Ankylosaurid (Dinosauria: Thyreophora) osteoderms from the Upper Cretaceous Cerro del Pueblo Formation of Coahuila, Mexico

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Abstract: Ankylosaurian dinosaur osteoderms have been discovered in the southeastern part of the State of Coahuila, Mexico, in the township of General Cepeda, in the locality known as El Palmar. The osteoderms were collected from rocks that had been correlated to the Cerro del Pueblo Formation (Late Cretaceous: Campanian) of the Difunta Group. The fossil material includes four dermal scutes and three associated fragments that at present cannot be identified. This is the first description of ostoederms and ankylosaurian material from Coahuila.

Key Words: Ankylosauridae, dermal scute, Late Cretaceous, Coahuila, Mexico

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Résumé : ***Découverte de plaques osseuses d'Ankylosauridé (Dinosauria : Thyreophora) du Crétacé supérieur de la Formation Cerro del Pueblo à Coahuila, Mexique.-*** Des plaques osseuses d'un ankylosauridé ont été découvertes dans la localité El Palmar, commune de General Cepeda, SE de l'État de Coahuila. Ces fossiles proviennent de couches sédimentaires appartenant à la Formation Cerro del Pueblo (Crétacé supérieur : Campanien) du Groupe Difunta. Le matériel comprend des plaques osseuses identifiées comme appartenant à la famille Ankylosauridae et d'autres fragments associés qui n'ont pas été identifiés. Nous présentons ici la première description détaillée de matériel de ce type provenant de l'État de Coahuila.

Mots-Clefs : Ankylosauridae, plaques osseuses, Crétacé supérieur, Coahuila, Mexique

Resumen : ***Osteodermos de un Ankylosaurio (Dinosauria : Thyreophora) del Cretácico superior de la Formación Cerro del Pueblo provenientes de Coahuila, México.-*** Osteodermos de un dinosaurio ankylosáurido fueron descubiertos en la parte sureste del Estado de Coahuila, México, Municipio de General Cepeda, en la localidad El Palmar. Los osteodermos fueron colectados de rocas que han sido relacionadas a la Formación Cerro del Pueblo (Cretácico superior : Campaniano) del Grupo Difunta. El material fósil incluye cuatro placas óseas y tres fragmentos asociados que no pueden ser identificados. Esta es la primer descripción de este tipo de osteodermos y material de ankylosáurido para Coahuila.

Palabras Clave : Ankylosauridae, placa ósea, Cretácico superior, Coahuila, México

Introduction

This short communication reports the finding of ankylosaur osteoderms from the area locally known as El Palmar. The site is located 12 km. northeast of the town of La Rosa, in the township of General Cepeda, Coahuila (Fig. 1). The fossils described in this study were collected from strata that have been correlated with the Cerro del Pueblo Formation, from the Late Cretaceous (Campanian) Difunta Group, (MCBRIDGE *et alii*, 1974). Other vertebrate and invertebrate remains were collected along with the ankylosaur material, among them several gastropods, bivalves, turtles of the family Tryonichidae, crocodiles and some unidentified fish vertebrae.

It is thought that the Cerro del Pueblo Formation, which consists of mudstone deposits, shell coquinas, and sandstones, was deposited on a low-gradient and broadly homogeneous coastal plain with transgressive-regressive episodes. This environment was a plant-rich wetland, with channels, lakes, swamps, coastal lagoons, deltaic lakes and bay deposits (MCBRIDGE *et alii*, 1974).

Ankylosaurs are well known from the Upper Cretaceous sediments of Asia (China, Mongolia) and North America (Canada, United States). In North America both major ankylosaur lineages, Ankylosauridae and Nodosauridae, are represented (CARPENTER *et alii*, 1998). Perhaps the most characteristic synapomorphy of ankylosaurs is the presence of osteoderms and the development of osseous cranial ornamentation (SERENO, 1986, 1999; COOMBS & MARYAŃSKA, 1990; VICKARYOUS *et alii*, 2001).

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The distribution of dermal scutes is extensive, reaching from the neck to the distal end of the tail, and sometimes can include elements across the abdomen (VICKARYOUS *et alii*, 2003); the individual osteoderms resemble oval to rectangular plates that may or may not be keeled or bear a spine. They are arranged bilaterally in transverse rows, with a mosaic of much smaller plates filling the spaces between larger elements (SERENO, 1986). Larger osteoderms commonly bear a longitudinal ridge or keel that tends to be higher on plates toward the flanks of the body, although in some species these ridges may be higher near the midline too, in some rows as in *Euoplocephalus tutus* (CARPENTER, 1982). And in ankylosaurids, the individual plates tend to be widely separated, but retain their oval shape (COOMBS & MARYAŃSKA, 1990).

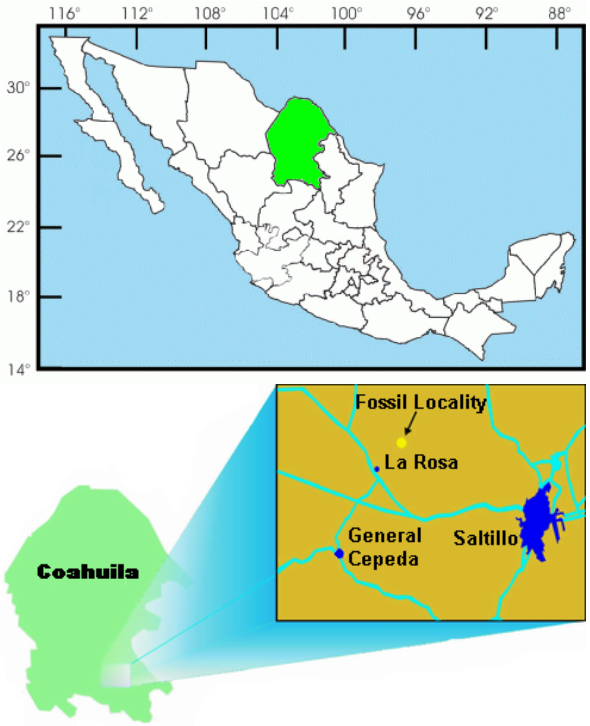

Figure 1: Map showing the location of the area of study, in the southeastern region of the State of Cohauila, Mexico.

Material from the El Gallo Formation in Baja California (MORRIS, 1971, 1973), and from other outcrops of the Cerro del Pueblo Formation in Coahuila had been referred to the genus Euoplocephalus (WEISHAMPEL *et alii*, 2003; RIVERA-SYLVA *et alii*, 2006), but none of these materials has been described, so this is the first published description of fossils of this type from Mexico.

Systematic Palaeontology

Dinosauria OWEN, 1842

Thyreophora NOPCSA, 1916

Ankylosauria OSBORN, 1923

Ankylosauridae BROWN, 1908

Ankylosauridae indeterminate

Material: The specimens are stored at the Museo de Paleontología of the Benemérita Escuela Normal de Coahuila (BENC). The material consists of four osteoderms (BENC-1/4-0001; BENC-1/4-0002; BENC-1/4-0003, and BENC-1/4-0004), that were recovered in association with three other indeterminate fragments (BENC-1/4-0005).

Horizon and Locality: The material was recovered from the Cerro del Pueblo Formation (Difunta Group, Upper Cretaceous, Campanian), 12 km northeast from the town of La Rosa, Township of General Cepeda, Coahuila, Mexico.

Description: When viewed dorsally, osteoderm BENC-1/4-0001 is oval in outline, apparently symmetrical, with a surface marked by a raised blunt keel oriented obliquely; the ventral surface is excavated. Osteoderm BENC-1/4-0002 has a circular shape when view dorsally, with a concave dorsal surface, and a convex ventral surface. Osteoderm BENC-1/4-0003 has a circular dorsal profile and lacks a keel. BENC-1/4-0004 is broken with the preserved portion semicircular in dorsal view; it has a slightly concave dorsal surface and a concave ventral surface.

Measurements: Measurements (in mm) of armor elements. H, height of osteoderm from base to top of crest; L, length of osteoderm along line of crest; W, width of osteoderm at right angle to length.

Armor Scutes		L	W	H
BENC - 1/4 - 0001	Wide Scute	81	113	43
BENC - 1/4 - 0002	Circ. Scute	66	83	26
BENC - 1/4 - 0003	Circ. Scute	48	50	16
BENC - 1/4 - 0004	Circ. Scute	34	39	21

Discussion

The most diagnostic feature of the ankylosaurs is their armour (BROWN, 1908; CARPENTER, 1982, 1984, 1990). Although several authors have proposed separate sets of terminology to describe the various shapes and sizes of ankylosaur osteoderms (FORD, 2000; BLOWS, 2001), the utility of these vocabularies remains untested, and therefore we describe them here using customary terminology. Ankylosaur armour is variable between genera, but is generally composed of small rounded osteoderms that form a fairly continuous shield over the dorsal surface of the body with large oval, flat or keeled elements on the neck and shoulders (CARPENTER, 1997), and small keeled elements on the back and tail. The dermal ossifications of the back had a wide range of shapes according to their positions on the different areas (NOPCSA, 1928). The osteoderms described here are referred to the Family Ankylosauridae based on the morphological features observed in the preserved material, mainly in BENC-1/4-0001 (Fig. 2A-C), where the plates are relatively thin-walled and deeply excavated ventrally as described by COOMBS (1978) and CARPENTER (2004) for the Ankylosauridae. They differ from the osteoderms of the Nodosauridae which have a flat ventral surface. The dorsal surface of our specimen has a sharp crest, low at the front end, but rising at the posterior end as described by NOPCSA (1928), and it is in accordance with COOMBS (1978) observations regarding the Ankylosauridae, for its height does not exceeds that of the maximum basal diameter.

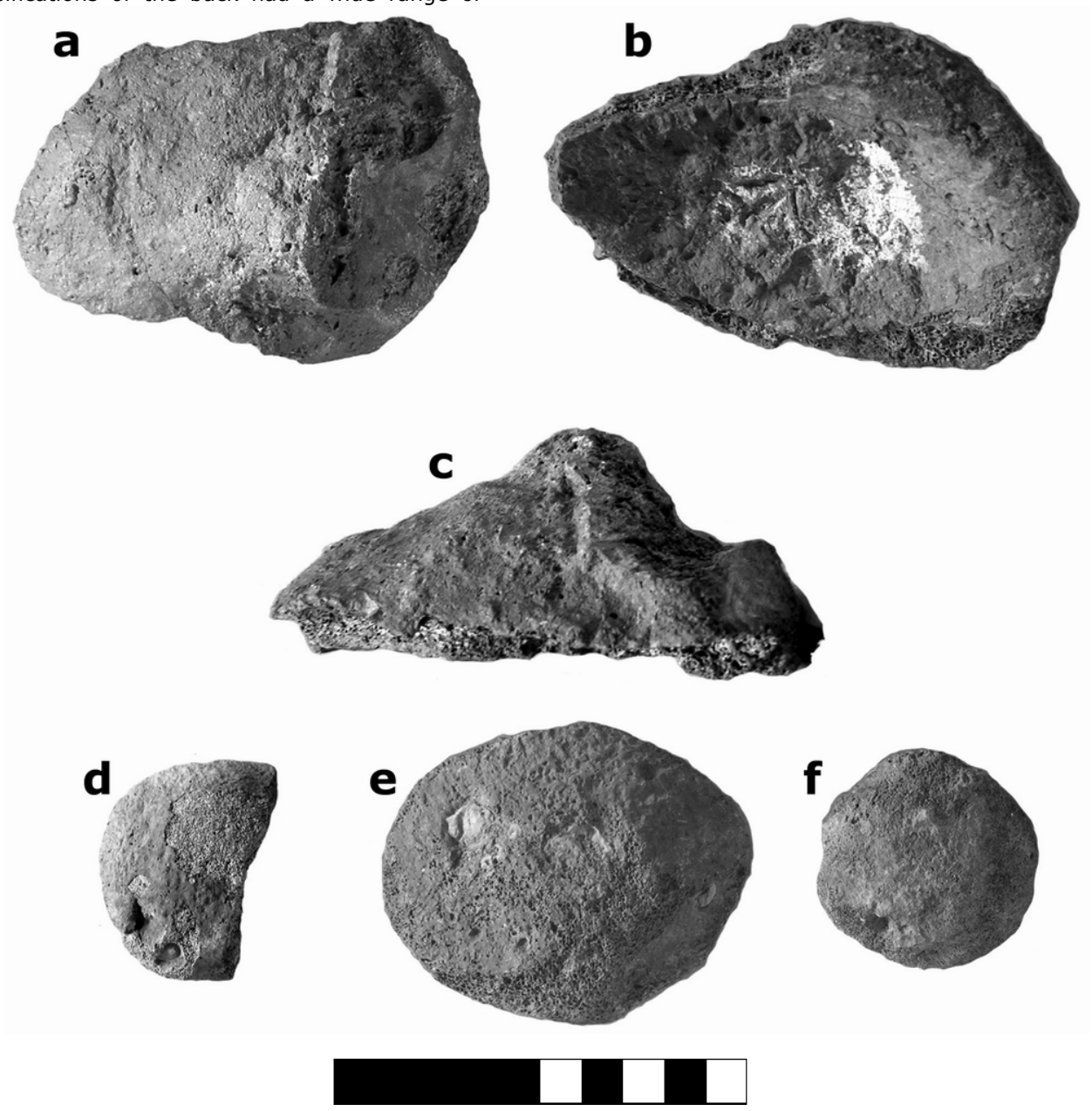

Figure 2: Ankylosaur osteoderms from Coahuila. a, dorsal view; b, ventral view, and c, caudal view of BENC-1/4-0001. d, Dorsal view of BENC-1/4-0004; e, dorsal view of BENC-1/4-0002, and f, dorsal view of BENC-1/4-0003. (Scale bar = 10 cm).

Specimens BENC-1/4-0002, BENC-1/4-0003 and BENC-1/4-0004 may be from the legs, among the large plates there (CARPENTER, 1982) or, according to NOPCSA (1928) could be from the intercalated rows which consist only of flat dermal osteoderms with a more or less circular outline.

The three fragments catalogued under the number BENC-1/4-0005 cannot be osteoderms for they are comprised of more massive and vascularised bone. They might be elements of the skull (TUMANOVA, 1981) or another bone that with these characteristics. Because they are fragmentary we cannot identify them more precisely.

The osteoderms (BENC-1/4-0001 and BENC-1/4-0002) share similarities: the oval outline, a keel and an excavated ventral surface, like those referred to *Euoplocephalus* by LAMBE (1910), PARKS (1924), NOPCSA (1928), and PENKALSKI (2001). In addition, *Euoplocephalus* is the most common Campanian-Early Maastrichtian ankylosaurid of western North America (COOMBS & MARYAŃSKA, 1990). However, while it is plausible that the material from Coahuila may represent this taxon, especially considering that the sediments of the Cerro del Pueblo Formation are dated Campanian, at the present time data are insufficient for provide a conclusive identification.

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