# A new Late Cretaceous reptiles bearing locality: Qarn Ganah, Kharga Oasis, Western Desert, Egypt



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## Abstract

The Late Cretaceous was not only the most active epoch of Gondwana fragmentation but also a time of significant climatic and evolutionary activity, which led to the extinction of many vertebrates. The African continent, the core of the supercontinent Gondwana, which became completely separated by the Late Cretaceous, has a poor and incomplete fossil record of that time when compared with other Gondawna continents. Here we report on an important discovery of a new vertebrate-bearing locality from the Campanian Quseir Formation, Qarn Ganah area near Kharga Oasis, Southwestern Desert, Egypt. Paleontological work has resulted in the discovery of a variety of different vertebrate groups including sharks and bony fishes, turtles, crocodyliforms and dinosaurs. The collected specimens are well-preserved isolated elements. One partial sauropod skeleton was found including some vertebrae, ribs, and limb bones. The recovered vertebrate fauna will be examined in detail to further refine their identification, establish their taxonomic affinities, and establish their collective relationship with other Late Cretaceous African faunas such as Dinosaurs, crocodyliforms and turtles. The new discovery will not only augment the growing collection of Late Cretaceous vertebrate faunas from Africa but also will improve understanding of global faunal changes and evolution during the late Mesozoic.

Keywords: Late Cretaceous, reptiles, Qarn Ganah, Western Desert, Egypt

## Introduction

There are only few upper Cretaceous reptiles bearing localities of the African continent [1]. Therefore, it is very poor knowledge of the reptile's habitats (especially dinosaurs) in Africa at that time. Some localities, containing very interesting remnants of Late Cretaceous reptiles are recorded in the Western Desert of Egypt, represented in Cenomanian deposits of Baharya oasis [2,3], Campanian deposits of Dakhla basin [1, 4, 5, 6] and Maastrichtian deposits in the western part of Dakhla basin near Ammonite hills [1] (Fig. 1). In the Southwestern Desert of Egypt, the Dakhla basin has excellent outcrops showing a wide lithological variety of Late Cretaceous, containing remnants of terrestrial and marine reptiles that may contribute to uncovering the mysteries of Mesozoic era life in the African continent.

The area is rich in fossil remains of many genera. In Kharga and Dakhla Oases, reptile remains were discovered [1, 6] Partial skeletons and separated elements of dinosaurs. Fish fossils are represented by many species of shark teeth recently discovered within the economic phosphate layer extending from Kharga to Dakhla Oasis. Throughout recent expeditions to the south of Kharga Oasis, the authors have uncovered new proof of turtles, crocodyliforms, and dinosaur

bones. Despite these and other previous investigations of the stratigraphical, paleontological, and paleoenvironmental investigations, there are gaps in information on the habitat of the Mesozoic era in Egypt, however in Africa. Moreover, the shape and the proportion of the reptiles and contemporary animals of the various paleo-environments are poorly known.

The post-Cenomanian major transgression of the Tethyan Sea occurred during the Campanian time. The commenced transgressive step of the Campanian Sea was as very shallow marine water, affected by the tidal currents [7] This event yielded supratidal to intertidal clastics alternated with fluvial and estuarine deposits, containing remnants of dinosaurs, turtles, and crocodyliforms bones, additionally to fishbone remains. These deposits are well represented in variegated shale Qusier Formation [8] = Mut Formation; [9] in the Southwestern Desert of Egypt. The best-documented post-Cenomanian record of purported Ornithischian was done by [5] from the Qusier Formation between Kharga and Beris oases near Gaga village.

In this study, a new upper Cretaceous (Campanian) reptile locality, namely Qarn Ganah, south of Kharga

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was discovered during our expeditions along the road between Kharga and Beris oases, (Fig. 2). The locality is very rich in Testudine partial skeletons and separated elements of sauropod dinosaurs, partial skeletons of Crocodyliform, bony fish and shark teeth. The locality seems to be very rich in Campanian reptiles fossils, which will make it very important and reliable to find new species and get more knowledge of the evolution series and the Late Cretaceous reptile's migration trends between the African continent and the other areas before and during the breaking of Gondwanaland.

# **Geologic setting**

Quseir Formation [8] (Mut Formation, [9] includes wide distribution in Kharga and Dakhla in the Southwestern Desert of Egypt. It extends from the northeast to the southwest between Kharga-Dakhla and gradually disappears to the west of Dakhla and is northerly equivalent to the Wadi Hennis Formation and El Hefhuf Formation in the Farafra depression [10]. It additionally extends from the east to the south along Darb Al Arbein between Kharga and Beris oases and southerly, equivalent to the lower part of the Kiseiba Formation [11].

Qusier Formation attains 80 m thickness at Dakhla [12, 13, 14] and was subdivided into two members, Mut Member at the base and Hindaw Member at the top [12]. The type of section of the Quseir Formation is at Gebel Atshan in the Quseir area, Red Sea coast [8]. It is composed of variegated claystone, siltstone, and sandstone intercalations. Quseir Formation is characterized by the presence of fragmented bones and partial skeletons of vertebrate fossils remaining as lungfish, sawfishes, turtle shells, crocodyliform bones and some separated partial skeletons of dinosaurs [6]. These deposits are attributed to the shallow marine environment.

Hendriks *et al.* [14] divided the Quseir Formation between Kharga and Beris into two consecutive main facies, the lower one is 25 to 45 m thick of tidal flat deposits and the upper one is about 20 m thick of inner shelf deposits. The lower one is subdivided into six subfacies, formed of vari-colored grey claystones and bioturbated sandstones. The first subfacies, the basal part of the Quseir Formation which is composed of grey to violet mottled claystone of supratidal to intertidal facies alternating with supratidal marsh and estuarine deposits, yielding freshwater gastropods and vertebrate fossils such as dinosaurs, turtles, crocodyliforms, and fishes, it represents the exposed deposits of Qarn Ganah (the study area), (Figs. 1-2). The reliable faunal assemblages estimate the geological age at which these layers were deposited. Therefore, the dating of the Qusier Formation relied on the stratigraphical superposition with the overlies Duwi Formation [10, 14, 15]. Sallam *et al.* [6] evidenced no yielded nanoplankton assemblages from the chosen rock samples of the stratigraphic section represented the Qusier Formation near Teneida village, Dakhla. However, they identified significant 23 nanoplankton taxa of the middle-upper Duwi Formation dated to the lower Campanian age comparable to zone CC23 (*Qadrum trifidum*).

The palynological study gave an optimized indicator for the relative age dating of the Qusier Formation based of the marginal and continental paleoenvironment of the present facies. Therefore, the exposed layers of the base of the Qusier Formation close to Bulaq village, east of Kharga are examined by [16], Depending on a certain marker angiosperm range such as proteacidites sp. and Syncolporites schrankii. He referred Qusier Formation to the Campanian age. The Santonian age is typically represented by the palmae and other proteaccean and Syncolporate pollens [16]. Therefore, the age of the Qusier Formation may be referring to Santonian to lower Campanian. El Atfy et al. [17] recorded for the first time the occurrence of African paleo-wildfire during the Campanian age at the base of the Qusier Formation near Beris oasis, south Kharga.

Qusier Formation at Qarn Ganah (the study area), (Fig. 2), exposes low-angle northeast inclined layers of about 25 m thick of variegated shales and gray glauconitic mudstones and siltstones intercalated with thin layers of ferruginous conglomeratic sandstone, containing fragments and coprolites. The section is topped by about 1 m thick of phosphatic layer, containing shark teeth and fishbone, (Fig. 3).

**Structurally**, the area between Qarn Ganah and Bulaq is morphologically formed of folded isolated consecutive hills along the extension of Darb Al Arbein between Kharga and Beris. These hills are formed of sandstones intercalated with thin layers of shales belonging to the Taref Formation and Quseir variegated shales in the floor around these hills. These hills are separated by a group of inferred faults, forming two horsts separated by graben [18]. The structural setting of the Qarn Ganah area represents a doubly plunging anticlinal structure around a northsouth trending axis [10].

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Fig. (1) Geological map of the Kharga Oasis, southwestern Desert, Egypt, showing the study area, Qarn Ganah, (modified after EL Azabi 2011).



Fig. (2) General view of Qarn Ganah at the south of Kharga oasis

# Vertebrate fossils of the study area

Qarn Ganah area, southeast Kharga Oasis is considered one of the most important vertebratebearing sites discovered by New Valley Vertebrate Paleontology Center, New Valley University. Qarn Ganah area contains an abundance of scattered elements of sauropod dinosaurs, crocodyliforms elements such as vertebrae and fragmented skulls, and complete and partial shells of turtles (Fig. 5). These vertebrate fossils are embedded in the gray to green compact mudstone of Hindaw Member, Quseir Formation.

Abu El-Kheir [19] detected three successive vertebrate bearing horizons HI, HII, and HIII. These horizons have well-exposed surfaces exhibiting a high abundance of well-preserved complete and partial shells, scattered long bones of fore, and kind limbs of sauropod dinosaurs. Some crocodyliforms elements such as vertebrae and fragmented skulls are observed in these horizons.



Fig. (3) Stratigraphic section of Qarn Ganah Area (the study area) (after Abu El-Kheir 2020)



Fig. (4) Satellite image of the Qarn Ganah area, showing the distribution of the fossils of Late Cretaceous reptiles (dinosaurs, turtles and crocodyliform).

AbdelGawad *et al.* [20] completely described the complete turtle shell of a side-neck turtle (Bothermydidae). They recorded the first new genus and new species of *Bothremydidae* from the Campanian age not only in Egypt but also in Africa. El Hedeny *et al.* [21] studied the bioerosion activities of the surface of the shell bone turtles of the Qarn Ganah area. They recorded nine echnogenera (*Nihilichnus, Cubiculum, Osteocallis, Radulichnus,* 

*Osteichnus, Sulculites*, and *Machinus*) representing 11 species. The exposed vertebrate fossils of the Qarn Ganah area are highly affected by weathering and by some human activities. Large surfaces of the vertebrate-bearing horizons are covered with sand sheets and old dry plants, covering the remnants of the vertebrate fossils which need a lot of works to discover them, (Fig. 5 - 6).



Fig. (5) Extraction of semi-complete turtle shell of Quesir Formation from Qarn Ganah area



**Fig.** (6) A) Complete humerus of sauropod dinosaur skeleton, B) Weathered limb of sauropod dinosaur imbedded in grayish mudstone of uppermost layer of Quseir Formation, C) Fragmented long bone of dinosaur from the uppermost layer of Quseir Formation, D & E) Fragmented turtle shells in the weathered surface of the uppermost layer of Quseir Formation, F) crocodyliforms vertebrae embedded in gray mudstone of Quseir Formation.

# Discussion

Qusier Formation of the Southwestern Desert has a wide variety and abundance of terrestrial and aquatic vertebrate fossils. These fossils are represented by turtle, sauropod dinosaurs, crocodyliforms and fishbones. Qusier Formation has well-extended exposures, the south Kharga Oasis. It forms of variegated shale and siltstone intercalation. Many vertebrate fossils are observed and collected from the uppermost part of the Qusier Formation along Darb El Arbien between Kharga and Beris.

Qarn Ganah southeast Kharga Oasis contains an abundance of Campanian well-preserved turtle shells, especially side neck turtles (*Bothromydids*). the turtle bones are well preserved, articulated, and not abraded shells. These preserved states may give some indication that the turtles were deposited in their places or transported for short distances by currents. The sauropod dinosaur's scattered elements, especially the fore and hind limbs are not well preserved, highly abraded, and also highly affected by the gypsum alteration of the hosted mudstone layers. These conditions may give some indication for the longdistance transportation of the dinosaur elements by high currents into the restricted ponds, where the accumulation of the turtle clusters.

The palynological studies of the Quseir Formation by **[16]** near Bulaq village, south Qarn Ganah area, and the presence of some petrified woods may prove the evidence for abundant nutrients that attracted the synchronized animals such as sauropod dinosaurs to this area. Qarn Ganah area is selected by the New Valley governorate and by the New Valley University as a scientific research area for New Valley University. The area will be an open museum for the Cretaceous vertebrates of Kharga under the control of New Valley University.

#### Conclusion

The discovery of the new Late Cretaceous vertebrate bearing localities of the African continent represents a new gesture of hope in increasing knowledge of the form of ancient life after its separation from the Gondwana landmass.

Despite some attempts which made to recover the Late Cretaceous vertebrates [22, 6], but it is still unknown to the Late Cretaceous life in Africa due to the scarcity of uncovered vertebrate fossils.

The Western Desert of Egypt represents one of the most important Cretaceous vertebrates bearing sites in the north of Africa and contains a variety of uncovered vertebrate fossils. These discoveries are contributing a big role in giving more information for understanding the nature of life in the Cretaceous era.

Qarn Ganah site in the south of Kharga Oasis, Egypt has well-exposed layers of supratidal to intertidal facies alternating with supratidal marsh and estuarine deposits of Qusier Formation, Campanian age, yielding four vertebrate bearing horizons. These horizons contain varieties of vertebrate groups such as crocodyliformes, sauropod dinosaurs, turtles, shark teeth, and fishbones.

The site has at least two species of dinosaurs, four species of turtles, and three species of crocodyliformes, in addition to many species of fish. The paleo-environmental and taphonomic conditions indicate that these fossils are attracted to live in and around restricted ponds, where abundance of nutrients, low currents water, and other suitable conditions for all the represented fauna in the study area.

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