

# FOSSIL ASSEMBLAGES, MAINLY FORAMINIFERS AND RUDISTS, FROM THE EARLY APTIAN OF SOUTHWESTERN MÉXICO. PALAEOBIOGEOGRAPHICAL CONSEQUENCES FOR THE CARIBBEAN REGION

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## ABSTRACT

A caprinid rudist association with *Amphitriscoelus waringi* Harris and Hodson, *Praeacprina* sp. cf. ? *P. pennyi* Harris and Hodson, *Caprina* sp. cf. *C. douvillei* Paquier and ?*Offneria* sp. is reported from Turitzio, State of Michoacán, México. It occurs together with the foraminifera *Palorbitolina lenticularis* (Blumenbach), *Choffatella decipiens* Schlumberger and *Everticyclammina* sp. and the algae *Deloffrella quercifoliipora* Granier and Michaud, *Marinella lugeoni* Pfender and *Arabicodium* sp.

The study of the embryonic apparatuses of the specimens of *Palorbitolina* from this locality indicates an earliest Aptian age for that population.

The presence of *Amphitriscoelus* and the other associated caprinids in México, constitutes evidence supporting the biotic homogeneity of the Caribbean Province during the Early Cretaceous.

**Keywords:** Orbitolinids, Rudists, Palaeobiogeography, Caribbean Province, Biostratigraphy, Early Aptian, Mexico.

## RESUMEN

Se reporta una asociación de rudistas procedente de los biostromas del miembro inferior de la Formación Comburindio que afloran en el Arroyo Los Hornos, al norte de la localidad de Turitzio, 20 Km al sur de la pequeña ciudad de Huetamo, Estado de Michoacán, en el sudoeste de México.

La fauna de rudistas corresponde a los caprinidos *Amphitriscoelus waringi* Harris y Hodson, *Praeacprina* sp. cf. ?*P. pennyi* Harris y Hodson, *Caprina* sp. cf. *C. douvillei* Paquier y ?*Offneria* sp.

Se ha estudiado una muestra para microfauna, tomada entre dos biostromas de rudistas. El elemento más importante son los foraminíferos orbitolinidos pertenecientes a la especie *Palorbitolina lenticularis* (Blumenbach), junto a los también foraminíferos *Choffatella decipiens* Schlumberger y *Everticyclammina* sp., el alga dasicladácea *Deloffrella quercifoliipora* Granier y Michaud, la solenoporácea *Marinella lugeoni* Pfender y la udoteácea cilíndrica *Arabicodium* sp.

El carácter relativamente primitivo de los aparatos embrionarios de los ejemplares de *Palorbitolina lenticularis* estudiados, indica una edad Aptiense inferior basal. Esta edad se atribuye también a la fauna de rudistas.

La presencia en México de *Amphitriscoelus waringi* y los otros caprinidos asociados, reportados también en Cuba y Texas, además de Trinidad y Venezuela, constituye una evidencia en favor de la homogeneidad biótica de la Provincia Caribeña durante el Cretácico inferior.

**Palabras clave:** Orbitolinidos, Rudistas, Paleobiogeografía, Provincia Caribeña, Biostratigrafía, Aptiense inferior, México.

## INTRODUCTION

The purpose of this paper is to describe a new faunal assemblage of early Aptian age of the Comburindio Formation (Pantoja-Alor, 1993) collected in the hills immediately to the north of the town of Turitzio, 20

Km south of the small city of Huetamo, State of Michoacán (Fig. 1). The fossils described were collected by Pantoja-Alor in 1992, during a project of geological mapping of the region.

The geological evolution of the area was influenced by major tectonic events. These include subduction and volcanism during the Palaeozoic (Ortega-Gutiérrez, 1981),

opening of the Gulf of México, subduction and orogeny during the Mesozoic (Tardy *et al.*, 1992; Monod and Faure, 1992) and truncation and re-initiation of subduction along the southwestern margin of México during the Cainozoic (Pantoja-Alor, 1992c).

The earliest published geological research of the Huetamo region dates back to Hall's (1903) reconnaissance survey. A generalized overview of the geology of this part of México was given by Burckhardt (1930). Pantoja-Alor (1959, 1990, 1992a) established the lithostratigraphic nomenclature and mapped the area. New investigations (García-Barrera and Pantoja-Alor, 1991; Pantoja-Alor, 1990, 1992b) on the biostratigraphy and structure of the San Lucas area (immediately east of Huetamo), have modified and established the stratigraphical sequence and corrected the nomenclature and the tectonic concepts proposed by Johnson *et al.* (1991). Other sources of geological information are unpublished Petróleos Mexicanos (PEMEX) reports (Salazar, 1973; Campa, 1977).

## GEOLOGICAL SETTING

Most of the southwestern margin of México, south of the Mexican Volcanic Belt is represented by the Guerrero Terrane. It was subdivided into the Huetamo, Iztapa-Zihuatanejo and Teloloapan subterrane (Campa and Coney, 1983). The rocks where the Turitzio fossil assemblage was collected belong to the Huetamo Subterrane. The Guerrero Terrane, a typical island arc, is characterised by magmatic (volcanics and intrusives), volcanoclastic and sedimentary rocks.

A thick Upper Jurassic sequence of conglomerate and sandstone, with interbedded dacite and andesite lava flows, rests with marked angular unconformity on the metamorphic (greenschist facies) rocks of the base-

ment of the Huetamo Subterrane. The Upper Jurassic rocks are covered with marked angular unconformity by sandstone, limestone and red beds with intercalated volcanics of Barremian to Albian age. During the Albian and part of the Cenomanian, large calc-alkaline batholiths were emplaced, uplifting the Mesozoic cover and influencing the sedimentary regime of the area (Pantoja-Alor, 1983), to give rise to a thick sequence of Upper Cretaceous marine and continental red beds.

## Local Geology

The Zirándaro Formation (Pantoja-Alor, 1993), of Late Jurassic age, is the lowest mapping unit around the locality of Turitzio. It consists of a thick sequence of turbiditic red beds, formed by breccia, conglomerate, sandstone and siltstone, with intercalated reddish limestone and lava flows of dacitic-andesitic composition. To the south and west it represents marine deltaic and fluvial facies, associated with volcanics that gradually change to the east to flysch-like turbiditic facies of the Angao Formation (Pantoja-Alor, 1959).

The name of Comburindio Formation was informally given by Salazar (1973) to the lower limestone, of Neocomian age, exposed near the rural town of Comburindio. Unfortunately the name was extended to embrace limestones of Albian and Cenomanian age and it needed to be redefined. The best outcrop of the base of this Formation is exposed along the small creek that crosses the town of Comburindio (Fig. 1). The basal part of the unit consists of fine conglomerate, marl and limestone that rests with a marked angular unconformity over the Zirándaro Formation, as shown in the column of Fig. 2.

The Comburindio Formation is divided (Pantoja-Alor, 1993) in two members: a) a lower calcareous and feldspathic sandy member, which is very fossiliferous, with at least four rudist biostromes with interbedded andesitic-dacitic tuffs and lava flows, and b) an upper volcanoclastic and volcanic member, formed by red siltstone, sandstone, volcanic conglomerates and andesite-dacite breccia, tuff and lava flows (Fig. 2). The lower member has a thickness of more than 400 m. A section of 257 m which includes three rudist biostromes of this lower member was measured along the Arroyo Los Hornos, located immediately north of the town of Turitzio.

The deposit of the Comburindio Formation corresponds to a magmatic island arc overlapped, during the Barremian to the Aptian, by a regional transgression on an active subduction margin. The environments for the lower member are marked by a tectonical unstable low angle coastal shelf, with reefal, lagunar and sandy (fan) facies, altered by some volcanic events. The upper member represents different deltaic marine and continental facies in a local transgressive-regressive regime, in an active volcanic event.

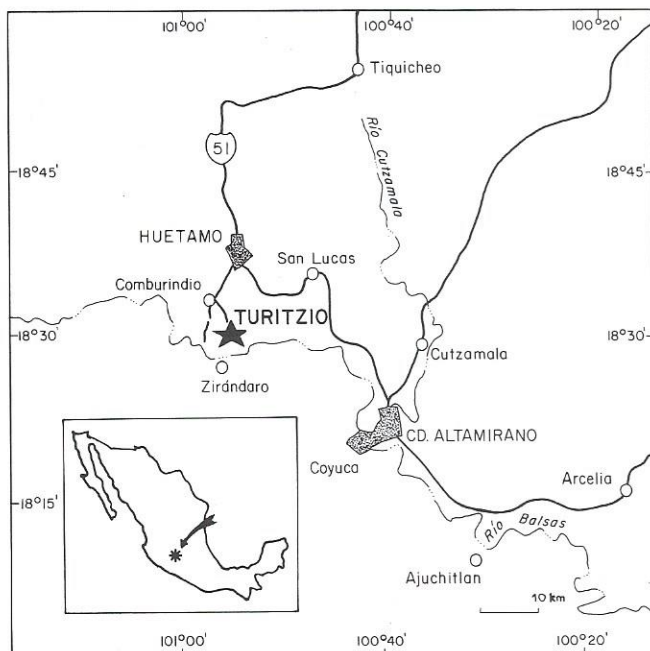


Figure 1. Sketch map showing the localities mentioned in the text.

## MICROPALAEONTOLOGICAL DATA

The studied sample JP-91-312 is a biomicrite con-

very frequent in the studied sample. Some other random sections of arenaceous foraminifera can be assigned to the genus *Everticyclammina* Redmond.

Algae are mainly represented by the dasycladacean *Deloffrella quercifoliipora* Granier and Michaud (Pl. 1, Figs. 2-3). This geographically and stratigraphically widespread taxon was first described from the Kimmeridgian-Portlandian of Poblado Catorce (frontier area between the states of Veracruz and Oaxaca, SE México); it was also recorded from the Upper Berriasian and Hauterivian of Switzerland and SE France, the Hauterivian and Barremian of the Pyrenees, the Barremian of the Elburz Range (Iran) (Granier and Michaud, 1987), and recently from the Portlandian-Lower Aptian of Senegal (Granier, 1992).

The sample also contains relatively small thalli of the solenoporacean species *Marinella lugeoni* Pfender (Pl. 1, Fig. 11). Cylindrical Udoteaceae showing a largely recrystallized cortical zone, but without a calcified medullar zone, probably belong to the genus *Arabicodinium* Elliott (Pl. 1, Fig. 10).

## AGE OF THE *Palorbitolina* BEDS

*Palorbitolina lenticularis* (Blumenbach) is the most important taxon for dating the beds with *Amphitriscoelus waringi*. According to Schroeder (1963), this foraminifer is geographically widespread in the Old World Tethys, and ranged from the late Barremian to the earliest late Aptian. During this time interval the sizes of the megalospheric embryo continuously increased and can be used for a more exact dating. The relatively primitive embryonic apparatuses of *Palorbitolina* from the hills of Turitzio (sample JP-91-312) indicate an earliest Aptian age for that population.

*Palorbitolina lenticularis* was already described and figured by Meza (1980) from several localities of México: Anticlinal of Characo (Guerrero), P. Oballos (Coahuila), S. Cadena (Durango) and Los Humeros (Puebla). Orbitolinids described by Ayala-Castañares (1960) from the Morelos Formation near Mal Paso (Huetamo region, Michoacán) under the name *Orbitolina morelensis* n. sp. belong to *Orbitolina* (*Mesorbitolina*) *texana* (Roemer) (not identical with *O. texana* in the sense of Douglass 1960; see Schroeder 1979), and to *O. (M.) gr. subconcava* Leymerie (some paratypes; = *O. texana* in

the sense of Douglass). This association is vastly younger than the *Palorbitolina* population from the hills of Turitzio and indicates a late Aptian-early Albian age (Schroeder In Schroeder and Neumann, 1985).

In the New World "*Orbitolina lenticularis*" has been reported from Venezuela (Dietrich 1924), Colombia (Karssten 1858), and Texas (Douville 1900). It is difficult, however, to determine whether these forms are conspecific with *Palorbitolina lenticularis*, as no structural details are given. True *P. lenticularis* was described by Sen Gupta and Grant (1971) from the Flemish Cap (western North Atlantic) under the name *Orbitolina conoidea* Gras (= *P. lenticularis*; see Schroeder 1963). An exact age was not given, and the reported range of "*O. conoidea*" communicated by Sen Gupta and Grant (1971) ("Neocomian to Cenomanian, with the maximum development in Aptian") has been obsolete for a long time. The highly developed embryonic apparatuses of the specimens figured by these two authors (1971, Fig. 3) indicate, that the age of the Flemish Cap material is final early Aptian to earliest late Aptian. Schroeder and Cherchi (1979) have described *Palorbitolina lenticularis* associated with "*Paleodictyoconus*" *arabicus* (Henson), from the Grand Banks continental rise in the northwestern Atlantic (DSDP Leg 43, Site 384). Embryonic apparatuses of the specimens from this latter locality are more primitive than those from Flemish Cap, but obviously more developed than the embryos of the *Palorbitolina*s from the hills of Turitzio. Therefore, the Mexican material, including the forms figured by Meza (1980, Pl. 1-2), can actually be regarded as the oldest *Palorbitolina* populations of the New World.

## RUDISTS

The fauna associated with *Palorbitolina lenticularis* consists of rudists of the family Caprinidae which are: *Amphitriscoelus waringi* Harris and Hodson, *Praecaprina* sp. cf. *?P. pennyi* Harris and Hodson, *Caprina* sp. cf. *C. douvillei* Paquier and *?Offneria* sp.

*Amphitriscoelus waringi* Harris and Hodson (Pl. 2, Figs. 4-8) is a small to medium size species, very variable in shape. Usually the valves are found separated and broken, with the exterior eroded. However, the internal structure is very well preserved and shows clearly all the features of the genus and the species. Both

### Plate I

Larger Foraminifera and Algae from the Lower Aptian Comburindio Formation of Turitzio, near Huetamo (Michoacán, México). All slides are housed in the collections of the Geologisch-Paläontologisches Institut der Universität, Frankfurt a. Main.

- |         |  |     |  |
|---------|--|-----|--|
| 1, 4, 5 | <i>Palorbitolina lenticularis</i> (Blumenbach).—1: Axial section (below on the right) and tangential section (above on the left), both showing the embryonic apparatus (sample JP-91-312-A, slide 201-1), X 40.—4: Axial section through a young specimen showing the large embryonic chamber surrounded by the peribryonic ring (sample JP-91-312-A, slide 201-1), X 100.—5: Random sections (sample JP-91-312-B, slide 202-1), X 15. | 6-9 | <i>Choffatella decipiens</i> Schlumberger.—6: Oblique sub-equatorial section (sample JP-91-312-A, slide 201-4), X 60.—7: Equatorial section (sample JP-91-312-B, slide 202-2), X 60.—8: Axial section (sample JP-91-312-A, slide 201-2), X 100.—9: Axial section (sample JP-91-312-A, slide 201-1), X 100. |
| 2, 3    | <i>Deloffrella quercifoliipora</i> Granier and Michaud.—Oblique sections (sample JP-91-312-A, slide 201-4), X 40.  | 10  | <i>Arabicodinium?</i> sp. Axial section (sample JP-91-312-A, slide 201-3), X 15.   |
|         |  | 11  | <i>Marinella lugeoni</i> Pfender (sample JP-91-312-B, slide 202-1), X 40.  |

taining abundant larger foraminifers and moreover fragments of bivalved shells, gastropods (mainly small nerineids), echinoderms, algae as well as reniform sponge spicules. Many of the biogenic components are developed as oncoids with a partly laminated cortex.

The most important faunal element are orbitolinid Foraminifera (Pl. 1, Fig. 5) exclusively belonging to *Palorbitolina lenticularis* (Blumenbach). This taxon is characterized (Schroeder 1963) by its megalospheric embryonic apparatus, situated in a central position at the tip

of the test. It consists of a relatively large embryonic chamber, which is covered by a layer of small subepidermal chamberlets and laterally surrounded by a periembryonic ring (Pl. 1, Fig. 4). The diameter of the embryonic chamber (measured below the subepidermal layer) varies between 0.15 and 0.25 mm.

*Choffatella decipiens* Schlumberger, an agglutinated planispiral and involute form (Pl. 1, Figs. 8-9), showing a subepidermal alveolar layer (Pl. 1, Fig. 6) and large apertures in the median plane (Pl. 1, Figs. 6-7), is also

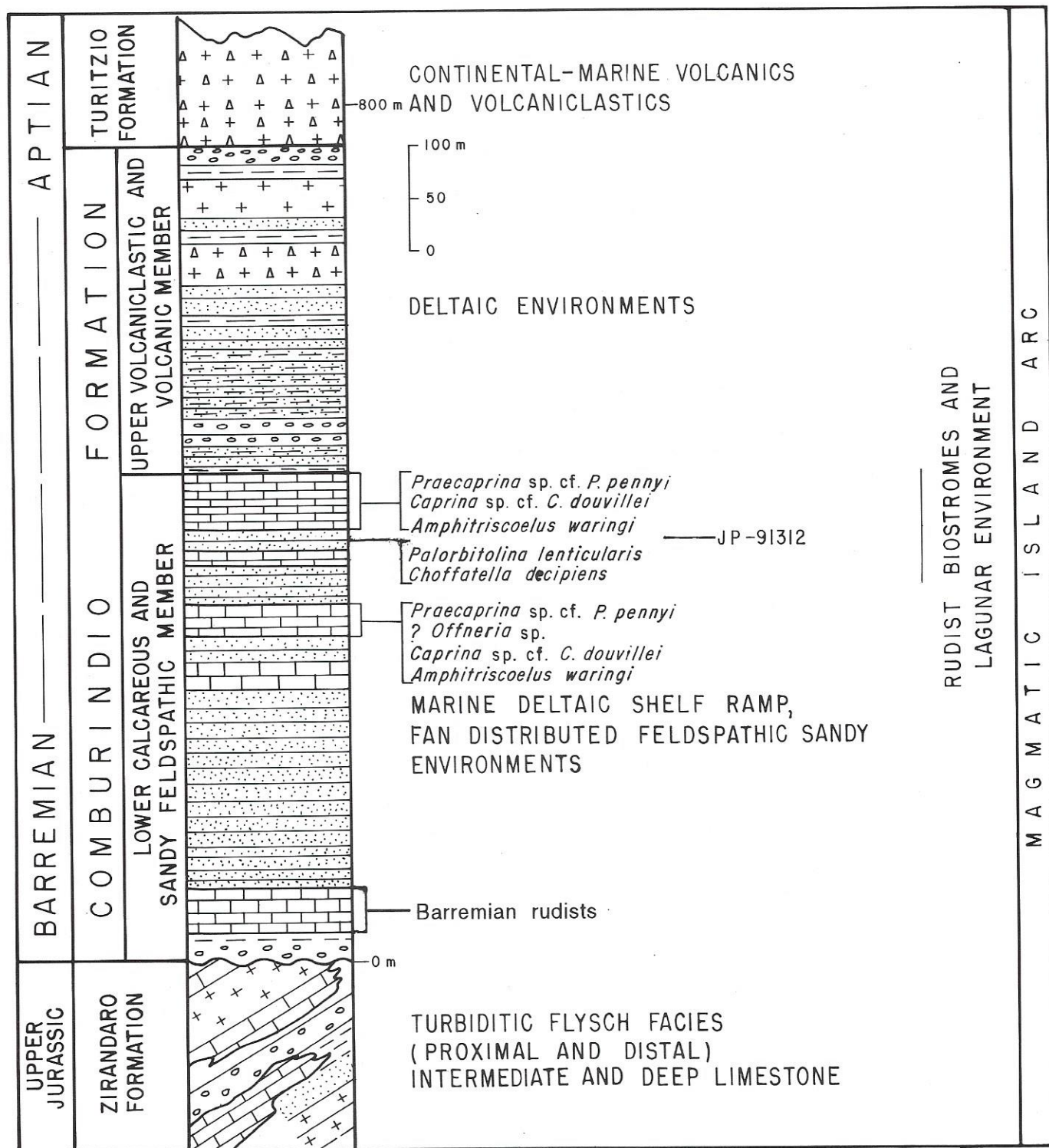
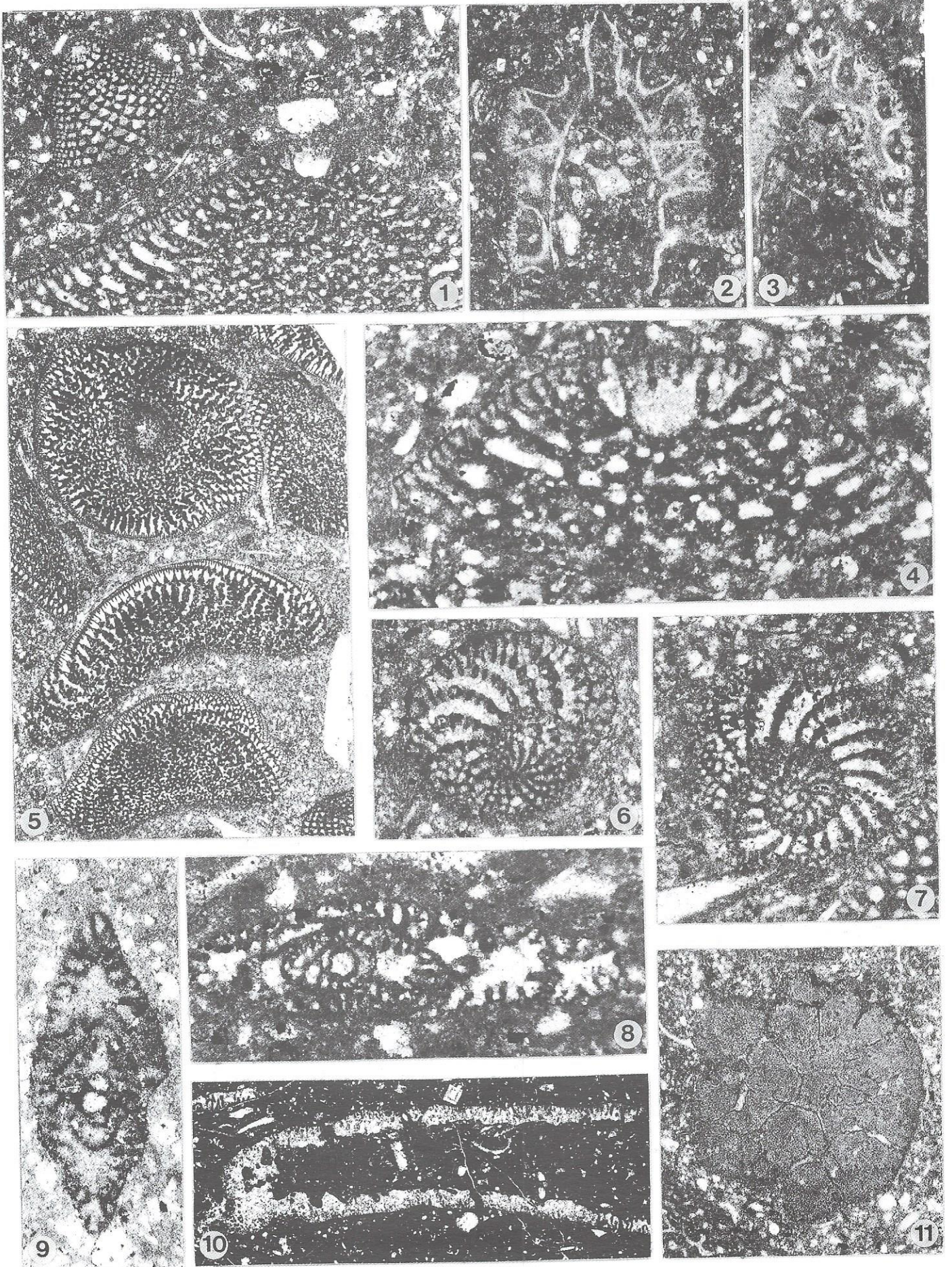


Figure 2. Stratigraphical profile of the Turitzio area with location of the fossiliferous levels studied.



valves present a big, subpentagonal body cavity with the ventral margin, the largest, lacking canals. There are five to seven, large, rectangular to subrounded posterior pallial canals in a single row, separated by thin simple septa; along the antero-dorsal margin there is a row of smaller, more numerous and rounded pallial canals. A large anterior accessory cavity is present in each valve.

When *Amphitriscoelus* was discovered in the island of Trinidad, its age was doubtful (Harris and Hodson, 1922). In 1944, in the nearby region of northeastern Venezuela, the same fauna of rudists was found together with species of bivalves and corals, which were studied respectively by Imlay and by Wells (*In* Hedberg and Pyre, 1944), who considered the age as early Aptian because of the great similarity with the Urgonian faunas of France. This age was confirmed by Masse and Rossi (1987) in a study of the foraminifers and calcareous algae of the Taguarumo Member of the Barranquín Formation, in Serranía del Interior of northeastern Venezuela. They also found *Amphitriscoelus waringi* and other caprinids in several localities.

*Praeacprina* sp. cf. ?*P. pennyi* Harris and Hodson (Pl. 2, Figs. 1-3) is a very big species, abundant and well preserved in the Huetamo region. The wall is very thick and the internal structure is different in each valve. The left valve, of rounded outline, is convex and coiled, and presents a few (from five to eight) big, oval to rectangular pallial canals in a single row in both, the posterior and the anterior margins, and a big trigonal body cavity with the ventral side, the longest, devoid of canals and provided, near the anterior margin, of a longitudinal angular projection ("cordon" or "saillie" of Paquier, 1905) which is a characteristic feature of *Praeacprina* and *Pachytraga* (Paquier, 1905). The right valve is cylindroconical, with a large body cavity and elongated anterior and posterior accessory cavities.

?*Praeacprina pennyi* Harris and Hodson from Trinidad is similar to the Mexican species, although not so big. The medium sized Mexican specimens are very like the biggest specimens of Trinidad in external shape and also in the internal features described by the au-

hors. The assignment of the specimens of Trinidad to *Praeacprina* by Harris and Hodson (1922) was doubtful due perhaps to its large size in comparison with the other species of the genus, and also because the specimens are broken and badly preserved as a result of recrystallization. It is our consideration that they may correspond to the Mexican species.

*Praeacprina varians* Paquier, from the Urgonian of France, although somewhat similar to the Mexican species in general shape, apart from being much smaller, differ because it presents a remarkable ventral depression with rounded keels in each side in both valves; besides, internally, the anterior and posterior canals are smaller, more numerous (from 13 to 15 in each row) and pyriform, and the smaller body cavity has a short ventral margin.

*Caprina* sp. cf. *C. douvillei* Paquier (Pl. 2, Figs. 9-11) is the most abundant rudist of the Huetamo region. It is a small to medium size species, similar to *Caprina douvillei*, described by Paquier (1905) from the upper Urgonian beds of Le Rimet, near Grenoble, France. This species has been found also in the Lower Aptian Sligo Formation of Texas (Skelton, 1982; Young, 1984).

Another species, distinguished now as ?*Offneria* sp. (Pl. 2, Figs. 12, 13), is well preserved and frequent. It differs from the known *Offneria* species, because the pallial canals are more regular in shape and size, with very few transversal septa; in longitudinal sections the tabulae of the pallial canals are present, but they are few and amply separated. It could be a new species of this genus or else a new genus closely related to *Offneria*.

## PALAEOBIOGEOGRAPHICAL CONSIDERATIONS

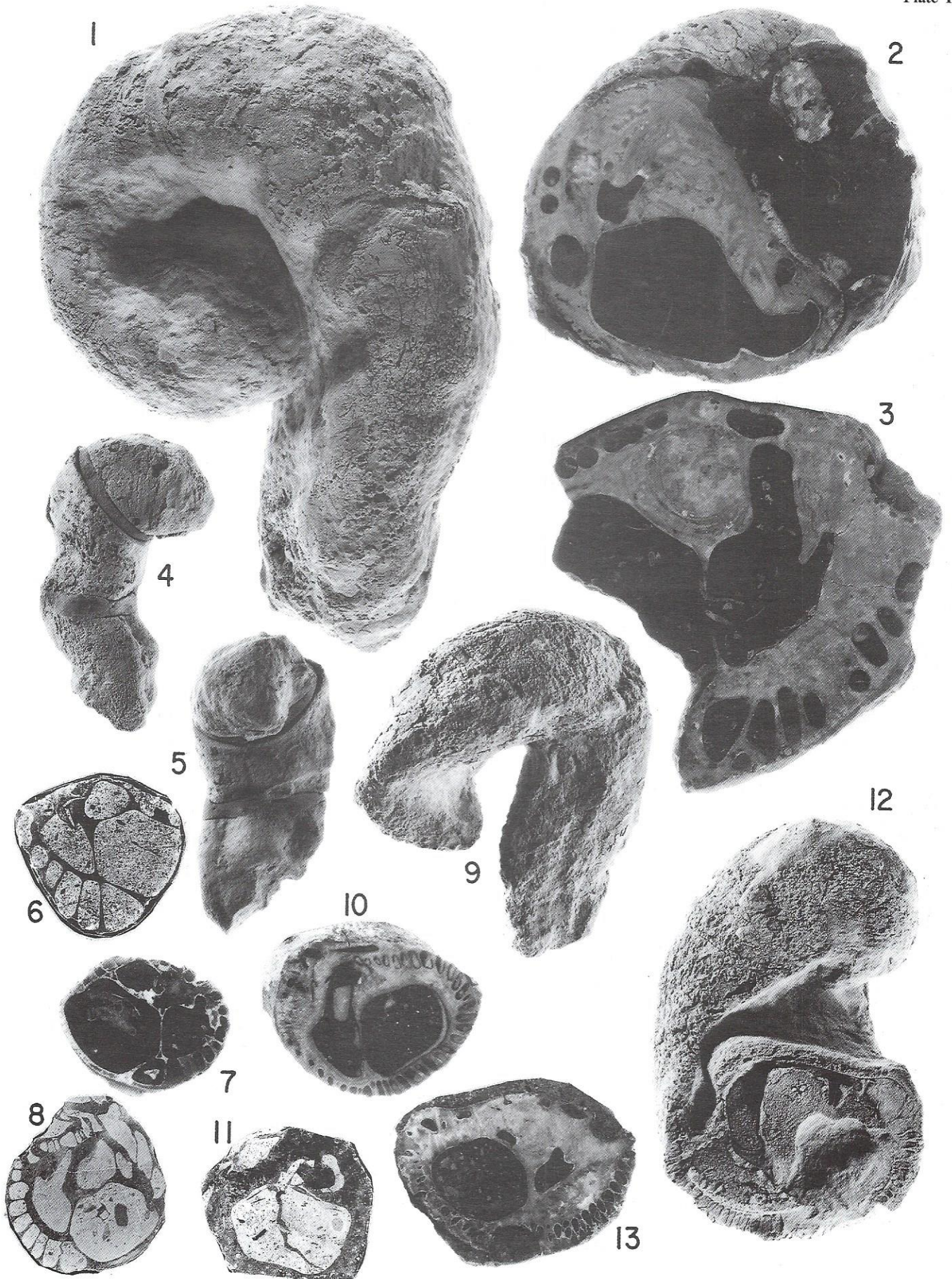
The discovery of *Palorbitolina lenticularis* and *Amphitriscoelus waringi* associated with other caprinids in the lower Aptian of the Huetamo region gives rise to some palaeobiogeographic considerations.

### Plate II

Rudists from the Lower Aptian Comburindio Formation of Turitzio, near Huetamo (Michoacán, México). All specimens are housed in the collections of the Instituto de Geología, Universidad Nacional Autónoma de México (acronym IGM).

- 1-3 *Praeacprina* sp. cf. ? *Praeacprina pennyi* Harris and Hodson.—1: Both valves, anterior view (specimen IGM-6446, sample JP-91-304), X 0.66.—2: Left valve cross section showing the body cavity with its anterior projection, also the posterior accessory cavity and a few pallial canals (specimen IGM-6447, sample JP-91-304), X 0.75.—3: Incomplete left valve, cross section, apical view showing the posterior accessory cavity, both teeth and posterior and anterior pallial canals (specimen IGM-6449, sample JP-91-304), X 1.
- 4-8 *Amphitriscoelus waringi* Harris and Hodson.—4: Both valves, lateral view (specimen IGM-6366, sample JP-90-235), X 1.—5: Dorsal view (same specimen), X 1.—6: Left valve cross section (specimen IGM-6367, sample JP-91-303) X 1.—7: Right valve cross section (specimen IGM-6368, sample JP-91-303), X 1.—8: Left valve cross section (specimen IGM-6363, sample JP-92-354), X 1. In all cross sections, the pentagonal body cavity, posterior and anterior accessory cavities and posterior and anterior pallial canals are clearly shown.
- 9-11 *Caprina* sp. cf. *Caprina douvillei* Paquier.—9: Both valves (specimen IGM-6448, sample JP-91-264), X 1.—10: Left valve cross section (specimen IGM-6450, sample JP-91-267), X 1.—11: Right valve (same specimen) X 1.
- 12-13 ?*Offneria* sp.—12: Left valve, apertural view (specimen IGM-6452, sample JP-92-330), X 1.—13: Left valve cross section, apical view (specimen IGM-6451, sample JP-92-330) X 1.

Plate II



The foraminiferal genus *Palorbitolina* was distributed worldwide on carbonate platforms of the Tethys Realm during the late Barremian - earliest late Aptian interval. Recent studies have shown (Schroeder, 1993), that *Palorbitolina* originated from *Valserina* Schroeder and Conrad 1968, a relatively small orbitolinid genus showing an eccentrically situated embryonic apparatus. *Valserina* was spread during the late Hauterivian - early Barremian only over a relatively restricted area of SW Europe (Jura Mountains, Subalpine Chains, Provence, eastern Pyrenees, Sardinia) characterizing, together with other endemic genera ("association a *Valserina*"), a special bioprovince (Cherchi and Schroeder, 1973). However, the worldwide geographical extension of the Tethyan carbonate platforms at the Barremian/Aptian boundary was favourable for the distribution of *Palorbitolinas*, which also reached the American continent during the early Aptian.

Although the presence of *Amphitriscoelus* was unconspicuously recorded in Texas by Perkins (in Dechaseaux *et al.*, 1969, p. N790), that notice was ignored by many palaeontologists, since this information was not published in any other way. Therefore, before 1992 it could be believed that the *Amphitriscoelus* assemblage was only present in a small area of Trinidad and northeast Venezuela.

Masse and Rossi (1987) reported the presence in Venezuela of the alga *Hensonella dinarica*, of "African" affinity, as well as the absence there of typically European microfossils. On this assumptions, they postulated that the Caribbean paleobiogeographical Province was separated in the early Aptian into a Southern province containing an endemic rudist fauna and microfossils with "African" affinity, and a Northern province that would comprise the Mexican, Texan and probably the Atlantic Bahamian regions, with a fauna of rudists, corals and bivalves, with predominantly European influence.

Recently, a Lower Aptian rudist fauna which includes *Amphitriscoelus waringi*, *Caprina douvillei*, *Offneria* sp. and ?*Pachytraga* sp. was discovered in the northeast flank of Cuba, in outcrops of a margin facies of the Bahamian Carbonate Platform in the Gibara area (Rojas *et al.*, 1992).

The presence of *Amphitriscoelus* in Mexico, Cuba and Texas, together with other rudists also present in Trinidad and Venezuela, associated with a diverse fauna of European affinity, greatly weakens the Masse and Rossi's hypothesis, and at least concerning the rudists, constitutes evidence supporting the biotic homogeneity of the Caribbean Province during the early Cretaceous.

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## BIBLIOGRAPHY

- Ayala-Castañares, A. 1960. *Orbitolina morelensis* sp. nov. de la formación Morelos del Cretácico inferior (Albiano) en la región de Huetamo, Michoacán, México. *Paleontología Mexicana*, 6, 1-16.
- Burckhardt, C. 1930. Étude synthétique sur le Mésozoïque Mexicain. *Mémoires de la Société Paléontologique Suisse*, 49, 1-280.
- Campa, M. F. 1977. *Estudio tectónico, Prospecto Altamirano-Huetamo*. Petróleos Mexicanos (PEMEX), IGPR-146, 94 p. (unpublished).
- Campa, M. F. and Coney, J. P. 1983. Tectono-stratigraphic terranes and mineral resources distribution in Mexico. *Canadian Journal of Earth Science*, 26, 1040-1050.
- Cherchi, A. et Schroeder, R. 1973. Sur la biogéographie de l'association à *Valserina* du Barrémien et la rotation de la Sardaigne. *Comptes rendus de l'Académie des Sciences de Paris*, (D) 277, 829-832.
- Dechaseaux, C., Perkins, B. F. and Cox, L. R. 1969. Family Caprinidae d'Orbigny, 1850. In: *Treatise on Invertebrate Paleontology* (Ed. R. C. Moore). N. The University of Kansas Press and The Geological Society of America, Boulder, 787-799.
- Dietrich, W. O. 1924. Zur Paläontologie und Stratigraphie der Kreide und des Tertiärs in der ostkaribischen Kordillere Venezuelas. *Centralblatt für Mineralogie, Geologie und Paläontologie*, 1924, 181-187.
- Douglass, R. C. 1960. The foraminiferal genus *Orbitolina* in North America. *Geological Survey Professional Papers*, 33, 1-52.
- Douvillé, H. 1900. Sur quelques Rudistes américains (Mexique et Texas). *Bulletin de la Société géologique de France*, 28, 205-221.
- García-Barrera, P. y Pantoja-Alor, J. 1991. Equinoides del Albiano tardío de la Formación Mal Paso, de la región de Chumbitaro, Estados de Guerrero y Michoacán. *Revista de la Sociedad Mexicana de Paleontología*, 4, 23-41.
- Granier, B. 1992. Les Algues et Foraminifères benthiques du Jurassique supérieur et du Crétacé inférieur du Sénégal. *Journal of African Earth Sciences*, 14, 239-253.
- Granier, B. et Michaud, F. 1987. *Deloffrella quercifoliipora* n. gen. n. sp., une algue dasycladacée nouvelle du Kimméridgien et du Portlandien du Sud-Est du Mexique. *Bulletin de la Société géologique de France*, (8) 3, 1089-1096.
- Hall, C. E. 1903. Notes on a geological section from Iguala to San Miguel Totolapa, State of Guerrero, Mexico. *Memorias de la Sociedad Científica Antonio Alzate*, 13, 327-335.
- Harris, G. H. and Hodson, F. 1922. The Rudistids of Trinidad. *Palaeontographica americana*, 1, 119-162.
- Hedberg, H. D. and Pyre, A. 1944. Stratigraphy of Northeastern Anzoátegui, Venezuela. *Bulletin of the American Association of Petroleum Geologists*, 28, 1-28.
- Johnson, C. A., Lang, H. R., Cabral-Cano, E., Harrison, C. G. A. and Barros, A. J. 1991. Preliminary assessment of stratigraphy and structure, San Lucas region, Michoacán and Guerrero States, SW Mexico. *The Mountain Geologist, Special issue*, 28, 121-136.
- Karsten, H. 1858. Über die geognostischen Verhältnisse des westlichen Columbiens, der heutigen Republik Neu-Granada und Equador. *Amtlicher Bericht der 32. Versammlung deutscher Naturforscher und Ärzte in Wien*, 80-117.
- Masse, J. P. et Rossi, T. 1987. Le provincialisme sud-caraïbe à



- l'Aptien inférieur. Sa signification dans le cadre de l'évolution géodynamique du domaine caraïbe et de l'Atlantique central. *Cretaceous Research*, **8**, 343-363.
- Meza, J. G. 1980. El género *Orbitolina* en México y su distribución estratigráfica. *Revista del Instituto mexicano del Petróleo*, **12**, 4-33.
- Monod, O. and Faure, M. 1992. Laramide tectonics in western Mexico: closure of an intra-arc basin (Arcelia) opened within an albian continental arc (Teloloapan-Zihuatanejo) (Guerrero State, Mexico). *29th International Geological Congress, Kyoto, Japan. Abstract A*, 472.
- Ortega-Gutiérrez, F. 1981. Metamorphic belts of southern Mexico and their tectonic significance. *Geofísica Internacional*, **20**, 177-202.
- Pantoja-Alor, J. 1959. Estudio geológico de reconocimiento de la región de Huetamo, Estado de Michoacán. *Boletín. Consejo de Recursos Naturales No-Renovables (México)*, **50**, 1-36.
- Pantoja-Alor, J. 1983. Geocronometría del magmatismo Cretácico-Terciario de la Sierra Madre del Sur. *Boletín de la Sociedad Geológica Mexicana*, **44**, 1-20.
- Pantoja-Alor, J. 1990. Redefinición de las unidades estratigráficas de la secuencia mesozoica de la región de Huetamo-Ciudad Altamirano, Estados de Michoacán y Guerrero. *Resúmenes. 10.ª Convención Geológica Nacional. Sociedad Geológica Mexicana*, 66.
- Pantoja-Alor, J. 1992a. La Formación Mal Paso y su importancia en la estratigrafía del sur de México. *Memoria. 11.ª Convención Geológica Nacional. Sociedad Geológica Mexicana*, 121-123.
- Pantoja-Alor, J. 1992b. Nuevas aportaciones al Tethys occidental de México. *Resúmenes. Reunión sobre la evolución geológica de México. Universidad de Guadalajara (México)*, 36.
- Pantoja-Alor, J. 1992c. El evento magmático "Balsas" (Paleógeno) de la Sierra Madre del Sur, México. *Actas. III Congreso Geológico de España y VIII Congreso Latinoamericano de Geología. Universidad de Salamanca*, 4, 221-225.
- Pantoja-Alor, J. 1993. Description of the localities visited in the field trip B. In: Pantoja-Alor, J., Alencaster, G. and Gómez-Caballero, A. (eds.). *Geology and rudist communities of the Huetamo region, State of Micoacan, Mexico. Guidebook of field trip B. Third International Conference on Rudists. Mexico D. F.*, 11-40.
- Paquier, V. 1905. Les Rudistes Urgoniens, II.—Série Inverse. *Mémoires Société géologique de France. Paléontologie*, **13**, 49-102.
- Rojas, R., Skelton, P. W. and Iturralde-Vinent. M. 1992. Cuban rudist faunas revisited. In *13th Caribbean Geological Conference, Programa y Resúmenes*, Pinar del Río, Cuba, 21.
- Salazar, M. S. 1973. *Prospecto Altamirano, Área Huetamo. Petróleos Mexicanos (PEMEX), IGPR-907*, 93 p. (unpublished).
- Schroeder, R. 1963. *Palorbitolina*, ein neues Subgenus der Gattung *Orbitolina* (Foram.). *Neues Jahrbuch für Geologie und Paläontologie, Abh.*, **117**, 346-359.
- Schroeder, R. 1979. Les Orbitolines de l'Aptien: définitions, origine et évolution. *Géobios, Mémoire spécial*, **3**, 289-299.
- Schroeder, R. 1993. Évolution du genre *Valserina* Schroeder 1968 et l'origine des Palorbitolines (Foraminifera). *Paläontologische Zeitschrift*, **67**, 239-244.
- Schroeder, R. and Cherchi, A. 1979. Upper Barremian - lowermost Aptian orbitolinid foraminifers from the Grand Banks continental rise, northwestern Atlantic (DSDP Leg 43, Site 384). In: *Initial reports of the Deep Sea Drilling Project* (Eds. B. E. Tucholke, P. R. Vogt and al.), **43**, 575-583.
- Schroeder, R. et Neumann, M. (ed.) 1985. Les grands foraminifères du Crétacé moyen de la région méditerranéenne. *Géobios, Mémoire spécial*, **7**, 1-161.
- Sen Gupta, B. K. and Grant, A. C. 1971. *Orbitolina*, a Cretaceous larger foraminifer, from Flemish Cap: paleoceanographic implications. *Science*, **173**, 934-936.
- Skelton, P. W. 1982. Aptian and Barremian Rudist Bivalves of the New World: some Old World similarities. *Cretaceous Research*, **3**, 145-153.
- Tardy, M., Lapiere, H., Ortiz, E., Freyrier, C., Coulon, C., Bourdier, J. L. and Yta, M. 1992. Origin and evolution of the Guerrero suspect terrane (Western Mexico, Greater Antilles and Colombian Andes). *29th International Geological Congress, Kyoto, Japan. Abstract A*, 254.
- Young, K. 1984. Biogeography and stratigraphy of selected Middle Cretaceous rudists in southwestern North America. *Memoria III Congreso latinoamericano de Paleontología, México*, 341-359.

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SEMINARIO

Presencia de una asociación de cráneos de grandes mamíferos en Venta Micena  
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En 1984 se descubrió en el Corte-III de Venta Micena una espectacular acumulación de cráneos y mandíbulas de grandes mamíferos (ver figura adjunta). La integran un cráneo de tigre de dientes de sable (1) (*Homotherium latidens*), uno de elefante infantil (2) (*Mammuthus meridionalis*), uno de rinoceronte (3) (*Stephanorhinus etruscus*), un cráneo (4) un paladar (5) y una hemimandíbula (6) de caballo (*Equus cf. numidicus*; Vera Eisenmann, com. pers.) y una hemimandíbula de búfalo de agua (7) (*Bubalus* sp.). Actualmente se expone en una sala del Museo de Prehistoria y Paleontología de Orce. No se ha descrito una asociación de este tipo en otros yacimientos estratiformes del Plio-Pleistoceno, por lo que su singularidad resulta evidente.

Los cráneos se encuentran completos, pero el paladar presenta indicios de haber sido comido por grandes carnívoros carroñeros y está topográficamente debajo, asociado a las mandíbulas de *Equus* y *Bubalus*, así como a otros huesos largos, que también presentan marcas de carroñeo y otras evidencias en su cara superior de haber estado un tiempo prolongado a la intemperie. Los cráneos se disponen sobre la cota de huesos que presumiblemente acumularon las hienas y están aplastados por el peso del sedimento, pero no muestran indicios de haber estado sometidos a la radiación solar. Las hienas no seleccionan las piezas craneales hasta estos límites y su actuación suele ser muy destructiva. Cuando una hiena de gran tamaño —*Pachycrocuta brevirostris*: 120/70 Kg— ataca un cráneo, donde la abertura de su mandíbula le permite actuar, no deja del mismo más que el paladar y los dientes, como sucede con el équido de la cota inferior, y en los rumiantes la calota con la base de los núcleos óseos. Por el contrario, a estos cráneos sólo les falta la región occipital, a excepción del correspondiente a *Homotherium*, que la conserva intacta, por lo que se deduce que fueron fracturados por esta zona, la más accesible, para extraerles el cerebro.

Por otra parte, los cráneos y restos craneales están escasamente representados en Venta Micena, donde para un total de 2561 restos no dentales clasificables, recolectados hasta el año 1987, se habían preservado únicamente 9 cráneos casi enteros, 11 fragmentos de bóveda craneal, 45 pedículos de cérvidos más cuernos de bóvido, 25 fragmentos maxilares y 39 hemimandíbulas completas (Martínez Navarro, 1991).

La acumulación en Venta Micena se debió exclusivamente a la acción de agentes biológicos, pues los fenómenos de transporte y depósito por agentes geológicos como el agua están excluidos, en función de que los huesos están orientados aleatoriamente, no se aprecian indicios de que hayan sido rodados, para muchos se puede deducir que estuvieron bastante tiempo sometidos a la radiación solar y en un porcentaje elevado se aprecian huellas de la acción de carnívoros carroñeros (desmembramiento casi total de todos los huesos, con mordeduras y fracturación en las zonas más vulnerables). En una proporción muy inferior de restos hay indicios de fracturación realizada por percusión y estrías de descarnación producidas con herramientas líticas. Tal y como indican Mendoza *et al.* (1993), la asociación de restos en Venta Micena, tomada en su conjunto, se aproxima bastante a las encontradas en cubiles de hienas manchadas actuales (*Crocuta crocuta*), según se deduce del análisis multivariante de las frecuencias de los diferentes elementos del esqueleto postcranial. Por otra parte, un dato que avala esta hipótesis es el hecho de haber encontrado abundante dentición decidual de hiena.

El estrato fértil del yacimiento tiene un espesor de 75 a 80 cm y está formado por una caliza micrítica con un 90-98% de pureza (Anadón *et al.*, 1987), precipitada en unas paleocharcas sobre un suelo de caliche de origen

diagenético (Gibert *et al.*, 1992). Por el grado de deterioro de las piezas se puede inferir cómo se fueron enterrando, pues se preservan siempre mejor por la parte inferior que por la superior, permitiendo ello deducir que se cubrieron de manera gradual. Por el estado de conservación de los fósiles se puede estimar cuánto tiempo estuvieron a la intemperie y, dado que algunos de los huesos, como los cráneos y una mandíbula de elefante, tienen más de 30 cm de espesor, el tiempo de exposición en superficie previo al enterramiento hubo de ser inferior a 8-10 años, pues en caso contrario jamás se habrían preservado.

La probabilidad de encontrar 4 cráneos completos reunidos por azar se puede calcular a partir del siguiente productorio:

$$P = \prod_{i=1}^4 [(c-i+1) / (N-i+1)] = 7 \times 10^{-11}$$

donde N = 2561 y c = 9. La probabilidad asociada al conjunto de la acumulación vendría determinada por los productorios correspondientes a cráneos, mandíbulas y paladar, multiplicado ello por el número de permutaciones con repetición de los elementos de estos tres grupos [P.  $R_7^{4,2,1} = 7! / (4! \times 2! \times 1!) = 105$ ]:

$$P = \prod_{i=1}^4 [(c-i+1) / (N-i+1)] \times \prod_{i=1}^2 [(m-i+1) / (N-i-3)] \times [P / (N-6)] \times 105 = 1,6 \times 10^{-14}, \text{ con } m=39 \text{ y } P=25$$

Como puede apreciarse, ambas probabilidades son prácticamente nulas, lo que sugiere que la acumulación no se produjo al azar, sino de manera selectiva. Dado que este tipo de comportamiento no ha sido observado en hienas, leopardos o puercoespines, se puede entonces deducir que los agentes biológicos responsables de generar dicha asociación fueron los homínidos, que se habrían especializado en obtener la máxima cantidad de proteínas animales a partir de la médula de los huesos y del cerebro, con el fin de poder alimentar principalmente a la población infantil del grupo.

La hipótesis más factible sobre el modelo de acumulación de huesos en el yacimiento, se puede formular en los siguientes términos: en un momento de desecación de las charcas y bajada del nivel freático, las hienas excavarían pequeños cubiles, que servían para proteger sus crías de la insolación y de otros carnívoros, pues los individuos adultos debido a su gran tamaño y a su comportamiento social debían estar a salvo de otros predadores. En las entradas se irían acumulando los restos de los cadáveres que iban comiendo. En esta etapa de ocupación de los cubiles no hay actividad antrópica sobre los huesos. En un determinado momento las hienas abandonan el lugar, bien por causas migratorias, bien a efectos de que se desparasitasen los cubiles ó, más probablemente, como consecuencia de una ligera subida de la lámina de agua de las charcas que hace que los cubiles, excavados sobre fango micrítico seco, se inunden y desplomen. Al marcharse las hienas los homínidos pueden actuar, aprovechando los restos de los ungulados abatidos por los carnívoros no fracturadores de huesos (básicamente *Homotherium* y *Megantereon*, los félidos con dientes de sable de tamaño león y leopardo, respectivamente, y *Canis falconeri*, cánido equivalente al moderno licaón). Acto seguido se produce una importante subida del nivel de agua que hace precipitar la caliza micrítica y sella toda la asociación. Ahora bien, no se puede excluir que existiera un cierto grado de competencia entre homínidos y hienas. Esta posibilidad alternativa se encuentra avalada por un metapodio de caballo que presenta marcas de acción antrópica y marcas producidas por mordeduras efectuadas por las hienas.

Finalmente, si se acepta la intencionalidad subyacente a la acumulación de cráneos, en el sentido de que por azar resulta altísimamente improbable que fuesen reunidos, cabe preguntarse cuál sería el significado de dicha asociación. Dado que los cráneos se encuentran en un punto que obviamente no era el lugar idóneo para establecer un campamento donde consumir los cerebros, se podría entonces especular con posibles connotaciones de carácter ritual. Esta última idea viene reforzada por el hecho de que el único cráneo completo con el occipital no perforado es el de *Homotherium*, carnívoro que presumiblemente abastiría la mayor parte de las grandes presas carroñeadas por los homínidos.

BIBLIOGRAFÍA

Anadón, P., Julià, R., De Deckker, P., Rosso, J. C. y Soulié-Marsché, I. 1987. Contribución a la Paleolimnología del Pleistoceno inferior de la cuenca de Baza (sector Orce-Venta Micena). *Paleontologia i Evolució. Memoria Especial*, 1, 35-72.

Gibert, J., Caporicci, R., Martínez Navarro, B. y Arribas, A. 1992. Estudio tafonómico de los metápodos de caballo de Venta Micena. In: *Proyecto Orce-Cueva Victoria (1988-1992): Presencia humana en el Pleistoceno inferior de Granada y Murcia (Coord. J. Gibert)*, Museo de Prehistoria "J. Gibert", Ayuntamiento de Orce (Granada), 107-114.

Martínez Navarro, B. 1991. *Revisión Sistemática y estudio cuantitativo de la fauna de macromamíferos del yacimiento de Venta Micena (Orce Granada)*. Tesis Doctoral Universidad Autónoma de Barcelona, Ed. microfilm, 264 p.

Mendoza, M., Palmqvist, P., Guerrero, S., Martínez Navarro, B., Pérez Claros, J. A., Gibert, J. y Eisenmann, V. 1993. Consideraciones tafonómicas, paleoecológicas y paleoetológicas sobre la comunidad de macromamíferos de Venta Micena (Orce, Granada). *Comunicaciones de las IX Jornadas de Paleontología*, Málaga, 73-78.

