# The Upper Sinemurian ammonite succession in the Sierra Madre Oriental (Mexico)

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**ABSTRACT:** In the Sierra Madre Oriental (Mexico), the biostratigraphic subdivision of the Upper Sinemurian can be refined. It has been possible to differentiate 11 horizons from the upper Obtusum Zone to the top of the Raricostatum Zone which are correlated with the NW European standard zonation. The index species of each horizon is figured.

## INTRODUCTION

Marine Lower Jurassic sediments have been known from Mexico since the pioneering works of Barcena (1875, 1877), Aguilera (1888), Felix (1891) and Böse (1894). The main areas are Sonora and Sierra Madre Oriental (Fig. 1) and we focus on the latter region. Biostratigraphical frameworks for the Sierra Madre Oriental were proposed by Burckhardt (1930), Erben (1954a, b; 1956) and more recently by Schmidt-Effing (1977) and Schlatter and Schmidt-Effing (1984). In this work, we briefly review the biostratigraphical implications of our studies since 2001 (Blau *et al.* 2001, 2002, 2003; Meister *et al.* 2002, 2005) and, in addition we illustrate the index species of each of the faunal horizons.

## BIOSTRATIGRAPHY

A revision of Erben's collection (Erben 1956) and the collections of Schmidt-Effing (1977) and Schlatter and Schmidt-Effing (1984) combined with our field data have facilitated the production of a synthetic range chart (Fig. 2) and the construction of a sequence of 11 faunal horizons in the Upper Sinemurian (Fig. 3).

The ranges are controlled by the authors' field observations in association with data given in the literature (*e.g.* Hillebrandt 2000, 2002; Taylor *et al.* 2001). The succession of horizons proposed here, however, is in part hypothetical due to the discontinuity of outcrops.

The ranges of several taxa not collected bed-by-bed: *Oxynoticeras palomense* Erben, *Gleviceras*

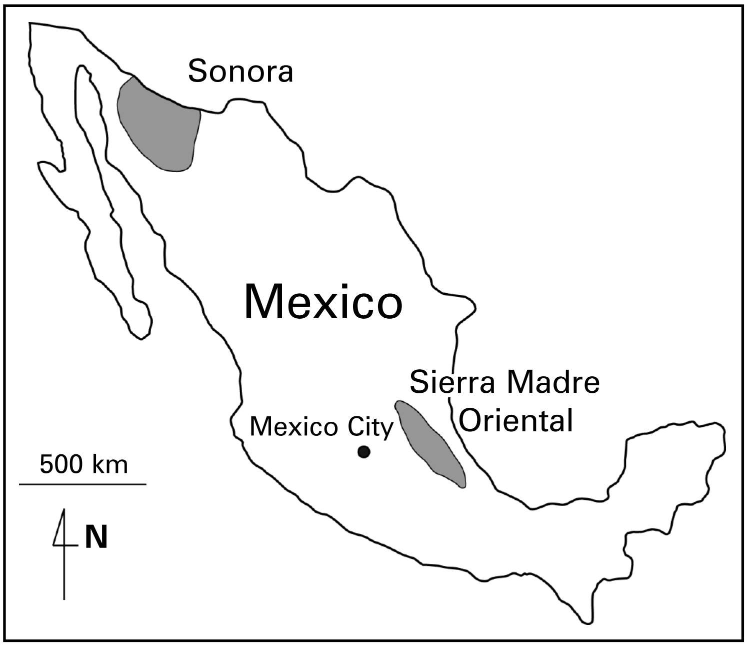


Fig. 1. Distribution of marine Lower Jurassic outcrops in Mexico (Sonora and Sierra Madre Oriental).

*aztecorum* Meister, Blau, Schlatter and Schmidt-Effing, *Gleviceras choffati* (Pompeckj), *Gleviceras* aff. *chollai* Taylor *et al.*, *Bifericeras tenangoense* Meister, Blau, Schlatter and Schmidt-Effing, *Paramicroderoceras* aff. *birchiades* (Rosenberg), *Eoderoceras* sp., *Angulaticeras floresi* (Erben), *Ectocentrites* aff. *dommerguesi* Meister, Vu Khuc, Huyen and Doyle, *Juraphyllites nardii* (Meneghini), *Aegolytoceras* sp., *Partschiceras* sp., are based on the ranges known from the literature for these genera and species and the maximum known range is used. It is likely, however, that all these taxa have a shorter range inside the period considered (see Figs 2 and 3).

**Upper Sinemurian**

Obtusum Zone

The presence of several *Arnioceras* in the Sierra Madre Oriental most probably indicates the presence of the Lower Sinemurian but does not exclude their presence in the lower/middle Obtusum Zone.

The *Euerbenites* horizon represents the first true Upper Sinemurian faunal association with *Euerbenites bravoi* (Tilmann), *Euerbenites corinnae* (Blau, Meister, Schlatter and Schmidt-Effing) and *Angulaticeras* sp. Its position in the Obtusum Zone is based on the occurrence of *Euerbenites corinnae* in Sonora below *Oxynoticeras* cf. *simpsoni* (Simpson) (see Taylor *et al.* 2001). This horizon, therefore, can be placed near in the upper part of the Obtusum Zone, but without the exclusion of a possible lower Oxynotum Zone age.

Oxynotum Zone

Following Erben (1956), the presence of *Oxynoticeras palomense* characterizes the Oxynotum Zone (*Oxynoticeras palomense* horizon). Some *Gleviceras* and *Bifericeras tenangoense* may indicate further horizons which can be included in the upper part of the zone.

Raricostatum Zone

In the Sierra Madre Oriental, the major part of the ammonite fauna belonging to this Zone is composed of Echioceratidae. The zone can be subdivided in to 9 horizons in this area.

Densinodulum Subzone

Within the *Plesechioceras* horizon, we include *Plesechioceras cihuacoatlae* (Erben), *Plesechioceras* cf. *domeykoense* Hillebrandt, and *Oxynoticeras* sp. Overlying this fauna an association with *Orthechioceras incaguasiense* Hillebrandt, *Orthechioceras pauper* (Erben), *Oxynoticeras* aff. *soemanni* (Dumortier), and *Phylloceras cylindricum* (Sowerby) corresponds to the *Orthechioceras pauper/incaguasiense* horizon. Based on the association described by Hillebrandt (2002) in South America, these two horizons belong to the Densinodulum Subzone.

A third unit, the *Orthechioceras* (?) *obliquecostatum* horizon, can be attributed to this subzone and characterized by the index species only.

Upper Densinodulum/
lower Raricostatum Subzones

The position of the *Orthechioceras jamesdanae sensu* Erben horizon in the context of the NW European standard zonation is not clear and it may represent an interval within the Densinodulum and/or Raricostatum subzones.

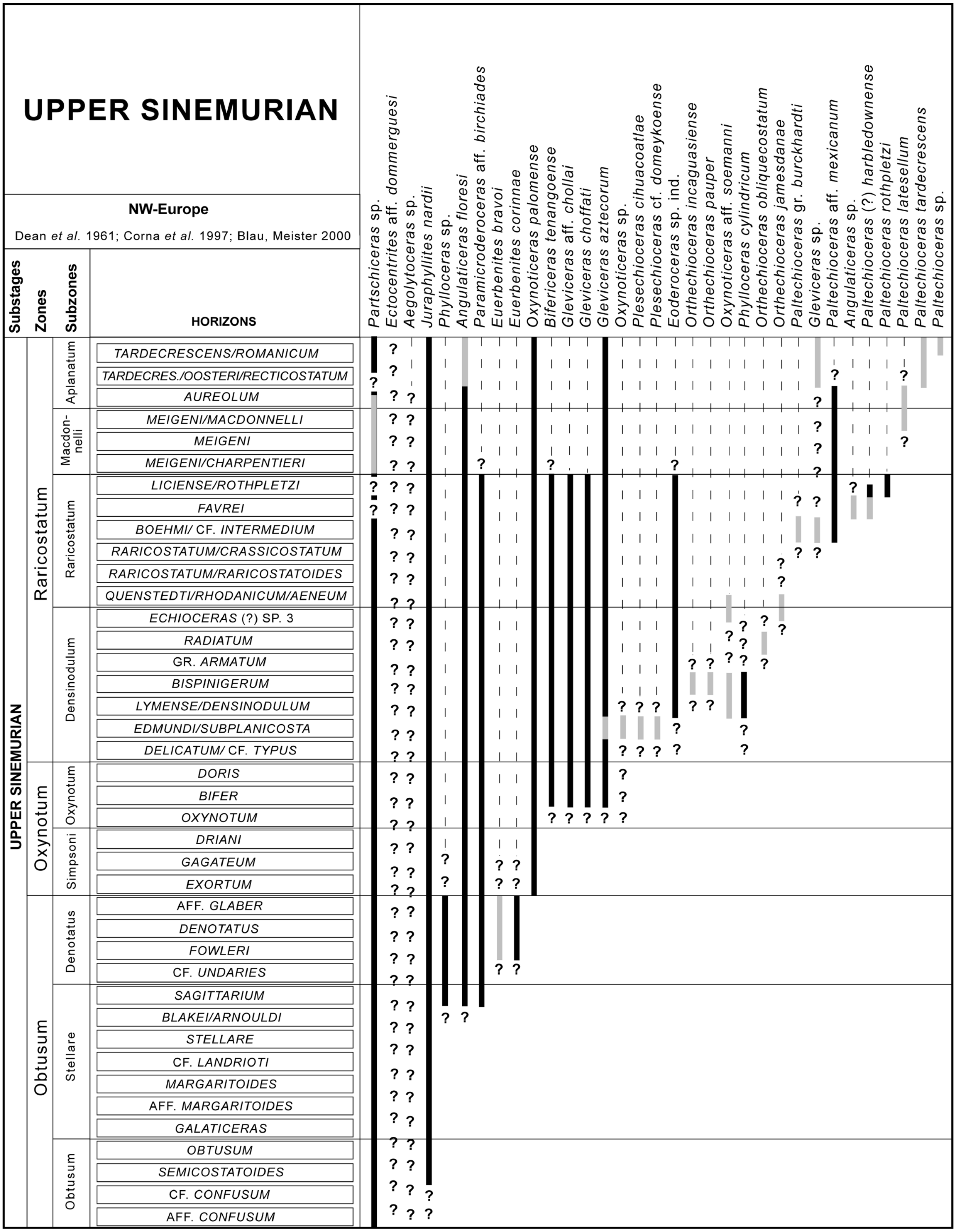


Fig. 2. Range chart of the ammonites from the Sierra Madre Oriental. Grey lines are used for bed-by-bed collected material and black lines cover the maximum ranges known from the literature for the respective genera and/or species. The question marks show the uncertainty for the ranges of the taxa.

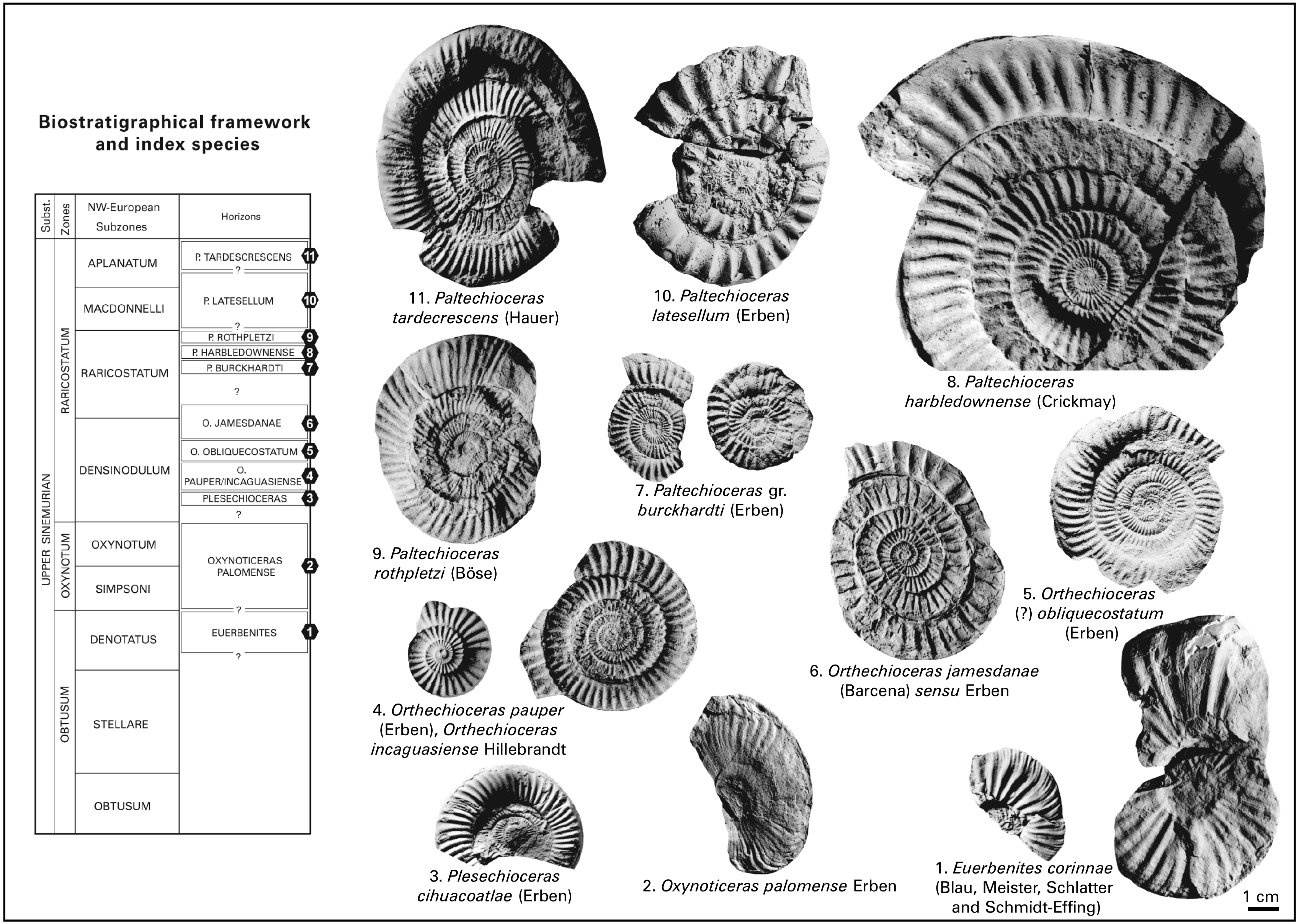


Fig. 3. The succession of faunal horizons in the Upper Sinemurian of the Sierra Madre Oriental and their correlation with the NW European standard zonation. Index species are indicated (all specimens are diminuished to 60% of their original size). The question marks underline the uncertainty of the position and/or the duration of some horizons.

*Orthechioceras jamesdanae* (Barcena) *sensu* Erben is very abundant and associated with *O.* aff. *soemanni*.

Middle Raricostatum Subzone

The *Paltechioceras* gr. *burckhardti* horizon is characterized by *Paltechioceras* gr. *burckhardti* (Erben) and *Gleviceras* sp. It represents the first occurence of *Paltechioceras* in the Sierra Madre Oriental. In NW Europe, the genus *Paltechioceras* is known from the European *boehmi/intermedium* horizon up to the *tardecrescens/romanicum* horizon (Fig. 2).

Middle Raricostatum to lower Aplanatum Subzone

Three horizons can be placed in this interval. The lowest, the *Paltechioceras harbledownense* horizon is characterized by the index species in association with *Angulaticeras* sp. In the Queen Charlotte Islands (*e.g.* Pálfy *et al.* 1994), *P. harbledownense* (Crickmay) occurs first and is later found associated with *Paltechioceras* cf. *rothpletzi* (Böse). In the Sierra Madre Oriental these two taxa have not been found in association, we suppose therefore that they form two distinct horizons with the *Paltechioceras rothpletzi* horizon above. The latter horizon yielded only the index species.

The succeding *Paltechioceras latesellum* horizon is also characterized by the index species only.

Aplanatum Subzone

The association of *Paltechioceras tardecrescens* (Hauer), *Paltechioceras* sp., *Angulaticeras floresi* and *Gleviceras* sp. characterizes the *Paltechioceras tardecrescens* horizon. The index species is the last *Paltechioceras* species found worldwide.

## CONCLUSIONS

The faunal horizons recognized here are allocated maximum time intervals in relation to the NW European standard zonation. Most probably, the duration of some horizons is much shorter than indicated, the sequence is more incomplete than proposed and new faunal horizons can be added. This sequence is based mainly on taxa described by Erben which show quite strong endemism of the fauna, reflecting difficulties with correlations with other regions. The interpretations of provincialism or endemism must be seen prudently because they reflect either biologic reality or only differences in taxonomic sensibility (see Dommergues *et al.* 2004; Meister *et al.* 2005). In the Sierra Madre Oriental, the proportion of the endemic fauna for the Upper Sinemurian reaches about 41%. This strong endemism can be explained by the embayment position of the Huayacocotla Basin which was perhaps isolated from other areas. The other faunal affinities (13% with South America, 7% with North America, 3% with Asia and mainly 36% with Tethyan area) indicate several possibilities (or combinations of them) of migrations ways: (1) southern peri-Pangean, (2) peri-Asiatic, (3) latudinal trans-Panthalassian, and (4) Boreal (Viking Corridor, Arctic seas). All these migration routes remain hypothetical and the existence of a 5$^{th}$ migration way, the Hispanic Corridor, cannot be exclude completely.

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