

# EARLY MAASTRICHTIAN MOLLUSCA FROM THE MEXCALA FORMATION OF THE STATE OF GUERRERO, SOUTHERN MEXICO

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**ABSTRACT**—Forty species of gastropods (six of them new: *Calliomphalus (Planolateralus) mexcalensis*, *Nododelphinula diminuta*, *Potamides temalacensis*, *Prychopotamides ancestralus*, *Amaurellina guerrera*, and *Drilluta gloriae*), and 13 species of bivalves are described from the lower Maastrichtian marls of the basal Mexcala Formation from Guerrero State, southern Mexico. Age interpretation was based on planktic foraminiferans. Associated fauna includes planktic and benthic foraminiferans, ostracods, solitary corals, crustaceans, echinoids, and vertebrates. The distribution of bivalve and gastropod species suggests that this area has affinities with the Gulf Coast Plain Province of the United States, although some species also are reported from the Middle East, Europe, and South America.

## INTRODUCTION

THE MEXCALA FORMATION outcrops in the states of Guerrero, Morelos, and Puebla, southern Mexico. Alencáster (1980) identified 15 species of gastropods from the studied area, but provided no descriptions. This paper provides an extensive documentation of the Maastrichtian molluscan species from this area. The fauna found includes planktic and benthic foraminifera, corals, gastropods, bivalves, scaphopods, crustaceans, echinoids, vertebrate remains, and palynomorphs. A new species of retroplumid crab was described by Vega and Feldmann (1992), and preliminary reports on the bivalves and echinoids were made by Salceda et al. (1995), Vega and Perrilliat (1995), and Perrilliat and Vega (1996), and echinoids by Sánchez-Rodríguez et al. (1995), and Sánchez-Rodríguez (1997). We have studied the area since 1990, making intensive collections from some localities north of Temalac, located 125 km south of Mexico City, and 70 km southeast of Iguala (Fig. 1). Most fossils were collected at locality 2448 [Locality Catalog of the Instituto de Geología (Universidad Nacional Autónoma de México)] (Fig. 2) described by Vega and Feldmann (1992). Additionally, we have collected some material from localities 2940, 2941, and 2942, which crop out beside the road between Temalac and Mitepec, a few meters north of locality 2448 (Fig. 2). These localities are also registered in the Locality Catalog of the Instituto de Geología, UNAM, and all described specimens are deposited in the Paleontological Collection of the Instituto de Geología, Universidad Nacional Autónoma de México, under the acronym IGM.

## REGIONAL GEOLOGY

Lower Paleozoic rocks of the basement Acatlán Metamorphic Complex are exposed in outcrops near Papalutla (Fig. 2). These rocks consist of more than 3,000 m of schists, phyllites, eclogites, migmatites, quartzites, and amphibolites (Ortega-Gutiérrez, 1978). The overlying sedimentary sequence in the study area is approximately 3,250 m, ranging in age from Early Cretaceous to Holocene (Fig. 3). The oldest unit is the Zicapa Formation, which includes 700 m of continental red beds interbedded with Aptian-Albian marine limestones (Cserna et al., 1980). The primary outcrop belt is along the banks of the Balsas River, near Zicapa, Guerrero. The Zicapa Formation has a transitional contact with the overlying Morelos Formation. Based on its stratigraphic location, the Morelos Formation has an inferred Albian-Cenomanian age. The Morelos Formation defined by Fries (1960), is 200–600 m thick and consists of limestones and dolomites. Primary outcrops are in the Morelos, Guerrero, and Mexico states. Regionally, the Morelos Formation exposures are found along the axes of NE–SW oriented anticlines. Here, the lithology consists of dark gray limestones and dolomites, with

variable amounts of black chert in the form of nodules and lenses. It is disconformably overlain by the Cuautla Formation, defined and subdivided by Fries (1960) into three facies based on differences in lithology and thickness. In the study area, the lithology of the Cuautla Formation consists of alternating gray limestones and brown calcareous mudstones. Toward the top of the unit mudstones disappear, and the thickness of the limestone increases. Total thickness of the Cuautla Formation near Temalac is approximately 100 m. The unit is truncated to the south by a normal fault. The age for the Cuautla Formation is generally taken to be Cenomanian-lower Coniacian in this area (Cserna et al., 1980). The Cuautla Formation is overlain by the Mexcala Formation, defined by Fries (1960) as a flysch-like sequence of 1,220 m of alternating coarse and fine grained clastics. The Mexcala Formation includes both pelagic and shallow water facies. Terrestrial dinosaur tracks were reported a few kilometers north of our main locality IGM 2448 (Ferrusquía-Villafranca et al., 1995). The Mexcala Formation ranges from Coniacian, exposed in central Guerrero (Bohnenberg-Thomas, 1955; Böse, 1923; Dávila-Alcocer, 1974; González-Arreola, 1977; López-Ramos, 1983; Perrilliat, 1974), to Maastrichtian, exposed in northeastern Guerrero, in the study area (Alencáster, 1980; Cserna et al., 1980; Ortega-Gutiérrez, 1980). Planktic foraminiferans of the Mexcala Formation in the study area (Locality IGM 2448) include: *Gansserina gansseri*, *Rosita fornicata*, *Globotruncana ventricosa*, *G. linneiana*, *Rugoglobigerina rugosa*, *Hedbergella monmouthensis*, and *Heterohelix globulosa*. These species, identified by Brian Huber, are indicative of an early Maastrichtian age (B. Huber, personal commun. 1994). The rocks at the localities studied include light-brown marls, with some strata of fine calcareous sandstones, about 30 to 50 cm thick. The lithology becomes sandier toward the top of the section (Fig. 4). The Mexcala Formation is disconformably overlain by the lower Tertiary Balsas Formation, with an estimated thickness of 150 m (Ortega-Gutiérrez, 1978). Quaternary alluvium lies on top of Balsas Formation outcrops.

## SYSTEMATIC PALEONTOLOGY

Class GASTROPODA Cuvier, 1797  
Order ARCHAEOGASTROPODA Thiele, 1925  
Superfamily TROCHOIDEA Rafinesque, 1815  
Family TURBINIIDAE Rafinesque, 1815  
Subfamily ANGARIINAE Thiele, 1924  
Genus CALLIOMPHALUS Cossmann, 1888

CALLIOMPHALUS (PLANOLATERALUS) ARGENTEUS ARGENTEUS  
Wade, 1926

Figure 5.1, 5.2

*Calliomphalus argenteus* WADE, 1926, p. 179, pl. 60, figs. 4–6 (not 7 and 11).

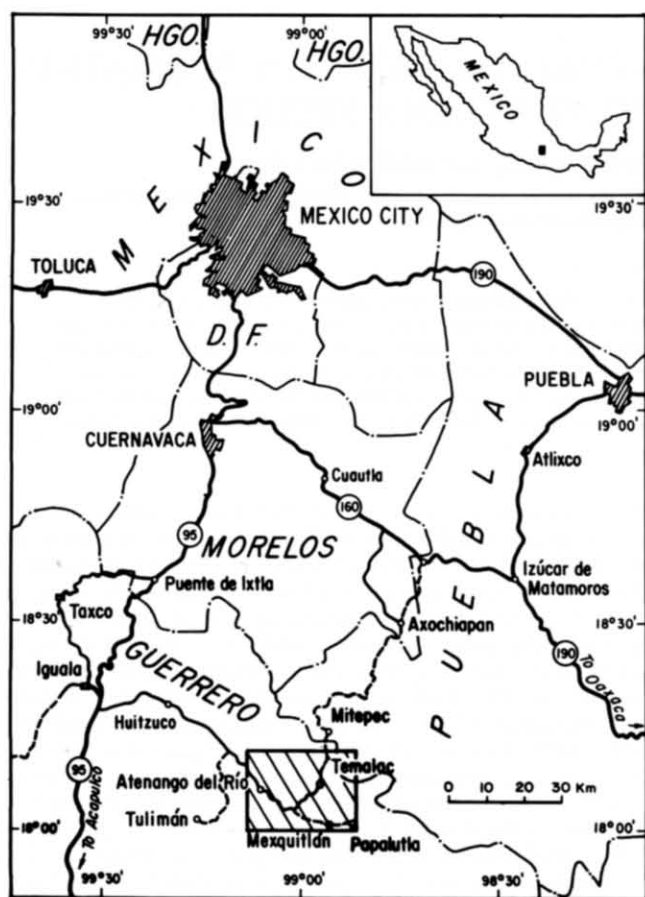


FIGURE 1—General location map of the study area, south of Mexico City. Framed area enlarged and detailed in Figure 2.

*Calliophthalmus (Planolateralus) argenteus* Wade. SOHL, 1960, p. 56, pl. 5, figs. 15, 29–31.

**Description.**—Small trochiform phanerocephalus shell; spire of medium height and acute; five whorls, increasing in size rather markedly; sculpture of shell ornate, consisting of numerous, sharply tuberculate spiral lirae of unequal strength, the strongest and most conspicuous lirae are around the periphery. Axial costae form tubercles where they intersect with lirae. Umbilicus deep, funnel shaped. Aperture circular.

**Material examined.**—Eight specimens. IGM 4151, height, 5.8 mm, diameter 5.3 mm; IGM 4152, height 9.1 mm, diameter 8.6 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—*Calliophthalmus (Planolateralus) argenteus* differs from *Calliophthalmus (Planolateralus) conanti* and *Calliophthalmus (Planolateralus) microcancelli* of the Ripley Formation in that the spiral lirae of *C. (P.) argenteus* are coarser and the thickest spiral produces a well-defined basal angulation.

CALLIOPHTHALMUS (PLANOLATERALUS) cf. DECORIS Sohl, 1960  
Figure 5.3–5.5

**Description.**—Small trochiform phanerocephalus shell, spire with six whorls; whorls flat-sided; base broadly rounded. Sculpture consisting of lirae and ribs which are tuberculated when

crossed by axial cords; two strong tuberculate spiral lirae at periphery, which bear four spiral threads. Umbilicus wide and nodded; spiral and axial sculpture continue onto umbilical wall.

**Material examined.**—Eight specimens. IGM 4153, height 10.5 mm, diameter 8.0 mm; IGM 4154, height 8.7 mm, diameter 6.5 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—The specimens agree with *Calliophthalmus (Planolateralus) decoris* in having two prominent coarse spiral cords. The presence of a fine spiral thread between the two prominent coarse spiral lirae distinguishes the Temalac specimens from *C. (P.) decoris*, a species from the Ripley Formation of Tennessee.

CALLIOPHTHALMUS (PLANOLATERALUS) MEXCALENSIS  
new species  
Figure 5.7–5.11

**Diagnosis.**—Small trochiform shell with ornate sculpture dominated by two strongly tuberculate spiral lirae at periphery and two fine spiral threads between these two spirals.

**Description.**—Small shell, trochoid, umbilicate. Protoconch consists of two smooth whorls. Suture impressed. Teleoconch with four flat sided whorls. Sculpture of whorls with axial and spiral lirae and threads. First whorl has only axial lirae. Second whorl with one coarse tuberculate spiral lira and three slender spiral lirae, one spiral thread adjacent to suture. In third whorl posteriorly below coarse spiral lirae appear two thin spiral threads. Last whorl periphery marked by one coarse lira; in some specimens tubercles become spinous in basal keel. Base has 10 spiral threads and growth lines. Umbilicus small; umbilical rim subangular with strong tubercles.

**Etymology.**—The name of the species refers to the formation where its samples were collected.

**Types.**—Holotype IGM 4155; paratypes IGM 4156, IGM 4157.

**Other material examined.**—126 specimens. Holotype IGM 4155, height 5.1 mm, diameter 5.8 mm; paratype IGM 4156, height 5.2 mm, diameter 5.8 mm; paratype IGM 4157, height 5.4 mm, diameter 5.3 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—The Mexican specimens differ from *Calliophthalmus (Planolateralus) microcancelli* in that the species of the Navarro Group of Texas exhibits five spiral lirae, all of the same size; it lacks the two coarse lirae and the two spiral threads between them. The specimens from Temalac also are larger than the species from Texas.

CALLIOPHTHALMUS (PLANOLATERALUS) sp.  
Figure 5.6

**Description.**—Small trochiform shell; protoconch not preserved; spire acute, six whorls with three spiral threads of same strength and axial costae that form tubercles where they intersect with spiral threads; one spiral cord on periphery. Umbilicus wide. Base with spiral threads.

**Material examined.**—Four specimens. IGM 4158, height 9.8 mm, diameter 7.0 mm; IGM 4159, height 9.2 mm, diameter 7.1 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—These specimens can be assigned to *Calliophthalmus (Planolateralus)* and are similar to *Calliophthalmus decrescens* in size but the Mexican specimens have only three spiral threads; whereas the species from the Maastrichtian of Belgium has five or six spiral threads per whorl. Specimens of all the known species assigned to this genus are smaller in size

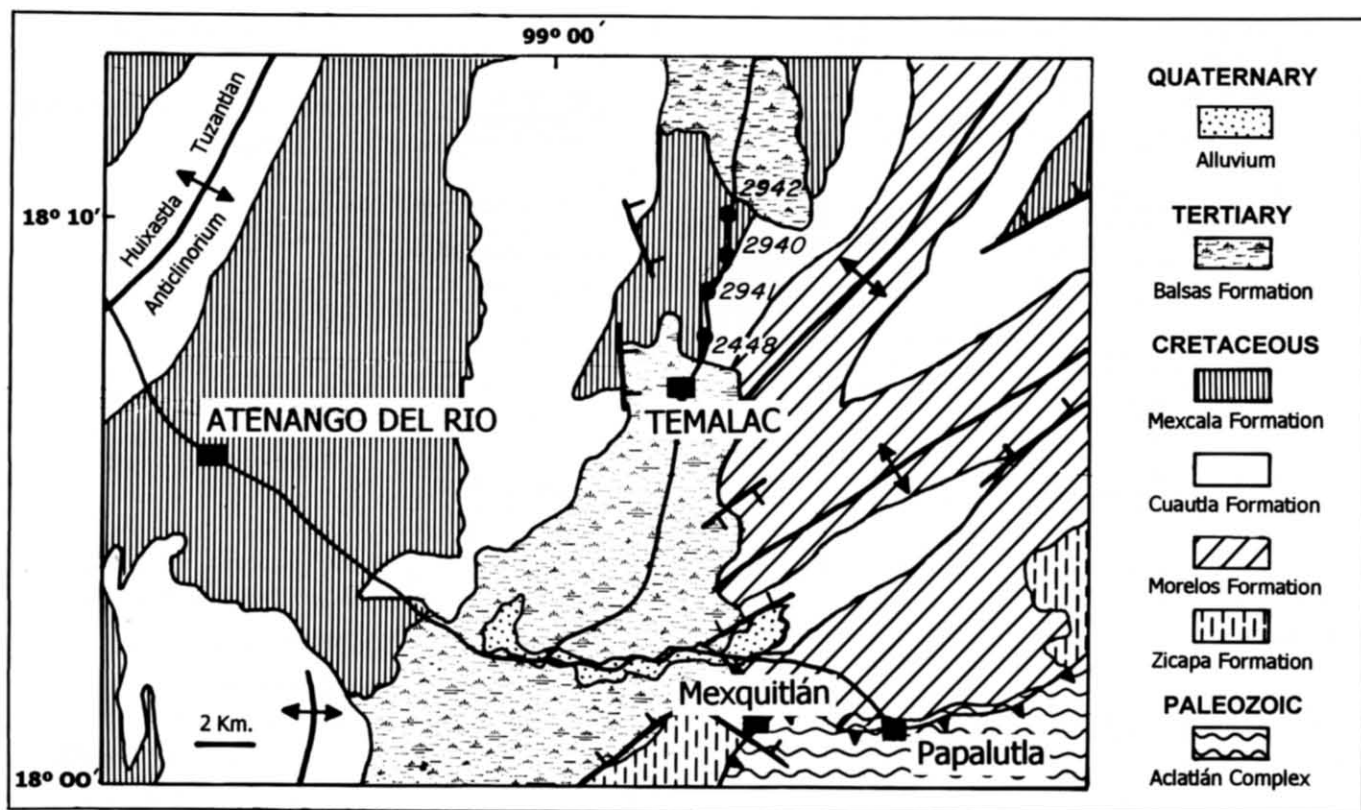


FIGURE 2—Geologic map of the study area, showing localities where the described material was collected. Localities are registered as IGM 2448, and IGM 2940 to IGM 2942.

and have more spiral threads in each whorl than those from the Mexcala Formation.

Genus *NODODELPHINULA* Cossmann, 1916  
*NODODELPHINULA DIMINUTA* new species  
 Figure 5.12–5.14

*Pterocerella* sp. cf. *P. poinsettiformis* Stephenson. ALENCÁSTER, 1980, p. 40, fig. 7.

**Diagnosis.**—Shell medium sized, strongly bicarinate whorls; sculpture of beaded spiral cords and threads.

**Description.**—Shell medium sized, thin, turbiniform, higher than wide; protoconch smooth; spire elevated, whorls bicarinate, adapical and stronger keel forming periphery; suture linear, subsutural ramp narrow, bearing four spaced, beaded cords; outer whorl slopes gently, with four beaded primary spiral cords and between each spiral cord one or two beaded spiral threads.

Base rounded bearing seven spiral beaded cords with secondary spiral threads among them. Umbilicus open. Aperture not preserved. Entire external surface with fine, close, procline, collabral striae.

**Etymology.**—The name for this species refers to the relatively small size when compared to the mean size for other species of this genus.

**Types.**—Holotype IGM 4160; paratypes IGM 4161, IGM 4162, IGM 4163.

**Other material examined.**—18 specimens. Holotype IGM 4160, height 27.9 mm, diameter 18.5 mm; paratype IGM 4161, height 23.6 mm, diameter 14.0 mm; paratype IGM 4162, height 17.2 mm, diameter 13.3 mm; paratype IGM 4163, height 25.3 mm, diameter 14.0 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—Darragh and Kendrick (1994) compared all species of *Nododelphinula*, and to avoid repetition, we will not comment on species substantially different from *N. diminuta*. Compared with *Nododelphinula draconis* from the Miria Formation (Maastrichtian) of Carnarvon Basin, northwestern Australia, the Mexican species is smaller, bears four spiral beaded cords rather than eight fine, beaded spirals, and is more slender.

This is the second record of the genus from the Maastrichtian.

Superfamily *NERITOIDEA* Rafinesque, 1815  
 Family *NERITIDAE* Rafinesque, 1815  
 Subfamily *NERITINAE* Rafinesque, 1815  
 Genus *NERITA* Linnaeus, 1758  
*NERITA* cf. *DIVARICATA* Orbigny, 1847  
 Figure 5.15, 5.16

**Description.**—Small, subglobose shell, spire short, consisting of three rapidly enlarging whorls. Last whorl sculptured with spiral striae, which in crossing transverse ribs produce an indistinct granulation. Inner lip flattened, smooth with subequal teeth on nearly straight edge. Outer lip not preserved.

**Material examined.**—One specimen. IGM 4164, height 6.1 mm, diameter 6.5 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—This specimen is smaller than *Nerita divaricata* of the Arrialoor Group of S. E. of Pachayri, southern India.



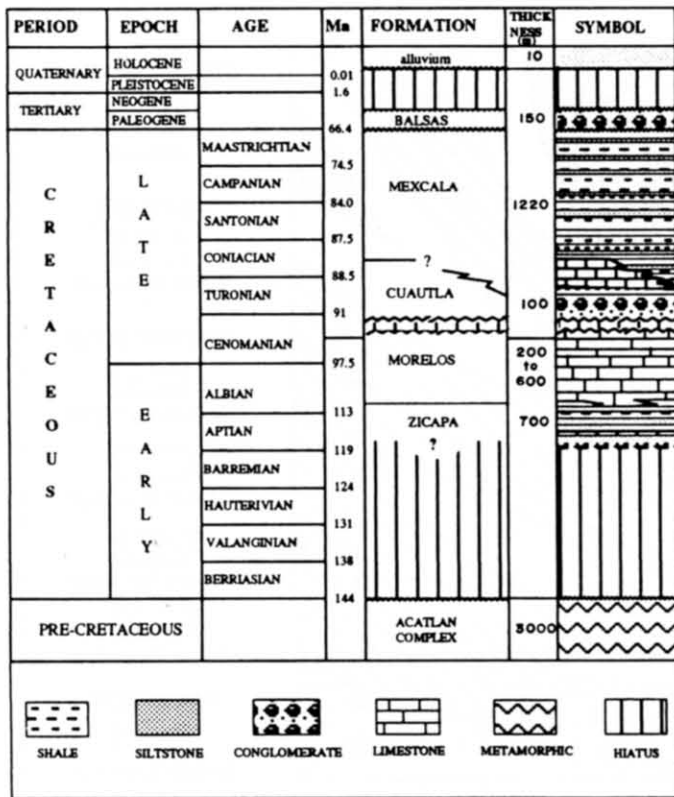


FIGURE 3—Regional geologic section, showing the lithostratigraphic units at the studied area.

Order CAENOGASTROPODA Cox, 1959  
 Superfamily CERITHIOIDEA Férussac, 1819  
 Family POTAMIDIDAE Adams and Adams, 1854  
 Subfamily POTAMIDINAE Adams and Adams, 1854  
 Genus POTAMIDES Brongniart, 1810  
 POTAMIDES TEMALACENSIS new species  
 Figure 5.17–5.20

*Cerithium weeksi* Wade of Alencáster, 1980, fig. 4. Not Wade, 1926.

**Diagnosis.**—Medium-sized cerithiid with numerous convex whorls sculptured with axial ribs noded at intersections with three spiral lirae. A varix present in last whorl diametrically opposite to aperture.

**Description.**—Protoconch and early whorls unknown. Only 11 to 13 whorls, including last whorl, are present in most complete specimens. Turriculate with convex whorls. First whorls

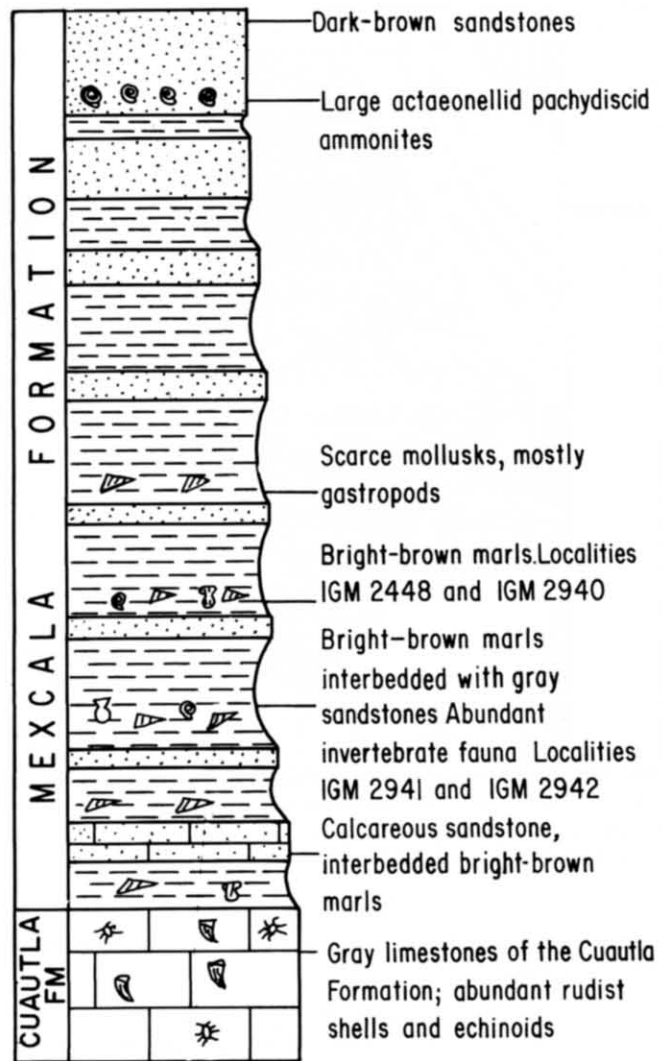
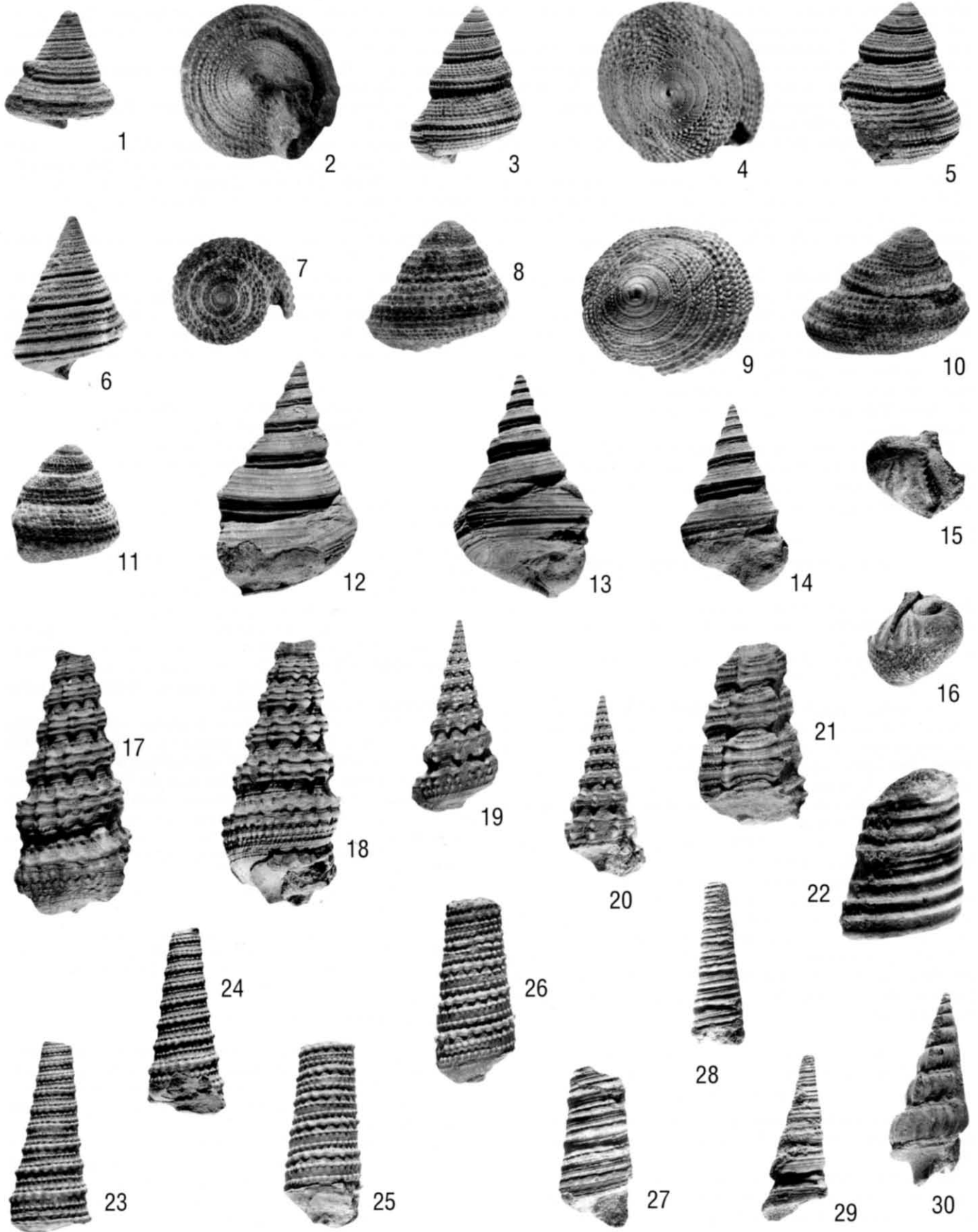


FIGURE 4—Condensed stratigraphic section of the Mexcala Formation at Temalac, showing relative position of localities.

sculptured with three spiral lirae; from fifth whorl there are two and later three spiral threads between spiral lirae, and between suture and lirae there are four spiral threads. Six spiral threads on last whorl, along with four spiral lirae and three or four intercalated spiral threads. Base sculptured with 18 spiral threads. Suture bears beaded lira. All whorls with 10 or 11 axial

FIGURE 5—1, 2, *Calliomphalus (Planolateralus) argenteus argenteus* Wade, 1926; 1, abapertural view, IGM 4151,  $\times 3.8$ ; 2, top view, IGM 4151,  $\times 5.5$ . 3–5, *Calliomphalus (Planolateralus)* cf. *decoris* Sohl, 1960; 3, abapertural view, IGM 4153,  $\times 2.7$ ; 4, top view, IGM 4153,  $\times 4.1$ ; 5, abapertural view, IGM 4154,  $\times 3.2$ . 6, *Calliomphalus (Planolateralus)* sp. Abapertural view, IGM 4158,  $\times 3.2$ . 7–11, *Calliomphalus (Planolateralus) mexcalensis* n. sp.; 7, top view, holotype IGM 4155,  $\times 4.4$ ; 8, abapertural view, holotype IGM 4155,  $\times 4.4$ ; 9, top view, paratype IGM 4156,  $\times 5.5$ ; 10, abapertural view, paratype IGM 4156,  $\times 4.5$ ; 11, abapertural view, paratype IGM 4157,  $\times 4.0$ . 12–14, *Nododelphinula diminuta* n. sp.; 12, abapertural view, holotype IGM 4160,  $\times 1.6$ ; 13, apertural view, holotype IGM 4160,  $\times 1.6$ ; 14, apertural view, paratype IGM 4161,  $\times 1.5$ . 15, *Nerita* cf. *divaricata* d'Orbigny, 1847; 15, apertural view, IGM 4164,  $\times 3.0$ ; 16, abapertural view, IGM 4164,  $\times 3.0$ . 17–20, *Potamides temalacensis* n. sp.; 17, abapertural view, holotype IGM 4165,  $\times 1.5$ ; 18, apertural view, holotype IGM 4165,  $\times 1.5$ ; 19, abapertural view, paratype IGM 4166,  $\times 1.5$ ; 20, apertural view, paratype IGM 4166,  $\times 1.5$ . 21, *Pyrazus pyramidatus* Deshayes, 1866. apertural view, IGM 4169,  $\times 2.0$ . 22, *Turritella trilira* Conrad, 1860. abapertural view, IGM 4174,  $\times 5.4$ . 23–26, *Ptychopotamides ancestralus* n. sp.; 23, abapertural view, paratype IGM 4171,  $\times 1.5$ ; 24, apertural view, paratype IGM 4171,  $\times 1.5$ ; 25, apertural view, holotype IGM 4170,  $\times 1.5$ ; 26, abapertural view, holotype IGM 4170,  $\times 1.5$ . 27, 28, *Turritella vertebroides* Morton, 1834; 27, apertural view, IGM 4177,  $\times 3.3$ ; 28, abapertural view, IGM 4178,  $\times 3.3$ . 29, *Turritella* cf. *chalybeatensis* Sohl, 1960. abapertural view, IGM 4180,  $\times 2.0$ . 30, *Calyptrophorus?* sp. apertural view, IGM 4182,  $\times 1.7$ . All specimens from locality IGM 2448.



ribs and spirals become nodulose where they override ribs. On last whorl, axial ribs disappear, leaving only beads. A varix present in last whorl, diametrically opposite to aperture. Aperture not preserved, but coarse callus present in some specimens.

*Etymology.*—The name of the species refers to the town of Temalac, the most important village near the localities where this material was collected.

*Types.*—Holotype IGM 4165; paratypes IGM 4166, IGM 4167, IGM 4168.

*Other material examined.*—730 specimens. Holotype IGM 4165, height 33.2 mm, diameter 15.7 mm; paratypes IGM 4166, height 23.5 mm, diameter 10.4 mm; IGM 4167, height 32.4 mm, diameter 15.2 mm; IGM 4168, height 30.3 mm, diameter 17.1 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—The Mexican specimens are assigned to the genus *Potamides* because they present beaded spiral threads and sinuous costae, and a varix diametrically opposite to the aperture. Another probable species of *Potamides* from India and from the beds "a Cérites" of Louristan in Iran is *Cerithium stoddardi*. This genus is well represented in the Tertiary by numerous species.

The specimen figured by Alencáster (1980) is *Potamides temalacensis*, is not *Cerithium weeksi*, since this latter species is smaller and is characterized by having only two spiral lirae in all the whorls, which are flattened.

Genus PYRAZUS Montfort, 1810  
PYRAZUS PYRAMIDATUS Deshayes, 1866  
Figure 5.21

*Cerithium pyramidatum* DESHAYES, 1866, p. 147.

*Pyrazus pyramidatum* Deshayes. DOUVILLÉ, 1904, p. 306, pl. 42, figs. 5, 6.

*Pyrazus pyramidatum* Deshayes. COSSMANN AND PISSARRO, 1910–1913, pl. 29, fig. 151-ter 2.

*Description.*—Small pyramidal shell with spire of three whorls. Protoconch and first whorls not preserved. Sculpture of six longitudinal ribs and five tuberculated spiral ribs in each whorl; fine spiral threads between these ribs. Ribs nearly in straight line. Aperture not preserved.

*Material examined.*—One specimen. IGM 4169, height 17.0 mm, diameter 15.4 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—This species also is found in the beds "a Cérites" (Maastrichtian) of Louristan, Kouch Mapeul, Iran and also is found in the Cuisien (lower Eocene) of Cuise, France. The Mexican specimen is smaller than the ones from Iran.

*Pyrazus pyramidatus* differs from *Pyrazus peruvianus* from the Maastrichtian of Tortuga, Paita Peninsula, Peru in that in the Peruvian species whorls have a pentagonal section formed by five strong ribs.

Genus PTYCHOPOTAMIDES Sacco, 1895  
PTYCHOPOTAMIDES ANCESTRALUS new species  
Figure 5.23–5.26

*Diagnosis.*—Shell medium-sized, turriculate. Sculpture of three nodulous spiral lirae; lira closest to suture coarser. Columella short.

*Description.*—Shell medium-sized, turriculate. Protoconch and earlier whorls unknown. Remaining whorls sculptured with three spiral lirae; adapical lira most conspicuous and nodulous; middle one more slender than other two. Five to seven fine spiral

threads in interspaces. Growth lines opisthocytic. Aperture unknown, columella short, but columellar plait that characterizes genus not visible.

*Etymology.*—The name for this species refers to the earliest report for the genus.

*Types.*—Holotype IGM 4170; paratypes IGM 4171, IGM 4172, IGM 4173.

*Other material examined.*—More than 500 specimens. Holotype IGM 4170, height 23.5 mm, diameter 9.5 mm; paratypes IGM 4171, height 23.4 mm, diameter 10.5 mm; IGM 4172, height 31.8 mm, diameter 12.2 mm; IGM 4173, height 31.3 mm, diameter 11.0 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—There are no related species in the Upper Cretaceous. *Cerithium semicoronatum* from the Lutetian of France exhibits the same ornamentation of three nodulous spiral lirae, but has coarser lira like a crown, which sets it apart from the Mexican specimens. Also, specimens of *C. coronatum* are smaller.

Family TURRITELLIDAE Lovén, 1847  
Subfamily TURRITELLINAE Lovén, 1847  
Genus TURRITELLA Lamarck, 1799  
TURRITELLA TRILIRA Conrad, 1860  
Figure 5.22

*Turritella trilira* CONRAD, 1860, p. 285. DOCKERY, 1993, p. 49, pl. 8, figs. 1–4. ELDER, 1996, p. 64, figs. 7, 8.

*Description.*—Shell medium-sized, turriculate. Protoconch and first whorls not preserved. Four remaining whorls with straight profile. Sculpture of three prominent ribs with interspaces deep. Basal carination and flat unornamented base.

*Material examined.*—14 specimens. IGM 4174, height 6.5 mm, diameter 4.2 mm; IGM 4175, height 11.7 mm, diameter 7.3 mm; IGM 4176, height 29.2 mm, diameter 14.0 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—*Turritella trilira* is a species with an average height of 60 mm. The Temalac specimens are quite small but have the three prominent ribs that characterize this species.

*Turritella trilira* is widely distributed in the Gulf and Atlantic coast region in Campanian and Maastrichtian strata. It is also reported from the Cárdenas Formation, San Luis Potosí (Myers, 1968); in the Parras and La Popa basins, Coahuila and Nuevo León (Wolleben, 1977; Vega and Perrilliat, 1990).

TURRITELLA VERTEBROIDES Morton, 1834  
Figure 5.27, 5.28

*Turritella vertebroides* MORTON, 1834, p. 47, pl. 3, fig. 13; WHITFIELD, 1892, p. 146, pl. 18, figs. 13–18; WELLER, 1907, p. 293, pl. 78, figs. 15, 16; WADE, 1926, p. 161, pl. 61, fig. 1; STEPHENSON, 1941, p. 290, pl. 53, figs. 5–13; STEPHENSON, 1955, p. 126, pl. 22, figs. 16–19; SOHL, 1960, p. 75, pl. 8, figs. 1–4, 12.

*Turritella paravertebroides* Gardner? WADE, 1926, p. 160, pl. 56, fig. 5.

*Description.*—Shell medium-sized. Protoconch not preserved; eight whorls with surface sculptured with four major spiral cords on well-rounded whorls. Fine transverse growth lines flexed medially. Suture moderately impressed. A fifth spiral cord at base delimits flat smooth base.

*Material examined.*—57 specimens. IGM 4177, height 9.0 mm, diameter 4.4 mm; IGM 4178, height 9.3 mm, diameter 3.3 mm; IGM 4179, height 26.2 mm, diameter 9.0 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—The specimens differ from *Turritella tippiana*

from the Ripley Formation of Mississippi in that the Ripley species has three primary spiral cords and closely spaced lower inferior spiral cords. *Turritella vertebroides* belongs to the triliriate group and is a widely distributed species in the Ripley and Owl Creek Formations of Mississippi and Alabama.

TURRITELLA cf. CHALYBEATENSIS Sohl, 1960  
Figure 5.29

*Description*.—Small-sized turritellid. Protoconch and earlier whorls missing. Teleoconch of seven whorls. Sculpture of numerous closely spaced faint spiral lirae; two spirals larger and tend to form subcarinations at one-quarter distance down whorl face; lower lira develops to strong basal carina. Growth lines faint. Suture impressed.

*Material examined*.—Seven specimens. IGM 4180, height 15.7 mm, diameter 5.7 mm; IGM 4181, height 10.2 mm, diameter 5.1 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—The specimens differ from *Turritella chalybeatensis* in that they do not possess the medially constricted whorls. *Turritella chalybeatensis* has been reported from the Owl Creek Formation of Tippah County, Mississippi.

Family STROMBIDAE Rafinesque, 1815  
Genus CALYPTRAPHORUS Conrad, 1857  
CALYPTRAPHORUS? sp.  
Figures 5.30, 6.1

*Description*.—Shell medium-sized, protoconch and aperture not preserved. Remaining five to seven whorls convex. Sculpture of two spiral lirae, with six to eight faint spiral lirae passing over ribs and another one or two more pronounced spirals close to suture. Four or five spiral lirae at base of last whorl. Axial ribs wide, rounded, almost straight and continuous from whorl to whorl. Varix present between each eight or nine ribs. Canal present along all whorls as in *Calyptraphorus*; varices opposite canal.

*Material examined*.—15 specimens. IGM 4182, height 20.1 mm, diameter 8.0 mm; IGM 4183, height 18.4 mm, diameter 9.5 mm; IGM 4184, height 24.4 mm, diameter 11.3 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—We tentatively assign these specimens to *Calyptraphorus* due to the presence of the canal. We cannot assign them to *Anchura* (*Helicaulax*) because none of these specimens has the aperture preserved, and therefore the alate lip and the posterior digitation cannot be confirmed. Also, all species assigned to *Anchura* have a nodulose sculpture of axial ribs and spiral threads. Because the aperture missing from all Temalac specimens, we cannot compare them with *Alarimella*, which has an expanded outer lip, although the sculpture of nearly aligned axial ribs and four spiral cords is similar to *Alarimella*.

Genus PUGNELLUS Conrad, 1860  
PUGNELLUS (PUGNELLUS) DENSATUS Conrad, 1858  
Figure 6.2, 6.3

*Strombus densatus* CONRAD, 1858, p. 330, pl. 25, fig. 14.  
*Pugnellus (Pugnellus) densatus* Conrad? SOHL, 1960, p. 114, pl. 14, fig. 8.

*Description*.—Shell medium-sized, thick. Spire low. Three convex whorls increasing markedly in size. Sculpture of early whorls faint spiral threads; noded transverse ribs on latter part of body whorl. Suture impressed. Last whorl rounded, abruptly constricted in front, merging into a narrow anterior canal.

*Material examined*.—Eight specimens. IGM 7592, height 20.8 mm, diameter 13.3 mm; IGM 4186, height 14.3 mm, diameter 8.7 mm; IGM 4187, height 17.0 mm, diameter 12.1 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—One specimen that exhibits the typical axial ribs of *Pugnellus densatus* does not present the reflection of the outer lip. It is similar to the specimen illustrated by Sohl (1960). *Pugnellus (Pugnellus) densatus* is widely distributed in the Owl Creek and Ripley Formations of Mississippi and Tennessee and in the Nacatoch Sand of Texas.

Superfamily NATICOIDEA Forbes, 1838  
Family AMPULLINIDAE Cossmann, 1918  
Genus AMAURELLINA Fischer, 1885  
AMAURELLINA GUERRERA new species  
Figure 6.4

*Diagnosis*.—Shell medium-sized, globose. Spire one fourth total height of shell, apex acute. Sculpture absent except for faint growth lines. Depressed subsutural ramp and raised shoulder. Inner lip covered with callus.

*Description*.—Shell medium-sized, naticoid. Protoconch unknown. Teleoconch of five whorls. First three whorls globose with suture impressed; later whorls with subsutural ramp and raised shoulder. Last whorl inflated. Sculpture absent except for faint growth lines. Inner lip covered with callus. Umbilicus close.

*Etymology*.—The name of this species is related to its occurrence in Guerrero State, southern Mexico.

*Types*.—Holotype IGM 4188, paratype IGM 4189.

Holotype.—IGM 4188, height 50.5 mm, diameter 40.0 mm; paratype IGM 4189, height 50.1 mm, diameter 40.5 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—Only two other species of *Amaurellina* are known from the Upper Cretaceous, one of them is *Amaurellina stephensoni* from the Ripley Formation of Tennessee, but the Mexican species is larger. The other species is *Amaurellina cretacea* from the Campanian of Vaals, at the border between Germany and the Netherlands, which also is a small species. *Amaurellina* is well represented in the Tertiary. *Amaurellina clarki* from the Eocene of California is comparable in size and shape with the Mexican specimens.

Genus PSEUDAMAURA Fischer, 1885  
PSEUDAMAURA cf. LEPTA Sohl, 1964b  
Figure 6.5, 6.6

*Description*.—Shell small, with spire less than half total shell height. Protoconch unknown. Teleoconch with six whorls. Suture impressed deeply. Sculpture of incised spiral lines. Aperture subovate, rounded anteriorly. Inner lip straight. Umbilical slit partly covered by inner lip.

*Material examined*.—184 specimens. IGM 7537, height 8.8 mm, diameter 7.7 mm; IGM 7538, height 10.7 mm, diameter 7.0 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—The specimens are smaller than *Pseudamaura lepta* from the Coffee Sand of Mississippi.

Family NATICIDAE Forbes, 1838  
Subfamily GYRODINAE Wenz, 1941  
Genus GYRODES Conrad, 1860  
Subgenus GYRODES Conrad, 1860  
GYRODES (GYRODES) MAJOR Wade, 1926  
Figure 6.7

*Gyrodes major* WADE, 1926, p. 164, pl. 57, figs. 4, 7, 11; SOHL, 1960, p. 118, pl. 16, figs. 6, 7, 10, 11, 15; SOHL, 1964b, p. 369, pl. 54, figs. 32, 35–37.



*Gyrodos (Gyrodos) major* Wade. DOCKERY, 1993, p. 74, pl. 20, figs. 13, 14.

**Description.**—Shell small, naticoid. Spire depressed. Protoconch unknown. Whorls flattened subnatally and crenate. Crenulations become low near aperture. Umbilicus rimmed by nonrenate carination in early stages that rounds off in late growth stages.

**Material examined.**—12 specimens. IGM 7539, height 8.2 mm, diameter 12.0 mm; IGM 7540, height 12.0 mm, diameter 14.9 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—*Gyrodos (Gyrodos) major* is known to range from early Campanian to the Maastrichtian in Mississippi and Tennessee. The Temalac specimens are smaller than those of the U. S. Gulf Coast.

GYRODES (GYRODES) SUPRAPLICATUS (Conrad, 1858)

Figure 6.8

*Rapa supraplicata* CONRAD, 1858, p. 332, pl. 35, fig. 20.

*Natica (Gyrodos) crenata* CONRAD, 1860, p. 289.

*Gyrodos crenata* Conrad. WHITFIELD, 1892, p. 126, pl. 16, figs. 5, 6.

*Gyrodos supraplicatus* (Conrad). STEPHENSON, 1923, pl. 89, figs. 3, 5; STEPHENSON, 1941, p. 280, pl. 51, figs. 13–16; STEPHENSON, 1955, p. 125, pl. 21, figs. 15, 16; SOHL, 1960, p. 117, pl. 16, figs. 1–5, 9, 13, 19.

**Description.**—Shell small. Spire strongly depressed with five whorls, rapidly expanding, bearing crenulations and strongly crenulate, sharp angulated umbilical margin. Second, less sharp and crenate spiral carina present inside the umbilicus.

**Material examined.**—10 specimens. IGM 7541, height 10.8 mm, diameter 12.0 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—*Gyrodos (Gyrodos) supraplicatus* is found in the Ripley and Owl Creek Formations of Mississippi, Clayton Formation of Tennessee and in the Nacatoch Sand of Texas. The Temalac specimens are much smaller than the Ripley and Owl Creek specimens.

Subfamily POLINICINAE Finlay and Marwick, 1937

Genus EUSPIRA Agassiz in Sowerby, 1842

EUSPIRA RECTILABRUM (Conrad, 1858)

Figure 6.9, 6.10

*Natica (Lunatia) rectilabrum* CONRAD, 1858, p. 334, pl. 35, fig. 28.

*Lunatia carolinensis* Conrad. STEPHENSON, 1923, p. 356, pl. 88, figs. 17, 18. *Polinices (Euspira) halli* (Gabb). WADE, 1926, p. 163, pl. 56, figs. 11, 12.

*Polinices rectilabrum* (Conrad). STEPHENSON, 1941, p. 276, pl. 50, fig. 16; STEPHENSON, 1955, p. 125, pl. 21, figs. 10–12.

*Polinices rectilabrum texanus* STEPHENSON, 1941, p. 276, pl. 50, figs. 7, 8.

*Euspira rectilabrum* (Conrad). SOHL, 1960, p. 122, pl. 17, figs. 5–7, 12–14; SOHL, 1964b, p. 370, pl. 55, figs. 1, 2, 7, 8; DOCKERY, 1993, p. 76, pl. 20, figs. 9, 10.

**Description.**—Shell small, moderately thick, globose. Protoconch not preserved. Teleoconch of six whorls rapidly increasing in size. Suture impressed. Surface with strongly prosocline growth lines. Aperture subovate, outer lip thin, parietal lip with thick callus, umbilicus narrow and without funicle.

**Material examined.**—29 specimens. IGM 7542, height 11.7 mm, diameter 8.0 mm; IGM 7543, height 6.2 mm, diameter 6.6 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—*Euspira rectilabrum* is found in the Coffee Sand of Mississippi, Ripley and Owl Creek Formations of Mississippi and Tennessee; San Miguel Formation, Neylandville Marl, Nacatoch Sand, Corsicana Marl, and Kemp Clay in Texas; Snow Hill Marl Member of the Black Creek Formation in Carolina; and Ripley and Providence Formations in Alabama and Georgia. The Temalac specimens are smaller than the Ripley and Owl Creek specimens.

Suborder PTENOGLOSSA Gray, 1853

Superfamily TRIPHOROIDEA Gray, 1847

(=CERITHIOPSOIDEA Adams and Adams, 1853)

Family TRIPHORIDAE Gray, 1847

Genus CERITHIELLA Verrill, 1882

CERITHIELLA NODOLIRATUM (Wade, 1926)

Figure 6.11

*Cerithium nodoliratum* WADE, 1926, p. 155, pl. 54, figs. 4, 5; SOHL, 1960, p. 82, pl. 9, figs. 15, 16, 24.

*Cerithiella nodoliratum* (Wade). DOCKERY, 1993, p. 79, pl. 23, figs. 3–5; pl. 24, figs. 3, 4; pl. 40, fig. 4.

**Description.**—Small-sized cerithiid with acuminate spire. Protoconch and aperture unknown. Teleoconch of six cancellate whorls with axial ribs and three spiral ribs, which increase in strength toward base of whorl. Basal margin angulate.

**Material examined.**—Four specimens. IGM 7544, height 15.3 mm, diameter 6.1 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—*Cerithiella nodoliratum* occurs in the Coffee Sand and Ripley Formations of Mississippi, and in the Coon Creek Tongue of the Ripley Formation of Tennessee.

CERITHIELLA AEQUALIRATA Dockery, 1993

Figure 6.12

*Cerithiella aequalirata* DOCKERY, 1993, p. 80, pl. 23, figs. 6, 7; pl. 24, figs. 6–8; pl. 40, figs. 5, 6.

FIGURE 6—1, *Calyptrophorus?* sp. abapertural view, IGM 4183,  $\times 2.2$ . 2, 3, *Pugnellus (Pugnellus) densatus* Conrad, 1858; 2, abapertural view, IGM 4187,  $\times 2.3$ ; 3, abapertural view, IGM 7592,  $\times 2.1$ . 4, *Amaurellina guerrera* n. sp. abapertural view, holotype IGM 4188,  $\times 1.0$ . 5, 6, *Pseudamaura* cf. *lepta* Sohl, 1964; 5, abapertural view, IGM 7537,  $\times 3.0$ ; 6, apertural view, IGM 7537,  $\times 3.0$ . 7, *Gyrodos (Gyrodos) major* Wade, 1926. top view, IGM 7539,  $\times 2.2$ . 8, *Gyrodos (Gyrodos) supraplicatus* (Conrad, 1858). top view, IGM 7541,  $\times 2.8$ . 9, 10, *Euspira rectilabrum* (Conrad, 1858); 9, apertural view, IGM 7542,  $\times 2.1$ ; 10, abapertural view, IGM 7542,  $\times 2.1$ . 11, *Cerithiella nodoliratum* (Wade, 1926). apertural view, IGM 7544,  $\times 2.5$ . 12, *Cerithiella aequalirata* Dockery, 1993. apertural view, IGM 7545,  $\times 2.5$ . 13, *Epitonium* cf. *faerium* Dockery, 1993. abapertural view, IGM 7546,  $\times 2.5$ . 14, *Sriaticostatum* cf. *bexarensis* (Stephenson, 1941). abapertural view, IGM 7547,  $\times 1.5$ . 15, *Opalia (Opalia)* sp. A. apertural view, IGM 7549,  $\times 2.0$ . 16, *Belliscala* sp. abapertural view, IGM 7548,  $\times 3.1$ . 17, *Opalia (Opalia)* sp. B. Apertural view, IGM 7550,  $\times 3.2$ ; 18, 19, *Bellifusus curvicostatus curvicostatus* (Wade, 1926); 18, abapertural view, IGM 7552,  $\times 2.6$ ; 19, abapertural view, IGM 7551,  $\times 2.0$ . 20, *Paleopsephaea mutabilis* Wade, 1926. Apertural view, IGM 7557,  $\times 2.3$ . 21, *Paleopsephaea?* sp. Abapertural view, IGM 7558,  $\times 2.0$ . 22–25, *Drilluta gloriae* n. sp.; 22, apertural view, paratype IGM 7555,  $\times 3.1$ ; 23, abapertural view, paratype IGM 7555,  $\times 3.1$ ; 24, abapertural view, holotype IGM 7554,  $\times 2.5$ ; 25, apertural view, holotype IGM 7554,  $\times 2.5$ . All the specimens are from locality IGM 2448, except 19 (IGM 2942) and 24 (IGM 2940).





*Description*.—Small turriculated shell. Protoconch and aperture not preserved. Teleoconch of six whorls bearing three strong spiral ribs; noded where they cross closely spaced axial ribs; and a weaker upper spiral rib that forms a subsutural collar.

*Material examined*.—Four specimens. IGM 7545, height 15.8 mm, diameter 6.0 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—*Cerithiella aequalirata* is found in the Coffee Sand of Mississippi.

Superfamily JANTHINOIDEA Lamarck, 1812

Family EPITONIIDAE Suter, 1913

Genus EPITONIUM Röding, 1798

EPITONIUM cf. FAERIUM Dockery, 1993

Figure 6.13

*Description*.—High-spined shell. Protoconch and aperture missing. Teleoconch with six convex whorls and sculptured with 13 slightly prosocline lamellae. Interspaces between lamellae smooth. Base with well defined disk. Lamellae on body whorl terminate at basal cord and continue across base as prominent growth varices.

*Material examined*.—One specimen. IGM 7546, height 14.5 mm, diameter 4.9 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—The Mexican specimen is different from *Epitonium faerium* from the Coffee Sand of Mississippi, in the number of lamellae, absence of microscopic fine spiral striations in the interspaces, and in being smaller in size.

Genus STRIATICOSTATUM Sohl, 1963

STRIATICOSTATUM cf. BEXARENSE (Stephenson, 1941)

Figure 6.14

*Description*.—Teleoconch consisting of three well-rounded whorls, with surface strongly ornamented by 16 coarse collabral transverse ribs. Surface of shell between ribs covered with fine, closely spaced round topped spiral lirae that extend to edge of transverse ribs.

*Material examined*.—One specimen. IGM 7547, height 25.2 mm, diameter 14.4 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—The Mexican specimen differs from typical *Striaticostatum bexarense* in that the former does not have strong transverse ribs composed of fluted lamellae that lend a honeycombed appearance and also has a smaller number of ribs. *Striaticostatum bexarense* is found in the Ripley Formation of Mississippi and the Corsicana Marl of Texas.

Genus BELLISCALA Stephenson, 1941

BELLISCALA sp.

Figure 6.16

*Description*.—Protoconch and aperture unknown. Teleoconch with only two convex whorls. Suture deeply impressed. Sculpture of 16 narrow, rounded, prominent axial ribs and small, distinct spiral ribs well developed both between and on crest of axial ribs.

*Material examined*.—Two specimens. IGM 7548, height 8.6 mm, diameter 6.7 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—The Mexican specimens are comparable with *Belliscala forsheyi* from the Nacatoch Sand of Texas, although *B. forsheyi* has 23 ribs on the largest whorl preserved whereas the Mexican specimens have only 16.

Subfamily OPALIINAE Cossmann and De Boury, 1912

Genus OPALIA Adams and Adams, 1858

Subgenus OPALIA Adams and Adams, 1858

OPALIA (OPALIA) sp. A

Figure 6.15

*Description*.—Shell medium-sized. Protoconch, aperture and first whorls of teleoconch not preserved, remaining four whorls well-rounded with 14 sharp widely spaced axial ribs. Fine spiral threads cover whorl sides and override transverse ribs.

*Material examined*.—One specimen. IGM 7549, height 23.1 mm, diameter 10.6 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—Compared with *Opalia (Opalia?) fistulosa* from the Ripley Formation of Mississippi, the Mexican specimen has 14 transverse ribs instead of 12 and the spiral lines are not finely punctate. *Opalia (Opalia)* sp. A resembles *Opalia ornata* from the Cretaceous of Pondoland, South Africa, in the sculpture of fine, rounded spiral ribs separated by linear grooves, with three or four smaller ribs among the larger ones near the middle of the whorl. *Opalia ornata* differs from the Mexican specimen in having 16 ribs per whorl.

OPALIA (OPALIA) sp. B

Figure 6.17

*Description*.—Shell small-sized. Protoconch and aperture not preserved. Teleoconch with three whorls. Whorls well rounded with 14 to 16 sharp crested, widely spaced axial ribs, and with 20 spiral threads that cover whorl sides and override transverse ribs. Spirals all of same width and separated by incised line.

*Material examined*.—Two specimens. IGM 7550, height 12.7 mm, diameter 7.2 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—The differences between these specimens and the one described above lies in the nature of the spiral threads. In *Opalia (Opalia)* sp. A, these spirals are not of the same width, whereas in *Opalia (Opalia)* sp. B all the spiral threads are of the same width.

Family FASCIOLARIIDAE Gray, 1853

Subfamily FASCIOLARIINAE Gray, 1853

Genus BELLIFUSUS Stephenson, 1941

BELLIFUSUS CURVICOSTATUS CURVICOSTATUS (Wade, 1926)

Figure 6.18, 6.19

*Odontofusus medians* WELLER, 1907, p. 761, pl. 90, fig. 6.

*Odontofusus curvicostata* WADE, 1926, p. 130, pl. 42, figs. 7–9.

*Bellifusus curvicostatus* STEPHENSON, 1941, p. 338.

*Bellifusus tenuistriatus* STEPHENSON, 1941, p. 339, pl. 65, figs. 7–9.

*Bellifusus curvicostatus curvicostatus* (Wade) SOHL, 1964a, p. 202, pl. 25, figs. 23, 24; pl. 26, figs. 18, 19, 23, 24.

*Description*.—Medium-sized fusiform shell. Protoconch not preserved. Teleoconch with six convex whorls. Rounded shoulder, constricted posteriorly to a collar, becoming wrinkled by coarse growth lines. Sculpture dominantly axial of 12–14 sinuous collabral ribs and faint spiral lirae. Aperture not preserved.

*Material examined*.—73 specimens. IGM 7551, height 22.6 mm, diameter 13.2 mm; IGM 7552, height 14.4 mm, diameter 8.0 mm; IGM 7553, height 28.0 mm, diameter 14.1 mm.

*Occurrence*.—Localities 2448, and 2942, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—*Bellifusus curvicostatus curvicostatus* is found in the Ripley Formation of Mississippi, Tennessee, Georgia, and Alabama, and the Nacatoch Sand of Texas.

Genus DRILLUTA Wade, 1916  
DRILLUTA GLORIAE new species  
Figure 6.22–6.25

*Diagnosis.*—Fusiform shell, with moderately developed wrinkled collar, slightly concave ramp, 10 shouldered straight collabral ribs.

*Description.*—Shell medium-sized, elongate. Protoconch of two and a half whorls, smooth. Sloping, moderately broad, and shallowly concave ramp; suture sinuous. Teleoconch with eight whorls with 10 shouldered, nearly straight, collabral ribs; in first and second whorls ribs slightly rounded and close to each other; in following whorls ribs more separated and sharp crested. Three weak spiral threads on ramp and ribs overridden by five strong spiral threads. Aperture not preserved. Columella bears two oblique moderately strong folds, anterior fold stronger, and faint third posterior fold.

*Etymology.*—The name of this species honors Dra. Gloria Alencáster, a well known Mexican paleontologist, and the first person to conduct a study of the molluscan fauna here described.

*Types.*—Holotype IGM 7554; paratypes IGM 7555, IGM 7556.

*Material examined.*—63 specimens. Holotype IGM 7554, height 23.4 mm, diameter 9.5 mm; paratype IGM 7555, height 13.1 mm, diameter 6.5 mm; paratype IGM 7556, height 25.4 mm, diameter 11.1 mm.

*Occurrence.*—Localities 2448, and 2940, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—*Drilluta communis* from the Ripley Formation of Tennessee, Mississippi and Texas; *Drilluta distans* from the Ripley Formation of Tennessee, Mississippi, Alabama, and Georgia; *Drilluta lemniscata* from the Ripley Formation of Mississippi; *Drilluta buboanus* from the Owl Creek Formation of Mississippi; and *Drilluta major* from the Ripley Formation of Tennessee all have shells with a convex last whorl and spirals that are rounded and larger than the specimens from Temalac. *Drilluta sicca* from the Turonian of California and Oregon has similar sculpture to the Mexican specimens consisting of 10–12 strongly shouldered, nearly straight collabral ribs, but *D. sicca* is larger in size and more elongate than *Drilluta gloriae*.

Genus PALEOPSEPHAEA Wade, 1926  
PALEOPSEPHAEA MUTABILIS Wade, 1926  
Figure 6.20

*Paleopsephaea mutabilis* WADE, 1926, p. 123, pl. 40, figs. 4, 5, 8; HARRISON, 1945, pl. 4, figs. 29, 30; SOHL, 1964a, p. 209, pl. 28, figs. 1, 6.

*Description.*—Medium-sized fusiform shell. Protoconch with two smooth whorls. Spire elevated and acute. Teleoconch of five whorls. Sculpture dominantly axial of 10 strong collabral ribs, these ribs evanesce on anterior slope of last whorl. No spiral sculpture preserved. Suture appressed and undulating about axial elevations. Inner lip excavated medially.

*Material examined.*—One specimen. IGM 7557, height 20.9 mm, diameter 10.0 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—The Mexican specimen has a greater diameter than those described from the Ripley Formation of Tennessee and Mississippi.

PALEOPSEPHAEA? sp.  
Figure 6.21

*Description.*—Small-sized fusiform shell. Slender outline. Protoconch and first whorls of teleoconch not preserved. Three remaining whorls. Sculpture dominated by nine strong collabral

ribs, ribs overridden by 12 spiral threads. Body whorl posteriorly constricted. Aperture incomplete, inner lip slightly callused. Columella bearing two weak plications.

*Material examined.*—One specimen. IGM 7558, height 18.8 mm, diameter 9.9 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—The Mexican specimen is different from *Paleopsephaea tenuilirata* of the Ripley Formation of Mississippi in being wider, having more axial ribs, and possessing spiral sculpture that is not close-spaced and that covers the whole whorl surface.

Subfamily FUSININAE Swainson, 1840  
Genus REMERA Stephenson, 1941  
REMER sp.  
Figure 7.1, 7.2

*Description.*—Small fusiform shell with protoconch of one smooth whorl. Teleoconch with six whorls, flat sided bearing eight rounded ribs per whorl. Ribs overridden by six flat spiral ribbons, and 14 spirals in last whorl. Aperture unknown and columella smooth.

*Material examined.*—One specimen. IGM 7559, height 14.5 mm, diameter 5.1 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—The Temalac specimen differs from *Remera stephensoni* from the Ripley Formation of Mississippi, Tennessee, Georgia and Alabama in being smaller and having fewer ribs. *Remera stephensoni* has from 14 to 16 ribs. In *Remera flexicostata* from the Owl Creek Formation of Mississippi, the ribs are more numerous and more closely-spaced, becoming strongly sinuous, and specimens larger in size.

Family VOLUTIDAE Rafinesque, 1815  
Subfamily VOLUTODERMINAE Pilsbry and Olsson, 1954  
Genus VOLUTOMORPHA Gabb, 1877  
VOLUTOMORPHA cf. RETIFERA Dall, 1907  
Figure 7.3

*Description.*—Shell medium-sized. Protoconch not preserved. Spire rather low. Teleoconch with three whorls; suture moderately impressed. Last whorl inflated, bordered at its upper margin by a collar; ornamented by narrow, moderately prominent axial ribs; spiral sculpture of numerous low ribs. Subsutural collar with spiral lirae. Aperture not preserved.

*Material examined.*—One specimen. IGM 7560, height 22.5 mm, diameter 12.1 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

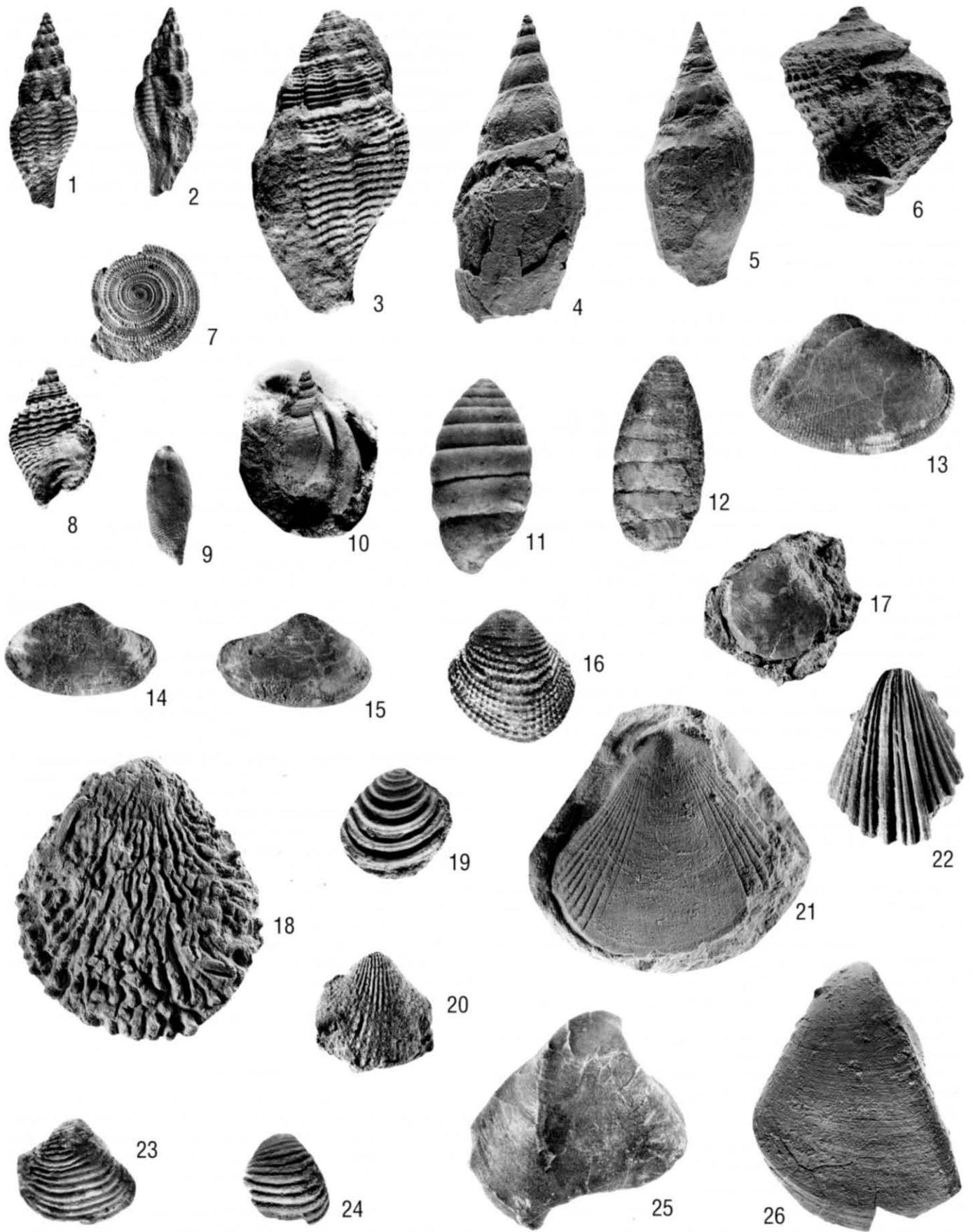
*Discussion.*—This young specimen of *Volutomorpha* compares well to *Volutomorpha retifera*, found in the Ripley Formation of Mississippi.

Subfamily ATHLETINAE Pilsbry and Olsson, 1954  
Genus LIOPEPLUM Dall, 1890  
LIOPEPLUM cf. CRETACEUM (Conrad, 1858)  
Figure 7.4, 7.5

*Description.*—Shell medium-sized, strombiform. Protoconch not preserved. Teleoconch with six whorls. Sculpture of transverse ribs limited to first three whorls, remaining whorls polished with faint growth lines. Suture impressed. Whorls lack pronounced callus ridge and shouldering. Aperture not preserved.

*Material examined.*—19 specimens. IGM 7561, height 56.1 mm, diameter 22.1 mm; IGM 7562, height 48.8 mm, diameter





21.4 mm; IGM 7563, height 37.9 mm, diameter 24.3 mm; IGM 7564, height 39.2 mm, diameter 19.2 mm.

*Occurrence*.—Locality 2941, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—The only difference between the Temalac specimens and typical *Liopeplum cretaceum* from the Owl Creek Formation of Mississippi, is that the Mexican specimens are smaller in size.

Family TURBINELLIDAE Swainson, 1840  
Subfamily VASINAE Adams and Adams, 1854  
Genus PYROPSIS Conrad, 1860  
PYROPSIS LANHAMI Stephenson, 1941  
Figure 7.6

*Pyropsis lanhami* STEPHENSON, 1941, p. 315, pl. 59, figs. 14–16; ALENCÁSTER, 1980, p. 41, fig. 15.

*Description*.—Shell medium-sized, subpyriform. Protoconch not preserved. Spire low bearing four peripherally expanded, shouldered whorls. Last whorl ornamented with seven moderately strong, spiral, nodose ribs. Nodes small. Aperture unknown.

*Material examined*.—One specimen. IGM 7565, height 27.0 mm, diameter 24.4 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—*Pyropsis lanhami* is known from the Navarro Group of Texas.

Superfamily CANCELLARIAEAE Gray, 1853  
Family CANCELLARIIDAE Forbes and Hanley, 1853  
Genus CANCELLARIA Lamarck, 1799  
CANCELLARIA sp.  
Figure 7.8

*Description*.—Shell small. Protoconch naticiform with two whorls. Teleoconch of three whorls, ornamented with spiral threads and axial ribs. Axials slender, 14 in each whorl and separated by wide smooth interspaces. Five spiral threads on each spire whorl and 15 on last whorl. Spiral threads override axials. Aperture unknown. Columella with three folds.

*Material examined*.—One specimen. IGM 7566, height 8.4 mm, diameter 5.1 mm.

*Occurrence*.—Locality 2942, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—This immature specimen is similar in the ornamentation to *Cancellaria siouxensis* from the Fox Hills Formation (Maastrichtian) of North Dakota.

Order HETEROSTROPHA Fischer, 1885  
Superfamily ARCHITECTONICOIDEA Gray, 1840  
Family ARCHITECTONICIDAE Röding, 1798  
Genus GRANOSOLARIUM Sacco, 1892  
GRANOSOLARIUM COFFEA Sohl, 1964b  
Figure 7.7

*Architectonica (Granosolarium) coffea* SOHL, 1964b, p. 360, pl. 53, figs. 19–22.

*Granosolarium coffea* SOHL, DOCKERY, 1993, p. 91, pl. 33, figs. 1, 2, 6; pl. 34, figs. 1–5.

*Description*.—Shell small-sized, discoidal. Protoconch of one whorl. Teleoconch of five whorls. Sculpture of noded spiral cords and lirae. Suture incised. Shell periphery marked by two noded cords. Moderately broad umbilicus; umbilical wall with spiral cord between margin and suture.

*Material examined*.—14 specimens. IGM 7567, height 6.6 mm, diameter 14.4 mm; IGM 7568, height 4.8 mm, diameter 10.9 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—*Granosolarium coffea* is found in the Coffee Sand of Mississippi.

Subclass HETEROBRANCHIA Gray, 1840  
Superfamily RINGICULOIDEA Philippi, 1853  
Family RINGICULIDAE Philippi, 1853  
Genus RINGICULA Deshayes, 1838  
Subgenus RINGICULINA Monterosato, 1884  
RINGICULA (RINGICULINA) cf. CLARKI Gardner, 1916  
Figure 7.10

*Description*.—Shell small, low spired, subglobose, ringiculid. Teleoconch of five whorls. Suture impressed. Spiral sculpture of few widely spaced fine incised lines restricted to upper one-fifth and lower one-third of last whorl; remainder of body whorl smooth. Outer lip varicose; inner lip arcuate, strongly constricted at base of body, calloused.

*Material examined*.—One specimen. IGM 7569, height 5.8 mm, diameter 3.4 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—The sculpture of the Mexican specimen compares well with that of *Ringicula clarki* from the Ripley Formation of Mississippi.

Family SCAPHANDRIDAE Adams, 1850  
Genus CYLICHNA Lovén, 1847  
CYLICHNA SECALINA Shumard, 1861  
Figure 7.9

*Cylichna secalina* SHUMARD, 1861, p. 195; STEPHENSON, 1941, p. 394, pl. 74, figs. 4–6; SOHL, 1964a, p. 299, pl. 49, figs. 26, 27.

FIGURE 7—1, 2, *Remera* sp. 1, Abapertural view, IGM 7559,  $\times 2.6$ ; 2, apertural view, IGM 7559,  $\times 2.6$ . 3, *Volutomorpha* cf. *retifera* Dall, 1907. Abapertural view, IGM 7560,  $\times 2.5$ . 4, 5, *Liopeplum* cf. *cretaceum* (Conrad, 1858); 4, abapertural view, IGM 7561,  $\times 1.0$ ; 5, abapertural view, IGM 7562,  $\times 1.0$ . 6, *Pyropsis lanhami* Stephenson, 1941. Apertural view, IGM 7565,  $\times 1.5$ . 7, *Granosolarium coffea* Sohl, 1964. Top view, IGM 7567,  $\times 1.6$ . 8, *Cancellaria* sp. Apertural view, IGM 7566,  $\times 3.3$ . 9, *Cylichna secalina* Shumard, 1861. Abapertural view, IGM 7570,  $\times 3.4$ . 10, *Ringicula (Ringiculina)* cf. *clarki* Gardner, 1916. Apertural view, IGM 7569,  $\times 5.0$ . 11, 12, *Holospira* sp.; 11, abapertural view, IGM 7572,  $\times 4.0$ ; 12, abapertural view, IGM 7573,  $\times 3.1$ . 13, *Nucula ciboloensis* Stephenson, 1941. Right valve, IGM 7574,  $\times 2.6$ . 14, 15, *Nuculana corsicana* Stephenson, 1941; 14, left valve, IGM 7576,  $\times 3.0$ ; 15, right valve, IGM 7576,  $\times 3.0$ . 16, *Crenella serica* Conrad, 1880. Left valve, IGM 7579,  $\times 3.3$ . 17, *Camptonectes* sp. Left valve, IGM 7581,  $\times 2.1$ . 18, *Plicatula batmensis* Coquand, 1880. Right valve, IGM 7584,  $\times 1.0$ . 19, *Astarte similis* Münster, 1890. Right valve, IGM 7586,  $\times 4.4$ . 20, *Cardium* sp. Right valve, IGM 7587,  $\times 3.7$ . 21, *Protocardia?* sp. Right valve, IGM 7588,  $\times 2.5$ . 22, *Neithea (Neithea)* cf. *youngi* Myers, 1968. Right valve, IGM 7582,  $\times 2.4$ . 23, *Corbula crassiplica* Gabb, 1860. Right valve, IGM 7590,  $\times 4.7$ ; 24, *Corbula* cf. *paracrassa* Wade, 1926. Right valve, IGM 7591,  $\times 6.0$ . 25, *Veniella* sp. Right valve, IGM 7589,  $\times 3.0$ . 26, *Veniella* cf. *jamaicensis* (Trechmann, 1927). Left valve, IGM 7590,  $\times 0.53$ . All the specimens are from locality IGM 2448, except 4, 5 from locality IGM 2941, 8 from locality IGM 2942, and 16, 17 from locality IGM 2940.

*Description*.—Shell small, slender, rounded at inferior extremity, subtruncated above. Sculpture of four to five strong raised spiral cords near apical end, fine and weakly incised grooves medially and fine growth lines. Aperture long. Columella twisted and bears weak fold.

*Material examined*.—Eight specimens. IGM 7570, height 7.0 mm, diameter 2.5 mm; IGM 7571, height 7.4 mm, diameter 2.4 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—*Cylichna secalina* is found in the Nacatoch Sand of Texas and the Ripley Formation of Mississippi.

Subclass PULMONATA Cuvier, 1817

Order STYLOMMATOPHORA Schmidt, 1855

Superfamily ORTHALICOIDEA Albers, 1860

Family UROCOPTIDAE Pilsbry and Vanatta, 1898

Genus HOLOSPIRA von Martens in Albers, 1860

HOLOSPIRA sp.

Figure 7.11, 7.12

*Description*.—Shell small, subcylindrical, obtuse at apex, 10 or 11 volutions, compactly coiled; suture nearly linear. Surface smooth. Aperture unknown.

*Material examined*.—Two specimens. IGM 7572, height 9.5 mm, diameter 5.2 mm; IGM 7573, height 12.1 mm, diameter 5.6 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—The Temalac specimens resembles *Holospira leidy* from the Eocene of New Mexico and *Holospira grangeri* from the Torrejon Formation (Eocene) of New Mexico in that both have the same number of whorls and are the same size. The Mexican specimens do not present a sculpture of coarse strong ribs as do the ones from New Mexico. *Holospira? leidy* from the Tertiary rocks of Fort Bridge, Wyoming and *Holospira leidy* from the Eocene of New Mexico have a larger number of ribs, are more flattened and are ornamented by small, comparatively distinct, regular, crowded oblique striae of growth.

Class BIVALVIA Linnaeus, 1758

Order NUCULOIDA Dall, 1889

Superfamily NUCULOIDEA Gray, 1824

Family NUCULIDAE Gray, 1824

Genus NUCULA Lamarck, 1799

NUCULA CIBOLOENSIS Stephenson, 1941

Figure 7.13

*Nucula ciboloensis* STEPHENSON, 1941, p. 72, pl. 8, fig. 10.

*Description*.—Shell small, subovate-elongate, inner margin finely crenulated. Anterodorsal margin broadly convex, postero-dorsal margin moderately steep, ventral margin rounded, finely crenulate. Surface marked by numerous low, fine, radiating ribs separated by very shallow interspaces.

*Material examined*.—47 specimens. IGM 7574, length 14.8 mm, height 10.4 mm, diameter 4.5 mm (both valves); IGM 7575, length 17.9 mm, height 11.1 mm, diameter 3.0 mm.

*Occurrence*.—Localities 2448 and 2940, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—All the Mexican specimens are flattened and are smaller in size than the ones from Texas. *Nucula ciboloensis* is found in the Navarro Group of Texas.

Superfamily NUCULANOIDEA Adams and Adams, 1858

Family NUCULANIDAE Adams and Adams, 1858

Genus NUCULANA Link, 1807

NUCULANA CORSICANA Stephenson, 1941

Figure 7.14, 7.15

*Nuculana corsicana* STEPHENSON, 1941, p. 75, pl. 8, figs. 19–20.

*Description*.—Shell small, moderately convex below beaks,

compressed posteriorly by broad, radiating sulcation. Postero-dorsal margin nearly straight. Anterodorsal margin broadly arched. Anterior margin rounded, ventral margin broadly rounded. Escutcheon long and narrow. Lunule distinct. Sculpture of numerous concentric ridges which fade out on posterior sulcation.

*Material examined*.—34 specimens. IGM 7576, length 9.7 mm, height 5.9 mm, diameter 3.6 mm; IGM 7577, length 9.8 mm, height 5.7 mm, diameter 3.4 mm; IGM 7578, length 9.0 mm, height 6.1 mm, diameter 2.6 mm.

*Occurrence*.—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—*Nuculana corsicana* is found in the Navarro Group of Texas.

Subclass PTERIOMORPHIA Beurlen, 1944

Order MYTILOIDA Férussac, 1822

Superfamily MYTILOIDEA Rafinesque, 1815

Family MYTILIDAE Rafinesque, 1815

Genus CRENELLA Brown, 1827

CRENELLA SERICA Conrad, 1860

Figure 7.16

*Crenella (Stalagmium) serica* CONRAD, 1860, p. 281, pl. 46, fig. 23.

*Crenella serica* Conrad. WELLER, 1907, p. 510, pl. 56, figs. 7, 8; GARDNER, 1916, p. 624, pl. 36, figs. 16–18; STEPHENSON, 1923, p. 241, pl. 62, figs. 1, 2; STEPHENSON, 1941, p. 153, pl. 25, figs. 13–15.

*Description*.—Shell small, equi-valve, inequilateral, strongly ventricose. Beaks strongly prominent, incurved, prosogyrate. Margins form nearly rectangular oval. Surface delicately reticulated by numerous fine, radiating ribs, crossed by spaced concentric ridges. Concentric ridges more prominent and more widely spaced than radiating ribs.

*Material examined*.—14 specimens. IGM 7579, length 8.0 mm, height 7.7 mm, diameter 7.4 mm; IGM 7580, length 6.2 mm, height 6.4 mm, diameter 5.1 mm.

*Occurrence*.—Locality 2940, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—*Crenella serica* is found in the Navarro Group of Texas, Ripley Formation of Mississippi, and Monmouth Formation of Maryland.

Superfamily PECTINOIDEA Rafinesque, 1815

Family PECTINIDAE Rafinesque, 1815

Genus CAMPTONECTES Agassiz in Meek, 1864

CAMPTONECTES sp.

Figure 7.17

*Description*.—Shell small, thin, subcircular. Beak small, scarcely rising above hinge line. Anterior ear larger than posterior one, and separated from remainder of shell by narrow rather deep sulci. Surface smooth.

*Material examined*.—Two specimens. IGM 7581, length 9.9 mm, height 10.3 mm.

*Occurrence*.—Locality 2940, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion*.—The Mexican specimens have affinities with *Camptonectes kaufmanensis* from the Navarro Group of Texas in size and shape; but differs from this species in lacking an ornamented surface of fine close-set low, broad-topped ribs.

Genus NEITHEA Drouet, 1824

Subgenus NEITHEA sensu stricto

NEITHEA (NEITHEA) cf. YOUNGI Myers, 1968

Figure 7.22

*Description*.—Small right valve strongly and evenly convex, semicircular in profile. Hinge line short, less than half shell width, almost straight. Beak strongly incurved. Dorsal slope



steep. Sculpture of six high, wide, round and smooth primary ribs, between these two secondary ribs. Interspaces almost as wide as ribs.

*Material examined.*—Two specimens. IGM 7582, length 10.3 mm, height 13.9 mm; IGM 7583, length 9.0 mm, height 10.8 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—The Temalac specimens differ from *Neithea youngi* in being smaller in size, and in one specimen the primary ribs are divided by two or three faint radial striae. All the ribs are crossed by growth lines. *Neithea youngi* is found in the Cárdenas Formation of San Luis Potosí, México. *Neithea youngi* is close to *Neithea (Neithea) bexarensis* from the Navarro Group of Texas in shape and ornamentation. However, *Neithea youngi* does not have two to five ribs developed on each primary rib, and its grooves are much wider.

*Neithea (Neithea) latericostata* from the Gramame Formation of Brazil is a similar species having three to five ribs developed on each primary rib.

Family PLICATULIDAE Watson, 1930  
Genus PLICATULA Lamarck, 1801  
PLICATULA BATNENSIS Coquand, 1880  
Figure 7.18

*Plicatula batnensis* COQUAND, 1880, p. 162; PERVINQUIÈRE, 1912, p. 162, pl. 9, fig. 21a-c.

*Description.*—Medium-sized oval shell, equivalve, equilateral. Beaks prosogyrous. Ornamented with numerous defined radiating ribs that bifurcate away from beak. Ribs with numerous slender spines.

*Material examined.*—Five specimens. IGM 7584, length 46.9 mm, height 52.4 mm, diameter 16.2 mm; IGM 7585, length 33.9 mm, height 37.4 mm, diameter 11.7 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—*Plicatula batnensis* is known in the Senonian of Algeria. It is larger than *Plicatula mullicaensis* from the Cretaceous of New Jersey.

Superfamily CRASSATELLOIDEA Férussac, 1822  
Family ASTARTIDAE Orbigny, 1844  
Subfamily ASTARTINAE Orbigny, 1844  
Genus ASTARTE J. Sowerby, 1816  
ASTARTE SIMILIS Münster in Goldfuss, 1826–1833  
Figure 7.19

*Astarte similis* Münster in GOLDFUSS, 1826–1833, p. 193, pl. 134, figs. 22a-b; HOLZAPFEL, 1889, p. 194, pl. 19, figs. 11–15; PERVINQUIÈRE, 1912, p. 246, pl. 19, figs. 1, 2, 3a, b, 4a, b, 5–7.

*Gouldia planissima* STOLICZKA, 1871, p. 289, pl. 10, fig. 3.

*Description.*—Small shell, convex, subtriangular in outline, equivalve, equilateral, beaks small, contiguous. Ventral and anterior margin rounded, posterior margin straight. Sculpture of 10 round crested concentric ribs, separated by wide interspaces. Lunule oval, escutcheon impressed.

*Material examined.*—Two specimens. IGM 7586, length 5.1 mm, height 4.9 mm, diameter 2.6 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—*Astarte similis* is found in the Maastrichtian of Garat Temblili, Tunisia, and India. The Mexican specimens differ from *Astarte? culebrensis* from the Navarro Group of Texas in having only seven strong broadly round crested concentric undulations. They are quite similar in size to the Texas specimens.

Superfamily CARDIOIDEA Lamarck, 1809  
Family CARDIIDAE Lamarck, 1809  
Subfamily CARDIINAE Lamarck, 1809  
Genus CARDIUM Linnaeus, 1758  
CARDIUM sp.  
Figure 7.20

*Description.*—Small semicircular shell, beak prosogyrous. Hinge nearly straight. Ventral margin rounded. Sculpture of square, nodose, radial ribs, separated by narrow interspaces.

*Material examined.*—13 specimens. IGM 7587, length 6.2 mm, height 6.4 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—Due to poor preservation, this specimen cannot be assigned to any known species in the Upper Cretaceous.

Subfamily PROTOCARDIINAE Keen, 1951  
Genus PROTOCARDIA Beyrich, 1846  
PROTOCARDIA? sp.  
Figure 7.21

*Description.*—Rounded small shell, beak central; equilateral. Posterior slope well defined by umbonal ridge. Sculpture of radial ribs in both anterior and posterior slopes; remainder of shell with faint concentric ribs.

*Material examined.*—Three specimens. IGM 7588, length 13.2 mm, height 16.1 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—Due to poor preservation, the specimen can be identified only provisionally to generic level.

Superfamily ARCTICOIDEA Newton, 1891  
Family ARCTICIDAE Newton, 1891  
Genus VENIELLA Stoliczka, 1871  
VENIELLA sp.  
Figure 7.25

*Description.*—Small-triangular, quite thick, strong shell, inequilateral. Beak prominent, strongly incurved, prosogyrate. Posterior side long, rounding obliquely with broad curve from dorsum to narrowly rounded posterodorsal extremity. Surface smooth.

*Material examined.*—One specimen. IGM 7589, length 13.2 mm, height 16.1 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—The Temalac specimen is a young specimen that lacks the flange-like concentric sculpture on posterior flank as in *Veniella conradi* from the Cretaceous of New Jersey and *Veniella humilis* from the Maastrichtian; however, specimens of these species are larger than the Mexican one.

VENIELLA cf. JAMAICENSIS (Trechmann, 1927)  
Figure 7.26

*Description.*—Large, solid shell with prosogyrate beak, inequilateral; area below beak broadly sunken. Posterior umbonal ridge strong, flange-like and defining a wide posterior submargin. Shell widely depressed in front of posterior ridge. Posterior margin gently curved. Shell nearly smooth except for fine growth lines.

*Material examined.*—One specimen. IGM 7590, length 68.3 mm, height 98.6 mm, diameter 32.9 mm.

*Occurrence.*—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

*Discussion.*—This specimen differs from *Roudaireia jamaicensis* from the Maastrichtian of Jamaica in not having coarse and close set growth lines near the lower margin. But as in the adult shell of this species, the Mexican specimen has a nearly

smooth surface except for fine growth lines and occasional coarse growth interruptions.

Family CORBULIDAE Lamarck, 1818  
 Subfamily CORBULINAE Lamarck, 1818  
 Genus CORBULA Bruguière, 1797  
 CORBULA CRASSIPICA Gabb, 1860  
 Figure 7.23

*Corbula crassiplica* GABB 1860, p. 394, pl. 68, fig. 25; WHITFIELD, 1885, p. 178, pl. 23, fig. 30; WELLER, 1907, p. 641, pl. 72, figs. 27, 28; GARDNER, 1916, p. 713, pl. 43, figs. 6, 7; WADE, 1926, p. 96, pl. 31, figs. 9–13; STEPHENSON, 1941, p. 234, pl. 44, figs. 16, 17.

**Description.**—Shell small, subtrigonal in outline, inequilateral, inequivalve, convex. Beak large, strongly inflated in umbonal region. Anterodorsal margin rounded, posterodorsal margin oblique, ventral margin rounded. Surface of right valve with strong, round crested, concentric ribs separated by deep interspaces. Left valve ornamented only with coarse growth lines.

**Material examined.**—One specimen. IGM 7590, length 5.2 mm, height 4.4 mm, diameter 2.6 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—*Corbula crassiplica* is found in the Navarro Group of Texas, Nacatoch Sand of Arkansas, Coffee Sand and Ripley Formation of Mississippi, Monmouth Formation of Maryland.

CORBULA cf. PARACRASSA Wade, 1926  
 Figure 7.24

**Description.**—Small shell, short, ovate trigonal in outline, inequilateral, umbones inflated; anterior margin well rounded; ventral margin arcuate; posterior and dorsal margins truncate. Sculpture of concentric well-rounded ridges.

**Material examined.**—Two specimens. IGM 7591, length 3.3 mm, height 3.3 mm.

**Occurrence.**—Locality 2448, Temalac, Guerrero. Lower Maastrichtian, Mexcala Formation.

**Discussion.**—As stated by Wade (1926, p. 97), *Corbula paracrassa* is a smaller form than *Corbula crassiplica* and has finer sculpture. *Corbula paracrassa* is found in the Ripley Formation of Tennessee.

#### PALEOBIOGEOGRAPHY

Alencáster (1980) proposed paleobiogeographic affinities of this fauna with the Atlantic and Gulf Coastal Plain of the United States. In this paper we identified 22 molluscan species which have been previously described from other localities around the world. From these, 19 are known from the Gulf Coastal Plain Province, whereas the remaining three have been described from France, India and Argelia. Eleven other species have also been related to species described from Texas, Alabama, Tennessee, Mississippi, and San Luis Potosí (east Mexico), whereas other two have affinities with species described from Jamaica and India. The lower Maastrichtian molluscan assemblage from the Mexcala Formation represents the southernmost occurrence of the Gulf Coastal Plain Faunal Province, although some typical species of this province have been recently reported from the Maastrichtian of Chiapas (Buitrón et al., 1995).

#### ACKNOWLEDGMENTS

This research was supported by the Dirección General de Apoyo al Personal Académico, UNAM, project IN202394. We are very grateful to R. M. Feldmann for his critical revision of

the manuscript. S. Tracey and R. Petit provided useful information to complete this paper. A. Altamira (Laboratorio de Fotografía, Instituto de Geología, UNAM) made numerous photographs. Special thanks to B. Huber of the Smithsonian Institution for his kind help in the identification of the planktic foraminiferans. Special thanks to L. Saul and C. Johnson for their critical review of the manuscript. The following persons provided help reviewing the manuscript: R. M. Feldmann, Z. de Cserna, G. Tolson, and M. Alcayde.

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