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INNER WHORLS OF *GREGORYCERAS* (AMMONITINA, PELTOCERATINAE) AS THE FIRST OCCURRENCE OF THE GENUS IN MEXICO

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Abstract. Two nuclei of *Gregoryceras* are described as the first record of the genus in Mexico. The occurrence in Mexico of the ubiquitous Tethyan genus *Gregoryceras* is interpreted as related to a major flooding episode that affected neritic shelves in the southern North-American plate.

Riassunto. Vengono descritti due nuclei di *Gregoryceras* come la prima testimonianza di tale genere in Messico. Il ritrovamento in Messico dell'ubiquitario genere tetideo *Gregoryceras* è messo in relazione ad un principale episodio di annegamento, che ha interessato le piattaforme neritiche nella parte meridionale della placca Nordamericana.

Introduction

The research program on marine Upper Jurassic rocks in Mexico is being carried out since 1985, in a project with the collaboration of the University of Mexico [UNAM] and the University of Granada, Spain. In this context, the precise recognition of the biostratigraphic distribution of ammonite faunas, gathered bed-by-bed from several Upper Jurassic type-sections in the northeastern part of Mexico, is in progress.

Recently, a bed-by-bed sampling on the type section of the Santiago Formation has been made in Central-East Mexico. The studied section is located in the southeastern part of the State of San Luis Potosí, near the town of Tamán on the left bank of Rio Moctezuma (Fig. 1). The lowermost 22 m of the section are made of scarce limestone beds and dominant claystones and siltstones. Some of the claystone horizons show calcareous concretions. The sampling has allowed the recognition of faunal assemblages characterized by ammonites and bivalves.

Among the ammonite remains, the occurrence of *Gregoryceras* sp. in the beds 20 and 42 (Fig. 1) is of special relevance (Villaseñor et al. 2002).

Material

Three incomplete specimens have been collected, two of which gathered from bed 42 seem to be nuclei. These inner moulds, IGM 6090 and IGM 6091 (Pl. 1, fig. 2 - 5), 11 to 15 mm in size, do not show suture lines and therefore it is difficult to conclude if they represent nuclei, juveniles, or even small adults. The small reported specimens show the morphological characters of the genus and we favor their interpretation as nuclei. They correspond to moderately evolute shells, of 34-36% involution. The whorl-section is rounded and slightly wider than high. The ventral region is wide, slightly convex and shows a subtle smoothing at the mid-venter line.

The umbilicus is deep and bordered by a near-vertical umbilical wall. The umbilical edge is widely rounded. The shell smaller than 6 mm is smooth since the absence of sculpture cannot be related to poor preservation. At shell size bigger than 6 mm the sculpture is made of ribs. These ribs do not reach the umbilical wall and some of them may be connected on the periumbilical edge to determine crescent-like couplet of ribs, but no nodes. On the flanks, the ribbing is typically rursiradiate showing a wide inflexion (40 to 48 degrees) close to the mid-flank. The bigger of the studied two nuclei (IGM 6090) shows an increasing number of defective bifurcations towards the adoral end of the preserved inner mould. This feature is typical for nearly complete adult shell, but cannot be interpreted as small-size but incomplete adult individual because no attenuation of sculpture exists (Pl. 1, fig. 1).

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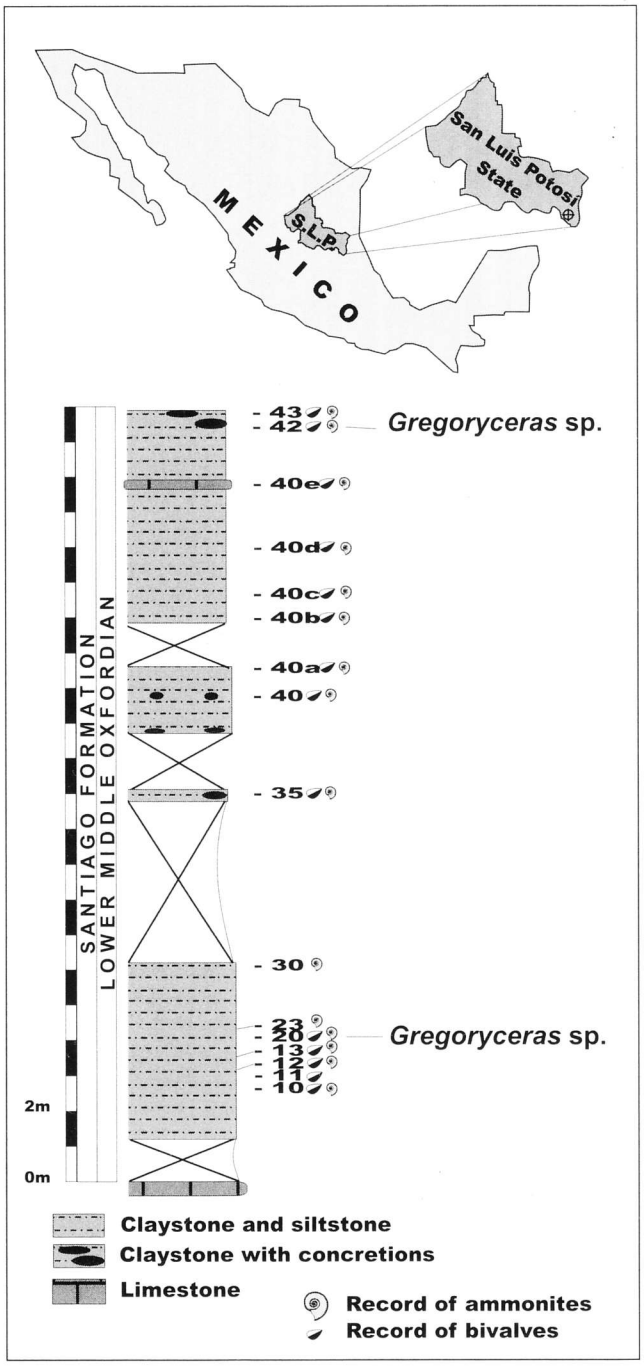

Fig. 1 - Geographic location of the studied area and stratigraphic section of the lowermost part of the Santiago Formation at the type area close to Tamán, San Luis Potosí State. Note stratigraphic horizons containing *Gregoryceras* sp. in the studied type section.

Taxonomic remarks

The small size of our specimens makes difficult the right identification at the species level. Morphological similarity exists with the inner whorls of the species *Gregoryceras* (*Gregoryceras*) *chongi* Gygi & Hillebrandt, *Gregoryceras* (*Gregoryceras*) *transversarium* (Quenstedt), and *Gregoryceras* (*Gregoryceras*) *riazi* (De Grossouvre).

With respect to *Gregoryceras* (*Gregoryceras*) *chongi* Gygi & Hillebrandt (1991) and close forms reported from Chile (Pl. 1, fig. 6, 7), the differences are related to the level at which the complete ribs end. In the Chilean specimens, the inner extreme of the ribs reaches the umbilical wall, but it is important to note that some specimens of this species show shorter ribs.

Morphological similarity also exists with the ubiquitous European species *transversarium*, which is also known from Chile according to Gygi & Hillebrandt (1991), in particular through the rounded umbilical edge and the arched bent of the ribs (Pl. 1, fig. 11, 14). However, the Mexican specimens differ in their less inflated depressed whorl section; as far as the whorl section of nuclei in *transversarium* is known from the specimens studied by Gygi (1977) (Pl. 1, fig. 10, 14). Comparison of inner whorls is also possible with the European species *Gregoryceras* (*Gregoryceras*) *riazi*. In fact, the beginning of ribs occurs at equivalent shell diameters, but, in this case, morphological difference has been identified in the absence of periumbilical nodes in the Mexican specimens, in their less coarse ribs, in their less flat and less convergent flanks, and also in their more globose shell (Pl. 1, fig. 8, 9, 12, 13).

On the basis of the comparative analysis, morphologic similarities and differences between the Mexican specimens and the previously mentioned species from Chile and Europe have been established. However, the small size of the specimens found in the Santiago Formation at Tamán impedes any conclusive interpretation of con-specific relationships with some of them. Therefore, we favor the interpretation of the Mexican material analyzed as *Gregoryceras* sp.

Remarks on biochronology and palaeobiogeography

According to Gygi & Hillebrandt (1991), who summarized their proposal for identification of *Gregoryceras* at the species level, the following morphological features are of interest for biostratigraphy: 1) the rib appearance at less than 20 mm; 2) the bending of ribs by angles greater than 25 degrees; and 3) the simple arcuate-shape of ribs. All these features point to an age equivalent to the early Transversarium Chron (non basal Antecedens subchron) in Europe. Therefore, we preliminary envisage an equivalent age for the Mexican specimens collected from the lower part of the type section for the Santiago Formation at Tamán, San Luis Potosí. The above described *Gregoryceras* imply the first report of this genus in Mexico, and confirm the wide distribution of the genus in the Americas. Previous citations of this genus were made by Gygi & Hillebrandt (1991) in the northern part of the Cordillera de Domeyko in Chile, and by Young & Olóriz (1993) in the northern rim of the Gulf of Mexico. In palaeobiogeographic terms, the comparative

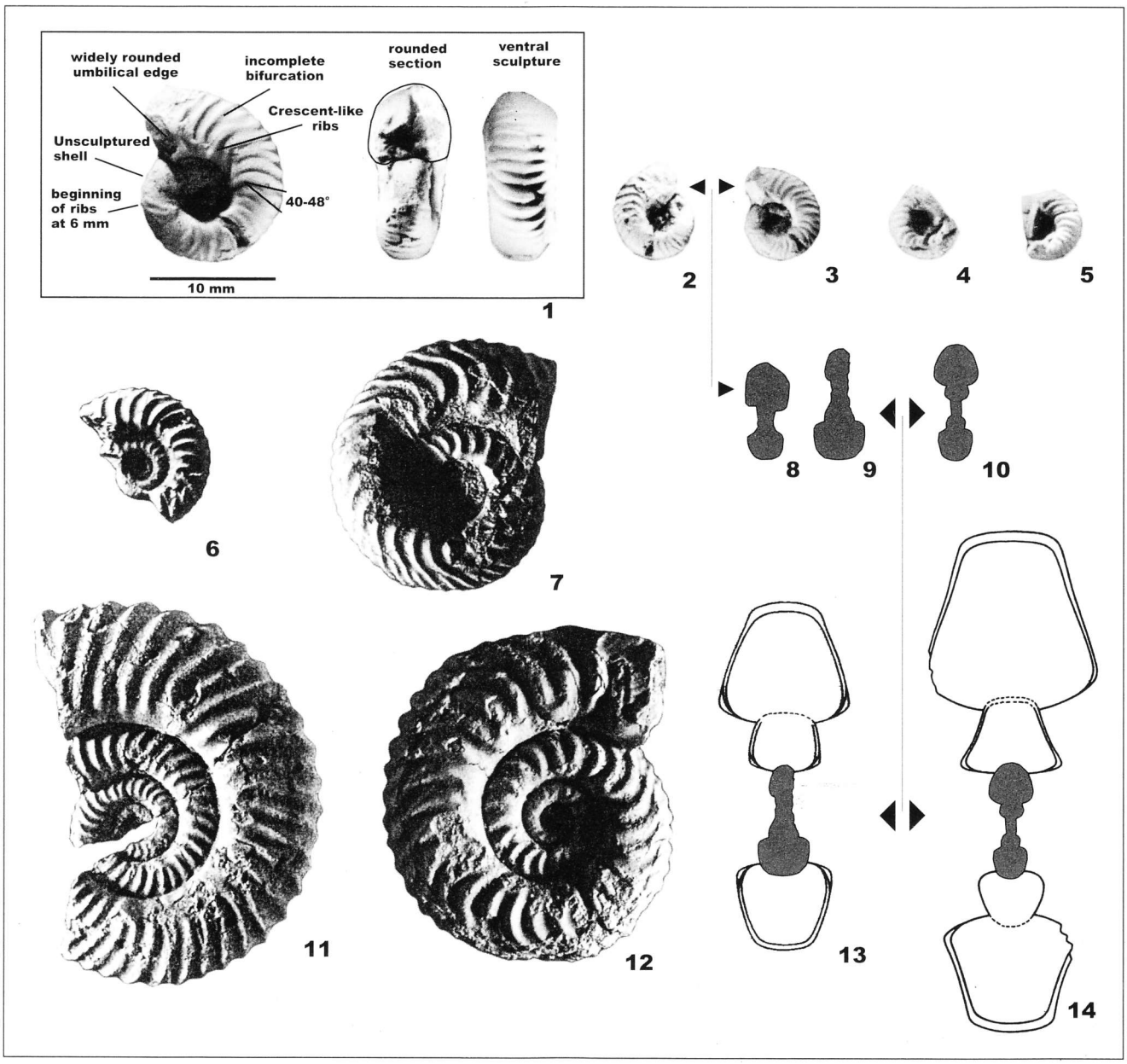

PLATE 1

Fig. 1-5. *Gregoryceras* sp. from the studied section; 1. Lateral, adoral and ventral views of IGM 6090, showing the most significant morphological characters (X2). Fig. 2-5. Left- and right-side views of the described small inner moulds (IGM 6090 and IGM 6091, respectively) (X1). Fig. 6. Reproduction of inner whorls of *Gregoryceras* (*Gregoryceras*) cf. *chongi* Gygi & Hillebrandt (1991, pl. 3, fig. 9a). Fig. 7. Reproduction of *Gregoryceras* (*Gregoryceras*) *chongi* Gygi & Hillebrandt (1991, pl. 5, fig. 4a). Fig. 8-10. Axial sections of IGM 6090, and the nuclei of European *Gregoryceras* (*Gregoryceras*) *riazi* and *transversarium* (taken from figs. 13, 14). Fig. 11. Reproduction of Chilean specimen of *Gregoryceras* (*Gregoryceras*) sp. cf. *transversarium* (Quenstedt) as illustrated in Gygi & Hillebrandt (1991, pl. 7, fig. 4a). Fig. 12. Reproduction of Chilean specimen of *Gregoryceras* (*Gregoryceras*) *riazi* (De Grossouvre) as illustrated in Gygi & Hillebrandt (1991, pl. 3, fig. 8a). Fig. 13. Reproduction of the axial section of European *Gregoryceras* (*Gregoryceras*) *riazi* (De Grossouvre) according to Gygi (1977, pl. 10, fig. 7). Fig. 14. Reproduction of the axial section of European specimen of *Gregoryceras* (*Gregoryceras*) *transversarium* (Quenstedt) according to Gygi (1977, pl. 10, fig. 17). Shadowed inner whorls of European species for comparison. All figures in natural size otherwise indicated.

analysis made at small size cannot be conclusive due to present limitations to the precise knowledge of the morphologic variability during the early ontogeny in species of genus *Gregoryceras*.

However, the studied specimens show the combination of phenotype traits identified in ubiquitous species adapted to epioceanic and epicontinental environments. On this basis, the occurrence of nuclei of *Gregoryceras* showing such a mosaic morphology in epicontinental shelf deposits from Mexico cannot be surprising (Fig. 2), and

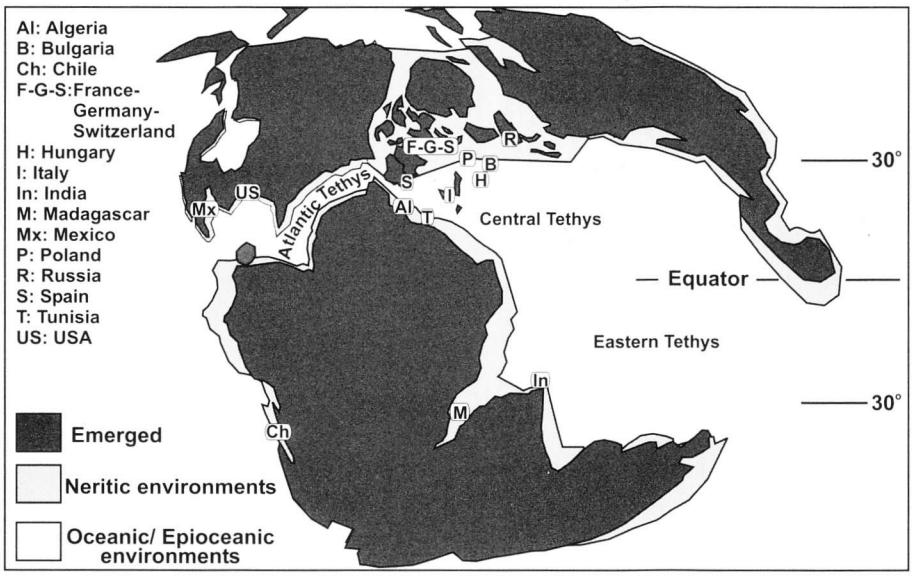

Fig. 2 - Oxfordian paleogeographic map adapted from Smith et al. (1995) showing the distribution of the genus *Gregoryceras*. Database in the Appendix.

presumably relates to transgressive pulses in the area (see Olóriz et al. 2003 for extended treatment), as well as occurred in other neritic environments far from European shelves and their epioceanic fringes (e.g. India: Krishna et al. 2000).

Discontinuous records of late-Early to Middle Oxfordian ammonite assemblages, registered in more or less calcareous horizons intercalated between mainly terrigenous sediments elsewhere in South America, accord with this interpretation (Gygi & Hillebrandt 1991 for northern Chile, including *Gregoryceras*; Hillebrandt & Gröschke 1995). In addition, ammonite assemblages from age-equivalent, discontinuous horizons, and containing a variable amount of widespread Tehyan genera (or ammonites with Tethyan-like morphology), have been reported even southwards from Argentina (Hillebrandt et al. 1992; Riccardi et al. 1992; Parent 1998), and can be correlated with the stratigraphic interval showing bivalve-rich assemblages interpreted as resulted from transgressive pulses in these regions (Damborenea 1996). A similar but slightly younger Oxfordian case, including *Gregoryceras*, has been recently reported from India by Krishna et al. (1995, 2002).

All this well adapts the widespread context of discontinuous record of ammonite assemblages in the Americas throughout the Lower to Middle Oxfordian (Imlay 1984, for North America; Riccardi et al. 1992, for South America), which corresponds to the time for major transgression in North America (Taylor et al. 1984), and for more variable trends related to palaeogeographic restructuring in the Americas (Riccardi et al. 1992; Marzolf 2002). The Early to Middle Oxfordian was also the time for major palaeogeographic change in peripheral areas of the central north-Atlantic and the Gulf of Mexico Basin and related areas (Emery & Uchupi 1984; Jansa 1986; Salvador 1987, 1991; Michaud & Fourcade 1989; Olóriz et al. 2003).

Conclusions

The present record of *Gregoryceras* from Tamán opens new perspectives for the future precision in the biostratigraphic interpretation of Mexican ammonite assemblages known from Burckhardt (1912), and reinforces the known occurrence of Tethyan perisphinctids in Mexico during the Oxfordian (Burckhardt 1912; Callomon 1992; Myczynski et al. 1998). The occurrence of the genus *Gregoryceras* in Mexico was favored by the major Oxfordian flooding affecting epicontinental shelves all over the proto-Atlantic.

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Appendix

(Synthetic bibliography for the data base used to consider records of the genus *Gregoryceras* as depicted in Fig. 3):

[Al] Algeria: Atrops & Benest (1984)

[B] Bulgaria: Sapunov (1976); Gygi (1977)

[Ch] Chile (Cordillera de Domeyko): Gygi & Hillebrandt (1991)

[F-G-S] France, Germany, Switzerland: Gygi (1977)

[H] Hungary: Fözy & Meléndez (1996)

[I] Italy (Sicily): Gemmellaro (1874, 1877, 1882); Sarti (1984, also for reference to classic papers); D'Arpa & Meléndez (2002)

[In] India: Krishna et al. (1995, 2002)

[M] Madagascar: Collignon (1959); Gygi (1977)

[Mx] Mexico (Central-East): Villaseñor et al. (2002)

[P] Poland (Pieniny Klippen Belt): Gygi (1977); Malinowska (1988)

[R] Russia (Russian Plate): Arkell (1956); Rogov (2001).

[S] Spain (Southern Spain, Subbetic): Sequeiros (1974); Caracuel et al. (2000). (Southern Spain, Prebetic): García-Hernández et al. (1979); Olóriz et al. (1999). (Iberian Range): Arkell (1956); Meléndez, (1989). (Balearic Islands): Fallot (1922); Olóriz et al. (1996).

[T] Tunisia: Gygi (1977)

[US] United States of America (Northern rim of the Gulf of Mexico): Young & Olóriz (1993)