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EARLY APTIAN BENTHIC FORAMINIFERA FROM THE EL CAJÓN FORMATION, HUETAMO, MICHOACÁN, SW MEXICO

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ABSTRACT

The El Cajón Formation represents the second order highstand system tract of the Lower Cretaceous supersequence that affected the Huetamo region (SW Mexico). This formation contains a well preserved assemblage of shallow-water benthic foraminifera: *Palorbitolina lenticularis* (Blumenbach) *Choffatella* aff. *Ch. decipiens* Schlumberger, *Everticyclammina hedbergi* (Maync), *Glomospira watersi* Loeblich, *G. urgoniana* Arnaud-Vanneau, *Praechrysalidina infracretacea* Luperto-Sinni, *Debarina* cf. *D. hahounerensis* Fourcade, Raoult and Vila, *Cuneolina* sp. and *Spiroloculina* sp. The age of these beds is early Aptian; the age assignment is based on the progressive evolution of the megalospheric embryo of *Palorbitolina lenticularis* (Blumenbach). The benthic foraminifera and the lithofacies suggest that this part of the El Cajón Formation was deposited on a nutrient rich warm shallow-water carbonate platform, probably with some turbidity. This foraminiferal assemblage is characteristic for the Tethys Realm.

Key works: Benthic foraminifera, early Aptian, El Cajón Formation, Huetamo, SW Mexico.

RESUMEN

La Formación El Cajón representa una supersecuencia de alto nivel en el Cretácico Inferior que afectó al área de Huetamo en el Estado de Michoacán, en el suroeste de México. Esta formación contiene una asociación de foraminíferos bentónicos de agua somera abundantes y bien preservados: *Palorbitolina lenticularis* (Blumenbach), *Choffatella* aff. *Ch. decipiens* Schlumberger, *Everticyclammina hedbergi* (Maync), *Glomospira watersi* Loeblich, *G. urgoniana* Arnaud-Vanneau, *Praechrysalidina infracretacea* Luperto Sinni, *Debarina* cf. *D. hahounerensis* Fourcade Raoult y Vila, *Cuneolina* sp. y *Spiroloculina* sp. La edad de esta asociación es aptiana temprana y está determinada por la evolución progresiva del aparato embrionario megalosférico de *Palorbitolina lenticularis* (Blumenbach). Los foraminíferos bentónicos y las litofacies indican que esta parte de la Formación El Cajón fue depositada en una plataforma carbonatada de agua cálida y somera con cierta turbiedad y rica en nutrientes. La asociación de foraminíferos es típica de la región de Tethys.

Palabras clave: Foraminíferos bentónicos, Aptiano temprano, Formación El Cajón, Huetamo, SW de México.

INTRODUCTION

In the southwestern continental margin of Mexico, where the Huetamo region is located, well exposed Early Cretaceous calcareous sequences occur.

These beds contain abundant marine invertebrate fossils, of which have been studied the rudists (Alencáster and Pantoja-Alor, 1995, 1996), the gastropods (Buitrón and Rivera-Carranco, 1985), the ammonites (González-Arreola *et al.*, 1996), the echinoids (García-Barrera and Pantoja-Alor, 1991) and the corals (Pantoja-Alor and Filkorn, 1995). On the other hand, although the presence of microfossils has been recorded (foraminifera and algae), the knowledge of the benthic foraminifera is rather scarce. The few papers reported on these microfossils are by Ayala-Castañares (1960), Meza (1980) and Pantoja-Alor and collaborators, 1994).

The larger benthic foraminifera represent an important tool for interpreting ancient environments. These fossils also permit the dating of the shallow-water environment, where they are common (Moullade, 1974). The objective of this investigation is concerned with the study of the benthic foraminifera of the El Cajón Formation. It is largely taxonomic, but it includes also paleoecological and paleobiogeographical interpretations, as well as a stratigraphic approach, for subsequent utilization in the correlation with other areas. Because the foraminifera are extremely valuable fossils, this paper is regarded as an important contribution for the stratigraphy of the carbonate platforms of the early Aptian of SW Mexico.

GEOLOGIC SETTING

The analysed samples were collected by Pantoja-Alor in 1995 from the El Cajón Formation, which is exposed on the Federal Road 51 at Barranca El Cajón (Figure 1), in the Huetamo region. Most of the southwestern margin of Mexico, south of the Trans-Mexican volcanic belt, is represented by the Guerrero terrane, which was divided in the Huetamo, Ixtapa-

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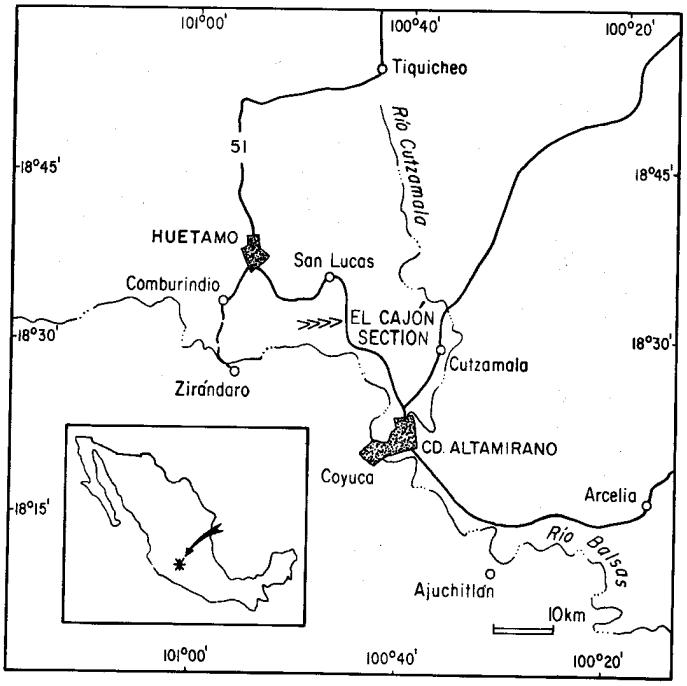

Figure 1. Sketch map showing the location of the El Cajón section.

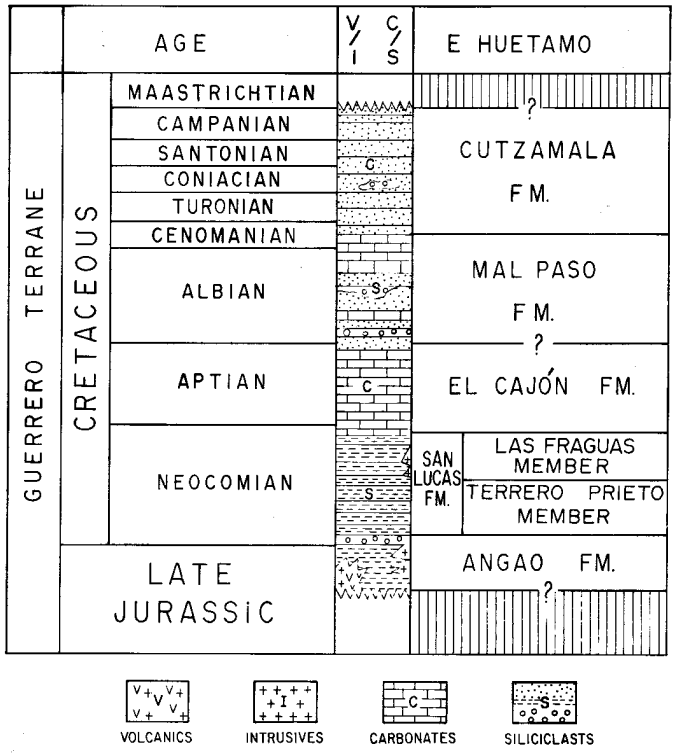

Figure 2. Stratigraphical relations of the El Cajón Formation.

Zihuatanejo and Teloloapan subterranes (Campa and Coney, 1983). The depositional framework of the Lower Cretaceous rocks is a complex process of uplift and downdropping of tectonic blocks affected by volcanic constructive (endogenous processes) and subaereal erosion within a magmatic island arc in an active margin.

From the Late Jurassic to the Albian, the region was flooded by a regional transgression that affected the major part of southern Mexico (Pantoja-Alor, 1993).

LOCAL STRATIGRAPHY

The Upper Jurassic and Lower Cretaceous sequences of the Huetamo region are the result of a transgressive system tract developed on a variable unstable shelf, which includes conglomeratic delta and shore facies, delta fan, shallow lagoon, tidal, intertidal and subtidal facies and reef environments, that change downdip to talud turbiditic and basinal fine sandy and shaly flysch facies. The Huetamo Quadrangle was divided by Pantoja-Alor (1993) in two parts, the West and East Huetamo regions.

The El Cajón Formation is located in the eastern part of the Huetamo region. It is overlying the volcaniclastic sandstone and marine epiclastic tuffs of the Las Fraguas member of the San Lucas Formation. The total thickness of the El Cajón Formation at the western anticline Characo is about 250 m and consists mostly of sandy limestone, coquinas of orbitolinids, bioclastic limestone with corals, rudists and gastropods. The top of this sequence is composed of massive limestone with shale intercalated near the unconformable contact with the sandy beds of the overlying Mal Paso Formation (Figure 2).

BENTHIC FORAMINIFERAL ASSEMBLAGE

A section 125 m thick from the El Cajón Formation was measured along the Federal Road 51 at Barranca El Cajón (Figure 1). More than 30 limestone samples were collected and investigated by thin sections. The studied samples yield an abundant and well preserved association mainly of the benthic foraminifera: *Palorbitolina lenticularis* (Blumenbach), *Choffatella* aff. *Ch. decipiens* Schlumberger, *Everticyclammina hedbergi* (Maync), *Debarina* cf. *D. hahounerensis* Fourcade, Raoult and Vila, *Glomospira urgoniana* Arnaud-Vanneau, *Glomospira watersi* Loeblich, *Praechrysalidina infracretacea* Luperto-Sinni, *Cuneolina* sp. and *Spiroloculina* sp. Other associated fossils are algae, gastropods, echinoderms and corals (Figure 3).

The microfacies analyses indicate that this limestone was varying from rudstone, grainstone, packsone to wackestone (Figure 4).

SYSTEMATIC PALEONTOLOGY

The studied species are housed in the micropaleontological collection of the Museum of Paleontology, Instituto de Geología, Universidad Nacional Autónoma de México, Ciudad Universitaria.

Order: Foraminiferida Eichwald, 1839
Suborder: Textulariina, Delage and Hérouard, 1890
Superfamily: Ammodiscacea Reuss, 1862

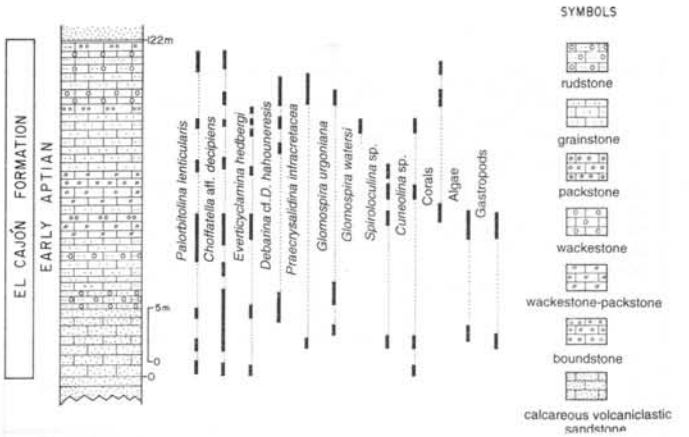

Figure 3. Stratigraphic column showing the lithology and distribution of benthic organisms in the El Cajón Formation.

Family Ammodiscidae Reuss, 1862
Subfamily: Ammovertellininae Saidova, 1891
Genus: *Glomospira* Rzehak, 1885

***Glomospira watersi* Loeblich, 1946**
(Figure 5/2)

1946 *Glomospira watersi* Loeblich, p. 134, pl. 22, figs. 3»b-1.
1983 *Glomospira watersi* Loeblich, 1946; Chiocchini and collaborators, p. 172, pl. 1, fig. 10.

This species is characterized by a small test with a proloculus followed by a tubular undivided second chamber with few oscillating coils; wall finely agglutinated.

Remarks—*Glomospira watersi* Loeblich was described from Pepper Formation in Bell County, Texas (Loeblich, 1946). This species has also been recorded from Lazio (Italy) by Chiocchini and collaborators (1983).

***Glomospira urgoniana* Arnaud-Vanneau, 1980**
(Figure 5/3)

1983 *Glomospira urgoniana* Arnaud-Vanneau, Chiocchini and collaborators, p. 172, pl. 1, figs. 14-16.

This form presents the test with the proloculus followed by undivided tubular second chamber that is streptospirally coiled somewhat irregularly, wall finely agglutinated, aperture at the open end of the tube.

Remarks—*Glomospira urgoniana* Arnaud-Vannea was recorded from the subalpine platform and the Oman-southern Iran region (Arnaud-Vanneau, 1986). This species was also reported from Venezuela (Masse and Rossi, 1987).

Superfamily: Lituolacea de Blainville, 1827

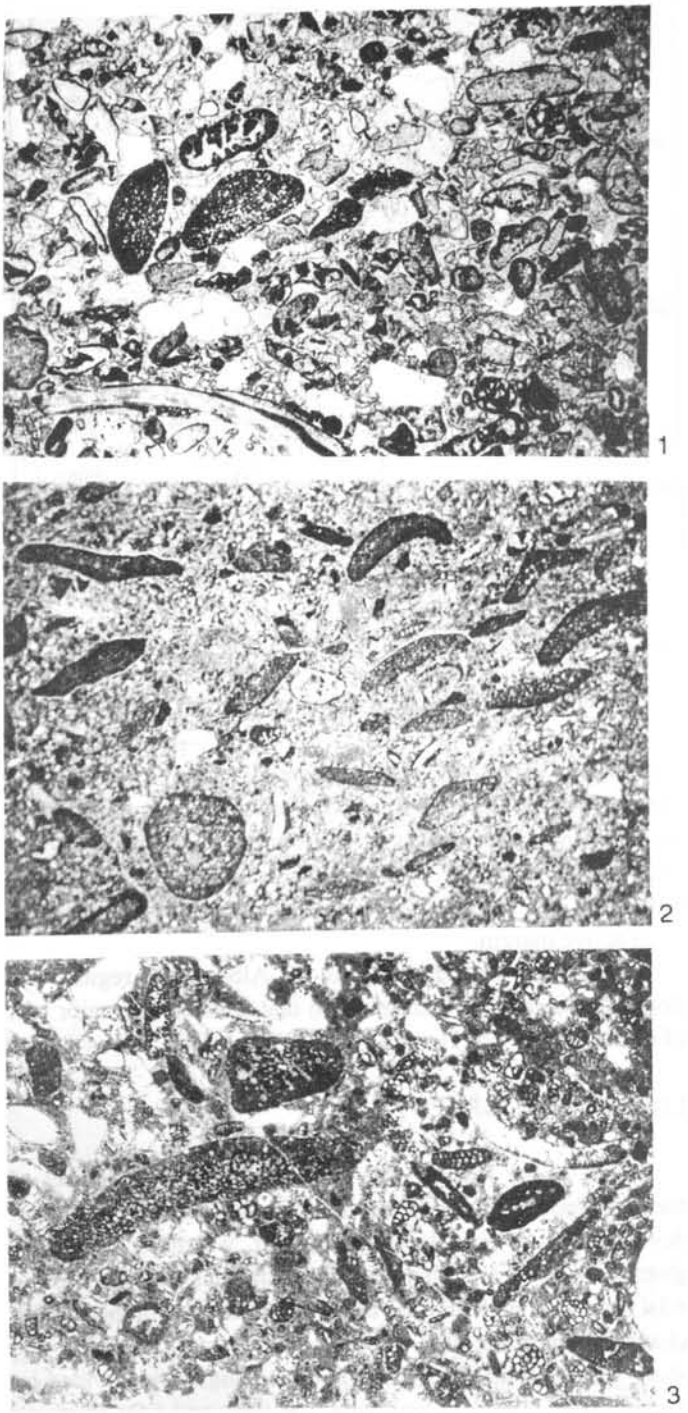

Figure 4. *1,* Rudstone with *Palorbitolina lenticularis* 1.6x, sample JP95469-13. *2,* Floadstone with *Palorbitolina lenticularis* 1x, sample JP95469-1. *3,* Packstone with *Palorbitolina lenticularis*, *Choffatella* aff. *decipiens*, *Debarina* cf. *D. hahounerensis*, *Cuneolina* sp. and smaller foraminifera, 3x, sample 95469-3.

Family: Haplophragmoididae Maync, 1952
Genus: *Debarina* Fourcade, Raoult and Vila 1972

***Debarina* cf. *D. hahounerensis* Fourcade, Raoult and Vila**
(Figure 6/4)

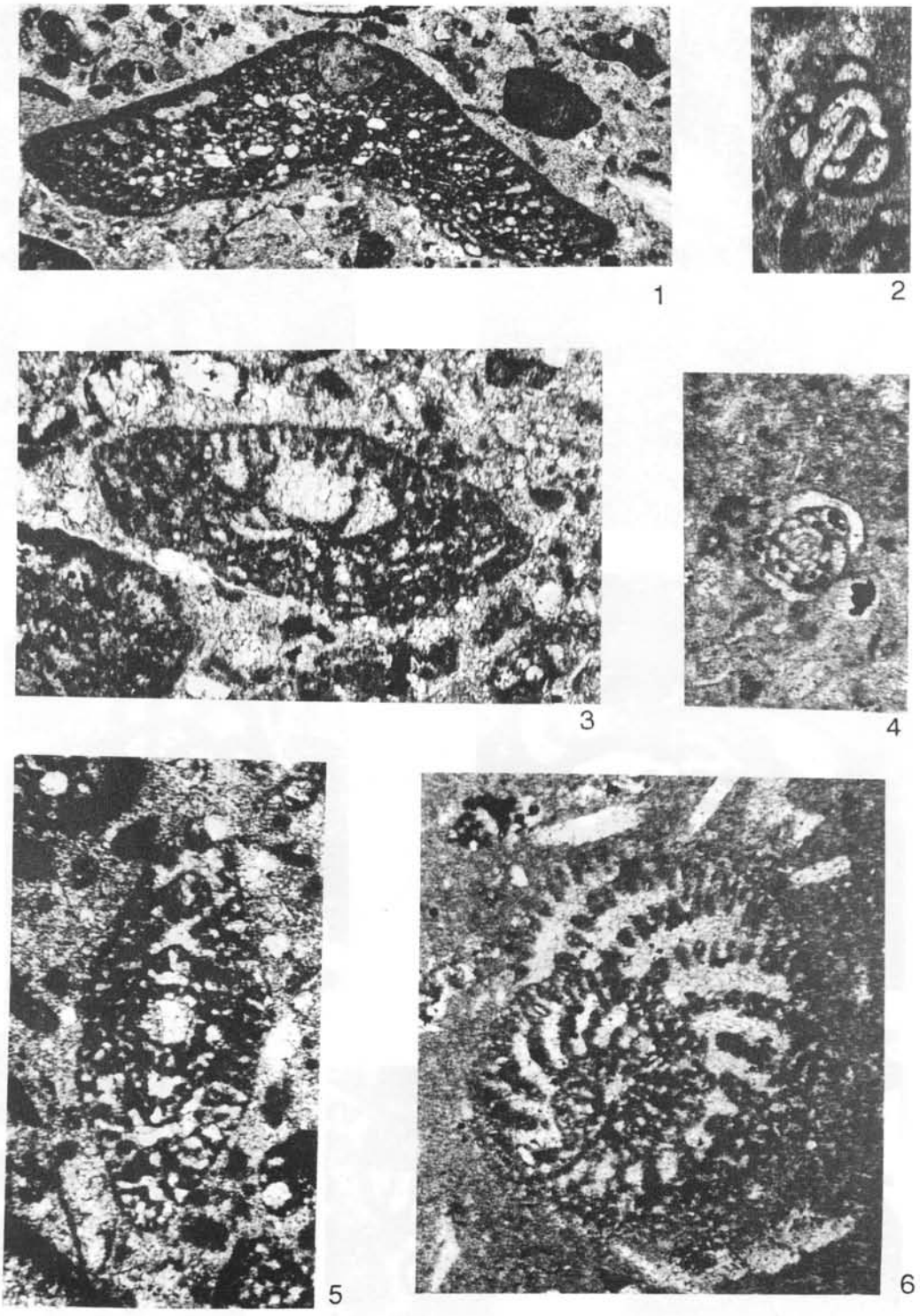

Figure 5. *1, 3*, *Palorbitolina lenticularis* (Blumenbach), sample JP 95469-1. *1,* Subaxial section of megalospheric form showing the embryonic apparatus, 48x. *3*, Axial section of young form showing the embryonic chamber with the periembryic ring, 87x. *2*, *Glomospira watersi* Loeblich, sample JP 95469-3, subaxial section showing the tubular second chamber winding irregularly, 80x. *4*, *Glomospira urgoniana* Arnaud-Vanneau, sample JP 95469-8, subequatorial section showing the second chamber streptospirally coiled, 75x. 5, 6, *Choffatella* aff. *Ch. decipiens* Schlumberger. *5,* Sample JP95469-1, axial section showing the proloculus and the alveolar inner layer, 88x. *6,* Sample JP95469-7, equatorial section showing the numerous chambers planispirally enrolled, 63x.

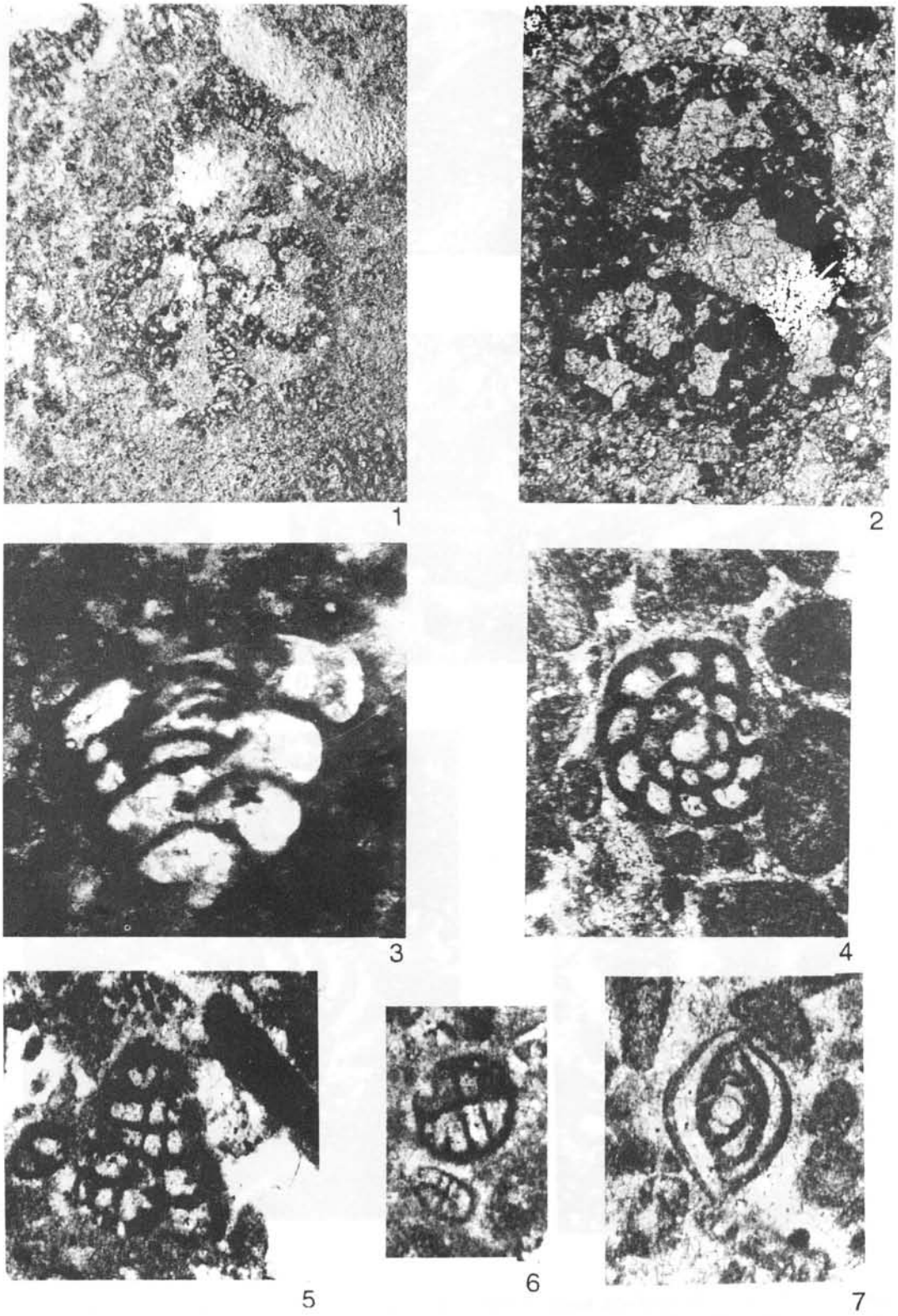

Figure 6. *1, 2, Everticyclammina hedbergi* (Maync). *1,* Sample JP95469-11, equatorial section showing the chambers wedgelike, 30x. *2,* Sample JP95469-1, subequatorial section showing the wall agglutinated with small foraminifers,.25x. *3, Praechrysalidina infracretacea* Luperto-Sinni, sample JP95469-22, axial section showing the triserial coiled, 80x. *4, Debarina* cf. *D. hahounerensis* Fourcade, Raoult and Vila, sample JP95469-3, subequatorial sections showing the aperture at base of septa, 88x. 5, 6, *Cuneolina* sp. Sample JP95469-3. *5,* Axial section showing the rectangular chamberlets, 90x. *6,* Transversal section showing the partitions perpendicular to the outer wall 90x. *7, Spiroloculina* sp., sample JP95469-3, axial section showing the fusiform outline and planispiral coiling, 80x.

Test planispirally enrolled, partially to completely involute; chambers six to nine per whorl, enlarging very slowly as added. Wall microgranular calcareous, probably agglutinated, structure simple, aperture a row of pores at the base on the apertural face.

Remarks—The Mexican specimens are here named *Debarina* cf. *D. hahounerensis* because they differ from the type species *Debarina hahounerensis* described by Fourcade, Raoult and Vila (1972), in having more chambers per whorl (10 to 14). It is important to know that Luperto-Sinni and Masse (1984) recorded some forms from Italy (Monterico limestone) with few chambers like the specimens identified from the Huetamo samples.

Superfamily: Cyclolinacea Loeblich and Tappan, 1964
Family: Cyclamminidae Marie, 1941
Subfamily: Buccicrenatinae Loeblich and Tappan, 1985
Genus: *Everticyclammina* Redmond, 1964

***Everticyclammina hedbergi* (Maync) 1953**
(Figure 6/1-2)

1953 *Pseudocyclammina hedbergi* Maync, p. 101, pl. 16, figs. 1-8.
1983 *Everticyclammina hedbergi* (Maync) Chiocchini and collaborators, 1983, p. 173, pl. 1, fig. 20.
1983 *Everticyclammina hedbergi* (Maync) Canérot, p. 134, pl. 1, fig. 5.

Test planispirally enrolled and involute, lenticular or slightly compressed, later with a tendency to uncoil. Chambers wedgelike, radial sutures slightly curved; wall agglutinated showing a coarsely labyrinthic interior structure. The test sometimes contains incorporated small foraminifers.

Remarks—*Everticyclammina hedbergi* was recorded from the Urgo-Aptian and Albian of Venezuela (Late Barranquín Formation and Lower Cogollo Limestone) by Maync (1953) and Masse and Rossi (1987). Also, it has been reported from Lazio, Italy, (Chiocchini *et al.,* 1983) and the Eastern Iberides (Canérot, 1983).

Subfamily: Choffatellinae Maync, 1958
Genus: *Choffatella* Schlumberger, 1905

***Choffatella* aff. *Ch. decipiens* Schlumberger, 1905**
(Figure 5/5-6)

Test planispirally involute, 16 chambers in the last whorl wall, with imperforate layer and alveolar inner layer, aperture in slight depression.

Remarks—The described species differs from *Choffatella decipiens* Schlumberger in having a less compressed test and fewer whorls and chambers, being very similar in other features; it is assigned as *Choffatella* aff. *Ch. decipiens.* Besides, because of its association with *Palorbitolina*, it is assumed that the palaecological aspects have resemblance.

Superfamily: Ataxophragmiacea Schwager, 1877
Family: Ataxophragmidae Schwager, 1877
Subfamily: Ataxophragminae Schwager, 1877
Genus: *Praechrysalidina* Luperto Sinni, 1979

***Praechrysalidina infracretacea* Luperto-Sinni, 1979**
(Figure 6/3)

1979 *Praechrysalidina infracretacea* Luperto-Sinni, p. 6-7, pl. 1-3.
1983 *Praechrysalidina infracretacea* Luperto-Sinni, Chiocchini and collaborators, p. 172, pl. 1, figs. 22-23.
1985 *Praechrysalidina infracretacea* Luperto-Sinni, Schroeder and Neumann, p. 14, pl. 6, figs. 1-10.

Test conical triserial, wall calcareous, thick, microgranular, dark, agglutinated material sparse, aperture terminal, cribate, consisting of numerous pores restricted to a well defined area.

Remarks—This species was described at the "*Palorbitolina lenticularis* level" of the terminal part of the early Aptian from the Murges de Bari (Italy) by Luperto-Sinni (1979). It has also been found in the Aptian and Albian (Chiocchini *et al.,* 1983) of Lazio (Italy).

Family: Cuneolinidae Saidova, 1981
Subfamily: Cuneolininae Saidova, 1981
Genus: *Cuneolina* d'Orbigny, 1839

***Cuneolina* sp.**
(Figure 6/5-6)

Small test conical with the chambers subdivided into nearly rectangular chamberlets by radial partitions. Wall agglutinated imperforate.

Superfamily: Orbitolinacea Martin, 1890
Family: Orbitolinidae Martin, 1890
Subfamily: Orbitolininae Martin, 1890
Genus: *Palorbitolina* Schroeder, 1963

***Palorbitolina lenticularis* (Blumenbach, 1805)**
(Figure 5/1-3)

1805 *Madreporites lenticularis* Blumenbach, pl. 80, fig. 1-6.
1960 *Orbitolina lenticularis* (Blumenbach), Douglas, p. 31, pl. 1, fig. 1-26.

1963 *Orbitolina* (*Palorbitolina*) *lenticularis* (Blumenbach), Schroeder, p. 348, pl. 23, figs. 1-9, pl. 24, figs. 1-10.
1971 *Orbitolina conoidea* Grass, Sen Gupta and Grant, p. 934, fig. 3.
1964 *Palorbitolina lenticularis* (Blumenbach), Schroeder, p. 465.
1980 *Palorbitolina lenticularis* (Blumenbach), Meza, p. 20, pl. 1, figs. 1-9, p. 23, pl. 2, fig. 12.
1994 *Palorbitolina lenticularis* (Blumenbach), Pantoja-Alor and collaborators, p. 215, pl. 1, figs. 1-5.

This large species presents the megalospheric apparatus in apical position, characterized by a relatively large embryonic cavity, covered by a layer of small subepidermal chamberlets and laterally bordered by a periembryonic ring. The diameter of the proloculus varies between 0.12 and 0.28 mm.

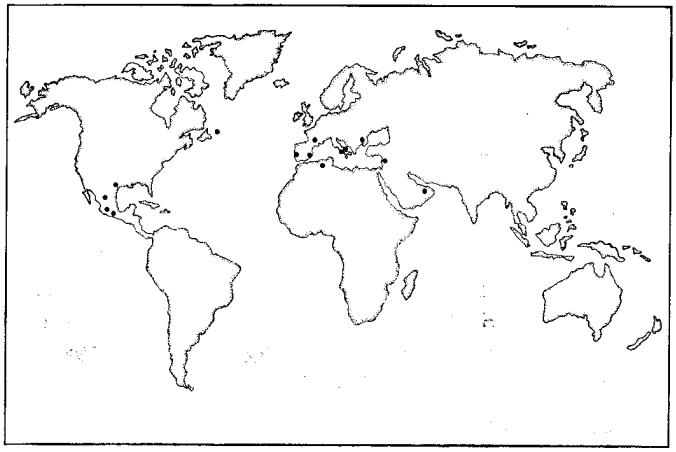

Figure 7. Geographical map of *Palorbitolina lenticularis* distribution.

Remarks—*Palorbitolina lenticularis* was widely distributed on the carbonate platforms of the Tethys Realm (Figure 7).

It is recorded from Italy (Luperto-Sinni and Masse, 1982, 1984, 1986; Chiocchini *et al.*, 1983); Spain (Vilas *et al.*, 1995); Portugal (Rey, 1973); France (Masse, 1995); the Prebalkans region Bulgaria (Peybernes *et al.*, 1979); Lebanon (Saint Marc, 1970); Alger (Leikine and Vila, 1975); Oman (Masse and Chartrousse, 1996).

From the American continent, this large foraminifer was reported by Schroeder and Cherchi (1979) from the south of the Grands Banks (North Atlantic). Before, Sen Gupta and Grant (1971) registered *Palorbitolina lenticularis* with the name of *Orbitolina conoidea* from the Flemish Cap.

In Mexico, Meza (1980) recorded this species from different localities: Los Humeros (Puebla); Characo anticline (Guerrero); Potrero de Oballos (Coahuila) and Sierra Cadena (Durango). Recently, *Palorbitolina lenticularis* has also been found in the Comburundio Formation (Michoacán), associated with rudists and algae (Pantoja-Alor *et al.*, 1994).

Suborder: Miliolina Delage and Hérouard
Superfamily: Miliolacea Ehrenberg, 1839
Family: Spiroloculinidae Weisner, 1920
Genus: *Spiroloculina* d'Orbigny, 1826

***Spiroloculina* sp.**
(Figure 6/7)

Test ovate, proloculus followed by a planispirally tubular second chamber of one whorl in length, wall calcareous, imperforate, porcelaneous.

Age—In the Barremian stage, the Orbitolinidae explosion occurred and originated the establishment of a specific diversification very important; this event permits an accurate biostratigraphic subdivision of the Aptian-Albian (Moullade, 1974).

The analyzed section contains the orbitolinid *Palorbitolina lenticularis,* which is considered the most important taxon to determine the age of the El Cajón Formation.

The reported range of this species is late Barremian to earliest late Aptian in the Old World Tethys (Schroeder, 1963).

On the other hand, the *Palorbitolina* beds are considered as late Barremian-early Aptian (Vilas *et al.*, 1995; Schroeder and Cherchi, 1979; Peybernes *et al.,* 1978; Meza, 1980; Masse and Chartrousse, 1996).

However, this species has been recorded mainly from lower Aptian strata (Luperto-Sinni and Masse, 1982, 1984, 1986; Saint Marc, 1970, 1977; Pantoja-Alor *et al.*, 1994).

The age of the El Cajón Formation, considered early Aptian, is based on the size of the megalospheric embryonic apparatus of *Palorbitolina lenticularis*. This age is confirmed by the presence of the benthic foraminiferal association including *Praechrysalidina infracretacea, Debarina* cf. *D. hahounerensis, Everticyclammina hedbergi*, *Choffatella* aff. *Ch. decipiens* and *Glomospira urgoniana.*

PALEOENVIRONMENT

Palorbitolina lenticularis is known from various shallow-water deposits, but is mainly abundant in muddy deposits of more or less marly carbonate, where it tends to be dominant, and is associated with a microfauna consisting of smaller foraminifera and few larger genera as *Choffatella* and *Everticyclammina* (Vilas *et al.*, 1995).

Notwithstanding the conspicuous character as facies index of *Palorbitolina lenticularis,* it has been reported from a relatively wide range of paleoenvironments, from the infralittoral zone (Rey, 1975; Arnaud-Vanneau, 1980), as far as deeper circalittoral conditions (Masse, 1976). Arnaud-Vanneau (1980) referred this species with different forms to infralittoral and circalittoral environments. Later, Arnaud (1981) proposed three settings: circalittoral, infralittoral and marly channels for three distinctive subspecies of *Palorbitolina lenticularis.*

Recently, Vilas and collaborators (1995), based on an Iberic-Prebetic example, explain a model with the *Palorbitolina* facies, present throughout the whole platform, from the littoral to the outer shelf area.

The present investigation, based on the lithology and the benthic foraminiferal association, suggests that the deposits of the El Cajón Formation coincide with the regional transgression of the Barremian-Aptian, allowing the development of rudist bioherms and the beds with a *Palorbitolina* assemblage.

This facies suggests an environment of open shallow-warm water deposited on a carbonate platform, with a limited but significant fine siliciclastic contribution (Figure 4) and rich nutrient water, where the spreading of *Palorbitolina lenticularis* occurred, together with *Choffatella* and other foraminifera.

PALEOBIOGEOGRAPHY

The paleobiogeographic distribution of the larger foraminifera was controlled by different biologic, climatic and geodynamic factors (Bassoullet *et al.*, 1985).

The benthic foraminiferal association, reported from the El Cajón Formation, shows a Tethysian affinity, with the presence of *Palorbitolina lenticularis*, which was widely distributed in the Tethys Realm of the Old World.

During the early Aptian this species extended as far as the American continent (Bassoullet *et al.*, 1985; Arnaud-Vanneau, 1986; Pantoja-Alor *et al.*, 1994).

Frequently, associated with *Palorbitolina*, is found *Choffatella,* considered a cosmopolitan form (Pélissié *et al.*, 1982), as well as *Everticyclammina hedbergi*, that was reported from Venezuela (Maync, 1953; Masse and Rossi, 1987). This species has been observed in other regions such as in Lazio, Italy (Chiocchini *et al.*, 1983), the Eastern Iberides (Canérot, 1983), Lebanon (Saint Marc, 1970) and Algiers (Leikine and Vila, 1975).

Finally, the occurrence of *Debarina* cf. *D. hahounerensis, Glomospira urgoniana* and *Praechrysalidina infracretacea* clearly shows the existence of a homogeneous province in which the foraminiferal assemblage shared the same paleoecological conditions during the early Aptian.

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