A new Tithonian (Upper Jurassic) marine vertebrate concentration Lagerstätte in north-eastern Mexico

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Our work upon the La Casita/La Caja Formation in north-eastern Mexico showed the area to be globally very rich in marine reptiles (Frey et al., 2002; Buchy et al., 2003, 2005a, in press a), most of which, though, are isolated finds. We report here upon a new Tithonian locality that yielded a rich assemblage of marine vertebrates and is best qualified as a concentration Lagerstätte (Seilacher et al., 1985).

Palaeogeographical and geological settings

During Late Jurassic and Early Cretaceous times, the Tethys basin opened towards the west, but the Mexican Gulf remained at least temporarily isolated from both the European Archipelago and the Pacific, with the Florida uplift forming a barrier (e.g. Buchy et al. 2003, 2005a, and references therein).

Deposition at the time in north-eastern Mexico included conglomerates, sandstones and siltstones of the La Casita Formation characterizing deltaic and inner shelf environments proximal to the Coahuila Peninsula in the area of Saltillo and Monterrey; shales, siltstones and phosphorites of the La Caja Formation indicate more distal outer shelf environments further to the south. Moreover, the time of the La Casita/La Caja Formations was characterised by block tectonic and sea level fluctuations as a result of rifting in the Gulf of Mexico, leading to an irregular sea floor topography and causing variable restrictions or subdivision of basins. Sections show rapid lateral changes in facies and abrupt variations in thickness, from 40 m to more than 500 m. Both the La Casita and the La Caja Formations are well known for their abundant and diverse faunal remains. Fossils are usually flattened in the siltstones and shales but are preserved 3-dimensionally in limestones and calcareous concretions which reach a few centimeters to more than 2 m in diameter. Diverse assemblages of ammonites were described and allow a detailed assignation of biostratigraphic zones of middle Kimmeridgian to early Berriasian times. In addition, belemnites, bivalves, brachiopods, serpulids, radiolarians and calpionellids are present, as well as marine vertebrates (Frey et al., 2002; Buchy et al., 2003, 2005a, in press a).

The Gomez Farías concentration Lagerstätte

About 70 km south of Saltillo, Coahuila, at the Sierra El Jabalí close to the city of Gomez Farías (Fig. 1), the total thickness of the La Caja Formation is 120 m with lithological boundaries present to the underlying Zuloaga and overlying Taraises Formations

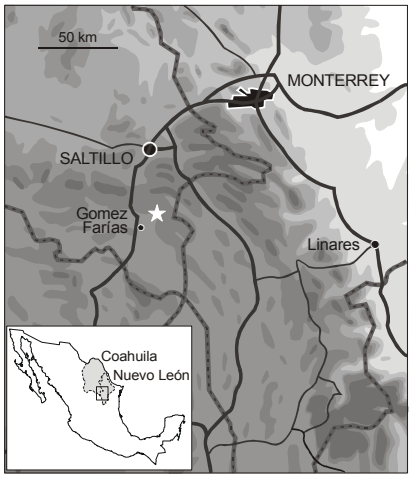

Fig. 1 — Map of Mexico (insert) and detail of south-east Coahuila and south Nuevo León; the fossiliferous locality is shown by a star.

(see references in Buchy et al., 2003). The layers are subvertical as a result of local tectonics (Fig. 2). At 23 m above the base of the La Caja Formation a 1.5 m thick coquina deposit is intercalated in a monotonous sequence of hemipelagic shale, siltstone and thin calcareous phosphorite. This coquinite practically consists of fossils embedded in a spar cement (fossiliferous rudstone). Individual shells were pressed upon each other during diagenesis and by tectonic compaction, and many are cracked. Aragonitic shells were recrystallized to calcite. The invertebrate assemblage includes bivalves, mostly oysters, ammonites and

belemnites; wood fragments up to more than a meter long witness the proximity of the emerged Coahuila Peninsula north of Saltillo. Oysters retained both their valves and form clusters on the upper surface of the coquinite. Vertebrate remains are extremely abundant, from isolated bones and teeth to complete articulated skeletons. The abundance of fossils in the coquinite is best explained by winnowing processes. The fine fraction of shale and silt-sized graines was washed out of the sediment by bottom currents, gentle enough to avoid major transport and to destroy delicate shells. Larger and heavier shells and bones were thus concentrated *in situ*. These characteristics suggest that the "bonebed" is an *in-situ* deposit which formed in a shallow subtidal mud bottom environment below storm wave base, as a result of reduced rate of sedimentation and condensation, possibly due to transgression.

Fig. 2 — Excavating the pliosaur CEP1843; note the vertical layer. Arrow 1 points at the complete humerus, arrows 2 at vertebrae visible in articular aspect.

Bones and teeth are preserved 3-dimensionally and surface preservation is usually good, without encrusting elements, though some specimens show local dissolution of the compacta (Buchy et al., 2005b, in press b). The bone is brown-red on a reddish matrix and exceedingly difficult to spot in the field (Figs 2, 3); extraction relies upon plastering areas as large as possible - despite the subvertical layering.

Marine reptiles form the majority of the assemblage for now; however, no systematic search for smaller elements like e.g. fish teeth was undertaken until now. We give here a preliminary faunal list for vertebrates, pending preparation and further exploration of the outcrop. All specimens mentioned here belong to the collections of the Museo del Desierto, Saltillo, Coahuila, Mexico.

Fig. 3 — CEP1823, holotype of *Geosaurus saltillense* Buchy et al., in press b, ventral surface of the interorbital area as it was exposed when discovered.

Identified vertebrate taxa

Teleostei:

Pachycormidae indet.: mandible and partial postcranium (CEP1840)
Aspidorhynchidae indet: mandible (CEP1864)

Sauropterygia:

Elasmosauridae indet.: isolated vertebrae (e.g. CEP 1801, 1803, 1804, 1809)
Pliosauridae indet.: subcomplete skeleton (CEP1843); isolated cervical centrum (CEP1850)

Ichthyosauria:

Ophthalmosaurus icenicus: skull and mandible and associated partial postcranium (CEP1876; Fig. 4)
Ophthalmosauridae indet.: numerous isolated vertebrae, including indicating very large individuals (e.g. CEP1811, 1813, 1818, 1819, 1822, 1826); partial postcrania (e.g. CEP1836)

Crocodyliformes: Thalattosuchia

Geosaurus saltillense Buchy et al., in press b: holotype partial cranium and postcranium CEP1823 (Figs 3, 5)
cf. *Metriorhynchus*: partial to subcomplete skulls and postcranium (CEP1831, 1856, 1857); isolated teeth (e.g. CEP1862)
Thalattosuchia indet.: partial rostrum (CEP1841); numerous isolated vertebrae and postcranial elements (e.g. CEP1810, 1816, 1855)

Among marine reptiles, all elements present scattered in the various La Casita/La Caja outcrops

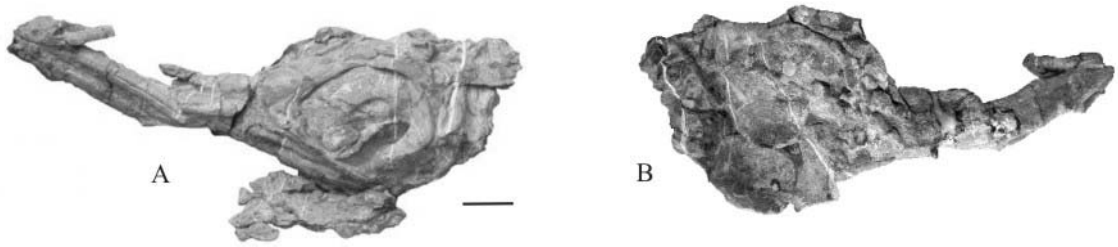

Fig. 4 — CEP1876, *Ophthalmosaurus icenicus*. A – "upper" side of the specimen, showing the skull in left lateral view; **B** – "lower" side of the same, exposing elements of the girdle, vertebrae and a humerus. In B, the black lines outline the mandibles: note the right one was strongly distorted, most likely by the body sinking and pressing it down while the specimen was embedded vertically in a soft sediment. Scale bar 50 mm.

are assembled in Gomez Farías; turtle remains are still absent (see Buchy et al., in press a).

At present, the composition of the assemblage is provisional due to ongoing work. Ichthyosaurs and crocodiles represent the most commonly found identifiable elements. Thalattosuchians appear more numerous and better preserved, with at least 3 partial skulls and associated postcrania, isolated teeth and rostrum. This confirms the trend suspected among La Casita/La Caja localities explored until now, where pliosaurs' diversity is the highest to the south and open sea, while they become rare toward the shore.

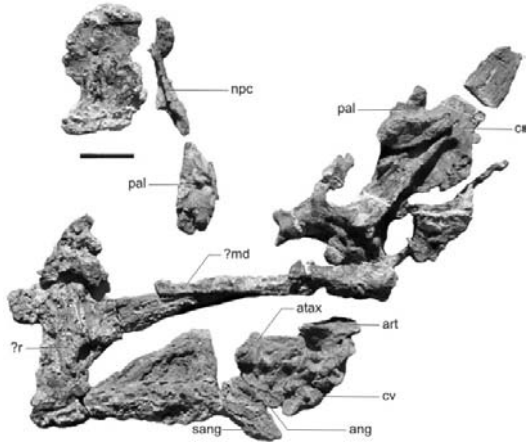

Fig. 5 — CEP1823, holotype of *Geosaurus saltillense* Buchy et al., in press b, after preparation, the main portion of cranium in dorsal view. Abbreviations – ang: angular; **art**: articular; **atax**: atlas/axis complex; **cr**: main portion of cranium; **cv**: cervical vertebrae; **md**: mandible; **npc**: nasopharyngeal canal; **pal**: palatine; **r**: rib; **sang**: surangular. Scale bar 50 mm.

Thalattosuchians are more common to the north and ichthyosaurs are present in all localities. Moreover, when pliosaurs and thalattosuchians show a clear endemism in the Mexican Gulf of the Late Jurassic (Frey et al., 2002; Buchy et al., 2003, 2005a, b, in press a, b, work in progress), CEP1876 is for now the only specimen identified as a member of an ubiquitous taxon, *Ophthalmosaurus icenicus*. Elasmosaurs are rare in all outcrops, possibly due to the lack of adequate living environments at the time in the Mexican Gulf, following recent suggestions upon elasmosaurs' life style (Buchy, 2005, this volume, McHenry et al., 2005).

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