Journal of African Earth Sciences 57 (2010) 391–412

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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

Geological Society of Africa Presidential Review No. 16

Vertebrate assemblages from the early Late Cretaceous of southeastern Morocco: An overview

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ARTICLE INFO

Article history:
Received 16 June 2009
Received in revised form 9 December 2009
Accepted 11 December 2009
Available online 23 December 2009

Keywords:
Africa
Mesozoic
Vertebrata
Palaeoecology
Palaeogeography

ABSTRACT

Fossils of vertebrates have been found in great abundance in the continental and marine early Late Cretaceous sediments of Southeastern Morocco for more than 50 years. About 80 vertebrate taxa have so far been recorded from this region, many of which were recognised and diagnosed for the first time based on specimens recovered from these sediments. In this paper, we use published data together with new field data to present an updated overview of Moroccan early Late Cretaceous vertebrate assemblages. The Cretaceous series we have studied encompasses three Formations, the Ifezouane and Aoufous Formations, which are continental and deltaic in origin and are often grouped under the name "Kem Kem beds", and the Akrabou Formation which is marine in origin. New field observations allow us to place four recognised vertebrate clusters, corresponding to one compound assemblage and three assemblages, within a general temporal framework. In particular, two ammonite bioevents characterise the lower part of the Upper Cenomanian (*Calycoceras guerangeri* Zone) at the base of the Akrabou Formation and the upper part of the Lower Turonian (*Mammites nodosoides* Zone), that may extend into the Middle Turonian within the Akrabou Formation, and allow for more accurate dating of the marine sequence in the study area. We are not yet able to distinguish a specific assemblage that characterises the Ifezouane Formation when compared to the similar Aoufous Formation, and as a result we regard the oldest of the four vertebrate "assemblages" in this region to be the compound assemblage of the "Kem Kem beds". This well-known vertebrate assemblage comprises a mixture of terrestrial (and aerial), freshwater and brackish vertebrates. The archosaur component of this fauna appears to show an intriguingly high proportion of large-bodied carnivorous taxa, which may indicate a peculiar trophic chain, although collecting biases alter this palaeontological signal. A small and restricted assemblage, the OT1 assemblage, possibly corresponds to a specific, localised ecosystem within the Kem Kem beds compound assemblage. Microfossils and facies from the Aoufous Formation, corresponding to the top of the compound assemblage, provide evidence of extremely abiotic conditions (hypersalinity), and thus of great environmental instability. At the base of the Akrabou Formation the first ammonite bioevent, *Neolobites*, corresponds to the onset of the marine transgression in the early Late Cenomanian while the Agoult assemblage (Late Cenomanian?) contains a variety of small fish species that have Central Tethyan affinities. Finally, the youngest *Mammites* bioevent in the late Early Turonian corresponds to a deepening of the marine environment: this sequence is isochronous with the Goulmima assemblage, a diverse collection of fish and other marine taxa, and shows affinities with taxa from the South Atlantic, the Central Tethys and the Western Interior seaway of North America, and further highlights the biogeographical importance of these North African Late Cretaceous assemblages.

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doi:10.1016/j.jafrearsci.2009.12.007

Contents

1. Introduction

The Cretaceous deposits surrounding the northern, eastern and southern borders of the Palaeozoic Tafilalt and Mader basins in Morocco have yielded numerous vertebrate remains for more than 50 years. The first discoveries of fossil vertebrates in the 'Grès Infracénomaniens' of the Kem Kem region were made by French geologists, including Choubert who found tooth plates of lungfish and ganoid scales south of Taouz in 1938 (Choubert, 1948; Choubert et al., 1952). Indeed, the first illustrations of vertebrate fossils from the Kem Kem beds were published by Choubert et al. (Fig. 1A) in 1952. In the late 1940s and early 1950s, Lavocat (1948, 1949, 1951, 1954a,b) published a series of notes on his palaeontological discoveries in this area of Morocco, with special emphasis on his dinosaur finds. In 1954, he published a geological synthesis of the Kem Kem area (Lavocat, 1954b) which is still one of the best accounts of the local geology. The first record of marine fish fragments in the Turonian of the High-Atlas and Midelt area had been made slightly earlier by Dubar (1949) and over the following decades only a few vertebrate remains from the 'mid' Cretaceous of this area of Morocco were described, including isolated fish fragments described by Tabaste (1963). In 1971, a German team from

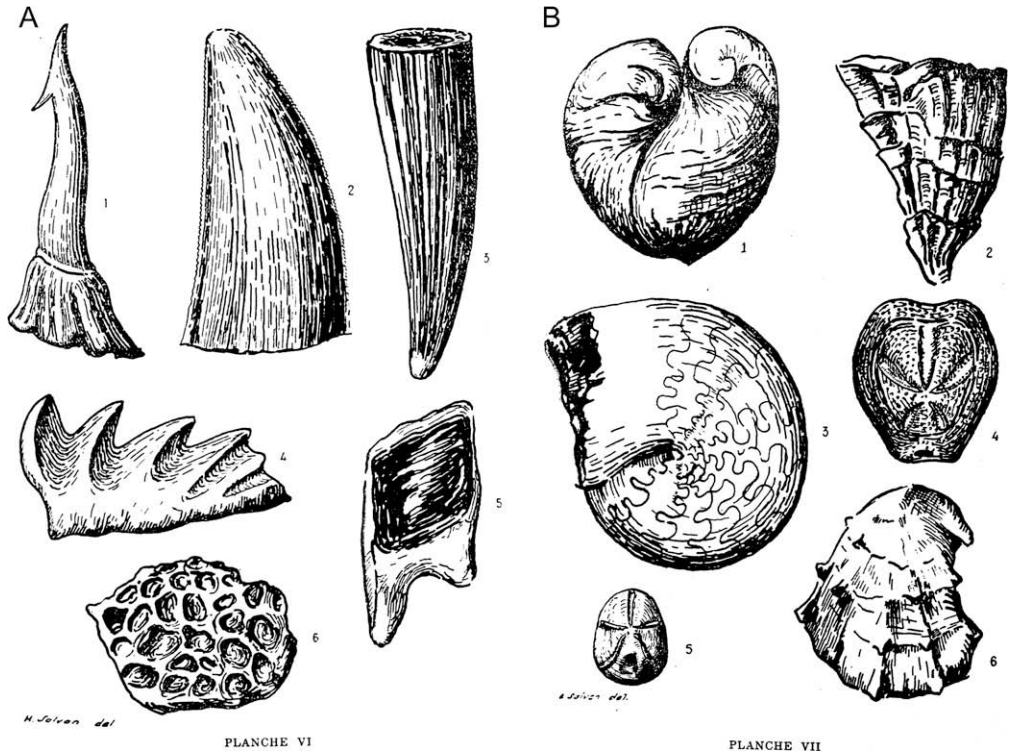

Fig. 1. Plates from Choubert et al. (1952): (A) the first illustrations of vertebrate fossils from the Kem Kem beds. Fig. 2 shows a theropod tooth referable to *Carcharodontosaurus* (not *Megalosaurus*) *saharicus*. Fig. 3, labelled as *Crocodilus* sp., is probably a *Spinosaurus* tooth; (B) invertebrates from the Cenomanian including *Neolobites vibrayeanus* (Fig. 3).