Journal of African Earth Sciences 117 (2016) 223–234

Contents lists available at ScienceDirect

Journal of African Earth Sciences

journal homepage: www.elsevier.com/locate/jafrearsci

Vertebrate paleontological exploration of the Upper Cretaceous succession in the Dakhla and Kharga Oases, Western Desert, Egypt

Hesham M. Sallam [a, b, *], Patrick M. O'Connor [b, c], Mahmoud Kora [a], Joseph J.W. Sertich [d], Erik R. Seiffert [e], Mahmoud Faris [f], Khaled Ouda [g], Iman El-Dawoudi [a], Sara Saber [g], Sanaa El-Sayed [a]

[a] Mansoura University Vertebrate Paleontology Center, Department of Geology, Faculty of Science, Mansoura University, Mansoura, 35516, Egypt
[b] Department of Biomedical Sciences, Ohio University Heritage College of Osteopathic Medicine, 228 Irvine Hall, Athens, OH, 45701, USA
[c] Ohio Center for Ecology and Evolutionary Studies, Irvine Hall, Ohio University, Athens, OH, 45701, USA
[d] Department of Earth Sciences, Denver Museum of Nature & Science, Denver, CO, 80205, USA
[e] Department of Anatomical Sciences, Stony Brook University, Stony Brook, New York, 11794-8081, USA
[f] Department of Geology, Tanta University, Tanta, Egypt
[g] Department of Geology, Faculty of Science, Assiut University, Assiut, Egypt

ARTICLE INFO

Article history:
Received 17 November 2015
Received in revised form
18 January 2016
Accepted 19 January 2016
Available online 21 January 2016

Keywords:
Vertebrate
Dinosauria
Nannofossil
Late Cretaceous
Egypt

ABSTRACT

The Campanian and Maastrichtian stages are very poorly documented time intervals in Africa's record of terrestrial vertebrate evolution. Upper Cretaceous deposits exposed in southern Egypt, near the Dakhla and Kharga Oases in the Western Desert, preserve abundant vertebrate fossils in nearshore marine environments, but have not yet been the focus of intensive collection and description. Our recent paleontological work in these areas has resulted in the discovery of numerous new vertebrate fossil-bearing localities within the middle Campanian Qusier Formation and the upper Campanian-lower Maastrichtian Duwi Formation. Fossil remains recovered from the Campanian-aged Quseir Formation include sharks, rays, actinopterygian and sarcopterygian fishes, turtles, and rare terrestrial archosaurians, including some of the only dinosaurs known from this interval on continental Africa. The upper Campanian/lower Maastrichtian Duwi Formation preserves sharks, sawfish, actinopterygians, and marine reptiles (mosasaurs and plesiosaurs). Notably absent from these collections are representatives of Mammalia and Avialae, both of which remain effectively undocumented in the Upper Cretaceous rocks of Africa and Arabia. New age constraints on the examined rock units is provided by 23 nannofossil taxa, some of which are reported from the Duwi Formation for the first time. Fossil discoveries from rock units of this age are essential for characterizing the degree of endemism that may have developed as the continent became increasingly tectonically isolated from the rest of Gondwana, not to mention for fully evaluating origin and diversification hypotheses of major modern groups of vertebrates (e.g., crown birds, placental mammals).

1. Introduction

Post-Cenomanian deposits from the Late Cretaceous of continental Africa are scarce (Haughton, 1963; Dingle et al., 1983; Mateer et al., 1992) and limited to only a few geographically restricted localities. Whereas the expanding terrestrial/freshwater vertebrate record from the 'Middle' Cretaceous (~Aptian-Cenomanian) has improved considerably in recent years (e.g., Sereno et al., 2004; Gomani, 2005; Sereno and Brusatte, 2008; Gottfried et al., 2009; Cavin et al., 2010; O'Connor et al., 2010; Gorscak et al., 2014; Sertich and O'Connor, 2014), our understanding of biotic dynamics leading up to and through the K-Pg boundary in Africa and Arabia remains extremely limited. Moreover, the few vertebrate fossils that are known from the Late Cretaceous of Africa derive from temporally restricted stratigraphic intervals, precluding direct comparison of faunas. This issue is particularly problematic for the latest Cretaceous, where the rate of new discoveries pales in

* Corresponding author. Mansoura University Vertebrate Paleontology Center, Department of Geology, Faculty of Science, Mansoura University, Mansoura, 35516, Egypt.
E-mail addresses: sallam@mans.edu.eg (H.M. Sallam), oconnorp@ohio.edu (P.M. O'Connor), jsertich@dmns.org (J.J.W. Sertich), erik.seiffert@stonybrook.edu (E.R. Seiffert), mhmfaris@yahoo.com (M. Faris).

http://dx.doi.org/10.1016/j.jafrearsci.2016.01.022
1464-343X/

comparison with earlier parts of the Cretaceous record.

The Late Cretaceous is of great interest for paleontologists as it coincides with a number of significant global-level faunal changes, and culminates in the extinction of many vertebrate (e.g., nonavian dinosaurs, marine reptiles) and invertebrate (e.g., ammonites) groups. The final two stages of the Cretaceous (Campanian and Maastrichtian) represent a time when Gondwanan fragmentation culminated in the near-complete isolation of most of the southern landmasses and Africa in particular (e.g. Müller et al., 1993; Smith et al., 1994; Scotese, 1998; Hay et al., 1999; Pletsch et al., 2001 and Scotese, 2001), offering a significant mechanism that could have profoundly influenced the evolutionary trajectories of numerous terrestrial vertebrate clades. However, our working knowledge of the African terrestrial biosphere and vertebrate diversity during this critical period of isolation is currently too limited to allow for meaningful comparisons of faunal patterns that have been documented in the Late Cretaceous on other landmasses. Moreover, the current sampling bias also precludes a critical evaluation of hypotheses positing the origin of major vertebrate groups prior to the Cretaceous–Paleogene boundary (e.g., Ericson et al., 2006; Meredith et al., 2011; Jetz et al., 2012; Jarvis et al., 2014; although see Prum et al., 2015 for a recent synopsis regarding the temporal origin of modern birds).

1.1. Background

Recently-developed Gondwana-wide (e.g., Sereno et al., 2004; Krause et al., 2006; Ali and Krause, 2011) and Africa-specific (e.g., O'Connor et al., 2006; Sertich and O'Connor, 2014; Gorscak and O'Connor, In Review) models related to Cretaceous biogeography can only be tested and refined through intensification of paleontological work in the uppermost Cretaceous deposits exposed on the continent. One of the most promising regions where such data may be collected corresponds to the sparsely vegetated circum-Saharan areas that preserve varied depositional settings (e.g., fluviatile, estuarine, near-shore marine, etc.) like the Western Desert of Egypt. Rigorously characterizing biotas (e.g., Claeson et al., 2014) that are unearthed from these units should provide insight into physical processes at both local and regional scales (e.g., timing of Gondwanan fragmentation, subdivision of large terrestrial landforms by marine transgressions, etc.) thought to influence terrestrial/freshwater communities during this time.

The Upper Cretaceous deposits along the Abu Tartur Plateau (Fig. 1), and in particular near the Dakhla and the Kharga Oases, hold great promise for the recovery of fossil vertebrates that are necessary for characterizing latest Cretaceous African faunas. New discoveries are essential for formally evaluating biogeographic models or characterizing the relative endemicity/increasing provincialism (e.g., Sereno et al., 1994, 2004) that may have existed on the African continent more generally during the Late Cretaceous. The Dakhla Oasis is situated in the southern part of the Western Desert about 150 km west of the Kharga Oasis, south of the Abu Tartur Plateau. A number of vertebrate clades have been noted from Cretaceous rocks in this region, either having been documented directly (e.g., Churcher, 1995; Rauhut and Werner, 1997; Lapparent de Broin and Werner, 1998; Churcher et al., 2006; Lamanna et al.,

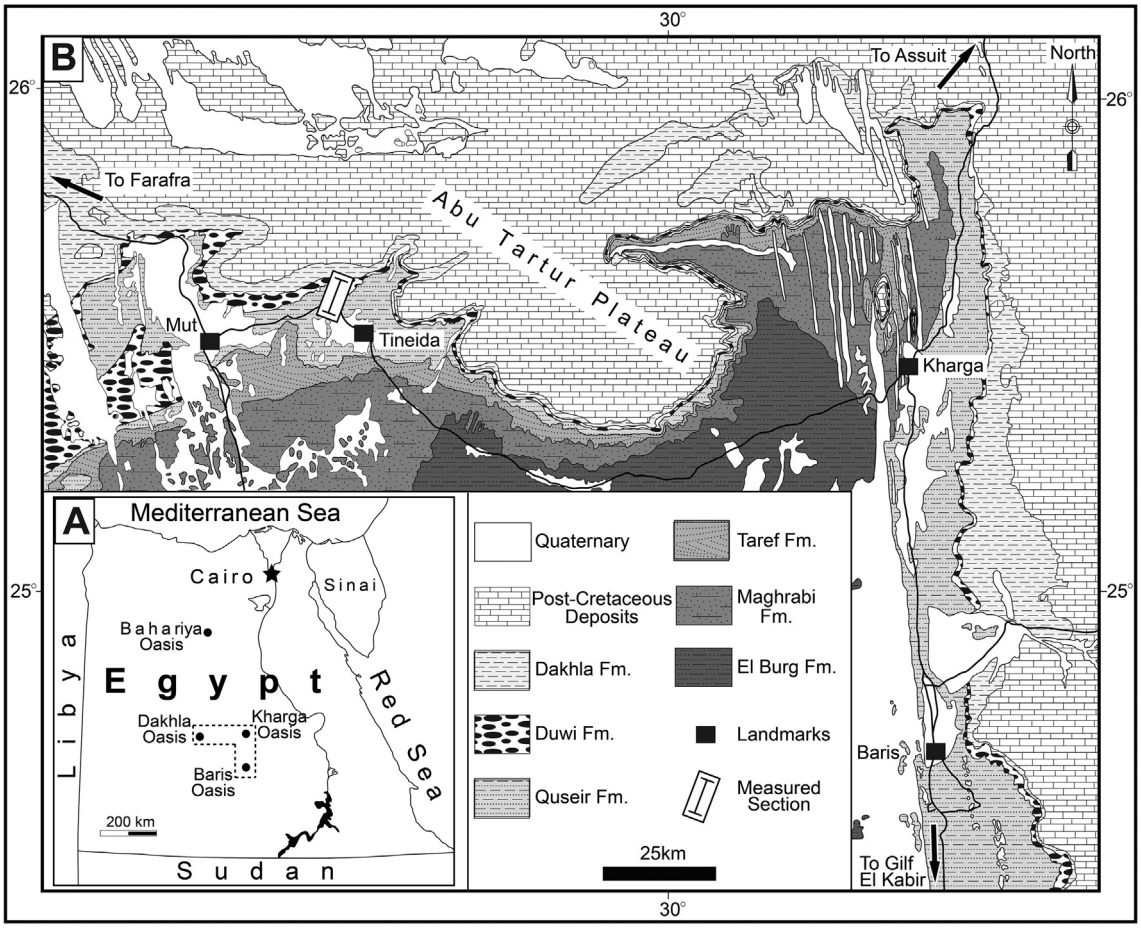

Fig. 1. Location (A) and geologic map (B) of the Dakhla and Kharga Oases in the Western Desert, southern Egypt, to illustrate main lithological units of the Upper Cretaceous–Paleogene succession. Modified after El Khawaga et al. (2005). The dashed box on A corresponds to the general location depicted in B.