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# MOLLUSK GASTROPODS IN A LOWER CRETACEOUS RUDIST-BEARING FORMATION OF JALISCO, WEST CENTRAL MEXICO

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ABSTRACT

The outcrops of sedimentary rocks of La Presa, Soyatlán de Adentro, Agua Zarca and El Conejo, in the northwest of Tamazula, State of Jalisco, are rich in fauna of rudists, nerineid and cassiopid gastropods which are indicative of Early Cretaceous age (late Aptian-early Albian) and are characteristic of shallow waters of the tropical regions.

The studied gastropods correspond to the species *Microschiza* (*Cloughtonia*) *scalaris* (Conrad), *Mesoglauconia* (*Mesoglauconia*) *burnsi* (Stanton), *Gymnentome* (*Gymnentome*) *zebra* (Gabb), *Pyrazus* (*Echinobathra*) *valeriae* (Verneuil and Lorière), *Lunatia pedernalis* (Roemer), *Natica conradi* (Hill), *Aptyxiella boehmi* Blanckenhorn, *Multiptyxis prefleuriaui* (Delpey), *Cossmannea* (*Eunerinea*) *hicoriensis* (Cragin), *Phaneroptyxis anguillina* (Bárcena and Castillo) and *Peruviella gerthi* Olsson, all of which are described for the first time in Tamazula.

The knowledge of the fauna of Tamazula allowed to establish paleobiogeographic relations with similar faunas of other Mexican regions, south of the United States, Peru, Brazil, Spain, Syrie, Lebanon and Algeria, in order to provide evidences on the western limits of the Caribbean province of the Tethys realm.

Key words: Gastropods, Lower Cretaceous, Jalisco, west central Mexico.

RESUMEN

Los afloramientos de rocas sedimentarias de La Presa, Soyatlán de Adentro, Agua Zarca y El Conejo, al noroeste de Tamazula, en el Estado de Jalisco, son ricos en faunas de rudistas, gasterópodos nerineidos y casiópidos, indicadoras del Cretácico Temprano (Aptiano tardío-Albiano temprano) y características de mares someros de regiones tropicales.

Los gasterópodos estudiados corresponden a las especies *Microschiza* (*Cloughtonia*) *scalaris* (Conrad), *Mesoglauconia* (*Mesoglauconia*) *burnsi* (Stanton), *Gymnentome* (*Gymnentome*) *zebra* (Gabb), *Pyrazus* (*Echinobathra*) *valeriae* (Verneuil y Lorière), *Lunatia pedernalis* (Roemer), *Natica conradi* (Hill), *Aptyxiella boehmi* (Blanckenhorn), *Multiptyxis prefleuriaui* (Delpey), *Cossmannea* (*Eunerinea*) *hicoriensis* (Cragin), *Phaneroptyxis anguillina* (Bárcena y Castillo) y *Peruviella gerthi Olsson* (Roemer), que son descritos por primera vez para la región de Tamazula.

Con el conocimiento de la fauna de Tamazula, se procedió a establecer relaciones paleobiogeográficas con faunas similares de otras regiones de México, del sur de los Estados Unidos, de Perú, Brasil, España, Siria, Líbano y Argelia, con la finalidad de aportar evidencias sobre los límites occidentales de la provincia Caribeña en el dominio del Tethys.

Palabras clave: Gasterópodos, Cretácico Inferior, Jalisco, centro-occidente de México.

## INTRODUCTION

Early Cretaceous marine fossils are practically unknown in west central Mexico. Nevertheless, in the vicinity of Tamazula, located to the southeast of the State of Jalisco, there is a particularly interesting area where numerous species and genera of bivalves and gastropods, and also several taxa of corals and echinoids, have been found. This association represents a shallow marine facies that shows clear affinities with other known faunas.

The fossil material described in this paper represents the results of three field seasons. The first one was conducted by Alfredo Guzmán-Roa (1980), working for the General Exploration Superintendence of Petróleos Mexicanos (Poza Rica Zone). In the second, B.E. Buitrón (1981b) from Instituto de Geología, Universidad Nacional Autónoma de México, collected the material in the Soyatlán de Adentro area. The third one corresponds to the collecting of various nerineids and rudists by Vicente Páez-Juárez (1992), who generously gave them to the first author of this paper for its study.

The extensive field work in the Tamazula area has yielded many fossiliferous outcrops; from these, the localities of La Presa, Soyatlán de Adentro, Agua Zarca, and El Conejo were selected. The discovery of these fossil sites represents an opportunity to study a rich and diverse gastropod fauna, specially when little is known on the geology and paleontology of the Lower Cretaceous of the State of Jalisco. The main objective of this work is to describe this important invertebrate fauna, that bears several index genera, to allow a reliable age assignment for the Tamazula outcrops. Also, the paleontological and paleogeographic aspects of this assemblage will be discussed in terms of its possible relationships with other faunas from southwestern Mexico, United States, the Caribbean and the Mediterranean regions. This information will help to define the limits of what is known as the Caribbean

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province, that comprises the western part of the realm of the sea of Tethys.

The names given to the four localities—La Presa, Soyatlán de Adentro, Agua Zarca and El Conejo—correspond to the major geographical features of an area close to 100 $km^2$, northwest of the town of Tamazula between 19°40'-19°50'N and 103°15'-103°20'W (Figure 1). All the outcrops belong to the same stratigraphical level and therefore are considered as pertaining to a coeval assemblage.

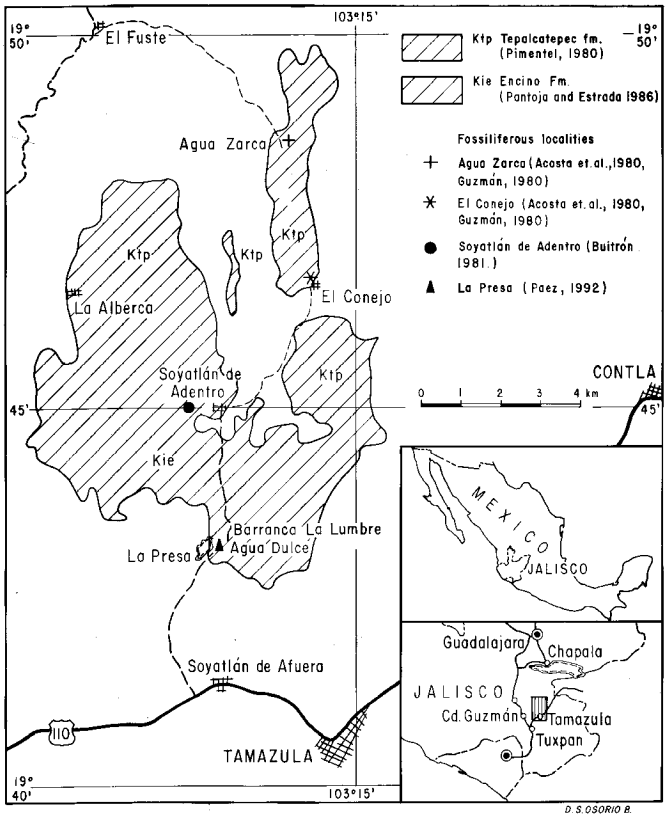


Figure 1. Geologic map showing fossiliferous localities mentioned in text.

## PREVIOUS WORK

The earliest work that deals with the paleontology of the Tamazula area corresponds to the description of an abundant rudist fauna from the small town of Soyatlán de Adentro, 5 km NW from Tamazula (Palmer, 1928). Among the numerous rudist species described in this paper are *Apricardia chavesi, Monopleura salazari, Chaperia socialis, Baryconites multilineatus, Caprinuloidea perfecta, C. gracilis, C. septata, C. multitubifera, C. costata, C. bisulcata* and *Coalcomana ramosa* (Boehm). Palmer (1928) assigned the age of this fauna to the Cenomanian. Later, Burckhardt (1930, p. 208) in his synthetic work on the Mesozoic of Mexico, devoted a small note regarding Palmer' s (*op. cit.*) study. Besides corroborating the Cenomanian age assignment, Burckhardt (*op. cit.*) also included some data on the lithological aspects of the Soyatlán de Adentro locality. More than fifty years later, Buitrón (1981b) determined 14 gastropod species from the same fossil site—Soyatlán de Adentro—and considered the age of the assemblage as late Aptian-early Albian, rather than Cenomanian. Additionally, when Buitrón (1981a, 1993) revised the distribution of the Cretaceous—Aptian-Albian—gastropods of western Mexico, she found that all the species of the Tamazula area were common in many other well-known localities of Mexico and of other countries.

Afterward, within the same general area, in the neighborhood of Tamazula, in a locality known as Cerro Tuxpan, Buitrón (1986) described another late Aptian-early Albian gastropod fauna composed of *Otostoma japonicum, Microschiza (Cloughtonia) scalaris, Mesoglauconia burnsi, M. (Triglauconia) kleinpelli, Gymnentome paluxiensis, G. zebra, Cassiope* sp. cf. *C. branneri, Pyrazus (Echinobathra) valeriae, P. (E.) vicinum, Aptyxiella* sp., *A. supracostata* and *Ptygmatis tomasensis*. The study of the rudists of the same area (Alencáster and Pantoja-Alor, 1986) reveals that these beds are older than Palmer's (1928) Cenomanian assignment. The presence of *Coalcomana ramosa* (Boehm), which has been reported from many other localities of Jalisco, Colima and Michoacán, is indicative of an early Albian age.

Since the gastropods described here are in association with *Coalcomana ramosa* (Boehm), the age determination of the Tamazula and the Soyatlán de Adentro faunas corresponds to the early Albian, without discarding that the base of the sequence might correspond to the late Aptian.

## GEOLOGICAL SETTING

In the area located to the northwest of the town of Tamazula, extensive Mesozoic outcrops are exposed. These marine beds bear an abundant and diverse paleobiota that includes rudists, ammonites, gastropods, corals, foraminifers, echinoids and algae.

The region has been studied by geologists of Petróleos Mexicanos (Acosta *et al.*, 1980; Guzmán-Roa, 1980). These works include some superficial geological surveys in which the following units were informally described: the Lower Cretaceous Alberca formation—Berriasian-Hauterivian—that consists of a sequence of mudstone and silty limestone, containing ammonites of the genera *Subthurmannia and Mexicanoceras*. Above the Alberca formation, conformably rests the Tecalitlán formation—Barremian-Aptian—composed of pyroclastics intercalated with claystone. Conformably above this unit, there are rocks of the Tepalcatepec formation, that range from the Albian to the Cenomanian. This unit, due to its lithology, was subdivided in two members; one formed by mudstone that grades into wackestone with miliolids and rudists, and the other composed of sandy tuff and limestone—wackestone, packstone, grainstone and boundstone—with andesite intercalations. Its fossil content includes abundant rudists. This unit is overlain unconformably by extrusive Pliocene-Quaternary igneous rocks (Acosta *et al.*, 1980).

In 1991, Páez-Juárez of the Instituto de Geología, found in the Tamazula area, above the ignimbrites of the Tecalitlán formation, a 1,200 m thick sequence of volcaniclastic and volcanosedimentary rocks. Páez-Juárez (1992) considered this unit as pertaining to the Encino Formation—Aptian-Albian—originally described by Pantoja-Alor and Estrada-Barraza (1986) from the Pihuamo area in Jalisco. Páez-Juárez (*op. cit.*) also reports outcrops of the Encino Formation in the Valle de Soyatlán de Adentro, in the Arroyo Agua Dulce and in the western flank of Cerro de la Lumbre, all in the Tamazula area (Figure 1). The unit described by Páez-Juárez (*op. cit.*) shows at its base a conglomerate of andesite-dacite fragments and sandstone. Above these beds, there is limestone—packstone-wackestone—with *Orbitolina*, which is overlain by silty layers with the gastropods *Microschiza* (*Cloughtonia*) *scalaris, Mesoglauconia* (*Mesoglauconia*) *burnsi, Gymnentome* (*Gymnentome*) *zebra, Pyrazus* (*Echinobathra*) *valeriae, Lunatia pedernalis, Natica conradi* and *Phaneroptyxis anguillina.* Above the beds with gastropods, there is a thick reefal horizon with *Toucasia, Coalcomana ramosa, Chondrodonta* and *Caprinuloidea.* Overlying the rudists, there is a dacite lava flow followed by siltstone, sandstone and limestone—mudstone to wackestone texture—that shows only a scarce rudist assemblage. Above the limestone, there are alternating beds that grade from conglomerate to siltstone and, overlying them, there is another siltstone-sandstone sequence in the La Presa locality. This layer bears the rudistid taxa *Coalcomana* spp., *Coalcomana ramosa* and the nerineids *Aptyxiella boehmi, Multiptyxis prefleuriaui* and *Cossmannea* (*Eunerinea*) *hicoriensis*. The section ends with a calcareous reefal horizon with the rudists *Caprinuloidea* spp., *Caprinuloidea perfecta* and *Caprinuloidea lenki*, that is topped by a thick sequence of mudstone and sandstone (Páez-Juárez, 1992) (Figure 2).

Regarding the presence of the rudist species within the Tamazula section, Páez-Juárez (*op. cit.*) determined that the age of the Encino Formation must range from the early to the middle Albian. Nevertheless, the gastropod assemblage studied here suggests that this preliminar age determination must be expanded to the late Aptian.

According to Páez-Juárez (1992, p. 9), the Encino Formation and the Albian-Cenomanian Tepalcatepec formation are formed by a sequence of limestone, sandstone, conglomerate, dacitic lava flows, and some siltstone horizons.

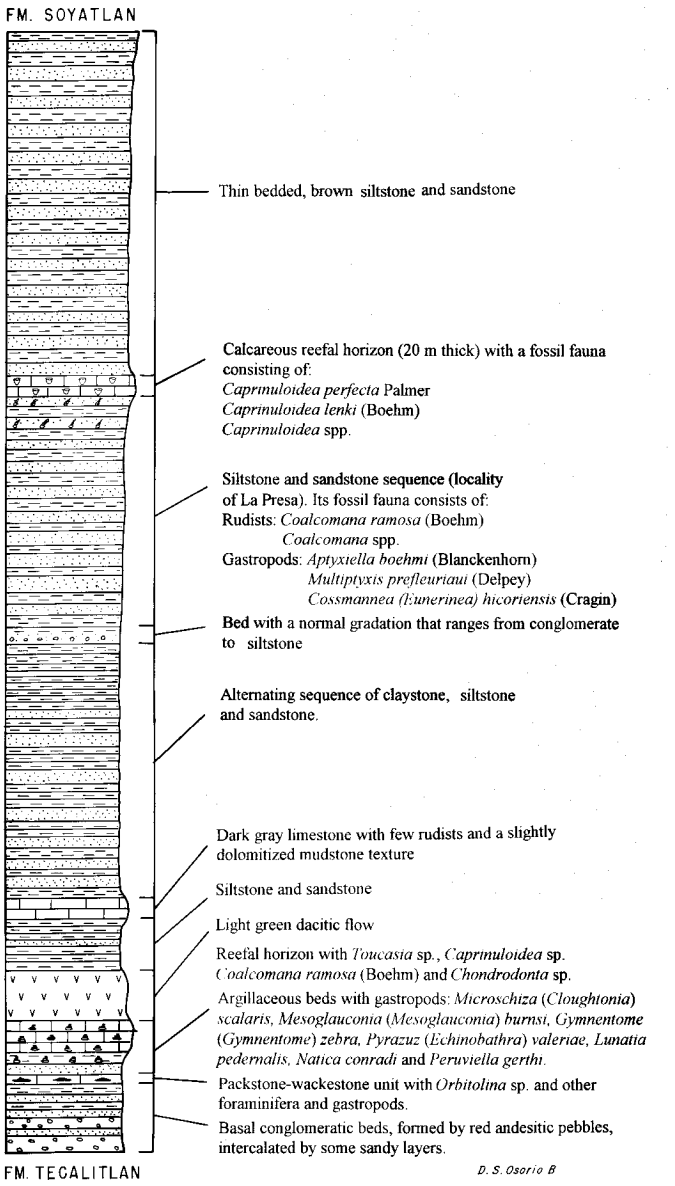


Figure 2. Stratigraphic section of the Encino Formation from Páez-Juárez (1992) slightly modified.

## SYSTEMATIC PALEONTOLOGY

The studied material has been deposited in the Museum of Paleontology of the Institute of Geology, Universidad Nacional Autónoma de México, Ciudad Universitaria, Delegación Coyoacán, 04510 D.F., with the catalogue numbers IGM-7396, IGM-7419.

Phylum Mollusca Linnaeous, 1758
Class Gastropoda Cuvier, 1797
Subclass Prosobranchia Milne-Edwards, 1848
Order Caenogastropoda Cox
Suborder Mesogastropoda Thiele, 1925
Superfamily Pseudomelaniacea Fischer, 1885
Family Pseudomelaniidae Fischer, 1885

Genus *Microschiza* Gemmellaro, 1878
Subgenus *Cloughtonia* Hudleston, 1882

***Microschiza* (*Cloughtonia*) *scalaris* (Conrad), 1852**
(Plate 1, figures 1-3)

1868 *Turbo gigas* Verneuil and Lorière, p. 27, pl. 3, fig. 1.
1852 *Natica? scalaris* Conrad, p. 234, pl. 7, fig. 50.

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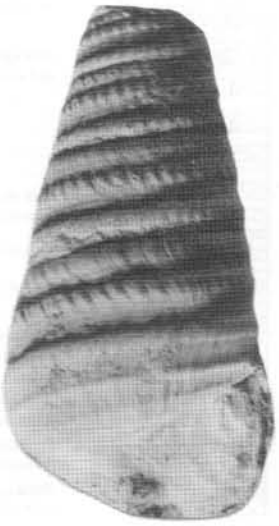

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11

1927 *Coronatica purpuroidea* (Conrad) Blanckenhorn, p. 135, pl. 2, figs. 26, a-c.
1940 *Microschiza (Cloughtonia) scalaris* (Conrad) Delpey, p. 70, text figs. 44-45.
1955 *Microschiza (Cloughtonia) scalaris* (Conrad) Allison, p. 412, pl. 41, figs. 1, 2.
1986 *Microschiza (Cloughtonia) scalaris* (Conrad) Buitrón, p. 22, pl. 1, figs. 2, 3.

| Catalogue No. | Height (mm) | Width (mm) | Apical angle |
|---|---|---|---|
| IGM-7396 | 93.0 | 59.9 | 71° |
| IGM-7397 | 64.0 | 48.0 | 70° |

**Locality**—Agua Zarca, El Conejo.

**Remarks**—*Microschiza (Cloughtonia) scalaris* has been described as *Turbo gigas* (Verneuil and Lorière, 1868, p. 27, pl. 3, fig. 1) from the Neocomian of Utrillas, Spain. Much later, Aguilar and others (1971) amended the age of those beds and assigned them to the upper Aptian-lower Albian, and Delpey (1940, p. 70, text figs. 44, 45) cited this taxon from the upper Aptian-lower Cenomanian of several localities of Syria and Lebanon.

Allison (1955, p. 412, pl. 41, figs. 1, 2) discussed this species from the Alisitos Formation—Aptian-Albian—of Punta China, Baja California, and Buitrón (1986, p. 22, pl. 1, figs. 2, 3) reported this species in the upper Aptian-lower Albian of Cerro Tuxpan, Jalisco State, Mexico.

*Microschiza japonica* (Nagao *in* Kase, 1984, p. 110, pl. 14, figs. 5-7) from the Hiraiga and Akito Formations—upper Aptian-early Albian—of the Miyako Distrit, Japan, is a similar species to *M. scalaris*, but smaller in size, with a more spherical shape and a lower spire.

Family Cassiopidae Kollmann

Genus *Mesoglauconia* Mennessier, 1984
Subgenus *Mesoglauconia* Mennessier, 1984

***Mesoglauconia (Mesoglauconia) burnsi* (Stanton, 1947)**
(Plate 1, figures 4, 5)

1947 *Cassiope burnsi* Stanton, p. 78, pl. 57, figs. 9, 10.
1984 *Cassiope burnsi* Stanton, González-León and Buitrón, p. 375, fig. 3.
1984 *Cassiope burnsi* Stanton, Herrera and others, p. 52.
1984 *Cassiope burnsi* Stanton, Valdez-Gómez, p. 292, pl. 1, figs. 6-7.
1984 *Mesoglauconia (Mesoglauconia) burnsi* (Stanton) Mennessier, p. 28, pl. 4, figs. 6-7.
1986 *Mesoglauconia (Mesoglauconia) burnsi* (Stanton) Buitrón, p. 22, pl. 1, figs. 4-6.

| Catalogue No. | Height (mm) | Width (mm) | Apical angle |
|---|---|---|---|
| IGM-7398 | 40.3 | 18.5 | 32° |
| IGM-7399 | 32.8 | 16.2 | 30° |
| IGM-7400 | 29.4 | 19.0 | 31° |

**Locality**—Agua Zarca, El Conejo.

**Remarks**—*Cassiope burnsi* was described by Stanton (1947, p. 78, pl. 57, figs. 9, 10) from the Glen Rose Formation—middle Albian—of Texas, U.S.A. It was registered by González-León and Buitrón (1984, p. 375, fig. 3) and Herrera and others (1984, p. 52) from the Albian beds of Lampazos, Sonora in the north of Mexico. Valdez-Gómez (1984, p. 292, pl. 1, figs. 6, 7) found it in the upper Aptian of Michoacán State, and Buitrón (1986, p. 22, pl. 1, figs. 4-6) in the Encino Formation—upper Aptian-lower Albian—of Cerro Tuxpan, Jalisco State, in central Mexico. This species is similar in the general morphology and shell proportions to *Cassiope branneri* (Stanton, 1947, p. 77, pl. 57, figs. 1-6; Hill, 1893, pl. 5, figs. 1-7) from the middle Albian—Glen Rose Formation—and from the Albian—Trinity Division—of Texas and Arkansas, U.S.A.; however, it is distinguished by the arrangement and less knotty character of the spiral ribs.

Mennessier (1984, p. 28, pl. 4, p. 6, 7) proposed a new genus (*Mesoglauconia*) and subgenus (*Mesoglauconia*) for *Cassiope burnsi* Stanton.

Genus *Gymnentome* Cossmann, 1909
Subgenus *Gymnentome* Cossmann, 1909

***Gymnentome (Gymnentome)* zebra Gabb, 1869**
(Plate 1, figure 6)

1869 *Chemnitzia zebra* Gabb, p. 260, pl. 35, fig. 5.
1947 *Cassiope zebra* (Gabb) Stanton, p. 79, pl. 57, figs. 7, 8.
1984 *Cassiope zebra* (Gabb) Mennessier, p. 67, pl. 20, figs. 14-16.
1986 *Gymnentome (Gymnentome) zebra* (Gabb) Buitrón, p. 25, pl. 1, figs. 8, 9.

| Catalogue No. | Height (mm) | Width (mm) | Apical angle |
|---|---|---|---|
| IGM-7401 | 40.2 | 25.0 | 29° |
| IGM-7402 | 25.0 | 41.0 | 30° |

**Locality**—Agua Zarca, El Conejo.

Plate 1. Figures 1, 2—*Microschiza* (*Cloughtonia*) *scalaris* (Conrad), specimen IGM-7396 (x 0.75). Figure 3—Specimen IGM-7397 (x 1). Figure 4—*Mesoglauconia* (*Mesoglauconia*) *burnsi* (Stanton), specimen IGM-7398 (x 2). Figure 5—Specimen IGM-7399 (x 2). Figure 6—*Gymnentome* (*Gymnentome*) *zebra* (Gabb), specimen IGM-7401 (x 1.5). Figure 7—*Pyrazus* (*Echinobathra*) *valeriae* (Verneuil and Lorière), specimen IGM-7403 (x 1.5). Figure 8—Specimen IGM-7405 (x 1.5). Figure 9—Specimen IGM-7404 (x 1.5). Figure 10—*Aptyxiella boehmi* (Blanckenhorn), specimen IGM-7408 (x 1.5). Figure 11—Specimen IGM-7409 (x 1.5).

**Remarks**—Several Cretaceous species as *Cassiope helvetica* (Pictet and Renevier, 1854, p. 28, pl. 3, figs. 2, a, 2, c) from the Aptian of Switzerland and Spain; *C. hyatti* and *C. paluxiensis* from the Albian of Texas and New Mexico, U.S.A. (Stanton, 1947, p. 78, pl. 57, figs. 9, 10; figs. 17, 18) are highly related with *Gymnentome (Gymnentome) zebra* (Gabb, 1869, p. 260, pl. 35, fig. 5; Mennessier, 1984, p. 67, pl. 20, figs. 14-16) from the Albian of Arivechi, Sonora, and from the later Aptian-early Albian of cerro Tuxpan, Jalisco State (Buitrón, 1986, p. 24, plate 1, figures 8, 9). These species fundamentally differ from *G. zebra* in that this last one has a pupoid shell and presents a smaller number of whorls, characterized by being arranged in a wrapping form.

Family Potamididae Troschel
Subfamily Potamidinae Troschel

Genus *Pyrazus* Monfort, 1810

***Pyrazus (Echinobathra) valeriae* (Verneuil and Lorière, 1868)**
(Plate 1, figures 7-9)

1868 *Cerithium valeriae* Verneuil and Lorière, p. 11, pl. 2, fig. 1.
1906 *Cerithium valeriae* Verneuil and Lorière, Aguilera, (tab.).
1984 *Pyrazus (Echinobathra) valeriae* (Verneuil and Lorière) Valdez-Gómez, p. 289, pl. 1, fig. 5.
1986 *Pyrazus (Echinobathra) valeriae* (Verneuil and Lorière) Buitrón, p. 25, pl. 1, figs. 14, 15.

| Catalogue No. | Height (mm) | Width (mm) | Apical angle |
|---|---|---|---|
| IGM-7403 | 48.1 | 16.0 | 25° |
| IGM-7404 | 41.5 | 19.0 | 26° |
| IGM-7405 | 38.9 | 20.5 | 25° |

**Locality**—Agua Zarca, El Conejo.

**Remarks**—This species is similar to *Pyrazus scalariformis* described by Nagao (1934, p. 257, pl. 36, fig. 24) and by Kase (1984, p. 137, pl. 20, figs. 18, 19) from the Hiraiga Formation—upper Aptian-lower Albian—of Miyako, Japan. However, the Mexican species has more salient varixes that confer to the profile a staircase aspect, similar to *P. valeriae* described by Verneuil and Lorière (1868, p. 11, pl. 2, fig. 1; by Aguilar and others (1971) from the upper Aptian-lower Albian of Utrillas, Spain. Valdez-Gómez (1984, p. 289, pl. 1, fig. 5) cited this species from the Aptian of Cocuaro and Los Llanos, Michoacán, and Buitrón (1986, p. 25, pl. 1, figs. 14, 15) from the upper Aptian-lower Albian of the Cerro Tuxpan, Jalisco.

Family Naticidae Forbes

Genus *Lunatia* Gray, 1847

***Lunatia pedernalis* (Roemer) 1852**
(Plate 2, figures 2, 4)

1849 *Natica pedernalis* Roemer, p. 410.
1852 *Globiconcha planata* Roemer (part), p. 42.
1852 *Natica pedernalis* Roemer, p. 43.
1869 *Lunatia pedernalis* Roemer, Gabb, p. 259, pl. 35, fig. 3.
1893 *Tylostoma pedernalis* (Roemer) Hill, p. 33, pl. 6, fig. 2.
1901 *Lunatia (Tylostoma) pedernalis* (Roemer) Hill, pl. 25, fig. 1.
1910 *Natica pedernalis* Roemer, Boese, p. 142, pl. 30, fig. 9.
1928 *Natica? pedernalis* Roemer, Adkins, p. 176.
1928 *Lunatia pedernalis* (Hill) Vanderpool, p. 99, pl. 12, fig. 1.
1947 *Lunatia? pedernalis* (Roemer) Stanton, 1947, p. 66, pl. 50, figs. 1, 2.

| Catalogue No. | Height (mm) | Width (mm) | Apical angle |
|---|---|---|---|
| IGM-7406 | 89.7 | 92.0 | 65.5° |

**Locality**—El Conejo, Agua Zarca.

**Discussion**—*Lunatia pedernalis* has an apparently similar form to *Lunatia? praegrandis* (Stanton, 1947, p. 66, pl. 50, figs. 1, 2), both from the middle Albian—Glen Rose Formation—of Texas, U.S.A. and Sonora, Mexico. However, *L. pedernalis* has a less elongated shell, whorls with shoulder, a different aperture form and a larger umbilicus.

Boese (1910, p. 142, pl. 30, fig. 9) described this species as *Natica pedernalis* from the Albian beds of La Encantada, Chihuahua State, Mexico.

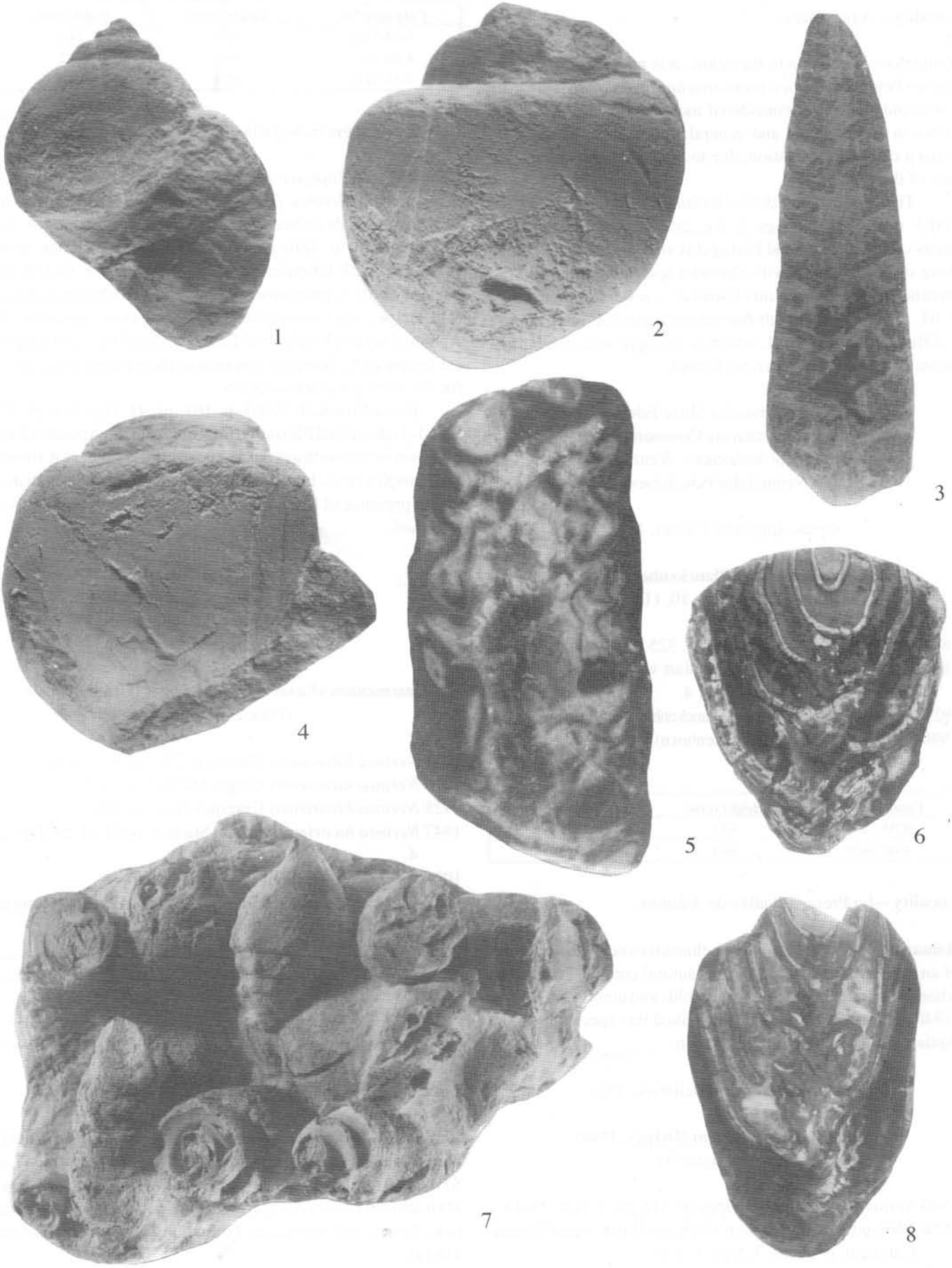
Genus *Natica* Scapoli

***Natica conradi* (Hill) 1888**
(Plate 2, figure 1)

1857 *Buccinopsis parryi* Conrad, p. 158.
1888 *Buccinopsis conradi* Conrad Hill, p. 130, pl. 3, figs. 2, 2, a.
1893 *Buccinopsis? parryi* Conrad Hill, p. 33, pl. 6, fig. 1.
1893 *Buccinopsis conradi* (Hill) Cragin, p. 220.
1947 *Natica? conradi* Stanton, p. 64, pl. 52, fig. 11.

| Catalogue No. | Height (mm) | Width (mm) | Apical angle |
|---|---|---|---|
| IGM-7407 | 69.3 | 64.8 | 88° |

Plate 2. Figure 1—*Natica conradi* (Hill), specimen IGM-7407 (x 1). Figures 2, 4—*Lunatia pedernalis* (Roemer), specimen IGM-7406 (x 0.75). Figure 3—*Multiptyxis prefleuriaui* (Delpey), specimen IGM-7412 (x 1.5). Figure 5—*Cossmannea (Eunerinea) hicoriensis* (Cragin), specimen IGM-7413 (x 1). Figure 6—*Peruviella gerthi* Olsson, specimen IGM-7418 (x 1); figure 8—specimen IGM-7419 (x 1). Figure 7—*Phaneroptyxis anguillina* (Bárcena and Castillo), specimen IGM-7417 (x 0.5).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**Locality**—Agua Zarca.

**Remarks**—In relation to the genus, it is not probable that the species belongs to *Natica sensu strictum*, even when it presents a naticoid shell; it is considered more convenient to use the genus in an undefined and general way, instead of trying to make a closer detemination, due to the bad state of conservation of the specimen.

The species *Leviathania leviathan* Pictet and Campiche (1863, p. 562, pl. 89, figs. 1, a-c, 2); from the Lower Cretaceous of Switzerland and Portugal is similar, but this is much more strong and large, with a broader apical angle and without umbilicus. The comparison of *Natica? conradi* (Stanton, 1947, p. 64, pl. 52, fig. 11) with *Buccinopsis parryi* Conrad, shows a difference on the shell, which is strongly ornamented and presents a prominent anterior channel.

Subclass Opisthobranchia Milne Edwards, 1848
Order Entomotaeniata Cossmann, 1896
Superfamily Nerineacea, Wenz, 1940
Family Nerinellidae Pchelintsev, 1965

Genus *Aptyxiella* Fischer, 1885

***Aptyxiella boehmi* (Blanckenhorn, 1927)**
(Plate 1, figures 10, 11)

1878 *Cerithium excavatum* Fraas, p. 325 (non d'Orbigny).
1890 *Cerithium excavatum* Brongniart var. *syriacum* Blanckenhorn, p. 112, pl. 9, figs. 3, 4.
1927 *Nerinea (Aptyxiella) boehmi* Blanckenhorn, p. 147, pl. 3, fig. 50.
1940 *Nerinella boehmi* (Blanckenhorn) Delpey, p. 155, figs. 110, 111.

| Catalogue No. | Height (mm) | Width (mm) |
|---|---|---|
| IGM-7408 | 42.0 | 22.7 |
| IGM-7409 | 46.1 | 24.4 |

**Locality**—La Presa, Soyatlán de Adentro.

**Remarks**—*Aptyxiella boehmi* is characterized by the presence of an external, conspicuous, spiral sutural cordon. The section whorl is quadrangular without any folds and umbilicus. Delpey (1940, p. 155, figs. 110, 111) described this species from the Aptian of El Bnayé (Abey), Lebanon.

Genus *Multiptyxis* Pchelintsev, 1953

***Multiptyxis prefleuriaui* (Delpey, 1940)**
(Plate 2, figure 3)

1940 *Nerinea prefleuriaui* Delpey, p. 185, pl. 3, figs. 11-15.
1986 *Plesioptyxis prefleuriaui* (Delpey) Buitrón and Rivera-Carranco, p. 72, pl. 1, figs. 3, a, b.

| Catalogue No. | Height (mm) | Width (mm) |
|---|---|---|
| IGM-7410 | 52.7 | 24.2 |
| IGM-7411 | 54.0 | 27.2 |
| IGM-7412 | 67.4 | 21.0 |

**Locality**—La Presa, Soyatlán de Adentro.

**Remarks**—*Multiptyxis prefleuriaui* presents a high relationship with *Nerinea fleuriaui* d'Orbigny (1842, p. 85, pl. 160, figs. 6-7) described from the Cretaceous of France, but Delpey (1940, p. 186) explained that the whorls are more excavated, with tubercles in the sutures and the fold of the internal cavity is more pronounced, with a quadrangular labial fold. Delpey (*op. cit.*) considers that this species, typical of the Aptian of several localities of Lebanon, could be a stratigraphical variety of *N. fleuriaui*, common of the Albian-Cenomanian for the same geographic region.

Rossi-Ronchetti (1965, p. 161, pl. 41, figs. 5-8; pl. 42, figs. 1-3) described *Plesioptyxis desioi* from the Aptian-Albian of Yosin in the northwest of Pakistan, and considers it similar to *P. prefleuriaui*, but the differences are mainly established by the presence of a major spiral angle and of an umbilicus in *P. desioi*.

Family Nerineidae Zittel, 1873

Genus *Cossmannea* Pchelintsev, 1931
Subgenus *Eunerinea* Cox, 1949

***Cossmannea (Eunerinea) hicoriensis* (Cragin, 1893)**
(Plate 2, figure 5)

1893 *Nerinea hicoriensis* Cragin, p. 225, pl. 42, fig. 6.
1925 *Nerinea hicoriensis* Cragin Dietrich, p. 115.
1928 *Nerinea hicoriensis* Cragin Adkins, p. 186.
1947 *Nerinea hicoriensis* Cragin Stanton, p. 83, pl. 58, figs. 2, 4.
1906 *Nerinea titania* Felix, Aguilera (plate).
1956 *Cossmannea (Eunerinea) hicoriensis* (Cragin) Alencáster, p. 38, pl. 6, fig. 7.

| Catalogue No. | Height (mm) | Width (mm) |
|---|---|---|
| IGM-7413 | 110.4 | 47.5 |
| IGM-7414 | 45.0 | 39.5 |
| IGM-7415 | 35.0 | 26.4 |

**Locality**—Presa de Soyatlán.

**Remarks**—*Nerinea hicoriensis* Cragin is characteristic of the base of the Travis Peak Formation of Texas (Stanton, 1947, p. 83). Other specimens have been found in the San Juan Raya Formation, Puebla (Alencáster, 1956, p. 38), Encino Formation, Jalisco and San Lucas Formation, Michoacán (Buitrón, 1981a).

Family Itieriidae Cossmann, 1896

Genus *Phaneroptyxis* Cossmann, 1896

***Phaneroptyxis anguillina* (Bárcena and Castillo, 1875)**
(Plate 2, figure 7)

1875 *Nerinea? anguillina* Bárcena and Castillo, p. 380, figs. 13, 14.
1906 *Nerinea (Itieria) natuchensis* Aguilera *nomen nudum* (tab.).
1925 *Itieria? anguillina* (Castillo and Bárcena) Dietrich, p.146.
1956 *Phaneroptyxis anguillina* (Castillo and Bárcena) Alencáster, p. 40, pl. 7, figs. 11, 12.
1980 *Phaneroptyxis anguillina* (Castillo and Bárcena) Buitrón and Barceló-Duarte, p. 54.
1986 *Phaneroptyxis anguillina* (Castillo and Bárcena) Buitrón and Rivera-Carranco, p. 77, pl. 3, figs. 4, a-c.

| Catalogue No. | Height (mm) | Width (mm) |
|---|---|---|
| IGM-7416 | 47.0 | 23.0 |
| IGM-7417 | 57.0 | 22.0 |

**Locality**—El Conejo, Agua Zarca.

**Remarks**—Bárcena and Castillo (1875, p. 380, figs. 13, 14) described *Nerinea? anguillina* from the Cretaceous of Huetamo, Michoacán. These authors considered that the sections of gastropods that are exposed in the limestone rocks of the caves of Cacahuamilpa, in the State of Morelos, Mexico, correspond to this species. Alencáster (1956, p. 40, pl. 7, figs. 11, 12) and Buitrón and Barceló-Duarte (1980, p. 54) cited it from the Barremian-Aptian of San Juan Raya, Puebla, Mexico. Buitrón and Rivera-Carranco (1986, p. 77, pl. 3, figs. 4, a-c) found this species in Huetamo, Michoacán.

Genus *Peruviella* Olsson, 1944

***Peruviella gerthi* Olsson, 1944**
(Plate 2, figures 6, 8)

1928 *Actaeonella* cf. *gigantea* (Sowerby) Gerth, p. 232-241.
1934 *Pervia gerthi* Olsson, p.73, pl. 9, figs. 1-3.
1936 *Trochactaeon sergipensis* Maury, p. 222 (225), pl. 13, figs. 2, 5, 6, 8.
1944 *Peruviella gerthi* Olsson, p. 6.
1979 *Peruviella gerthi* Kollmann and Sohl, p. A13, figs. 4, d, 5, f-k.

| Catalogue No. | Height (mm) | Width (mm) | Apical angle |
|---|---|---|---|
| IGM-7418 | 60.5 | 51.2 | 32° |
| IGM-7419 | 70.0 | 46.0 | 32° |

**Locality**—Presa de Soyatlán.

**Remarks**—As it is observed in *Peruviella dolium* (Roemer) and *Peruviella gerthi* Olsson (Kollman and Sohl, 1979, p. A13, figs. 4, d, 5, f, k; p. A14, figs. 4, e-g, 6, f-k) from the Albian of Texas, of Peru and Brazil, respectively, exists a close relationship among the peruvielids of the Cretaceous of America.

The fundamental difference among these two species is based on the general form of the shell and also on the design of the folding, since the columellar lip is much larger than the other folds in *P. gerthi*; on the other hand, *P. dolium* Roemer is a species with a great polymorfism and an intergradation of characters that hinders to a certain point, the specific determination (Kollmann and Sohl, 1979).

## PALEOBIOGEOGRAPHIC RELATIONSHIPS

The gastropods described in this investigation are characteristic of the neritic facies; their association with rudists is meaningful, considering that these organisms are typical of the reefal facies. For this reason, the analysis of the world distribution of the species from Tamazula, allows to know the affinities of similar associations in other regions of the world during the Early Cretaceous. The establishment of this faunistic distribution also contributes to the knowledge of the displacement that the lands and seas had along the geological time, since one of the most relevant characteristics of the Cretaceous was the great movement of the tectonic plates, originating the climatic changes that were increasing the natural selection forces and the distribution of the organisms (Kauffman, 1979). These events are fundamental, since it has been found that the Caribbean subprovince was united to the Mediterranean province. On the other hand, the Caribbean subprovince was a center of endemism during the Albian. Other important datum is that the greater reef systems of the Cretaceous are found on paleolatitudes 30 to 40° N (Habich, 1979), that comprise the south of the United States, Mexico, the Antilles, the Mediterranean zone, Egypt, Palestine and the southeast of Asia. In other sense, other relevant consideration is that the advances of the sea onto the land, put in touch, but narrowed, the Gulf-Antillean zone throughout Texas, New Mexico, Arizona (U.S.A.), Sonora, Sinaloa, Colima, Jalisco, Michoacán, Puebla (Mexico), implying increases in the temperature, which meant more favorable conditions for the dispersion and radication of the gastropods.

Among the species of Tamazula, Jalisco, with a wide paleogeographic distribution, are the following:

*Microschiza (Cloughtonia) scalaris* (Delpey, 1940, p.70) from several localities of the late Aptian-early Cenomanian of Syria and Lebanon; from Punta China, Baja California Norte (Allison, 1955) and from the upper Aptian-lower Albian of Tuxpan, Jalisco (Buitrón, 1986, p. 22).

*Mesoglauconia (Mesoglauconia) burnsi* was described for the first time by Stanton (1947, p. 78, pl. 57, figs. 9, 10) from the Glen Rose Limestone (Albian) of Wise County,

Texas, U.S.A. González-León and Buitrón (1984, p. 375, fig. 3) and Herrera and coworkers (1984, p. 52) cited it from the Albian of the area of Lampazos, Sonora; Valdez-Gómez (1984, p. 292, pl. 1, figs. 6, 7) from the Aptian of Cocoaro and Los Llanos, Michoacán, and Buitrón (1986, p. 22) from the Aptian of Tuxpan, Jalisco.

*Gymnentome* (*Gymnentome*) *zebra* was discussed by Gabb (1869, p. 260, pl. 35, fig. 5), by Mennessier (1984, p. 67, pl. 20, figs. 14-16), from the Albian of Arivechi, Sonora, Mexico and by Buitrón (1986, p. 24, pl. 1, figs. 8, 9) from the upper Aptian-lower Albian of the Encino Formation of Tuxpan, Jalisco.

*Pyrazus* (*Echinobathra*) *valeriae* was reported from upper Aptian-lower Albian beds from Utrillas, Spain (Verneuil and Lorière, 1868, p. 11, pl. 2, fig. 1; Aguilar *et al.*, 1971). Also this species is known from coeval sediments from Cocoaro, Michoacán (Valdez-Gómez, 1984, p. 289, pl. 1, fig. 5) and Cerro Tuxpan, Jalisco (Buitrón, 1986, p. 25, pl. 1, figs. 14, 15).

Lunatia pedernalis is cited by Gabb (1869, p. 278) from the Albian of Arivechi, Sonora and by Stanton (1947, p. 67) from the middle Albian of Glen Rose Limestone, Texas; Buitrón (1981b) refers it to the region of Tamazula, Jalisco. Boese (1910, p. 142, pl. 30, fig. 9) described this species from the Albian beds of La Encantada, Chihuahua State.

*Natica conradi* was reported by Stanton (1947, p. 65) from the Queen Formation—Cretaceous—of Arkansas and from the Glen Rose Formation—Albian—of Texas; and also by Buitrón (1981a, tab. 12), from the region of Tamazula, Jalisco.

*Aptyxiella boehmi* has a scarce distribution in the Lower Cretaceous of Mexico (Buitrón, 1981a, tab. 12), since it is recorded from the Aptian of several localities of Lebanon (Delpey, 1940, p. 155, figs. 110-111).

*Multyptyxis prefleuriaui* was described by Delpey (1940, p. 186) from the Aptian of several localities of Lebanon. Buitrón and Rivera-Carranco (1986, p. 72) reported it from the Aptian of the Huetamo area of Michoacán State.

*Cossmannea (Eunerinea) hicoriensis* is typical of the Aptian of the San Juan Raya region, Puebla (Alencáster, 1956, p. 38). Stanton (1947, p. 83) refers it to several localities of Texas, while Buitrón (1981a, tab. 12) from the Aptian of the west of Mexico (Michoacán and Jalisco).

*Phaneroptyxis anguillina* has only been reported from the Barremian-Aptian of central and southern Mexico. In the Huetamo area, Buitrón and Rivera-Carranco (1986, p. 75, pl. 3, figs. 4, a-c) cited this taxon from the Encino Formation—Aptian-Albian—and in the San Juan Raya area it has been reported by Alencáster (1956, p. 40, pl. 7, figs. 11, 12) from the Zapotitlán Formation—Barremian—and from San Juan Raya Formation—Aptian.

*Peruviella gerthi* is mentioned from middle to late Albian of Peru and Brazil (Kollman and Sohl, 1979, p. A13, figs. 4, d, 5, f, k; p. A14, figs. 4, e-g, 6, f-k) (Table 1).

Table 1. Paleogeographic distribution of the gastropods from Tamazula, Jalisco.

| SPECIES | USA | | MEXICO | | | | | | SOUTH AMERICA | | EU-ROPE | ASIA | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Arkan-sas | Texas | Baja Cali-fornia | Sonora | Chihua-hua | Jalisco | Michoa cán | Puebla | Peru | Brazil | Spain | Syrie | Leba-non | Algeria |
| *Microschiza* (*Cloughtonia*) *scalaris* (Conrad) | | | Ap-Al | | | Ap-Al | | | | | Ap-Al | Ap-Ce | Ap | Ap-Ce |
| *Mesoglauconia* (*Mesoglauconia*) *burnsi* (Stanton) | | Al | | Al | | Ap-Al | Ap-Al | | | | | | | |
| *Gymnentome* (*Gymnentome*) *zebra* (Gabb) | | | | Al | | Ap-Al | | | | | | | | |
| *Pyrazus* (*Echinobathra*) *valeriae* (Verneuil and Loriere) | | | | | | Ap-Al | Ap-Al | | | | Ap-Al | | | |
| *Lunatia pedernalis* (Roemer) | | Al | | Al | Al | Ap-Al | | | | | | | | |
| *Natica conradi* (Hill) | Al | Al | | | | Ap-Al | Ap-Al | | | | | | | |
| *Aptyxiella boehmi* (Blanckenhorn) | | | | | | Ap-Al | | | | | | | Ap | |
| *Multiptyxis prefleuriaui* (Delpey) | | | | | | Ap-Al | Ap-Al | | | | | | Ap | Ap |
| *Cossmannea* (*Eunerinea*) *hicoriensis* (Cragin) | | Ap | | | | Ap-Al | Ap | Ap | | | | | | |
| *Phaneroptyxis anguillina* (Bárcena and Castillo) | | | | | | Ap-Al | Ap-Al | Ba-Ap | | | | | | |
| *Peruviella gerthi* Olsson | | | | | | Ap-Al | | | Al | Al | | | | |

Abbreviations: Ba, Barremian; Ap, Aptian; Al, Albian; Ce, Cenomanian.

The world known distribution of these taxa implies that on the Aptian-Albian existed a wide marine faunistic province, that comprised the southeast of United States of America, the west and southeast of Mexico, the Caribbean and the Mediterranean regions of Europe and Asia.

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