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Hemipelagic cephalopods from the Maastrichtian (late Cretaceous) Parras Basin at La Parra, Coahuila, Mexico, and their implications for the correlation of the lower Difunta Group

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ABSTRACT

Few biostratigraphic data exist from the Parras and La Popa basins, mainly due to the absence of index fossils. This paper describes 19 ammonoid species from 15 genera and 1 nautilid from La Parra, southeastern Coahuila, Mexico. The assemblage consists of Tethyan [(*Baculites ovatus*, *Brahmaites* (*Anabrahmaites*) *vishnu*, *Fresvillia constricta*, *Hauericeras rembda*, *Pachydiscus* (*P.*) ex gr. *neubergicus*, *Solenoceras reesidei*, *Tetragonites* cf. *superstes*], cosmopolitan (*Anagaudryceras politissimum*, *Desmophyllites diphylloides*, *Diplomoceras cylindraceum*, *Gaudryceras kayei*, *Phyllopachyceras forbesianum*, *Pseudophyllites indra*), and cold water taxa [*Fresvillia teres*, *Hypophylloceras* (*Neophylloceras*) *surya*, *H.* (*N.*) *hetonaiense*, *Pachydiscus* (*P.*) cf. *egertoni*]. *Eutrephoceras* sp. and *Menuites* juv. sp. were not determined to species level. A similar assemblage was recently described from the coeval Méndez Formation at Cerralvo, Nuevo León. Species endemic to North America, particularly the Western Interior Seaway, are absent at La Parra. The ammonoid assemblage and associated planktonic foraminifers allow for precise biostratigraphic assignation to the early Maastrichtian planktonic foraminiferal zone CF 5, and thus provide an important marker level for correlation of the lower Difunta Group. The new biostratigraphic data presented herein allow for the first time precise dating of the Cañon del Tule Formation of the Difunta Group. Their combination with existing sequence- and magnetostratigraphic data improve the correlation of the lower Difunta Group with time-equivalent lithostratigraphic units such as the Cárdenas Formation in Mexico. They also provide new insight into ammonoid migration patterns induced by sea-level changes. *Baculites ovatus* migrated into the La Popa Basin as a result of the sea-level highstand documented at La Parra.

1. Introduction

A large foreland basin developed north of the Sierra Madre Oriental (SMO) in an extended area of the Mexican states of Coahuila and Nuevo León. Rapid subsidence of the basin related to late Cretaceous Laramidic orogeny resulted in thick sediment accumulation, for instance immediately north of the SMO mountain range between Saltillo and Monterrey (Fig. 1). Sediment accumulation in this foreland reaches >6000 m thickness and is known as the Difunta Group. To the north, Difunta Group sediments gradually decrease in thickness and near the Rio Grande, some 300 km north of Saltillo, only 100–200 m of coeval sediments are present, known as Escondido Formation (Cooper, 1971). The Difunta sediment complex is mostly Maastrichtian in age, but it occasionally reaches the Paleogene (McBride et al., 1974; Vega-Vera et al., 1989; Soegaard et al., 2003; Vega et al., 2007).

The Difunta Group sediments accumulated in an enormous siliciclastic deltaic complex, fed by a river system located in Chihuahua and western Coahuila, and opened to the east into the ancient Gulf of Mexico. Progradation of the delta front gradually moved the coast lines towards the east; during the Campanian they reached the area of Saltillo and during the Maastrichtian coast lines prograded towards Monterrey (Weidie et al., 1972; McBride et al., 1975). East and south of Monterrey, the coeval Méndez Formation was deposited under open marine conditions and consists of marl and shale containing pelagic faunal assemblages. For instance, planktonic foraminifers indicate that water depths of >100 m existed 50 km east of Monterrey (Stinnesbeck, 1996; Keller et al., 1997) and >300 m 100 km southeast of Monterrey (Keller et al., 1997; Stinnesbeck et al., 2001).

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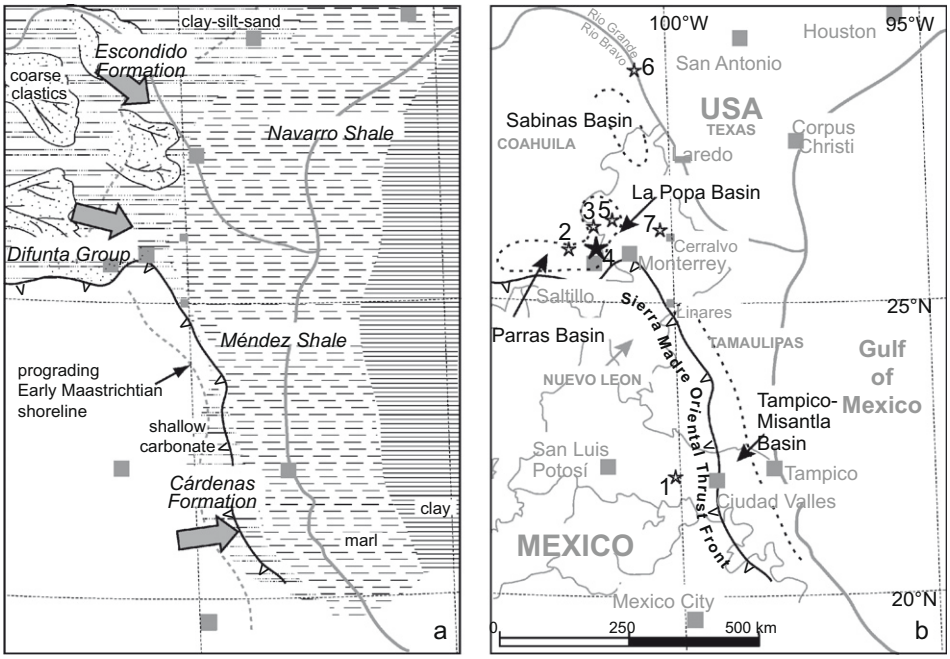

Fig. 1. (a) Paleogeographic lithofacies map of northeastern Mexico (modified after Goldhammer and Johnson, 2001; Soegaard et al., 2003) with the coastline prograding from the northeast and east (after Weidie et al., 1972). (b) Same map with geographic locations and paleogeographic elements, and northeastern Mexican ammonoid localities. 1: Cárdenas, S.L.P. 2: Rincón Colorado, Coah., Parras Basin. 3: Reata, Coah., Parras Basin. 4: La Parra, Coah., Parras Basin. 5: Mina, N.L, Parras Basin. 6: Eagle Pass, Texas, Rio Grande Embayment, 7: Loma Los Martinitos near Cerralvo, N.L, open shelf.

The Difunta Group has been mapped and subdivided into a series of lithostratigraphic units, or formations (e.g. McBride et al., 1974; Lawton et al., 2001; Soegaard et al., 2003, and Fig. 2). The changes in lithology and facies throughout the sequence were recently related to relative changes in sea level (e.g. Soegaard et al., 2003; Shelley and Lawton, 2005). This sequence stratigraphic approach greatly improved correlation within the enormously thick sediments, which were deformed by salt diapirism coeval with sedimentation and by folding and faulting near the Sierra Madre Front range. However, age-diagnostic taxa such as ammonoids other than *Sphenodiscus* and *Coahuilites*, planktonic foraminifers, or calcareous nannofossils were hitherto not described. These fossil groups are abundant and diverse in the pelagic Méndez Formation (Ifrim et al., 2004), but are virtually unknown from the deltaic Difunta Group, likely resulting from the extreme shallow and coastal facies as well as low salinity. In consequence, most correlations within the late Cretaceous part of the Difunta Group and beyond are isolated and tentative, including the age of dinosaur assemblages (Eberth et al., 2004), correlation between the Difunta Group and global sea-level changes (Lawton et al., 2001; Soegaard et al., 2003; Aschoff and Giles, 2005), or correlation with the coeval Cárdenas Formation in central-east Mexico (Schafhauser et al., 2007).

Here we report on a new locality with Difunta Group sediments containing abundant and diverse hemipelagic ammonoids previously unknown from this lithostratigraphic unit, and suitable for precise biostratigraphic dating. We also summarize existing bio-, magneto- and sequence stratigraphic data in order to present a new correlation of the late Cretaceous part of the Difunta Group.

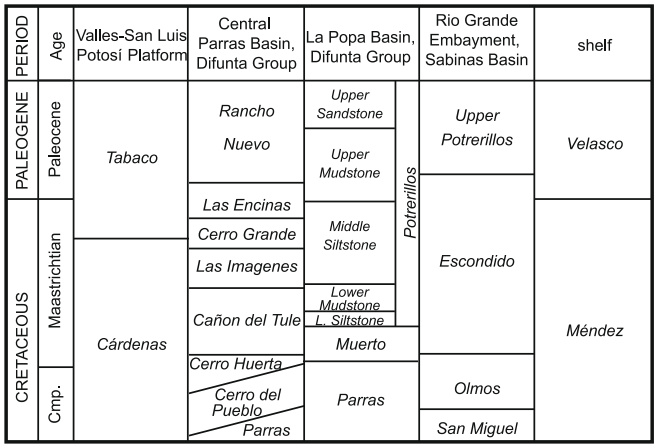

Fig. 2. Stratigraphic correlation of Campanian-Paleocene formations in northeastern Mexico (after Sohl et al., 1991; Vega and Perrilliat, 1995; Lawton et al., 2001; Soegaard et al., 2003; Eberth et al., 2004; Schafhauser et al., 2007; Vega et al., 2007, and data herein).

2. Introduction to the La Parra locality

The fossil locality La Parra was brought to our attention in September 2005 by co-author RRG, and by Biol. Martha Carolina Aguillón from the Museo del Desierto at Saltillo. The hamlet La Parra is located approximately 20 km north of Saltillo in the northeastern Mexican state of Coahuila. The fossil site is reached by car following the new highway 57 connecting Saltillo with Monclova (Fig. 3). At approximately 18.5 km north of the intersection with the Saltillo-Monterrey highway, a dirt road branches off to the right (east) to Ejido Higo and from there directs eastwards to the Arroyo La Encantada. The fossil site is reached following this dirt road for 3.5 km, and is located on an unpopulated plain in the desert where small gullies ("arroyos") erode a unit of marlstone (N 25°42′20.3″; W 100°58′12.6″), from which the cephalopods were collected.

Sandstone beds are present in the lower part of the visible section. They are overlain by approximately 50 m of gray marlstone, which weathers to rounded shapes. Specimens of *Exogyra* are present in the upper part of the marlstone, both isolated in the marlstone and forming a distinct bed. These lithologies suggest that the ammonoid-bearing marlstone exposed at La Parra is best