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The first mandible fragment of *Deinosuchus* (Eusuchia: Alligatoroidea) discovered in Coahuila, Mexico

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Abstract

Here we report on the first mandible fragment of the giant alligatoroid eusuchian crocodyliform *Deinosuchus* found in Mexico. The specimen comes from Las Jicoteas locality, northwestern Coahuila. It was collected in 2007 by the first author. The fragment is from a left surangular, coming from the mandible of a *Deinosuchus* between six and seven metres in length.

Keywords: *Deinosuchus*, Alligatoroidea, Eusuchia, late Campanian, Coahuila, Mexico.

Resumen

Aquí reportamos sobre el primer fragmento craneal de aligatorido eusuchio crocodiliforme gigante Deinosuchus*, que ha sido encontrado en México. El espécimen proviene de la localidad de Las Jicoteas, noroeste de Coahuila. Fue colectado en 2007 por el primer autor. El fragmento es un surangular izquierdo, de la mandíbula de un* Deinosuchus *el cual tendría una longitud de entre 6 y 7 metros.*

Palabras clave: Deinosuchus*, Alligatoroidea, Eusuchia, Campaniano tardío, Coahuila, México.*

1. Introduction

Fossil remains of Mesozoic crocodyliforms are scarce in Mexico. *Thalattosuchia* has been reported from Late Jurassic marine sediments of Oaxaca (Ferrusquía and Comas, 1988), Puebla (Frey *et al*., 2002), Nuevo León (Buchy *et al*., 2006a; Velasco-Segura, 2007; Buchy, 2008) and Coahuila (Buchy *et al*., 2006b). From Cantera Tlayua (Albian, Early Cretaceous), Puebla, a crocodilian similar to the pholidosaurid *Crocodileimus* has been reported (Reynoso *et al*., 2000). Moreover, a few Late Cretaceous crocodyliforms have been discovered. From the San Carlos and Aguja formations, in Chihuahua, fossil remains assigned to *Deinosuchus* cf. *D. riograndensis* were described by Brown *et al*. (2004). Other crocodyliforms have been reported from Coahuila, including goniopholids and *Brachychampsa* from the Cerro del Pueblo Formation (Rodríguez-de la Rosa and Cevallos, 1998) and *Deinosuchus riograndensis* from the Aguja Formation (Rivera-Sylva *et al*., 2011).

Our understanding of fossil crocodyliforms in Mexico is still developing. Therefore, the description of newly discovered remains, no matter how small, is important to establish a database that later will allow reconstruction of the evolutionary history of those crocodyliforms that inhabited the area of today's Mexico.

The mandible fragment described here was recovered from a site located in the municipality of Ocampo, in the western part of Coahuila, close to the border with Chihuahua, 22 km northwest of the town of El Carricito

(Figure 1).

2. Geology

The structural tectonics of northwest Coahuila consists of narrow anticlines and wide synclines. Both are affected by normal and lateral faults. Lateral faulting puts in discordant contact the marine sequence of limestones and mudstones containing lamellibranchs and abundant foraminifers that could correspond to the marine member of the Aguja Formation with the transitional sequence of sandstones, mudstones and siltstones, which correlate with the continental sequence where many dinosaur remains occur.

The Aguja Formation comprises mainly irregularly interbedded clay and sandstone, ranging from a few tens of millimetres to more than twelve metres in thickness. Beds of arenaceous and rudaceous, coquina sandstone, carbonaceous clay, lignite, and a rare fresh-water limestone appear in parts of the section. The formation is characterized by rapid vertical and lateral facies changes, as well as by a proportion of sand that is present in either the overlying or the underlying units (Hopkins, 1965).

Based on the colour variation of the clay, the formation is roughly divided into three parts. The basal part consists of a grey-green clay, which weathers to a buff-yellow colour, and resembles the clays of the underlying Pen Formation. The clay of central part is green with some buff-yellow beds. In the top part, the clay shows a melange of pale maroons, greens, blue-blacks, and reds much resembling the clay in the overlying Javelina Formation. The change in clay colour probably correlates with a change from open water marine conditions, through intertidal marine, brackish and fresh water conditions with terrestrial conditions in the centre of the formation, where lignites and carbonaceous clay form the dominant lithology. This lithology also occurs throughout the lower part of the Aguja Formation.

Hopkins (1965) recognised oscillating marine transgressions in the Aguja Formation alternating with non-marine episodes as the result of local intermittent delta progression, and subsequent subsidence due to the compaction of the underlying clays.

The system was deltaic with a narrow pro-delta seam with marshes, oxbows, and near shore lagoons with sandy or silty bars (Hopkins, 1965; Weide *et al*., 1972; Lehman, 1982).

3. Systematic palaeontology

Crocodyliformes Benton and Clark, 1988
Eusuchia Huxley, 1875
Alligatoroidea Gray, 1844
Deinosuchus Holland, 1909

Deinosuchus indet.

3.1. Material. Fragmentary left surangular of *Deinosuchus* (Figure 2A-C), which is housed in the *Museo del Desierto*, Saltillo, Coahuila, Mexico under the collection number CPC 485 (CPC: Colección Paleontológica de Coahuila).

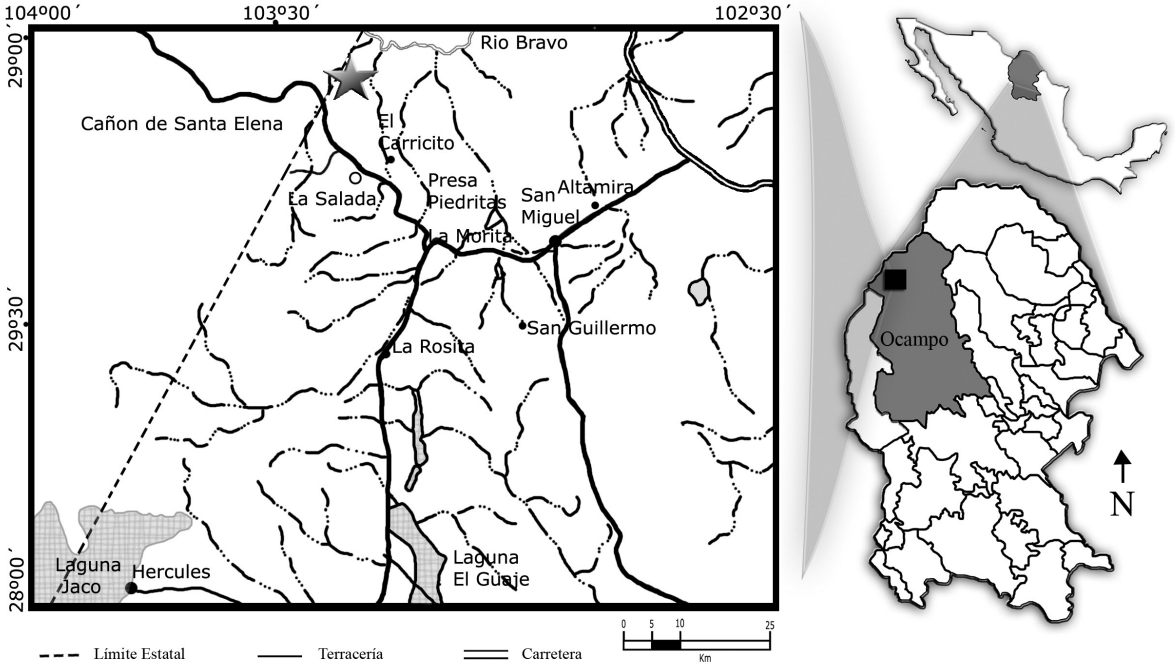

Figure 1. Geographical map of the locality

3.2. Horizon and Locality. The material was recovered from the upper member of the Aguja Formation (Upper Cretaceous, Campanian), west of the El Carricito, Township of Ocampo, Coahuila, Mexico.

3.3 Preservation. The bone is uncrushed, but the rostal and caudal margin show sub-vertical breaks, exposing spongiosa encased by a dense compacta. The specimen was broken horizontally in two halves of approximately the same size, which were glued together (Figure 2A, B).

3.4 Description. The fragment is identified as coming from a left surangular based on a smooth, slightly convex dorsal surface that would normally occur immediately rostral to the mandibular glenoid fossa (Figure 3). This surface is an elongate oval three times as long as wide in the preserved portion (Figure 2C, C´). This is the insertion place of the caudal-most portion of m. adductor mandibulae externus superficialis (Holliday and Wittmer, 2007) and has the typical morphology for eusuchian crocodyliforms. The transversely striated, rugose face of the surangular-coracoid suture, where the caudal process of the coronoid contacted the surangular, lies rostrally (Figure 2A, A´). The rostral process that formed the caudodorsal margin of the mandibular fenestra has broken off, as has the entire caudal part of the bone (Figure 3).

The external face is deeply and irregularly pitted. The dorsolateral margin is slightly bulged, where the lateral fibres of m. adductor mandibulae externus superficialis inserted (Figure 2A, A´). The internal face shows a faint horizontal sub-parallel striation in its dorsal half and a pronounced caudally radiating striation in its ventral half. In the caudoventral third a breakage with the spongiosa is exposed (Figure 2B, B´). Adjacent to the cranial margin of the bone there are three depressions with rounded cranial margins and longitudinal dorsal and ventral margins running parallel to each other (Figure 2B, B´). The bone wall tapers from a thickness of approximately 25 millimetres cranially to a 2 millimetre thick edge that formed the caudal margin of the mandibular fenestra. Both striae and depressions from the insertion place of m. pterygoideus dorsalis (Holliday and Wittmer, 2007) are deduced from their orientation on the internal surface of the surangular (Figure 2B, B´).

The caudoventral face of the surangular represents the cranial-most portion of the surangular angular suture, which as a rugose, has a slightly transversally-striated structure (Figure 2 B, B´). The cranionventral portion of the bone is missing (Figure 3).

3.5 Comments. Previously discovered specimens of *Deinosuchus* in Mexico come from the Late Cretaceous (Campanian) of Chihuahua (Westgate *et al*., 2002; Brown *et al*., 2004).

The specimens from Coahuila are likely conspecific with *Deinosuchus* (*Phobosuchus*) *riograndensis*, which is known from the Aguja Formation, Big Bend National Park, Texas (Colbert and Bird, 1954; Schwimmer, 2010).

The specimen presented here is the fragment of a left surangular (Figure 2), which is diagnosed as coming from *Deinosuchus* by its coarse and irregular pitting on its external much resembling that of the osteoderms and its massiveness (Colbert and Bird, 1954). Identification beyond genus level is not possible based on the given material, despite the likelihood that the material comes from *D. riograndensis* (Schwimmer, 2010).

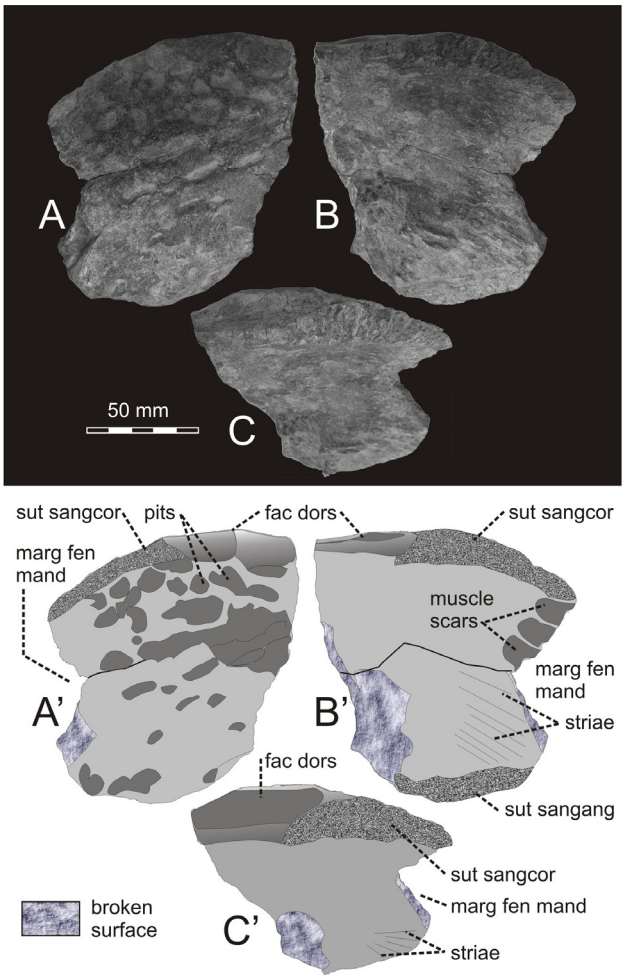

Figure 2. Fragment of a left surangular; A) external view, B) internal view, C) dorsal view. Abbreviations: fac dors = facies dorsalis, marg fen mand = margo fenestrae mandibularis, sut sangang = sutura suranguloangularis, sut sangcor = sutura surangulocoronoidea.

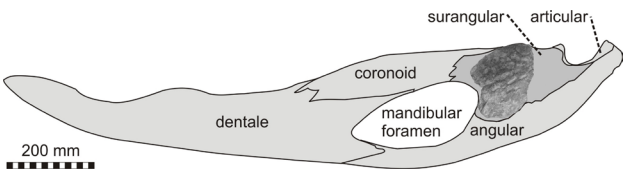

Figure 3. Fragment of the left surangular in the osteological context of the mandible of *Alligator mississippiensis*, traced from an original skull. Note the close match of the fragment and the reconstructed size.

4. Discussion

Cranial remains of *Deinosuchus* are generally sparse in the fossil record and only comprise fragments. The fragments which were used by Colbert and Bird (1954) to reconstruct the *Deinosuchus* skull formerly on display at the American Museum of Natural History in New York refer to the most complete cranial material of *Deinosuchus* discovered to date. This skull reconstruction is based on that of a modern Cuban crocodile (*Crocodylus rhombifer*). The American Museum specimen preserves a portion of the left surangular that does not reach the mandibular fenestra. We superimposed the surangular fragment described here onto the mandible of an American Alligator (*Alligator mississippiensis*) and found a perfect match including the direction and distance of the sutures with the coronoid and the angular (Figure 3). Scaling the bone up based on the skull of *A. mississippiensis*, the skull of the *Deinosuchus*, to which the articular belonged, had a length between 0.9 and 1.0 m. For the entire animal this would have meant a total length of 6.5 to 7 m, a predator that certainly attacked medium-sized dinosaurs as is evidenced by bite marks in dinosaur bones (Rivera-Sylva *et al*., 2009).

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