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PERMIAN FAUNA OF THE LOS ARCOS FORMATION, MUNICIPALITY OF OLINALÁ, STATE OF GUERRERO, MEXICO

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ABSTRACT

This paper documents the faunal assemblage of the Los Arcos Formation, in the Olinalá region, in northeastern State of Guerrero. A Middle Permian age is assigned based on ammonoids.

The illustrated brachiopods are *Orbiculoidea ovalis* Cloud, *Thamnosia depressa* (Cooper), *Spiriferellina cristata* (Von Schlotheim), *Cancrinella rugosa* Cloud, *Leiorhynchoidea schucherti* Cloud, *Krotovia* sp., *Wellerella* sp., *Hustedia* sp., *Composita* sp., *Costiferina* sp.; the gastropod *Babylonites carinatus* Yochelson; the nautiloids *Bitaunioceras coahuilensis* Miller and *Metacoceras* sp.; the ammonoids *Paraceltites elegans* Girty, *Waagenoceras dieneri* Böse, *Pseudogastrioceras roadense* (Böse), and *Stacheoceras toumanskyae* Miller and Furnish; the pelecypod *Posidoniella* sp.; columnals of the crinoid *Preptoprennum rugosum* Moore and Jeffords; and the conulariid *Paraconularia* sp.

Key words: Middle Permian, ammonoids, brachiopods, pelecypods, State of Guerrero, Mexico.

RESUMEN

Esta investigación se refiere al conjunto faunístico proveniente de la Formación Los Arcos, que aflora en la región de Olinalá, en la parte nororiental del Estado de Guerrero. Con base en las especies de los amonoideos, se ha asignado a los estratos una edad del Pérmico Medio.

Los fósiles ilustrados son los braquiópodos *Orbiculoidea ovalis* Cloud, *Thamnosia depressa* (Cooper) , *Spiriferellina cristata* (Von Schlotheim), *Leiorhynchoidea schucherti* Cloud, *Cancrinella rugosa* Cloud, *Leiorhynchoidea schucherti* Cloud, *Krotovia* sp., *Wellerella* sp., *Hustedia* sp., *Composita* sp., *Costiferina* sp.; el gasterópodo *Babylonites carinatus* Yochelson; los nautiloideos *Bitaunioceras coahuilensis* Miller y *Metacoceras* sp.; los amonoideos *Paraceltites elegans* Girty, *Waagenoceras dieneri* Böse, *Pseudogastrioceras roadense* (Böse) y *Stacheoceras toumanskyae* Miller y Furnish; el pelecípodo *Posidoniella* sp.; la columnela del crinoide *Preptoprennum rugosum* Moore y Jeffords y, por último, el conulárido *Paraconularia* sp.

Palabras clave: Pérmico Medio, amonoideos, braquiópodos, pelecípodos, Estado de Guerrero, México.

INTRODUCTION

The recent discovery of Paleozoic sedimentary rocks in southern Mexico (Corona-Esquivel, 1981) and the recognition of their paleontological significance and importance to the geological reconstruction of southern Mexico motivated the Instituto de Geología to carry out a detailed study of the fossil faunas in the region of Olinalá, State of Guerrero.

This work, which began in 1985, resulted in the discovery of an invertebrate fossil assemblage composed of ammonoids, nautiloids, brachiopods, pelecypods, crinoids, gastropods, and a conulariid that indicates a Permian age for the Los Arcos Formation. Also, the biostratigraphic range of a crinoid group, previously restricted to the Mississippian period, has now been extended to the Permian. The fauna is sparse but very well-preserved. Studied specimens are deposited in the paleontological collection at the Instituto de Geología, UNAM.

The present study has the following objectives: (a) to provide a description of the invertebrate fauna assemblage of Olinalá; (b) to compare the ammonoid and brachiopod species with those from other localities; and (c) to define the biostratigraphy of the Paleozoic sedimentary succession of the studied area.

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LOCATION AND ACCESSIBILITY

The fossil locality is in the northeastern part of the State of Guerrero, within the area comprised by the towns of Olinalá, Huamuxtitlán and Cualac—geographic coordinates 17°45' - 17°50' N and 98°40' - 98°45' W (Figure 1). From Mexico City, it can be reached by taking Federal Route 95 to the south toward Acapulco. At Chilpancingo, one should take the road that leads to the east to Chilapa and Tlapa; at Km 141, take dirt road for a distance of 28 km to reach Olinalá, which is to the north. An alternate access is by Federal Route 140 from Mexico City to Cuautla, Izúcar de Matamoros and Acatlán. Before Acatlán—28 km—the side road to the south leads to Huamuxtitlán, Cualac and Olinalá.

To reach the type locality of the Los Arcos Formation, one should start at Olinalá and go toward Cualac; at Km 2.4 is Los Arcos, the remains of an old aqueduct. From there, one should continue on foot along a stream and a limestone outcrop, Unit 5, which is approximately 600 m downstream. Subsequent units are exposed farther downstream. Units 1-7 also crop out in the stream that crosses the road between Olinalá and Mexteopan (Figure 2).

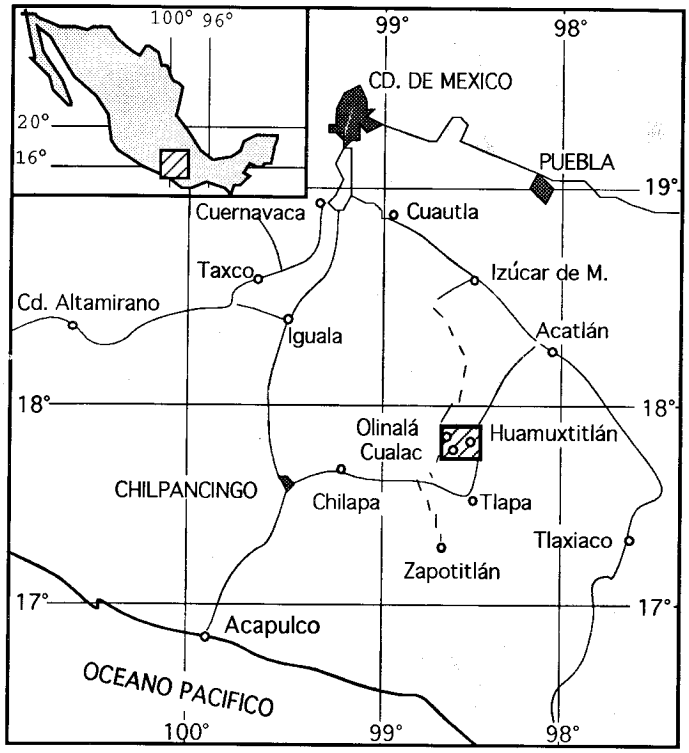

Figure 1.- Location map of the Olinalá-Huamuxtitlán area.

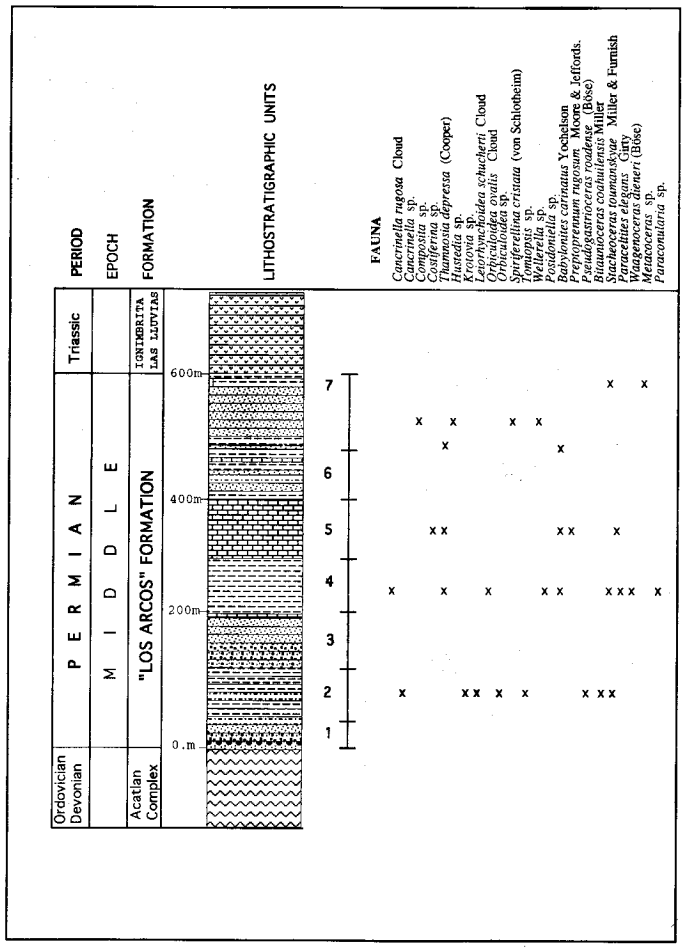

Figure 2.- Stratigraphic section and fossil assemblages.

PREVIOUS STUDIES

Studies concerning the structural geology and lithological succession were carried on by Jenny (1933), Guzmán (1950) and Benavides (1978). Corona-Esquivel (1981) defined the stratigraphy of the Olinalá-Tecocoyunca region in the northeastern part of the State of Guerrero, where he reported Late Permian ammonoids. Later, Corona-Esquivel and Boardman (1982) presented the results of research on the Permian marine environment in the Cualac region. Flores and Buitrón (1982) published a geological-paleontological study of the northeastern part of this state. In 1984, González-Arreola and Corona-Esquivel reported new ammonoid species. Corona-Esquivel (1985) also completed a geological study of the region between Olinalá and Huamuxtitlán.

STRATIGRAPHY

In the study area, metamorphic, sedimentary and igneous rocks crop out; the oldest ones, early Paleozoic in age, belong to the Acatlán Complex and constitute the basement. These rocks are unconformably overlain by a sedimentary rock cover that has a thickness of approximately 3,800 m (Corona-Esquivel, 1981); the oldest unit in this sedimentary cover and the main interest of this study, is the Permian Los Arcos Formation.

The Las Lluvias ignimbrite of Triassic(?) age and the Cualac Conglomerate of the Middle Jurassic lie unconformably on the Los Arcos Formation.

The fauna mentioned in this paper originates from Units 2,4,5 and 7, and the geology of these units is described by Corona-Esquivel (*op. cit.*; Figure 2).

BIOSTRATIGRAPHY AND GEOGRAPHIC DISTRIBUTION

The biostratigraphic section illustrated herein (Figure 2) is based on surveys done by Corona-Esquivel in 1979 and published in 1981; the lithostratigraphic units described by this author are accepted and the reader is referred to this paper for further information concerning the lithology of these units.

The illustrated material is deposited in the paleontological collection at the Instituto de Geología, UNAM, using the initials IGM.

The assemblages of each unit (Figure 2) and the biostratigraphic and geographic distributions are described below.

The first unit (Unit 1), which unconformably overlies the Acatlán Complex, contains no fauna; the overlying unit (Unit 2) has abundant ammonoids, brachiopods and nautiloids. The ammonoids belong to *Pseudogastrioceras roadense* (Böse) (Plate 1, figures i-k), and *Stacheoceras toumanskyae* Miller and Furnish (Plate 1, figures f, g), and the nautiloid to *Bitauniceras coahuilensis* Miller (Plate 1, figure a). The brachiopods are *Leiorhynchoidea schucherti* Cloud (Plate 3, figures

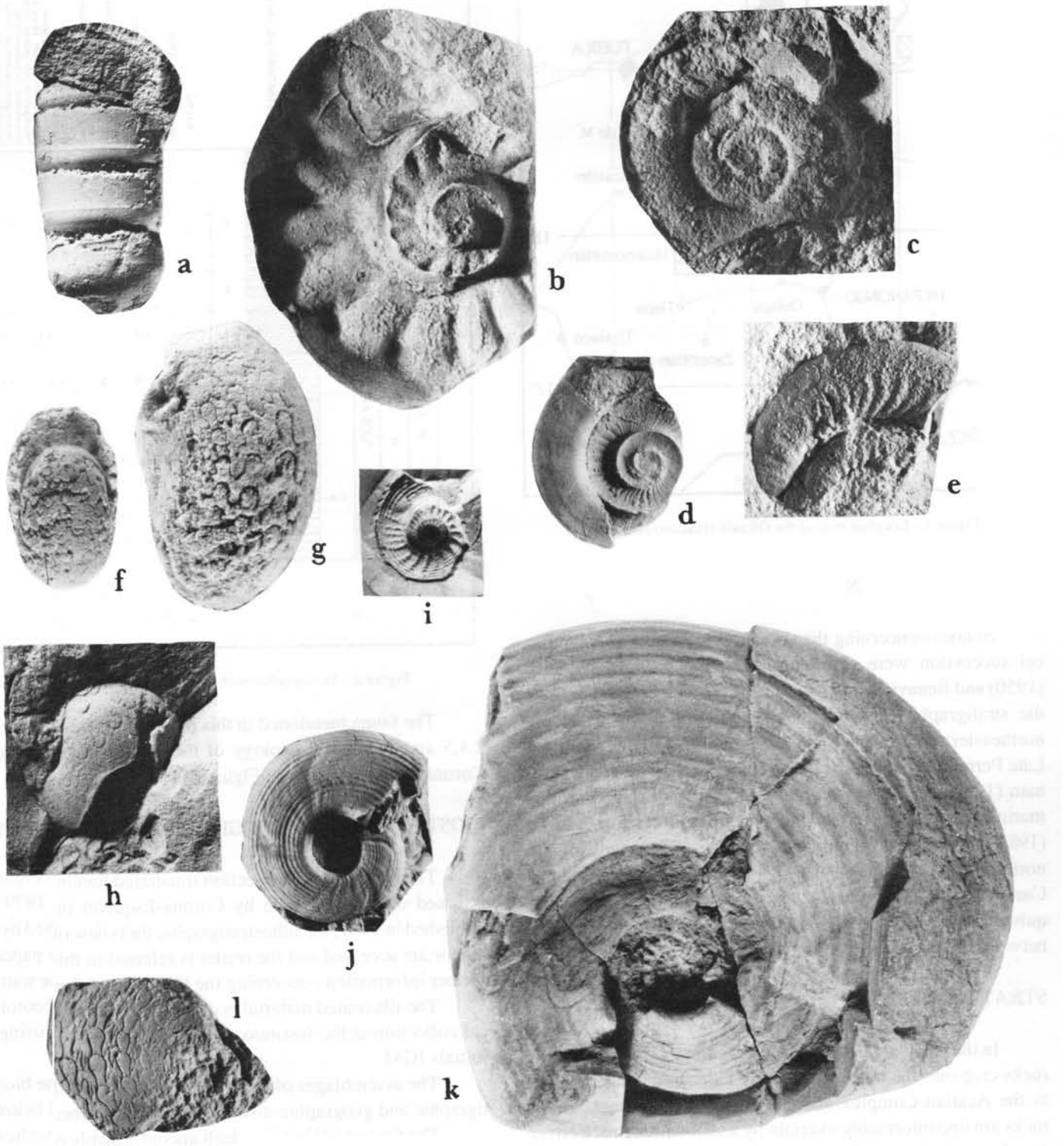

Plate 1.- (All figures natural size). a, *Bitauniocerascoahuilensis* Miller, Middle Permian, IGM 4840; b, *Metacoceras* sp., Middle Permian, IGM 4841; c, *Paraceltites elegans* Girty, Middle Permian, IGM 4842; d, *Paraceltites elegans* Girty, Middle Permian, IGM 3822; e, *Paraceltites elegans* Girty, Middle Permian, IGM 4843; f, *Stacheoceras toumaskyae* Miller and Furnish, Middle Permian, IGM 4844; g, *Stacheoceras toumaskyae* Miller and Furnish, Middle Permian, IGM 4845; h, *Waagenoceras dieneri* (Böse), Middle Permian (Guadalupian), IGM 4846; i, *Pseudogastrioceras roadense* (Böse), Middle Permian, IGM 4847; j, *Pseudogastrioceras roadense* (Böse), Middle Permian, IGM 4849; k, *Pseudogastrioceras roadense* (Böse), Middle Permian, IGM 4848; l, *Stacheoceras toumanskyae* Miller and Furnish, Middle Permian, IGM 5076.

h, i), *Tomiopsis* sp. (Plate 2, figures h, i), *Krotovia* sp. (Plate 3, figure d), *Orbiculoidea* sp. and *Cancrinella* sp.

Pseudogastrioceras roadense (Bösc) has a wide geographic distribution; the Tethyan realm dominates and it is observed throughout the Permian; in Mexico, this species has been recognized from the Permian of Las Delicias, Coahuila (King *et al.*, 1944). *Stacheoceras toumanskyae* Miller and Furnish has been found in the Middle Permian of Las Delicias, Coahuila (King, *op. cit.*; Wardlaw *et al.*, 1979).

The nautiloid *Bitauniocerasa coahuilensis* Miller has also been recognized in Las Delicias, as well as in Texas, Sicily, Timor and the Urals. This species ranges throughout the Permian (Sweet, 1964).

With respect to the brachiopods, *Leiorhynchoidea schucherti* Cloud is known only from the Permian of Las Delicias (King *et al.*, 1944; Warldlaw *et al.*, 1979); *Tomiopsis* sp., with an eastern distribution, has been found in Australia, Russia, and Asia, and ranges from the Carboniferous to the Permian; the genus *Krotovia* sp. is cosmopolitan and ranges from the Mississippian to Lower-Upper (?) Permian; *Orbiculoidea* sp. also has a cosmopolitan distribution and it extends from the Ordovician to the Permian; and *Cancrinella* sp. ranges from the Pennsylvanian to the Permian and it has been recorded in Europe, Asia, Australia and North America (Ager *et al.*, 1965).

No fauna has been found in Unit 3. Unit 4 yielded a diverse and abundant fauna: ammonoids, pelecypods, gastropods, brachiopods and one conulariid. Ammonoids were assigned to *Stacheoceras toumanskyae* Miller and Furnish (Plate 1, figure l); *Paraceltites elegans* Girty (Plate 1, figures c-e); and *Waagenoceras dieneri* Böse (Plate 1, figure h). Of these, *Paraceltites elegans* Girty ranges from Lower to Middle Permian (Spinosa *et al.*, 1975) and is known in Texas as well as in Las Delicias. Lastly, *Waagenoceras dieneri* Böse is an index fossil of the middle part of the Middle Permian (Guadalupian) in the southern United States and in Las Delicias, Coahuila, Mexico (King *et al.*, 1944; Warldlaw *et al.*, 1979).

Pelecypods have been assigned to the genus *Posidoniella* sp. (Plate 2, figures a-c). This genus has been known from the Mississippian of the United States and the Carboniferous of Europe (Cox *et al.*, 1969).

Gastropods were assigned to *Babylonites carinatus* Yochelson (Plate 2, figures f, g). This species is characteristic of the North American Middle Permian (Knight *et al.*, 1960).

This unit has yielded the brachiopod *Thamnosia depressa* (Cooper) (Plate 3, figure c), and several specimens of *Orbiculoidea ovalis* Cloud (Plate 2, figures j, k) as well as one specimen of *Cancrinella rugosa* Cloud (Plate 3, figures f, g). *Thamnosia depressa* (Cooper) has been interpreted to be of Middle Permian age for El Antimonio, Sonora, Mexico (Cooper *et al.*, 1965); previously, it was recognized in the study area of this paper by Flores and Buitrón (1982); however, the exact stratum in which it was found was not specified. *Orbiculoidea ovalis* Cloud and *Cancrinella rugosa* have been interpreted to be of Middle Permian age for Las Delicias, Coahuila, Mexico (King *et al.*, 1944; Warldlaw *et al.*, 1979).

The conulariid was assigned to *Paraconularia* sp. (Plate 2, figure e) and it compares with a specimen recognized by Finks (1955), which is from western Texas and of Permian age.

Unit 5 contains crinoid ossicles, mostly fragmented, a few bryozoans and one ammonoid. Crinoids having distinctive columnals were assigned to *Preptoprennum rugosum* Moore and Jeffords (Plate 2, figure 4), which is known from the Upper Pennsylvanian of the United States (Moore and Jeffords, 1968). The ammonoid was assigned to *Paraceltites elegans* Girty (Plate 1, figure c) and its geographic distribution and stratigraphic range have been previously mentioned.

In a section located between Rancho Viejo and Llano Grande, northeast of Olinalá, a change of facies from limestone to sandstone and limestone was observed. The calcareous sequences have yielded abundant gastropods, which were assigned to *Babylonites carinatus* Yochelson, as well as the brachiopods *Thamnosia depressa* (Cooper) (Plate 3, figures a, b) and *Costiferina* sp. (Plate 3, figure e); this last genus is characteristic of the Asian Permian (Ager *et al.*, 1965).

Fossil fauna is unknown in the overlying unit (Unit 6), but Unit 7, the last Paleozoic sedimentary unit, shows a relatively abundant faunal assemblage which is represented by ammonoids, nautiloids, brachiopods and gastropods. At the base of this unit, *Thamnosia depressa* (Cooper) and *Babylonites carinatus* Yochelson were found once again. The ammonoids were assigned to *Stacheoceras toumanskyae* Miller and Furnish. The geographic distribution and stratigraphic range of this fauna are mentioned above.

The nautiloid belongs to *Metacoceras* sp. (Plate 1, figure b); it has a cosmopolitan distribution and ranges from Pennsylvanian to Permian (Kummel, 1964).

Other brachiopods were assigned to *Spiriferellina cristata* (Von Schlotheim) (Plate 3, figures q, r), *Wellerella* sp. (Plate 3, figures j-l), *Hustedia* sp. (Plate 3, figures o, p) and *Composita* sp. (Plate 3, figures m, n). *Spiriferellina cristata* (Von Schlotheim) is known from the German Permian. *Wellerella* sp. and *Hustedia* sp. range from Pennsylvanian to Permian and Carboniferous to Permian, respectively, in Europe, Asia, and America (Guatemala; Stehli and Grant, 1970). *Composita* sp. shows a wide range, from Upper Devonian to Permian, and is known in Europe, North America, Central America (Stehli and Grant, 1970), SE Asia and Australia.

DISCUSSION

The three part division of the Permian (Lower, Middle and Upper) established by the Subcommision on Permian Stratigraphy (Permophiles, 1993) is respected here, since these chronostratigraphic units are internationally recognized.

Doubts have raised about the age of the Los Arcos Formation, since Flores and Buitrón (1982) report a fauna of

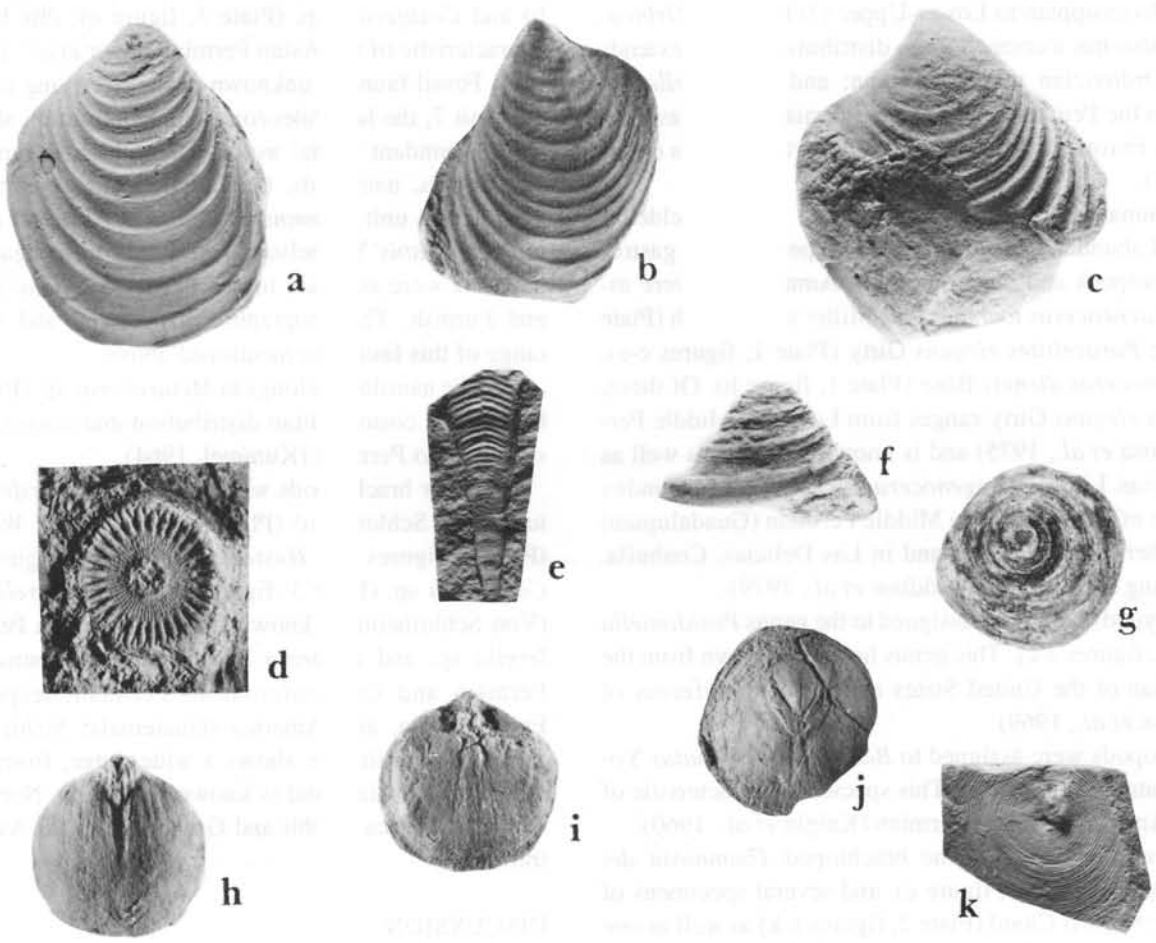

Plate 2.- (All figures natural size). a, *Posidoniella* sp., Middle Permian, IGM 5077; b and c, *Posidoniella* sp., Middle Permian, IGM 5078; d, *Preptoprennum rugosum* Moore and Jeffords, Middle Permian, IGM 5079; e, *Paraconularia* sp., IGM 5080; f and g, *Babylonites carinatus* Yochelson, Middle Permian, IGM 4839; h and i, *Tomiopsis* sp., Middle Permian, IGM 4838; j, *Orbiculoidea ovalis* Cloud, Middle Permian, IGM 4822; k, *Orbiculoidea ovalis* Cloud, Middle Permian, IGM 4823.

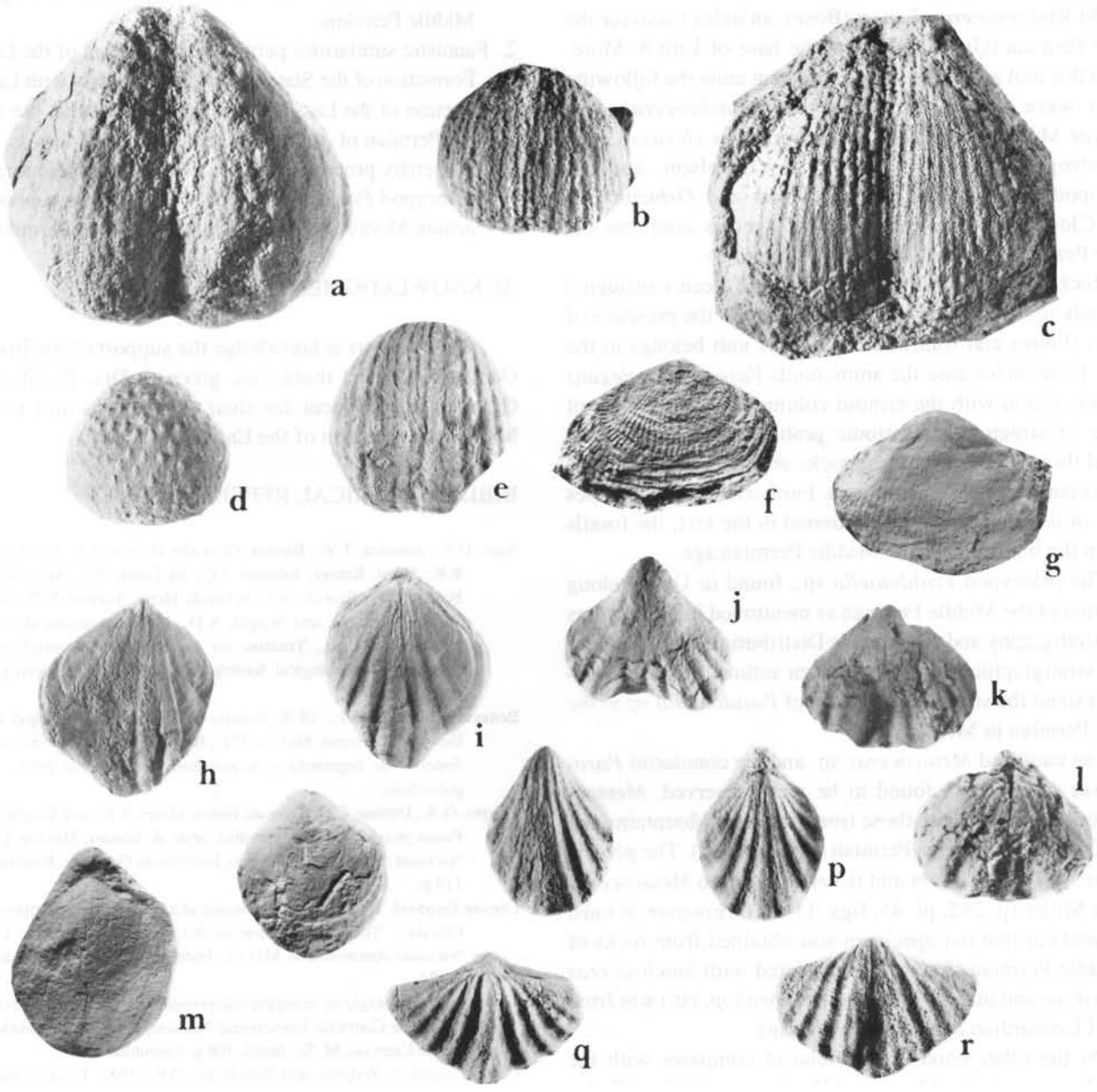

Plate 3.- (All figures natural size). a, *Thamnosia depressa* (Cooper), Middle Permian, IGM 4825; b, *Thamnosia depressa* (Cooper), Middle Permian, IGM 4826; c, *Thamnosia depressa* (Cooper), Middle Permian, IGM 4827; d, *Krotovia* sp., Middle Permian, IGM 4824; e, *Costiferina* sp., Middle Permian, IGM 4828; f, *Cancrinella rugosa* Cloud, Middle Permian, IGM 4829; g, *Cancrinella rugosa* Cloud, Middle Permian, IGM 4839; h and i, *Leiorhynchoidea schucherti* Cloud, Middle Permian, IGM 4831; j, *Wellerella* sp., Middle Permian, IGM 4832; k and l, *Wellerella* sp., Middle Permian, IGM 4833; m, *Composita* sp., Middle Permian, IGM 4835; n, *Composita* sp., Middle Permian, IGM 4836; o and p, *Hustedia* sp., Middle Permian, IGM 4834; q and r, *Spiriferellina cristata* (Von Schlotheim), Middle Permian, 4837.

Pennsylvanian age in this formation. However, the research carried out for the present paper, involving faunas collected from all stratigraphic levels, eliminates any doubt that the age for the Los Arcos Formation be Middle Permian. This conclusion is based on the following evidence:

(a) The base of the formation, Units 2 and 3, has *Stacheoceras toumanskyae* Miller and Furnish, an index to the Middle Permian, as well as *Pseudogastrioceras roadense* (Böse) and *Leiorhynchoidea schucherti* Cloud; these last two species are restricted to the Permian.

(b) *Waagenoceras dieneri* (Böse), an index fossil for the Middle Permian (Guadalupian), at the base of Unit 4. Moreover, in this unit as well as in the overlying units the following species were found: the ammonoids *Stacheoceras toumanskyae* Miller and Furnish and *Paraceltites elegans* Girty, the gastropod *Babylonites carinatus* Yochelson, and the brachiopods *Cancrinella rugosa* Cloud and *Orbiculoidea ovalis* Cloud. The presence of these species confirms the Middle Permian age for Units 4 to 7 (Figure 2).

Rocks of Unit 5 as defined here had been considered previously to be of Pennsylvanian age, due to the presence of crinoids (Flores and Buitrón, 1982). This unit belongs to the Middle Permian because the ammonoids *Paraceltites elegans* Girty was found with the crinoid columnals, and because of absence of structural or tectonic problems that could have affected these rocks; also, these rocks are over- and underlain by rocks containing Permian fauna. Furthermore, in the facies change of this unit which is mentioned in the text, the fossils found in the limestone are of Middle Permian age.

The pelecypod *Posidoniella* sp., found in Unit 4 along with fauna of the Middle Permian as mentioned in the sections on Biostratigraphy and Geographic Distribution, has a Carboniferous stratigraphic range. The present authors propose therefore to extend the stratigraphic range of *Posidoniella* up to the Middle Permian in Mexico.

The nautiloid *Metacoceras* sp. and the conulariid *Paraconularia* sp. are both found to be well-preserved. *Metacoceras* could compare with those from the Glass Mountains and Sierra Diablo of the Texas Permian (Miller, 1945). The generic assignment is not in doubt and is very similar to *Metacoceras cooperi* Miller (p. 285, pl. 45, figs. 11, 12). However, it must be pointed out that our specimen was obtained from rocks of the Middle Permian (Figure 2) associated with *Stacheoceras toumanskyae* and that the Miller's specimen (*op. cit.*) was from rocks of Leonardian age (Lower Permian).

On the other hand, the conulariid compares with the genera *Paraconularia* (Moore and Harrington, 1967) of Ordovician to Permian ages and with the species *Conularia leonardensi* Finks, from the upper part of the Leonard Formation at Split Tank, Glass Mountains, Texas (Finks, 1955); the specimen illustrated by Finks (*op. cit.*) and the one collected in Olinalá are very similar. However, in view of the fact that there is only a single specimen from the same stratum where a *Waagenoceras dieneri* Böse was collected, it was not assigned to the species mentioned by Finks (*op. cit.*). Therefore, studies of additional specimens of *Metacoceras* and *Paraconularia* from the study area are needed in order to document their features and to determine if any changes should be proposed in the stratigraphic range or classification of these genera.

CONCLUSIONS

1. Based on the study of the faunal assemblage observed, the age for the Los Arcos Formation was confirmed as ranging from Middle Permian.
2. Faunistic similarities permit the correlation of the Los Arcos Formation of the State of Guerrero not only with La Difunta Section of the Las Delicias Valley, Coahuila, but also with the Permian of Asia and Sicily.
3. It is hereby proposed to extend the stratigraphic range of the pelecypod *Posidoniella* and the crinoid *Preptoprennum rugosum* Moore and Jeffords into the Middle Permian.

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