro-Arabia, the first pterosaur recovered from the Cretaceous of East Africa, and, significantly, a specimen that was recovered from fluvial deposits rather than the near-shore marine settings typical of most pterosaur discoveries.

Key words: Pterosauria, Pterodactyloidea, Africa, Kenya, Late Cretaceous.

INTRODUCTION

Upper Cretaceous terrestrial/freshwater deposits from continental Africa are rare (Haughton 1963, Dingle et al. 1983, Mateer et al. 1992) and limited to a handful of geographically-restricted sites. Despite this paucity of terrestrial sequences, a number of paleobiogeographic hypotheses have been proposed to account for the distribution of terrestrial vertebrate groups (e.g., dinosaurs) on former Gondwanan landmasses during the Late Cretaceous (~100 to 65 mya) (see Krause et al. 2006 for a recent summary). This period is of significance in that it coincides with the most active fragmentation of the Gondwanan supercontinent (Scotese 2001), an event that likely influenced the evolution and spatial distribution of resident biotas through speciation, dispersal, and extinction events. O'Connor et al. (2006) discussed limitations

analysis in the face of an abundance of missing data framing the most obvious deficiency for Gondwanan wide inferences as the 'African Gap' during the Late Cretaceous Period.

Within this general context then, it is not surprising that the fossil record of the lightly-built pterosaurs of Afro-Arabia is limited to a handful of mostly incomplete skeletal and dental remains (e.g., Reck 1931, Sereno 1994, Galton 1980, Montillet et al. 1982, Sighele 1998, Russell et al. 1998, Unwin and Heinrich 1999, and Kellner 1999, Wellnhofer and Buffetaut 1999, Sereno et al. 2000, Barrett et al. 2008, Costa and Hübner 2009). Exceptions to these isolated discoveries include (1) the Maastrichtian azhdarchid *Phosphatodraco* consisting of a semi-articulated series of five cervical vertebrae recovered from the Oulad Abdoun Phosphatic Basin in Morocco (Pereda Suberbiola et al. 2009).



Recent field research in the Lapurr sandstone [Turkana Grits] in West Turkana, northwestern Kenya (Fig. 1), has yielded a number of new Late Cretaceous vertebrates (Sertich et al. 2005, 2006). Included among the archosaurs are multiple saurischian dinosaurs, crocodyliforms, and the pterosaur vertebra detailed in this report. This represents the first pterosaur reported from the Late Cretaceous of East Africa and one of the few pterosaurs from the continent recovered from a fluvial depositional system.

Pterosauria Kaup 1834
Pterodactyloidea Plieninger 1901
?Azhdarchidae Nesov 1984

Material – KNM-WT (Kenya National Museum, West Turkana) 47893 is a heavily-abraded, isolated caudal cervical vertebra (Fig. 2).

Locality and horizon – The specimen described herein was recovered from the Lapurr sandstone, “Turkana Grits” (Upper Cretaceous) exposed in the Lapurr Range on the west side of Lake Turkana, northwestern Kenya (Fig. 1). The Lapurr sandstone is a succession of fine to coarse arkosic sandstones of indeterminate age resting nonconformably over Precambrian metamorphic basement and overlain by Oligocene basalts. Fluvial deposition of the Lapurr sandstone is likely related to the development of the Cenomanian-Paleogene Anza Rift system (Bosworth and Morley 1994, Morley et al. 1999, Tiercelin et al. 2004), though reliable age estimates of the series remain elusive. An estimate of Upper Cretaceous (Turonian-early Campanian) is based on comparisons with subsurface geological information (Winn et al. 1993, Bosworth and Morley 1994) and overall faunal composition. Vertebrate macrofossils, including KNM-WT 47893, occur primarily as isolated and abraded elements in the lower 200 m of the > 400 m section. KNM-WT 47893 was recovered during surface collection from an erosional deflation lag at 4°16’46’’N, 35°49’02’’E.

Diagnosis – KNM-WT 47893 is here referred to Azhdarchidae on the basis of the following combination of

DESCRIPTION

KNM-WT 47893 is a caudal cervical vertebra consisting of a fused centrum and neural arch. The vertebra is heavily abraded and lacks cortex over most of its surface, instead revealing the complex meshwork of widely-spaced trabecular bone characteristic of most pterodactyloids (Fig. 2). The centrum is short and low, with overall proportions characteristic of the caudalmost cervical or cranialmost, non-notarial dorsal vertebrae. The centrum is 34.2 mm long and 29.0 mm wide at mid-central length. The vertebral height is 36.8 mm measured from the ventral surface of the centrum to the preserved extent of the neural spine. The centrum is procoelous, dorsoventrally-compressed, and exhibits a distinctly convex condyle on the caudal surface. The reniform condyle extends past the caudal extent of the postzygapophysis (Fig. 2C). The cotyle is moderately concave, does not extend past the cranial extent of the prezygapophysis, and exhibits a slight median hypapophysis at its cranioventral margin (Fig. 2F). The centrum lacks a lateral pneumatic foramen typical of most non-azhdarchid pterodactyloids (Kellner 2003, Averianov 2007; also, see Andres and Ji 2008). There is no evidence of a postexapophysis, indicating that it was either not preserved or that this vertebra is from a more caudal position such that its absence would be expected.

The attachment of the pedicle is restricted to the cranial half of the centrum, resulting in a modest space between the postzygapophysis and the dorsal surface of the centrum (Fig. 2A). This is characteristic of caudal cervical vertebrae (~C8-C9) in many pterodactyloid taxa. The neural canal is large (22% of centrum height) and round in cross-section when viewed caudally. Poor preservation of the cranial end of the vertebra precludes a direct determination of neural canal size and shape. Pneumatic foramina adjacent to the neural canal are not present on either end of the vertebra. Whereas the ovoid postzygapophyseal facet is oriented at approximately 45 degrees relative to the horizontal, poor preservation prevents any specific determination of prezygapophyseal morphology. A small, craniocaudally-restricted transverse process is preserved at the cranial end of the neural



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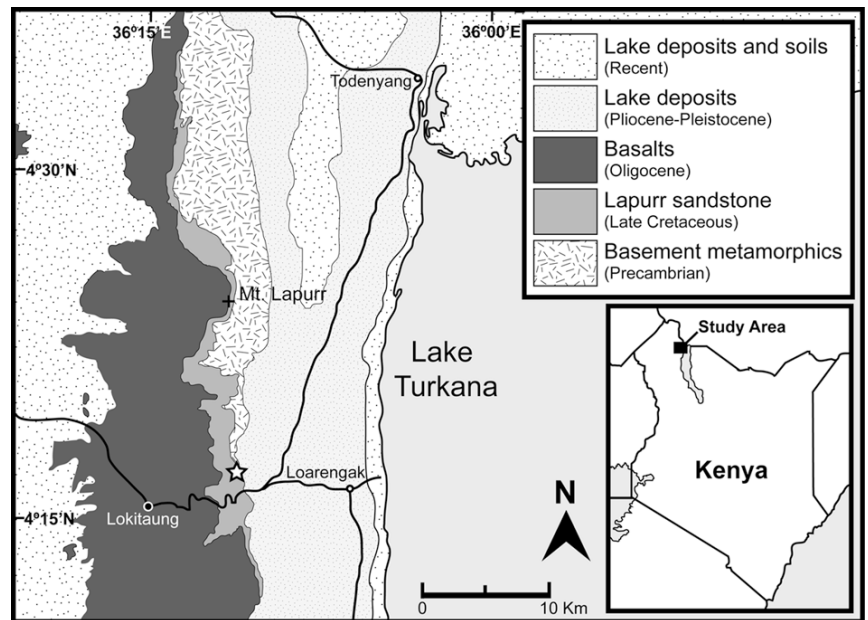


Fig. 1 – Map showing the location of the Lapurr sandstone exposures in northwestern Kenya and the locality (star) from which the pterosaur vertebra here detailed was recovered.

present on a cranial dorsal vertebra) incomplete. The craniocaudally-restricted neural spine slopes caudodorsally, but this may also reflect the state of preservation, and a modest postspinal fossa is present. Due to extreme weathering, it is unclear to what extent the transverse process and neural spine were developed.

DISCUSSION

The presence of a post-Cenomanian azhdarchid pterosaur in East Africa is consistent with the temporal range of the clade, which minimally spans all of the Late Cretaceous (Unwin 2003, 2006) or from the latest Jurassic through the end of the Cretaceous (Kellner 2003), depending on which classification scheme is used. KNM-WT 47893 compares favorably with an azhdarchid, pre-notarial dorsal vertebra (ZIN PH 54/53 [Paleoherpetological Collection of the Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia]) recovered from the Late Cretaceous (Turonian-Coniacian) Tyul'keli locality in Kazakhstan (Averianov 2007). However, KNM-WT 47893 differs in having a

along the cranial half of the centrum) indicating the specimen is positioned within the caudal-most or cranial-most (i.e., pre-notarial) dorsal series (Kellner 1986). Moreover, the presence of a reduced hypophysis further suggests a caudal cervical position for the vertebra. With these characteristics taken together, we have chosen to classify KNM-WT 47893 as a cervical vertebra until additional materials of the form are recovered.

The recovery of pterosaur remains from the Late Cretaceous of Kenya is significant for a number of reasons. First, the Afro-Arabian record of pterosaurs is extremely sparse, consisting mostly of isolated teeth and teeth from a range of Cretaceous sites in Morocco (Kellner and Mader 1996, 1997, Sigogneau-Russier et al. 1998, Wellnhofer and Buffetaut 1999, Knoll et al. 2000). Notable exceptions among the fragmentary Moroccan discoveries are

- (1) the rostral portion of an anhanguerid upper jaw (Mader and Kellner 1999),

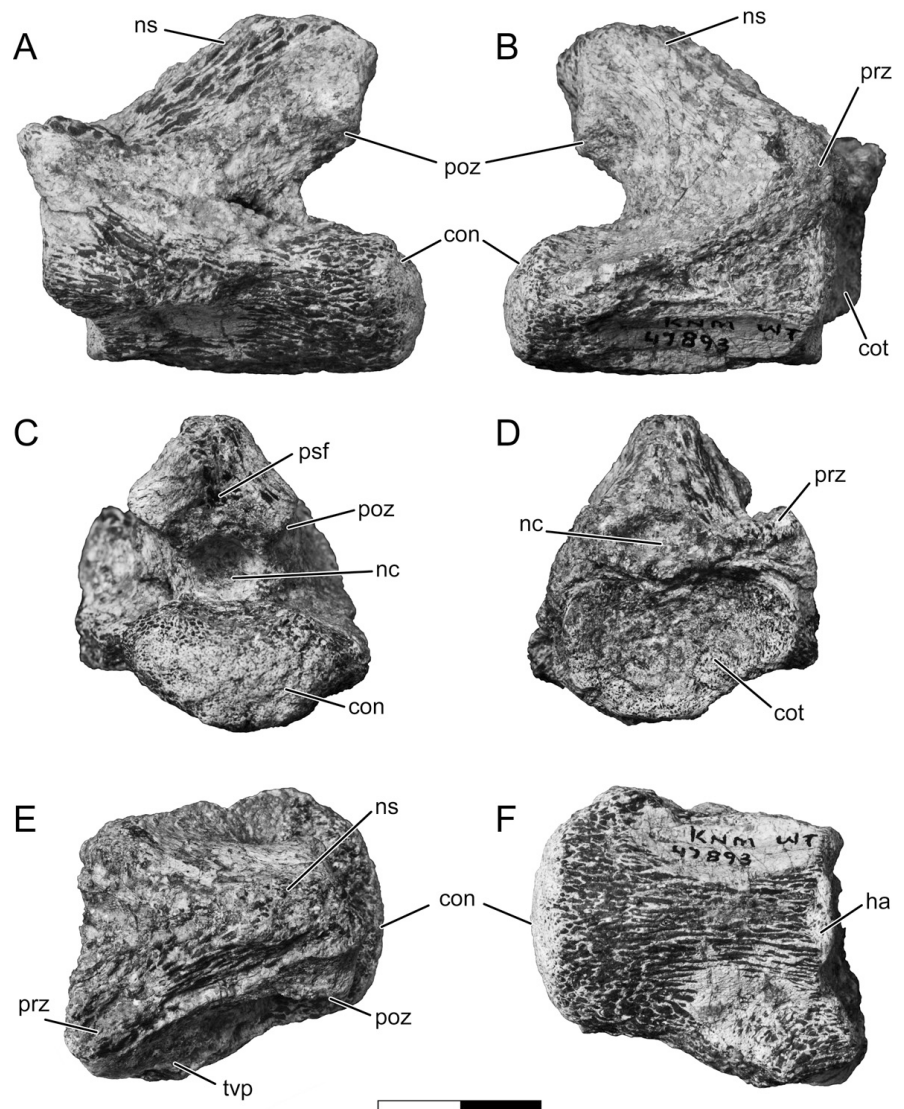
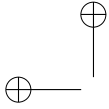


Fig. 2 – Caudal cervical vertebra (KNM-WT 47893) of *Azhdarchidae* indet. in left lateral (A), right lateral (B), caudal (C), cranial (D), dorsal (E), and ventral (F) views. **Abbreviations:** con, condyle; cot, cotyle; ha, hypapophysis; nc, neural canal; ns, neural spine; poz, postzygapophysis; prz, prezygapophysis; psf, postspinal fossa, tvp, transverse process. Scale bar equals 2.0 cm in A – E.

for a comment on the interpretation of this specimen), and

(3) a fused mandibular symphysis recently referred to *Azhdarchidae* (Ibrahim et al. 2010).

Heinrich 1999, Kellner et al. 2007, Costa and Kellner 2009), an ornithocheirid metacarpal from Cenomanian-Turonian deposits in the Democratic Republic of Congo (Swinton 1948, Monteillet et al. 1982), a cervical vertebra and partial tibia from Campanian-Maastrichtian



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tiguous portion of what is now westernmost Asia (e.g., Jordan, Israel, etc.) include a pterodactyloid hind limb from the Cenomanian of Israel (Tchernov et al. 1996), cranial endocasts referred to azhdarchids (Lewy et al. 1993), and limited materials of the azhdarchid *Arambourgiania* from the Maastrichtian of Jordan (Arambourg 1954, Frey and Martill 1996).

CONCLUSION

The discovery of a new pterydactyloid pterosaur with azhdarchoid affinities from the Late Cretaceous of Kenya, although not unexpected at the continent level, adds a novel datum to a large region of Afro-Arabia. Perhaps most significant is the fact that KNM-WT 47893 was recovered from the fluvial Lapurr sandstone in the Turkana Grits, rather than from marine phosphate units as is typically the case for the vast majority of Afro-Arabian pterosaurs. Additional fieldwork in the Lapurr sandstone is currently underway and will no doubt continue to add important new data to the extremely sparse Late Cretaceous vertebrate record of Afro-Arabia.

ACKNOWLEDGMENTS

We would like to thank the scientific, curatorial and preparation staff at the National Museums of Kenya (Nairobi, Kenya) for assistance during the course of this project, specifically, E. Mbua and M. Macharwas. J. Groenke, M. Macharwas, A. Moru, H. Sallam, E. Seifert, & others assisted with field research during the 2008 expedition. We also thank the following agencies and institutions for supporting the field and museum research related to this project: US National Science Foundation (EAR-0617561), National Geographic Society (CRE), Ohio University College of Osteopathic Medicine, and Ohio University Office of Research and Sponsored Programs, Turkana Basin Institute.

RESUMO

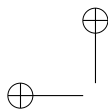
Uma vértebra cervical caudal isolada de pterossauro (~ pós-cervical) foi recuperada do Cretáceo Superior do arenito de Lapurr do Oeste de Turkana, noroeste do Quênia. O centro vertebral é curto, largo e comprimido dorsoventralmente. Embora

cas tanto no centro quanto no arco neural. Este representa dos poucos pterossauros recuperados do conjunto Afro-Arabia, o primeiro pterossauro proveniente do Cretáceo do Leste da África e, significativamente, um espécime que foi recuperado de depósitos fluviais e não do cenário marinho próximo ao tipo, típico da maioria das descobertas de pterossauros.

Palavras-chave: Pterosauria, Pterodactyloidea, África do Sul, Cretáceo Superior.

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