



The First Documentation for Crocodile Fossils from Fat'ha Formation (Middle Miocene), Southern Mosul City, Northern Iraq

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ABSTRACT

A detailed crocodile fossils study was conducted for the Fat'ha Formation that cropped out at the South Mosul city of Nineveh, northern Iraq. The objective of this study is to determine the remains of crocodile fossils in Fat'ha Formation through a detailed investigation.

Investigation carried out on it to indicate the presence of at least one new additional taxon, a previously unidentified form differing from crocodiles in the morphology of its lower jaw. Both forms are endemic to the African continent and also present at that time all around the Mediterranean basin. The presence this fossil in North Africa at that time also indicated oscillating periods that varied from normal salinity to brackish and saline environments, with the shallow lagoon and sometimes deep lagoonal environment that do not exceed the shelf margin zone, before the onset of more arid conditions in the region that led to the disappearance of the crocodiles and the development and expansion of the modern species. The ideal classification that applies in this case is Animalia (Kingdom), Chordata (Phylum), Reptilia (Class), Order of Crocodylia (alligators), Alligatoridae alligators (Family), Paleosuchus (Genus) belonging to caimans, and Paleosuchus palpebrosus (species) which in turn goes back to Cuvier's smooth-fronted caiman (dwarf types of caiman).

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1. INTRODUCTION

The study site is situated in northern Iraq, precisely; in the north limb of the Najma anticline, approximately 45 km southern the city of Mosul, at longitude (43° 08' 35"E) and latitude (36° 35' 35"N). This section is already located within the Low Folded Zone as stated by the tectonic divisions of Iraq [1]. The location and section from which the samples used in this study were taken are depicted in Figure 1.

The specimen was extracted from the limestone rock successions within the sequences of the Fatah Formation that were exposed in the study area. The Fat'ha Formation is one of the most widespread formations in the Miocene sequences and is mostly found in the Jazira area and the zone of the low folds, in the part of unstable shelf. According to [2], this formation is also exposed in the Butma-Chamchal region and in northern Iraq within the larger zone of high folds.

The variance in thickness of this formation indicates the presence of two main areas of high thickness. The first is the northeastern area, located in the Jazira region, approximately west of Sinjar within the (Jazira-Sinjar Basin) and extending to Syria. The second is in the southeastern direction of Mosul (Kirkuk Basin) towards Kirkuk and Khanaqin and extending to Iran [2].

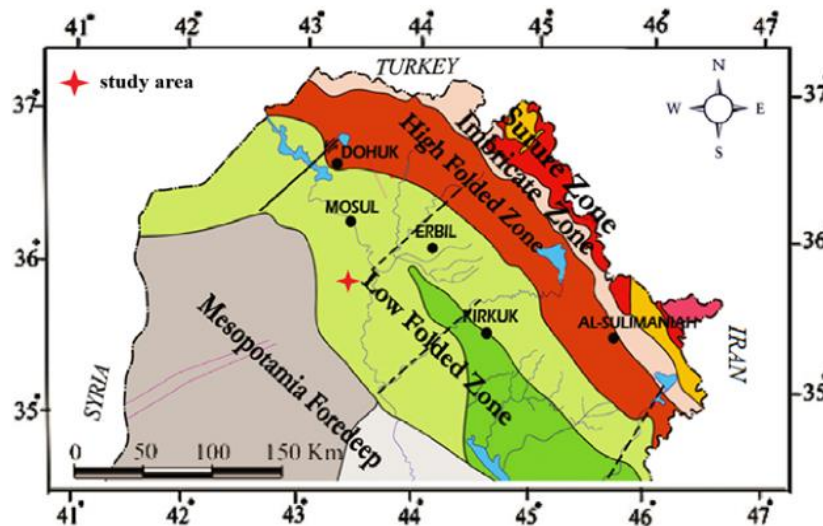


Figure 1. Location of the study area within the Low Folded Zone [1].

The Fat'ha Formation is 600 meters thick in Sinjar and exceeds 1000 meters thick in the Kirkuk Basin [3]. The thickness decreases towards the north and south, which roughly corresponds to the uplift of Mosul High and Salman Zone due to the nature of the basin and its tectonic activities during the middle Miocene [2].

Most researches indicate that the Fat'ha Formation consists of semi-closed lagoons in Iraq, and the carbonate rock units and evaporite in the Fat'ha Formation in the High Folded and Imbricate Zones are not similar to those found in the original site in the zone of Low Folds and Al-Jazira area [4].

From the basin edge to its depocenter, the succession is composed of numerous carbonate-evaporate cycles that differ in thickness and characteristics. Cycles around the basin margin are composed of calcareous mudstone (marl), carbonate, and evaporite, in addition to red clastic mudstone units. Whereas, the lateral equivalents of these cycles towards the depocenter of the basin consist of marl, carbonates, and evaporites with very modest accumulations of red clastic silt at the higher portion of the cycle in the upper division of the formation [5, 6, 7, 8].

The depositional indicative of typical sabkha original conditions due to occurrence of dolomite and stromatolite, and the sabkha sub-environments were not extensively distributed across the formation [9,10,11]. Instead, the preferred interpretation suggests including a lagoon environment with limited contact with the sea. While [12] proposed a semi-restricted lagoonal setting model.

2. PREVIOUS STUDY

Tectonic stratigraphy: [13], interpreted paleofacies maps as a way to prove the activity of the Mosul Fault since the Middle Jurassic and perhaps before that, and pointed out that three main blocks dominate the Forland Basin in northern Iraq (with its two main parts, Zagros and Taurus) compared to [14,15]. These blocks are called Mosul, Sinjar, and Kirkuk, and the main basal faults that separate them are the Mosul fault and the Great Zab fault, respectively. The study area is located within the Sinjar block, Figure 2.



Figure 2. Map of northern Iraq divided into three blocks, showing the location of the study area.

Also [13] stated that the relative vertical movement between these three blocks from the Upper Jurassic to the present time led to important tectonic conclusions, including that the Miocene period was characterized by the rise and fall of the Sinjar Block, which resulted in a succession of shoaly lagoonal facies and deep facies but in general, Sinjar Block is considered high compared to Mosul Block. [13] also pointed out that the setting of the three previously mentioned blocks has become like terraces, as Sinjar Block remained at the highest level while Kirkuk Block was at the lowest level, Figure 3.

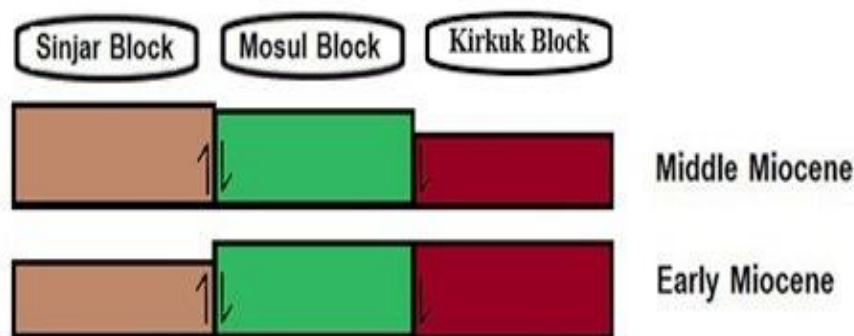


Figure 3. Relative Movements of Sinjar, Mosul, and Kirkuk Blocks [13]

Such oscillation, represented by the rise and fall of the above blocks, was sufficient to change the paleogeography of the Fat'ha Formation Basin and the disparity of the coastline in that period. It should be noted that the study section is exceedingly adjacent to the intersection of the Mosul and Greater Zab faults, and this means that the site is very close to the coastline of the Fat'ha Formation Basin.

3. RESULTS AND DISCUSSION

Presently, there are three main families conceded inside this Crocodilia: Alligatoridae (Alligator; Caiman; Melanosuchus; and Paleosuchus) is the first, Crocodylidae (Crocodylus; Osteolaemus; and Tomistoma) is the second while Gavialidae, which comprise only one species, Gavialis gangeticus represent the third, Figure 4. Reptiles belonging classificationally to the Archosauria were the most common terrestrial vertebrates throughout the Mesozoic (248–64) million years ago. During the Triassic Period onally to the Archosauria were the most common terrestrial vertebrates throughout the Mesozoic (248–64) million years ago. During the Triassic Period (248–201.4) million years ago, the order Thecodontia, (the basal group of Archosaurs) gave rise to the both Saurichia and Ornithischia orders which collectively are referred to as dinosaurs; the Pterosaurs, who were skin-winged fliers; and the Crocodilia. The word Crocodilia belongs to a crown group that includes all of its descendants in addition to *Gavialis*, *Alligator*, *Paleosuchus*, *Caiman*, *Melanosuchus*, *Tomistoma*, and *Osteolaemus* [17, 18, 19, 20]. According to [21], the only living Archosaurian reptiles are Crocodilians, which have thrived as predators that habitat freshwater for the past 200 million years. There have been three main types of crocodilians, and the number of extinct species much outweighs that of surviving relatives Figure 5.

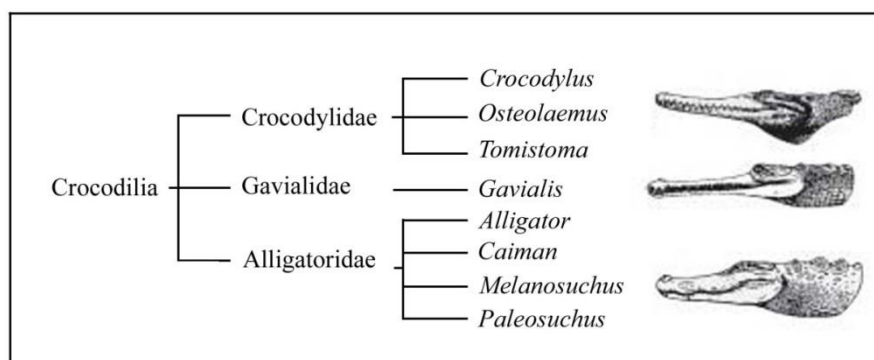
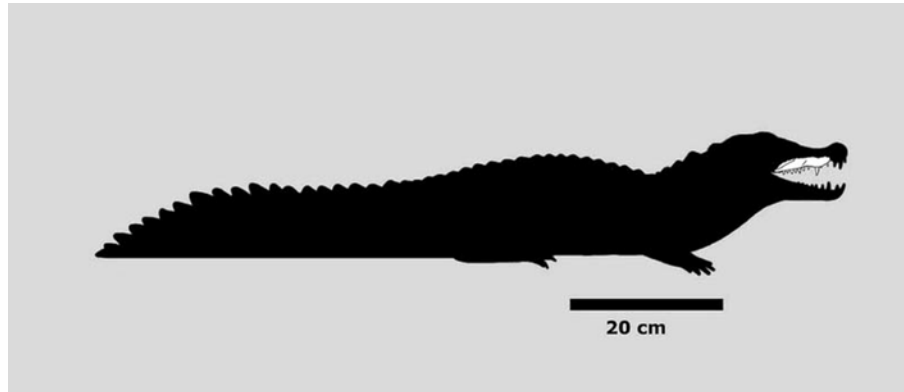


Figure 4. Classification of crocodiles [16]



[Figure 5.](#) Sketch of study crocodile's size

3. 1. The Classification of Crocodiles

[22] clear up that in Greek, the term “ancient crocodilian” describes the thick bony scales of dwarf caimans that resemble those of early types of crocodilians.

Kingdom: Animalia

Phylum: Chordata

Class: Reptilia — reptiles

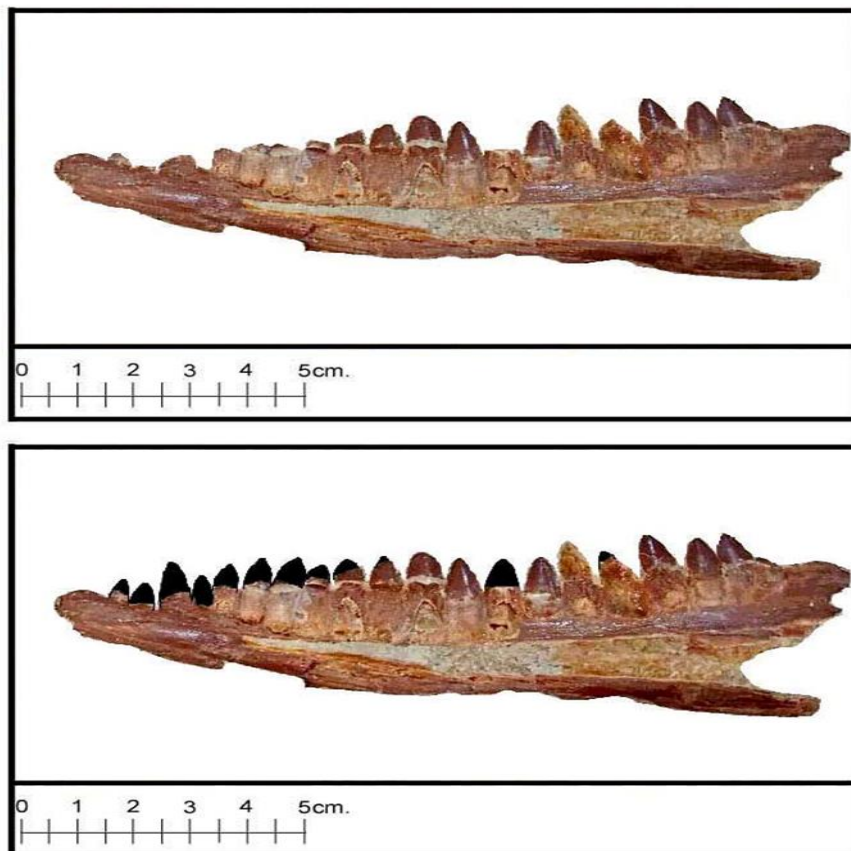
Order: Crocodylia — alligators, caimans, crocodiles, gharials

Family: Alligatoridae — alligators and caimans

Genus: Paleosuchus [23] — dwarf and smooth-fronted caimans

Species: Paleosuchus palpebrosus [24] — dwarf caiman, Cuvier's dwarf caiman, Cuvier's smooth-fronted caiman, plate 1.

Source: [25]



[Plate 1.](#) Image of study specimens from Fat'ha Formation

4. CONCLUSION

Crocodylians have developed a protective screen around their bodies that is both armoured and sensitive to their surroundings. Since all extant crocodylians have used a semi-aquatic environment, the research case of extinct species also belongs to it. Because of their proximity to the research region and their knowledge of Iraq's paleogeography, crocodylians can identify surface waves.

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