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EOCENE FORAMINIFERA FROM MEXICO

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ABSTRACT

The guide foraminifera of the Eocene deposits of the Tampico embayment, Mexico, are indicated with notes on their character and range. Special consideration is given to the Aragon fossils, of upper Lower Eocene age. Nine new species and four new varieties of foraminifera are described.

INTRODUCTION

The geological formations of the Tampico embayment, Mexico, mentioned in this paper are as follows: Alazan (Lower Oligocene), Chapapote (Upper Eocene), Guayabal (Middle Eocene), Aragon and Chicontepec (Lower Eocene), and Velasco (Upper Cretaceous).

The more common species of foraminifera found in the Chapapote and Guayabal formations have been described by Cushman and Cole.¹ The term Aragon is here introduced for beds immediately underlying the Guayabal, which contain a fauna described in this paper for the first time. The foraminiferal faunas of these three formations are distinct and afford an excellent illustration of the use of these microfossils in stratigraphy. The species of most value for recognition of each division are discussed below and their distribution is shown in a table.²

CHAPAPOTE FORMATION

The stratigraphic range of the more common Chapapote and Guayabal foraminiferal species has been worked out chiefly in oil-wells from Alamo northwest to Cerro Azul, a distance of about 32 kilometers, and also from surface outcrops in the haciendas of Horcones, Cerro Viejo and Tamatoco (Fig. 1). References to the more important Chapapote guide species are given below. These species do not range up into the Lower Oligocene (Alazan), except in certain localities where there is a

¹W. S. Cole, "A Foraminiferal Fauna from the Guayabal Formation in Mexico," *Bull. Am. Pal.*, Vol. 14 (1927), No. 51; "A Foraminiferal Fauna from the Chapapote Formation in Mexico," *Idem.* (1928), No. 53.

²The writer is indebted to the Mexican Eagle Oil Company for generous permission for publication. The types of the species will be deposited in Dr. Cushman's collection.

disconformity at the base of the Oligocene and derived Eocene foraminifera are found in the basal 50 feet or so of the Oligocene. These last conditions are found in parts of the Buenavista river valley and notably at and near the Alazan type locality, from where mollusca referred to Vicksburg have been described by Cooke.³ Generally the Oligocene-Eocene contact is sharp and may be distinguished readily with the aid of the foraminifera.

TABLE SHOWING RANGE OF THE MORE IMPORTANT GUIDE SPECIES FOR THE CHAPAPOTE, GUAYABAL AND ARAGON FORMATIONS.^a

Species	Chapapote	Guayabal	Aragon
* <i>Hantkenina alabamensis</i> Cushman	c		
<i>Textularia eocaena</i> (Gümbel) Cole	f		
<i>Hantkenina brevispina</i> Cushman	c	r	
* <i>Anomalina dorri</i> Cole	c	r	
<i>Globigerina inflata</i> d'Orbigny	c	f	
<i>Globigerina mexicana</i> Cushman	c	f	
<i>Eponides cerroazulensis</i> (Cole)	f	r	
<i>Anomalina umbonata</i> Cushman	r	c	
* <i>Rotaliatina mexicana</i> Cushman	c	r	
<i>Hantkenina longispina</i> Cushman		c	r
<i>Hantkenina mexicana</i> Cushman		f	f
<i>Bulimina semicostata</i> Nuttall, n. sp.	f	f	f
<i>Eponides trümpyi</i> Nuttall, n. sp.	f	r	f
<i>Amphistegina mexicana</i> Cole			
* <i>Cristellaria mexicana</i> Cushman		c	
<i>Discocyclina perpusilla</i> Vaughan			
<i>Fronicularia interrupta</i> Karrer			
* <i>Nodosaria mexicana</i> Cushman		c	
<i>Operculina cushmani</i> Cole			
* <i>Eponides guayabalensis</i> Cole		c	
<i>Eponides mexicana</i> (Cushman)			
<i>Ceratobulimina eximia</i> (Rzehak)			
<i>Textularia zapotensis</i> Cole			
<i>Globigerina topilensis</i> Cushman			
* <i>Globorotalia spinulosa</i> Cushman		c	f
<i>Globorotalia crassata</i> (Cushman)			
<i>Anomalina dorri</i> var. <i>aragonensis</i> Nuttall, n. var.			
<i>Textularia aragonensis</i> Nuttall, n. sp.			
* <i>Cornuspira polygyra</i> Reuss			
<i>Cristellaria asperuliformis</i> Nuttall, n. sp.			c
<i>Globigerina cretacea</i> d'Orbigny			
<i>Globigerina pseudobulloides</i> Plummer			
<i>Glomospira charoides</i> (Jones and Parker)			
* <i>Hantkenina mexicana</i> var. <i>aragonensis</i> Nuttall, n. var.			c
* <i>Hastigerinella eocanica</i> var. <i>aragonensis</i> Nuttall, n. var.			c
* <i>Globorotalia aragonensis</i> Nuttall, n. sp.			c
<i>Vulvulina pectinata</i> Hantken var. <i>mexicana</i> Nuttall, n. var.			

^a Explanation. Stratigraphic range is shown by solid horizontal line. Relative abundance of species is indicated by (c) common, (f) frequent, (r) rare. (*) Indicates most important guide species.

³C. W. Cooke, *Proc. U. S. Nat. Mus.*, Vol. 73 (1928), Art. 10.

The term Tantoyuca has been used as a formational name in papers by Cushman and Cole. The type locality is in the vicinity of Tantoyuca, in particular to the east of it on the Tantoyuca-Chopopo road, towards the Tecomate stream. The writer is in agreement with the view expressed in Cole's paper that the type Tantoyuca is probably a near-shore facies of the Chapapote and both may be correlated as being Upper Eocene (Jackson) in age. The fauna of the Tantoyuca requires special study and is not dealt with in this paper. These beds contain numerous species of foraminifera recorded both from the Chapapote and Guayabal, as well as others restricted to the formation. Of particular interest is the

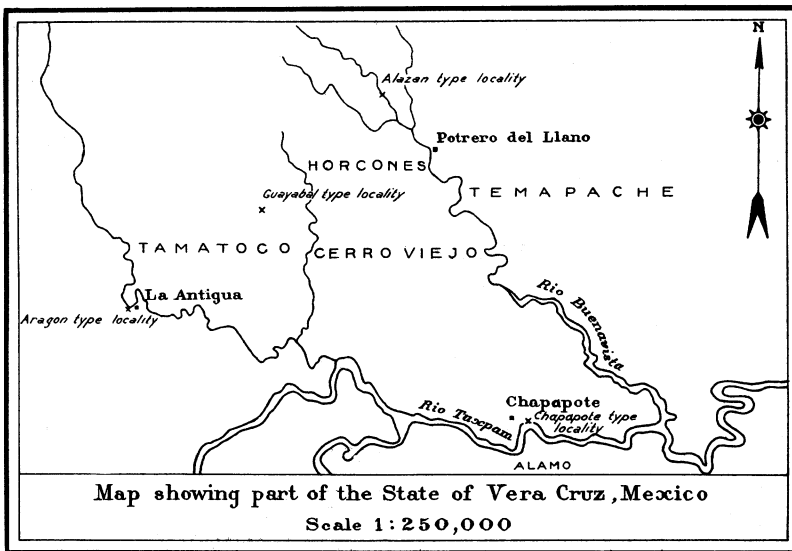


Figure 1

occurrence of *Lepidocyclina ocalana* Cushman, *L. ocalana* var. *subdecorata* Cushman and *Cardita* aff. *planicosta* (Lam.). The term Tantoyuca has often been loosely employed by geologists in Tampico, and beds of Guayabal age have frequently been included under this formation.

GUAYABAL FORAMINIFERA

The following species are of most value for distinguishing the Chapapote:

TEXTULARIA EOCAENA (GÜMBEL)

Textularia eocaena (Gümbel). COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 6, Pl. 3, fig. 7.

HANTKENINA ALABAMENSIS CUSHMAN

Hantkenina alabamensis CUSHMAN, 1925, Contr. Cushman Lab. Foram. Research, Vol. 1, p. 7, Pl. 1, fig. 11; 1927, Jour. Pal., Vol. 1, p. 160, Pl. 25, fig. 17; COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 11.

HANTKENINA BREVISPIA CUSHMAN

Hantkenina brevispia CUSHMAN, 1924, Proc. U. S. Nat. Mus., Vol. 66, Art. 30, p. 2, Pl. 2, fig. 3; 1927, Jour. Pal., Vol. 1, p. 160, Pl. 26, fig. 1. COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 12.

HANTKENINA LONGISPINA CUSHMAN

See page 284.

BULIMINA SEMICOSTATA NUTTALL, N. SP.

See page 285.

ROTALIATINA MEXICANA CUSHMAN

Rotaliatina mexicana CUSHMAN, 1925, Contr. Cushman Lab. Foram. Research, Vol. 1, p. 4, Pl. 1, fig. 1. COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 15, Pl. 3, figs. 3, 4.

EPONIDES CERROAZULENSIS (COLE)

Globigerina cerro-azulensis COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 17, Pl. 1, figs. 11-13.

EPONIDES TRUMPYI NUTTALL, N. SP.

See page 287.

GLOBIGERINA INFLATA D'ORBIGNY

Globigerina inflata D'ORBIGNY, 1839, Hist. Nat. Canaries. Foram., p. 134, Pl. 2, figs. 7-9; BRADY, 1884, Rept. Voyage *Challenger* Zool., Vol. 9, p. 601, Pl. 79, figs. 8-10; COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 33, Pl. 4, fig. 19; 1928, Bull. Am. Pal., Vol. 19, No. 53, p. 17.

GLOBIGERINA MEXICANA CUSHMAN

Globigerina mexicana CUSHMAN, 1925, Contr. Cushman Lab. Foram. Research, Vol. 1, p. 6, Pl. 1, fig. 8; 1927, Jour. Pal., Vol. 1, p. 168, Pl. 26, figs. 16, 17; COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 18, Pl. 2, fig. 11.

ANOMALINA DORRI COLE

Anomalina dorri COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 18, Pl. 3, figs. 1, 2. A closely related form is described below from the Aragon, see page 290.

ANOMALINA UMBONATA CUSHMAN

Anomalina umbonata CUSHMAN, 1925, Bull. Am. Assn. Petrol. Geol., Vol. 9, p. 300, Pl. 7, figs. 5, 6; 1927, Jour. Pal., Vol. 1, p. 170, Pl. 27, figs. 10, 11; COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 35; 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 19.

GUAYABAL FORMATION

A marked change in facies occurs between the Chapapote and Guayabal. The former contains a very rich fauna, *Globigerina* often forming the majority of the washed sample. In the Guayabal shallower water conditions prevailed, *Globigerina* becomes much less common and larger forms like *Operculina*, *Amphistegina* and *Discocyclus* are present. Lithologically the Chapapote is a practically pure marl and the foraminifera are brilliant white. The Guayabal shale beds have thin sand partings and the foraminifera are usually stained a light brown by iron.

The term Tempoal was introduced by W. A. Ver Wiebe⁴ for shale exposed in the river at the town of Tempoal. Cole pointed out that the foraminiferal fauna of the Tempoal is very similar to that of the Guayabal. The writer has also examined material from this locality and regards the type Tempoal as constituting probably the lower part of the Guayabal. There appears to be no reliable lithological or paleontological means by which it is possible to separate the type locality Tempoal from the Guayabal, so that the former name appears superfluous. The maximum thickness observed for the Guayabal in the Tampico embayment has been 3,000 feet, these beds being considered as Middle Eocene in age.

GUAYABAL FORAMINIFERA

The more important species that serve for the recognition of this formation are the following.

TEXTULARIA ZAPOTENSIS COLE

Textularia mexicana COLE (not Cushman), 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 11, Pl. 5, fig. 5.

Textularia zapotensis COLE, May 20th, 1929, Corrigenda slip to same publication. This second name was proposed, as the first was preoccupied.

HANTKENINA MEXICANA CUSHMAN

See page 284.

CRISTELLARIA MEXICANA CUSHMAN

Cristellaria mexicana CUSHMAN, 1925, Bull. Am. Assn. Petrol. Geol., Vol. 9, p. 299, Pl. 7, figs. 1, 2.

Robulus mexicanus (CUSHMAN), 1927, Jour. Pal., Vol. 1, p. 151, Pl. 23, fig. 9 (in error given as fig. 8); COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 18, Pl. 1, fig. 20.

⁴Am. Jour. Sci. (5), Vol. 8 (1924), p. 486.

CRISTELLARIA MEXICANA VAR. NUDICOSTATA (CUSHMAN AND HANNA)

Robulus mexicanus var. *nudicostatus* CUSHMAN AND HANNA, 1927, Proc. Cal. Acad. Sci., Vol. 16, No. 8, p. 216, Pl. 14, fig. 2; COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 19. This variety always occurs associated with *C. mexicana*.

NODOSARIA MEXICANA CUSHMAN

Nodosaria mexicana CUSHMAN, 1925, Contr. Cushman Lab. Foram. Research, Vol. 1, p. 5, Pl. 1, figs. 3, 4; 1927, Jour. Pal., Vol. 1, p. 155, Pl. 24, figs. 15, 16; COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 16, Pl. 3, figs. 3, 4.

FRONDICULARIA INTERRUPTA KARRER

Frondicularia interrupta KARRER, 1877, Abhl. K. K. Geol. Reichs., Vol. 9, p. 380, Pl. 16, fig. 27.
Frondicularia sp., COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 24, Pl. 2, fig. 10.

OPERCULINA CUSHMANI COLE

Operculina cushmani COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 23, Pl. 2, fig. 14.

EPONIDES GUAYABALENSIS COLE

Eponides guayabalensis COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 29, Pl. 2, figs. 18-20; CUSHMAN, 1929, Jour. Pal., Vol. 3, p. 180, Pl. 23, fig. 6; WEINZIERL AND APPLIN, 1929, Jour. Pal., Vol. 3, p. 394, Pl. 42, figs. 1a-c.
Eponides patelliformis STADNICHENKO, 1927, Jour. Pal., Vol. 1, p. 232, Pl. 38, figs. 6-8.

This species, which is common in the Guayabal, is recorded from the Claiborne (Middle Eocene) of Texas.

EPONIDES MEXICANA (CUSHMAN)

Pulvinulina mexicana CUSHMAN, 1925, Bull. Am. Assn. Petrol. Geol., Vol. 9, p. 300, Pl. 7, figs. 7, 8.
Eponides mexicana (CUSHMAN), 1927, Jour. Pal., Vol. 1, p. 165, Pl. 26, figs. 6, 7. COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 29, Pl. 2, figs. 6-8.

GLOBOROTALIA CRASSATA (CUSHMAN)

See page 288.

GLOBOROTALIA SPINULOSA CUSHMAN

See page 288.

PLANORBULINA (PLANORBULINELLA) GUAYABALENSIS NUTTALL, N. SP.
 Plate 25, Figures 15-17

Test lenticular, compressed, equilateral. Surface of chambers smooth, sutures limbate, raised above the chamber surfaces and all clearly visible externally. An equatorial section shows the first chamber to be circular and the earlier portion to be coiled with one large whorl, after which the chambers are arranged concentrically with adjacent

series of chambers alternating. There are two apertures, one on each side of each chamber, the walls being finely perforate.

This species differs from *P. larvata* Parker and Jones in having a different surface ornamentation and in the larger coiled portion. The maximum observed diameter is 2 mm., and the thickness about 0.2 mm., but the periphery was broken in the specimens examined.

AMPHISTEGINA MEXICANA COLE

Amphistegina mexicana COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 31, Pl. 2, fig. 13.

This species differs from *A. lessoni* in the much larger number and straighter sutures.

CERATOBULIMINA EXIMIA (RZEHAKE)

Pulvinulina eximia RZEHAKE, 1888, Ann. K. K. Hofmuseums, Wein, Vol. 3, pt. 3, p. 263, Pl. 11, fig. 7.

Rotalia dorri COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 29, Pl. 4, figs. 5, 6.

Ceratobulimina eximia COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 20; CUSHMAN, 1929, Jour. Pal., Vol. 3, p. 182, Pl. 24, fig. 3.

This species occurs frequently in the Guayabal, especially in the lower part. It has also been recorded from the Claiborne of Texas.

GLOBIGERINA TOPILENSIS CUSHMAN

See page 289.

DISCOCYCLINA PERPUSILLA VAUGHAN

Discocyclina perpusilla VAUGHAN, 1929, Proc. U. S. Nat. Mus., Vol. 76, Art. 3, p. 9, Pl. 2, figs. 3-5.

Discocyclina clarki COLE, 1928, Bull. Am. Pal., Vol. 14, No. 51, p. 36, Pl. 2, fig. 31 (not *Orthophragmina clarki* Cushman).

DISCOCYCLINA CUSHMANI VAUGHAN

Discocyclina cushmani VAUGHAN, 1929, Proc. U. S. Nat. Mus., Vol. 76, Art. 3, p. 11, Pl. 3, figs. 1-4.

LEPIDOCYCLINA (POLYLEPIDINA) PROTEIFORMIS VAUGHAN

Lepidocyclina (Polylepidina) proteiformis VAUGHAN, 1924, Bull. Geol. Soc. Am., Vol. 35, p. 810, Pl. 32, figs. 1-7, text figs. 6 a-c; 1929, Proc. Nat. Ac. Sci., Vol. 15, No. 3, p. 290, Pl. fig. 8.

ARAGON FORMATION

The beds immediately underlying the Guayabal, as defined above, contain a distinct foraminiferal fauna. These strata were mentioned by

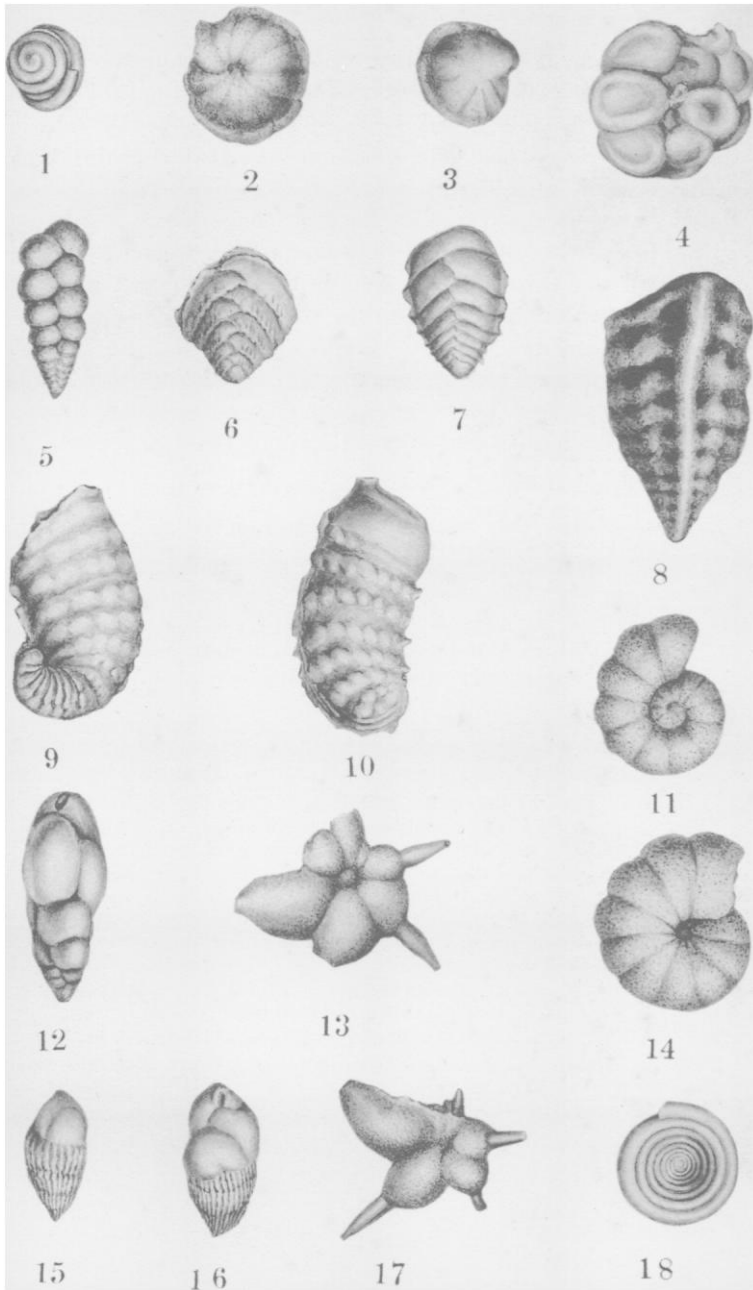
Cole⁵ as an unnamed formation, consisting of about 200 feet of shale. The average thickness of the formation in the Tampico embayment is about 500 feet, while it may be considerably thinner in wells between Cerro Azul and Alamo. These beds are designated as the Aragon formation and the type locality defined as shale outcrops in the Rio de La Puerta, immediately west of La Antigua village, which is situated about 19 kilometers west of Potrero del Llano. The Aragon usually overlies shale with the Velasco fauna described by Cushman,⁶ while towards the mountain front it rests upon the Chicontepec formation. It differs from the Guayabal in being of deeper water facies, the former resembling the Chapapote by its abundance of *Globigerina*, which are however of different species. The Aragon is of Lower Eocene age and contains several species also present in the Midway of Texas.

⁵W. S. Cole, Bull. Am. Pal., Vol. 14 (1928), No. 51, p. 9.

⁶J. A. Cushman, Bull. Am. Assn. Petrol. Geol., Vol. 10 (1926), p. 581.

EXPLANATION OF PLATE 23

- FIGS. 1.—*Glomospira charoides* (Jones and Parker), × 40. Arroyo La Laja, 380 m. S. 77° W. of La Antigua-Potrero del Llano road crossing.
- 2, 3.—*Haplophragmoides acutidorsatum* (Hantken) × 20. La Antigua, Rio La Puerta.
- 4.—*Trochammina irregularis* White. × 20. Arroyo La Laja, 2830 m. S. 70° W. of La Antigua crossing.
- 5.—*Textularia agglutinans* d'Orbigny. × 20. La Antigua, Rio La Puerta.
- 6.—*Textularia aragonensis* Nuttall, n. sp. × 40. 1850 m. N. 85° W. of El Tule.
- 7.—*Vulvulina pectinata* var. *mexicana* Nuttall, n. var. × 20. Rio La Puerta. 200 m. upstream from La Antigua crossing.
- 8.—*Verneuilina triquetra* (Munster). × 20. Arroyo La Laja, 720 m. S. 70° W. of La Antigua crossing.
- 9, 10.—*Cristellaria asperuliformis* sp. nov. × 20. Fig. 9. Holotype, Arroyo Pedernales, 4000 m. N. 2° E. of Camaitlan. Fig. 10. 1200 m. N. 60° W. of La Antigua crossing.
- 11, 14.—*Nonionina boueana* d'Orbigny. × 40, Fig. 11. Same locality as Fig. 7. Fig. 14, 1670 m. N. 70° W. of La Antigua crossing.
- 12.—*Bulimina elegans* d'Orbigny. × 40. Same locality as Fig. 7.
- 13, 17.—*Hantkenina mexicana* Cushman × 40. Arroyo Puentitla, 2600 m. N. 73° E. of El Tule.
- 15, 16.—*Bulimina semicostata* Nuttall, n. sp. × 40. Same locality as Fig. 8.
- 18.—*Cornuspira polygyra* Reuss × 20. Same locality as Fig. 8.



ARAGON FORAMINIFERA

FAMILY AMMODISCIDAE

GLOMOSPIRA CHAROIDES (JONES AND PARKER)

Plate 23, figure 1

Trochammina charoides JONES AND PARKER, 1862, Intro. Foram., p. 141, Pl. 11, fig. 3.
Ammodiscus charoides BRADY, 1884, Rep. Voy. Challenger, Zool., Vol. 9, p. 334, Pl. 38, figs. 10-16.

The species, which is fairly common in the Aragon, appears to be the same as the living form. In the Tampico embayment this species has not been observed in younger beds.

FAMILY LITUOLIDAE

HAPLOPHRAGMOIDES ACUTICOSTATUM (HANTKEN)

Plate 23, figures 2, 3

Haplophragmium acuticostatum HANTKEN, 1875, Mitth. Jahrb. K. Ungar. Geol. Anstalt, Vol. 4, p. 12, Pl. 1, fig. 1; ANDREAE, 1884, Abh. Geol. Spezialkarte Elsass-Lothr., Vol. 2, p. 197, Pl. 7, fig. 5.

This species occurs sparingly in the Aragon, while a very closely related form has been observed in the lower part of the Guayabal.

FAMILY TROCHAMMINIDAE

TROCHAMMINA IRREGULARIS WHITE

Plate 23, figure 4

Haplophragmium acervulata FRIEDBERG (not Grzybowski), 1902, Abh. Akad. Wiss. Krakau, Vol. 41, p. 638, Pl. 1, fig. 9.
Trochammina irregularis WHITE, 1928, Jour. Pal., Vol. 2, No. 4, p. 307, Pl. 42, fig. 1.

The chambers are crushed and somewhat variable in number. This form has been observed in the Chapapote, Aragon and Chicontepec, while White records it from the Velasco.

FAMILY TEXTULARIDAE

TEXTULARIA AGGLUTINANS D'ORBIGNY

Plate 23, figure 5

Textularia agglutinans D'ORBIGNY, 1839, in De la Sagra, Hist. Phisiq. etc. Cuba. Foram., p. 144, Pl. 1, figs. 17, 18, 32-34.

This species, which has been observed fossil in the Miocene, Oligocene and Eocene of the United States, is present in the Aragon.

TEXTULARIA GOESII CUSHMAN

Textularia goesii CUSHMAN, 1911, U. S. Nat. Mus., Bull. 71, pt. 2, p. 15.
Textularia trochus BRADY (not d'Orbigny), 1884, Rept. Voy. *Challenger*, Zool., Vol. 9,
 Pl. 43, fig. 17; Pl. 44, figs. 1-3.

This species, which is present in the Alazan and Chapapote, has also been observed in the Aragon and Chicontepec.

TEXTULARIA ARAGONENSIS NUTTALL, N. SP.

Plate 23, figure 6

Test very compressed, suboval, slightly longer than broad, widest portion about at the center. Initial end tapered, apertural end broadly rounded. Sides only slightly convex, the thickness near the periphery being only a little greater than at the center. Chambers about three times as long as wide, ornamented with thin limbate sutures from which fine raised projections extend a short distance backwards on the chamber surfaces. Aperture a narrow transverse slit at the base of the last chamber. Average length 0.4 mm.

This species resembles *T. velascoensis* Cushman⁷ from which it may be distinguished by its much more compressed form and the somewhat less ornate sutures. Cushman⁸ referred his species to *Bolivinoidea*, while White⁹ placed it under *Gümbelina*. Both species depart much from the original definition of these genera and seem best retained under *Textularia*, though they are peculiar for the genus. The above species has so far only been observed sparingly in the Aragon formation.

VULVULINA PECTINATA VAR. MEXICANA NUTTALL, N. VAR.

Plate 23, figure 7

Vulvulina pectinata HANTKEN, var., 1875, Mitth. Jahrb. K. Ungar. Geol. Anstalt, Vol. 4, p. 68, Pl. 7, fig. 10.

Test compressed, central portion inflated, border narrow, each chamber with a thin triangular projecting flange. Sutures narrow, depressed, showing the chambers to be biserially arranged except for a terminal uniserial chamber. This variety differs from the specimen figured by Hantken in being proportionally shorter and ending uniserially. Average length 1 mm. This species is frequent only in the Aragon.

⁷J. A. Cushman, Bull. Am. Assn. Petrol. Geol., Vol. 10 (1926), No. 6, p. 584.

⁸J. A. Cushman, Jour. Pal., Vol. 1 (1927), p. 159.

⁹T. M. White, Jour. Pal., Vol. 3 (1929), p. 39.

FAMILY VERNEUILINIDAE

VERNEUILINA TRIQUETRA (MÜNSTER)

Plate 23, figure 8

Textularia triquetra Münster, Römer, 1838, Neues Jahrb., p. 384, Pl. 3, fig. 19.*Verneuilina triquetra* Franke, 1928, Abh. Preuss. Geol. Land. N. F., Vol. 3, p. 136, Pl. 12, fig. 13.

One of the features which distinguishes this species from closely related forms is the great width of the test for a major part of its length. This species, found rarely in the Aragon, has been recorded from the Cretaceous and older Tertiary of Europe, while the living form figured by Brady is probably distinct.

GAUDRYINA BRADYI CUSHMAN

Gaudryina bradyi Cushman, 1911, U. S. Nat. Mus., Bull. 71, pt. 2, p. 67, fig. 107.*Gaudryina pupoides* d'Orbigny, Brady, 1884, Rep. Voy. Challenger, Zool. Vol. 9, p. 378, Pl. 46, figs. 1-4.*Textularia chapotensis* Cole, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 6, Pl. 2, fig. 9.

This species has a wide range in the Tertiary of the Tampico embayment.

GAUDRYINA AFF. GAUDRYINOIDES (FORNASINI)

Clavulina gaudryinoides Fornasini, 1885, Boll. Soc. Geol. Ital., Vol. 4, p. 106, Pl. 6, figs. 3-9.*Gaudryina gaudryinoides* Cole, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 13, Pl. 2, fig. 30.

A short *Gaudryina* with a small oval aperture situated a short distance above the base of the last chamber is found in the Aragon. The specimens are all less elongate than Fornasini's original figures, but appear to be the same as the species identified by Cole from the Guayabal.

FAMILY OPTHALMIDIIDAE

CORNUSPIRA POLYGYRA REUSS

Plate 23, figure 18

Cornuspira polygyra Reuss, 1864, Sitz. Ak. Wiss. Wien, Vol. 48, (1) p. 39, Pl. 1, fig. 1.*Cornuspira hornesi* Karrer, 1866, Sitz. Ak. Wiss. Wien, Vol. 52, (1) p. 495, Pl. fig. 10.

This simple foraminifera represents a very close and multicoiled thin *Cornuspira* which has been recorded from the Lower Tertiary and Upper Cretaceous of Europe. It is common in the Aragon and ranges down into the Chicotepec and Velasco, while other species of this genus, which are rarely found in younger beds of the Tampico embayment, are more loosely coiled.

FAMILY LAGENIDAE

CRISTELLARIA CONVERGENS BORNEMANN

Cristellaria convergens BORNEMANN, 1855, Zeitschr. Deutsch. Geol. Ges., Vol. 7, p. 327, Pl. 13, figs. 16, 17; CUSHMAN, 1927, Jour. Pal., Vol. 1, p. 152, Pl. 23, fig. 12; COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 8, Pl. 1, figs. 4, 5.

Typical specimens of this species occur in the Aragon. It has been observed to range up into the Alazan.

CRISTELLARIA CREPIDULA (FICHEL AND MOLL)

Nautilus crepidula FICHEL AND MOLL, 1803, Test. Micr., p. 107, Pl. 19, figs. g-i.

This species, which has been observed in the Alazan, Chapapote and Aragon, has also been recorded by Cushman and White¹⁰ from the Velasco.

CRISTELLARIA ROTULATA (LAMARCK)

Lenticulites rotulata LAMARCK, 1804, Ann. Mus., Vol. 5, p. 188; 1806, Vol. 8, Pl. 62, fig. 11.

This cosmopolitan species, which is recorded as ranging from the Cretaceous to the present day, is found in the Aragon.

CRISTELLARIA CULTRATA (MONTFORT)

Robulus cultratus MONTFORT, 1808, Conch. Syst., Vol. 1, p. 215, 54th genre.

Varietal forms of this well known species occur in the Aragon. It also has a wide vertical range in the sediments of the Tampico embayment.

CRISTELLARIA ASPERULIFORMIS NUTTALL, N. SP.

Plate 23, figures 9, 10

Test with earlier portion close-coiled, later portion uncoiled, compressed, especially in the earlier portion. Chambers distinct, separated by elevated limbate sutures, which bear fine tubercles that are variable in number and become less pronounced or absent in the last chambers. Aperture radial, terminal. Periphery sharp, in most specimens with a thin narrow keel. Average length 1.5 mm.

This species, which is frequent in the Aragon, is practically confined to this formation. It presents a fair range of variation in its external ornamentation. Of described species it resembles *C. asperula* Gümbel from the Eocene of the Alps¹¹ which is, however, much less compressed, particularly in the earlier portion. It also bears affinities to *C. sub-*

¹⁰T. M. White, Jour. Pal., Vol. 2 (1928), p. 202.

¹¹Abh. K. Bayer. Ak. Wiss., Vol. 10 (1870), Pl. 1, fig. 65.

aculeata var. *tuberculata* Plummer from the Midway of Texas.¹² It is distinguished from *C. mexicana* by having more chambers, more tubercles on the sutures, the initial part much more compressed and the edge sharper.

MARGINULINA GLABRA D'ORBIGNY

Marginulina glabra D'ORBIGNY, 1826, Ann. Sci. Nat., Vol. 7, p. 259, No. 6, Modèle No. 55.

This well known species has been observed in the Aragon and is also present in the Alazan.

NODOSARIA COMMUNIS (D'ORBIGNY)

Dentalina communis D'ORBIGNY, 1826, Ann. Sci. Nat., Vol. 7, p. 254, No. 35.

This species has been observed in the Alazan, Guayabal and Aragon.

NODOSARIA VERTEBRALIS (BATSCH)

The specimens are similar to specimens figured by Brady.¹³

NODOSARIA GRANTI PLUMMER

Nodosaria granti PLUMMER, 1926, Univ. Texas Bull. 2644, p. 83, Pl. 5, fig. 9.

A few rare specimens assigned to this species described from the Midway occur in the Aragon.

NODOSARIA LONGISCATA D'ORBIGNY

Nodosaria longiscata D'ORBIGNY, 1846, Foram. Foss. Vienne, p. 32, Pl. 1, figs. 10-12.

This species, which is present in the Aragon, ranges up into the Meson.

LAGENA ORBIGNYANA (SEGUENZA)

Fissurina orbignyana SEGUENZA, 1862, Foram. Montal. Miocen. Messina, p. 66, Pl. 2, figs. 25, 26.

Rare specimens of this species occur in the Aragon.

¹²Univ. Texas Bull. 2644 (1926), p. 101.

¹³Rep. Voy. *Challenger*, Zool., Vol. 9 (1884), Pl. 64, figs. 11-14.

FAMILY NONIONIDAE

NONIONINA BOUEANA D'ORBIGNY

Plate 23, figures 11, 14

Nonionina boueana D'ORBIGNY, 1846, Foram. Foss. Vienne, p. 108, Pl. 5, figs. 11, 12.
 REUSS, 1862, Bull. Ac. Roy. Belg., Ser. 2, Vol. 15, p. 156, Pl. 3, figs. 47, 48;
 BRADY, 1884, Rep. Voy. Challenger, Zool., Vol. 9, p. 729, Pl. 109, figs. 12, 13.

The interpretation of this species at the present day is such as to include forms showing considerable variation. The specimens from the Aragon are about as depressed as those figured by Brady; they have a less angled border than d'Orbigny's figured specimen and one side is more close-coiled than the other, as in Reuss' figured specimens from the Pliocene of Antwerp.

FAMILY HANTKENINIDAE

HANTKENINA LONGISPINA CUSHMAN

Hantkenina longispina CUSHMAN, 1924, Proc. U. S. Nat. Mus., Vol. 66, Art. 30, p. 2, Pl. 2, fig. 4; 1926, Bull. Am. Assn. Petrol. Geol., Vol. 10, p. 299, Pl. 7, fig. 3; 1927, Jour. Pal., Vol. 1, p. 160, Pl. 26, fig. 2; COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 24, Pl. 4, fig. 7.

This name is best retained only for the very long-spined variety: forms grading into *H. mexicana* also being found.

HANTKENINA MEXICANA CUSHMAN

Plate 23, figures 13, 17

Hantkenina mexicana CUSHMAN, 1924, Proc. U. S. Nat. Mus., Vol. 66, Art. 30, p. 3, Pl. 2, fig. 2; 1927, Jour. Pal., Vol. 1, p. 160, Pl. 25, fig. 18.

This species was originally described from the Guayabal formation of Zardo Creek exposures, where it is associated with *Cristellaria mexicana* Cushman, *Nodosaria mexicana* Cushman, *Anomalina umbonata* Cushman, *Eponides guayabalensis* Cole and *Discocyclus cushmani* Vaughan. Cole¹⁴ considered *H. mexicana* to be characteristic of the Aragon (unnamed formation in his table), while the form typical of this formation is the variety described below. *H. mexicana* occurs both in the Guayabal and Aragon.

HANTKENINA MEXICANA VAR. ARAGONENSIS NUTTALL, N. VAR.

Plate 24, figures 1-3

This variety differs from the type in generally having larger more inflated chambers, which always taper more gradually into the terminal

¹⁴W. S. Cole, Bull. Am. Pal., Vol. 14 (1927), No. 51, p. 9.

spines. The latter are not infrequently broken as in figure 3. This form is a valuable and fairly common guide species for the Aragon.

FAMILY BULIMINIDAE

BULIMINA PUPOIDES D'ORBIGNY

Bulimina pupoides D'ORBIGNY, 1846, Foram. Foss. Vienne, p. 185, Pl. 11, figs. 11-12; BRADY, 1884, Rep. Voy. *Challenger*, Zool., Vol. 9, p. 400, Pl. 50, fig. 15.

This species has been observed in the Alazan, Guayabal and Aragon.

BULIMINA ELEGANS D'ORBIGNY

Plate 23, figure 12

Bulimina elegans D'ORBIGNY, 1826, Ann. Sci. Nat., Vol. 7, p. 270, No. 10; BRADY, 1884, Rep. Voy. *Challenger*, Zool., Vol. 9, p. 398, Pl. 50, figs. 1-4; CHAPMAN, 1892, Quart. Jour. Geol. Soc., Vol. 48, p. 514, Pl. 15, fig. 9.

There appears to be no certain method of distinguishing this form as found in the Aragon from the living species, which in Europe has been recorded ranging back through the Tertiary into the Upper Cretaceous. This species is particularly abundant in the Chicontepec and uncommon in the Aragon, while very closely related forms range up sparingly into the Alazan.

BULIMINA SEMICOSTATA NUTTALL, N. SP.

Plate 23, figures 15, 16

Test cylindrical, elongate, tapering to a blunt point at the initial end, rounded at the apertural end. The last three or four chambers are smooth, sutures depressed, narrow, distinct. Earlier chambers indistinct, covered with fine, irregular, only slightly elevated longitudinal costae. Aperture short, straight. Average length 0.5 mm.

This species resembles *B. semistriata* d'Orbigny¹⁵ from which it may be distinguished by its coarser striations and more elongate shape. It is frequent in the Chapapote, rare in the Guayabal and fairly common in the Aragon.

LOXOSTOMUM APPLINAE (PLUMMER)

Plate 24, figures 4, 5

Bolivina applini PLUMMER, 1926, Univ. Texas Bull. 2644, p. 69, Pl. 4, fig. 1.

Test attenuate, subcylindrical, somewhat compressed. Biserial portion occupies generally somewhat over half the length of the test, gradually tapering to the initial end which is pointed. The biserial part

¹⁵Figured by Fornasini, Bull. Soc. Geol. Ital., Vol. 20 (1901), p. 200, fig. 5.

of the test is compressed, with sutures visible externally and surface covered with fine longitudinal striae. Uniserial part smooth, punctate, usually with four or five chambers of the same width throughout, sutures distinct with crenulate indentations. Aperture terminal, small, rounded, usually central, with a low poorly defined lip. Average length 1.1 mm.

The Mexican forms differ from the type in having the uniserial portion well developed, specimens such as that figured by Mrs. Plummer from the Midway of Texas being also found. This species has been observed in the Aragon and Chicontepec.

FAMILY ELLIPSOIDINIDAE

PLEUROSOTOMELLA ALTERNANS SCHWAGER

Pleurostomella alternans SCHWAGER, 1866, Novara-Exped. Geol., Ser. 3, p. 238, Pl. 6. figs. 79, 80; PLUMMER, 1926, Univ. Texas Bull. 2644, p. 69, Pl. 4, fig. 2.

This species, which has been observed in the Alazan and Chapapote is also present in the Aragon and Chicontepec.

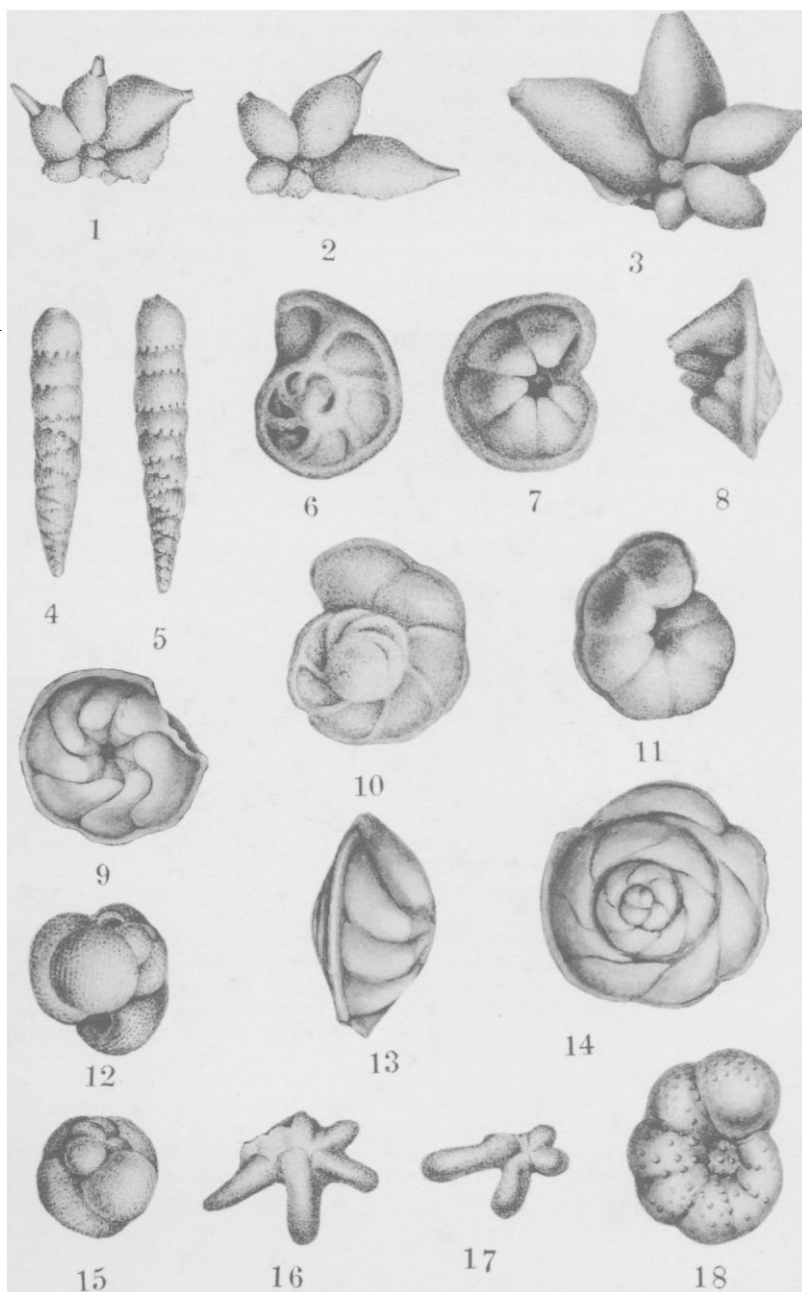
PLEUROSOTOMELLA AFF. ALAZANENSIS CUSHMAN

Pleurostomella alazanensis CUSHMAN, 1925, Contr. Cushman Lab. Foram. Research, Vol. 1, p. 5, Pl. 1, fig. 2.

Forms closely related to this species are found in the Aragon. They vary in the degree of inflation of the test; some specimens are well tapered and pointed, while others are blunt and rounded at the initial end.

EXPLANATION OF PLATE 24

- FIGS. 1-3.—*Hantkenina mexicana* var. *aragonensis* Nuttall, n. var. $\times 40$. Fig. 1. Arroyo Puentilla, 2600 m. N. 73° E. of El Tule. Figs. 2, 3. 1200 m. N. 48° W. of La Antigua.
- 4, 5.—*Loxostomum applinae* (Plummer). $\times 40$. 2400 m. N. 32° E. of Camaitlan.
- 6-8, 10, 11.—*Globorotalia aragonensis* Nuttall, n. sp. $\times 40$. La Antigua Rio La Puerta. Figs. 6, 10, dorsal view. Figs. 7, 11, ventral view. Fig. 8, side view.
- 9, 13, 14.—*Eponides triumpyi* Nuttall, n. sp. $\times 40$. Fig. 9, ventral view; Rio La Puerta, 200 m. upstream from La Antigua crossing. Fig. 13, side view; 1850 m. N. 85° W. of El Tule. Fig. 14, dorsal view; Alazan well 33 from 2080 feet.
- 12, 15.—*Globigerina* sp. $\times 40$. La Antigua, Rio La Puerta.
- 16, 17.—*Hasterigerinella eocanica* var. *aragonensis* Nuttall, n. var. $\times 20$. Arroyo La Laja, 720 m. S. 70° W. of La Antigua crossing.
- 18.—*Anomalina dorri* var. *aragonensis* Nuttall, n. var. $\times 40$. Ventral view, Rio La Puerta, 200 m. upstream from La Antigua crossing.



ELLIPSONODOSARIA SUBNODOSA (GUPPY)

Ellipsoidina subnodosa GUPPY, 1894, Proc. Zool. Soc. London, p. 650, Pl. 41, fig. 12.
Ellipsonodosaria subnodosa CUSHMAN, 1928, Contr. Cushman Lab. Foram. Research,
Vol. 4, p. 102, Pl. 14, figs. 15, 16.

This species is readily distinguished by its nodosarian test and lipped aperture. It has been observed in the basal Alazan, Chapapote, Guayabal and Aragon.

FAMILY ROTALIIDAE

GYROIDINA GIRARDANA (REUSS)

Rotalina girardana REUSS, 1851, Zeitschr. Deutsch. Geol. Ges., Vol. 3, p. 73, Pl. 5, fig. 34.
Gyroidina girardana CUSHMAN, 1927, Jour. Pal., Vol. 1, p. 164, Pl. 25, figs. 7-9; COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 15.

This species, which is present in the Aragon, ranges up into the lower part of the Alazan.

EPONIDES UMBONATA (REUSS)

Pulvinulina umbonata REUSS, 1851, Zeitschr. Deutsch. Geol. Ges., Vol. 3, p. 75, Pl. 5, fig. 35.
Eponides umbonata COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 15; CUSHMAN, 1929, Contr. Cushman Lab. Foram. Research, Vol. 5, pt. 4, p. 98, Pl. 14, figs 8a-c.
Rotalia umbonata GALLOWAY AND MORREY, 1929, Bull. Am. Pal., Vol. 15, No. 55, p. 26, Pl. 5, fig. 1.

This species is found in the lower part of the Alazan, has been recorded by Cole from the Chapapote and is present in the Aragon.

EPONIDES TRÜMPYI NUTTALL, N. SP

Plate 24, figures 9, 13, 14

Test rotaliform, biconvex, dorsally slightly and ventrally strongly elevated. Border with a rounded peripheral flange. Dorsally smooth, with four or five visible whorls, slowly increasing in width. Sutures not elevated, thin, set at an acute angle to the outer chamber wall. In the earlier whorls only, the sutures do not always quite reach the inner chamber wall; in the later whorls they extend the whole distance across the chambers. Ventrally with a rounded central boss of clear shell substance, with about seven narrow radial sutures, which are slightly depressed toward the margin. At one-third of the distance from the center of the test to the border the sutures present a marked sub-angular sinuosity, extending forward in the direction of coiling. Aperture an elongate slit at the base of the last chamber, extending from the periphery the whole distance to the ventral boss. Average diameter 0.7 mm.

This very characteristic species resembles *P. promineus* Reuss¹⁶, which, however, has different sutural features. It is of fairly frequent occurrence in the Chapapote, Guayabal and Aragon, while a small variety occurs in the Chicontepec. It is named for Dr. D. Trümpy, chief geologist of the Aguila Company.

FAMILY GLOBOROTALIIDAE

GLOBOROTALIA CRASSATA (CUSHMAN)

Pulvinulina crassata CUSHMAN, 1925, Bull. Am. Assn. Petrol. Geol., Vol. 9, p. 300, Pl. 7, fig. 4.

Globorotalia crassata COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 34, Pl. 1, figs. 7, 8.

Typical specimens of this species are found in the Aragon, this form being however more common in the Guayabal.

GLOBOROTALIA SPINULOSA CUSHMAN

Globorotalia spinulosa CUSHMAN, 1927, Contr. Cushman Lab. Foram. Research, Vol. 3, p. 114, Pl. 23, fig. 4; COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 34, Pl. 1, fig. 9.

It is sometimes somewhat difficult to distinguish this species from *P. crassata*, which presents a rougher surface and more rounded border. It occurs in the Guayabal and Aragon.

GLOBOROTALIA ARAGONENSIS NUTTALL, N. SP.

Plate 24, figures 6-8, 10, 11

Test plano-convex, dorsally slightly elevated, rotaliform. Dorsally with two visible whorls, the first being small and much obscured by supplementary shell growth. The last whorl has about seven chambers, separated by limbate sutures, which have a roughened surface and are for the most part raised, but not always clearly demarcated from the finely perforate chamber surface. Border subacute, sometimes slightly lobulate, with a narrow peripheral beading. Ventral surface elevated with generally six chambers, which have a roughened surface and are separated by narrow, deeply depressed sutures. At the center is a narrow deep umbilicus, sometimes partly filled with secondary growth, which may hide part of the aperture, which is an elongate slit extending from the umbilicus to near the periphery and situated at the base of the last chamber. Average diameter 0.6 mm.

This species is common in the Aragon and very rare in the Chicontepec. It is likely to be confused with *G. velascoensis* of the Velasco

¹⁶Sitz. K. Ak. Wiss. Wien., Vol. 59, pt. 1, p. 463, pl. 3, fig. 2.

shale,¹⁷ but differs from typical specimens of the latter in having a smaller umbilicus, a smaller number of chambers in the last whorl and a more elevated dorsal surface.

FAMILY CHILOSTOMELLIDAE

CHILOSTOMELLOIDES OVIFORMIS (SHERBORN AND CHAPMAN)

- Lagena (Obliquina) oviformis* SHERBORN AND CHAPMAN, 1886, Jour. Roy. Micro. Soc., p. 745, Pl. 14, fig. 19.
Chilostomelloides oviformis CUSHMAN, 1927, Jour. Pal., Vol. 1, p. 168, Pl. 26, fig. 10;
 COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 16.

This species ranges from Alazan to Chicontepec.

PULLENIA SPHAEROIDES (D'ORBIGNY)

- Nonionina sphaeroides* D'ORBIGNY, 1826, Ann. Sci. Nat., Vol. 7, No. 1, p. 293.
Pullenia sphaeroides BRADY, 1884, Rept. Voy. Challenger, Zool., Vol. 9, p. 615, Pl. 84, figs. 12, 13.

This species occurs sparingly throughout the Tertiary of the Tampico embayment.

PULLENIA QUINQUELOBA REUSS

- Nonionina quinqueloba* REUSS, 1851, Zeitschr. Deutsch. Geol. Ges., Vol. 3, p. 71, Pl. 5, fig. 31.
Pullenia quinqueloba BRADY, 1884, Rept. Voy. Challenger, Zool., Vol. 9, p. 617, Pl. 84, figs. 14, 15.

This species is present in the Alazan, Chapapote and Aragon.

FAMILY GLOBIGERINIDAE

GLOBIGERINA TOPILENSIS CUSHMAN

- Globigerina topilensis* CUSHMAN, 1925, Contr. Cushman Lab. Foram. Research, Vol. 1, p. 7, Pl. 1, fig. 9; COLE, 1927, Bull. Am. Pal., Vol. 14, No. 51, p. 33.

This species is found in the Guayabal and Aragon.

GLOBIGERINA CRETACEA D'ORBIGNY

- Globigerina cretacea* D'ORBIGNY, 1840, Mém. Soc. Géol. France, (1), Vol. 4, p. 34, Pl. 3, figs. 12, 13.

This species has been observed in the Aragon, Chicontepec and Velasco.¹⁸

¹⁷Jour. Pal., Vol. 2 (1928), No. 4, p. 281.

¹⁸For the latter see Jour. Pal., Vol. 2 (1928), p. 133, Pl. 8, Fig. 9.

GLOBIGERINA PSEUDOBULLOIDES PLUMMER

Globigerina pseudobulloides, PLUMMER, 1926, Univ. Texas Bull. 2644, p. 133, Pl. 8, fig. 9.

This species is typical and fairly common in the Aragon, appearing to be identical with that described from the Midway of Texas.

GLOBIGERINA SP.
Plate 24, figures 12, 15

This species resembles *G. orbiformis* Cole, but the figure and description of this species are poor, rendering specific determination uncertain.

HASTIGERINELLA EOANICA VAR. ARAGONENSIS NUTTALL, N. SP.
Plate 24, figures 16, 17

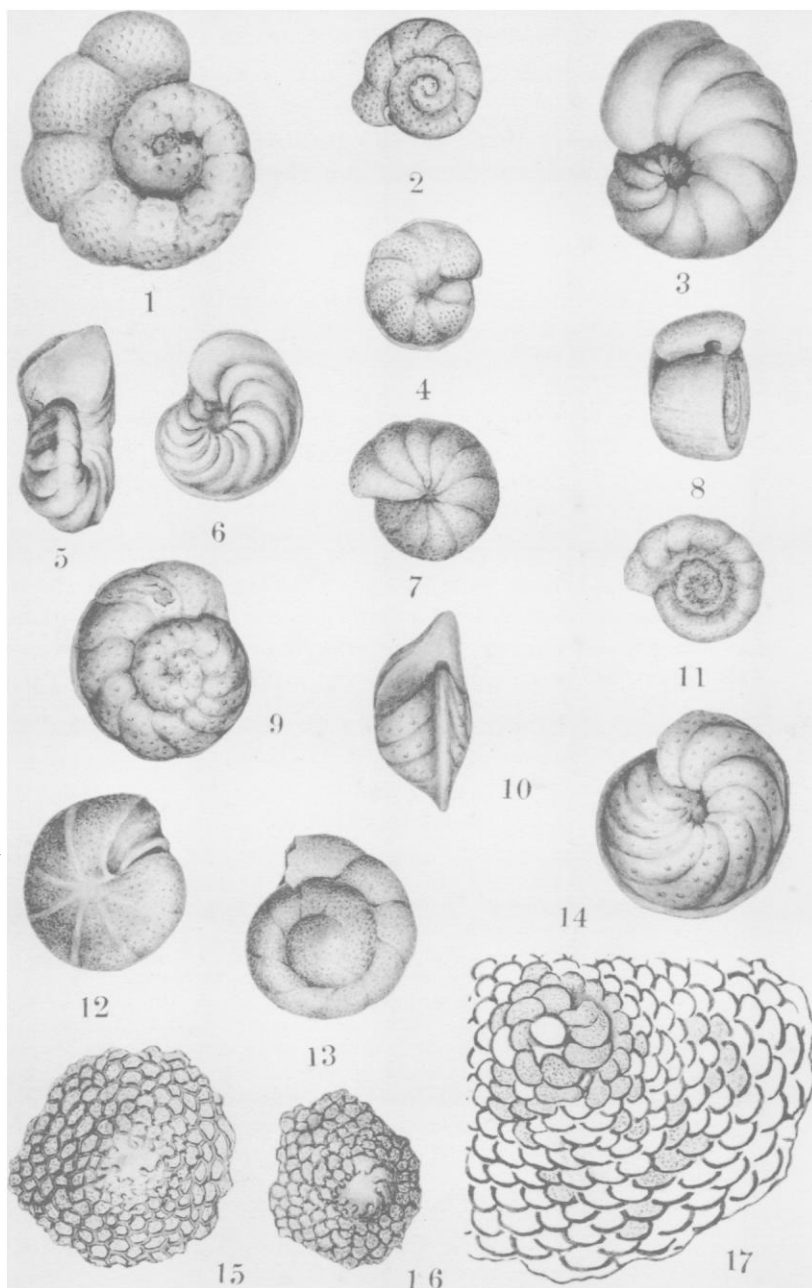
Hastigerinella eoanica NUTTALL, var., 1928, Jour. Pal., Vol. 2, No. 4, p. 376, Pl. 50, figs. 9-11.

This species differs from the form described from the Isthmus of Tehuantepec in having more elongate chambers. These are, however, not as attenuate as those of *H. jarvisi* Cushman.¹⁹ The terminations are also smooth and rounded and never spinose as in the latter species. This variety has so far only been found in the Aragon of the Tampico region.

¹⁹Contr. Cushman Lab. Foram. Research, Vol. 6, 1930, pt. 1, p. 15.

EXPLANATION OF PLATE 25

- FIGS. 1.—*Anomalina dorri* var. *aragonensis* Nuttall, n. var. $\times 40$. Dorsal view. Rio La Puerta, 200 m. upstream from La Antigua crossing.
2, 4.—*Cibicides tuxpamensis* Cole. $\times 20$. Fig. 2, dorsal view. Fig. 4, ventral view. La Antigua, Rio La Puerta.
3, 5, 6.—*Cibicides cushmani* Nuttall, n. sp. $\times 40$. Fig. 3, dorsal view. Fig. 5, side view. Fig. 6, ventral view. La Antigua, Rio La Puerta.
7, 8, 11.—*Cibicides grmsdalei* Nuttall, n. sp. $\times 40$. Fig. 7, ventral view. Fig. 11, dorsal view. Rio La Puerta, 200 m. upstream from La Antigua crossing. Fig. 8, side view, 1670 m. N. 70° W. of La Antigua crossing.
9, 10, 14.—*Cibicides subspirata* Nuttall, n. sp. $\times 40$. La Antigua, Rio La Puerta.
12, 13.—*Cibicides pygmaea* (Hantken) $\times 40$. La Antigua Rio La Puerta.
15-17.—*Planorbulina* (*Planorbulinella*) *guayabalensis* Nuttall, n. sp. Macatepec well 5, core at 4500 feet. Figs. 15, 16, $\times 20$. Fig. 17, equatorial section, $\times 40$.



FAMILY ANOMALINIDAE

ANOMALINA DORRI VAR. ARAGONENSIS NUTTALL, N. VAR.

Plate 24, figure 18; Plate 25, figure 1

Anomalina dorri COLE, var., 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 18, Pl. 3, figs. 1, 2.

In both the type of the species from the Chapapote and the varietal form from the Aragon the dorsal surface shows generally two whorls and is only slightly umbilicate. On the ventral surface only the last coil is visible and a deep umbilicus is present. The amount of beading on the sutures is variable and the test is coarsely punctate.

The variety differs from the type in certain minor but constant details. The test is smaller and the sutures in the ultimate half of the last whorl are more sharply defined, also more depressed. Average diameter 0.6 mm.

A. dorri is common in the Chapapote and rare in the Guayabal, while this variety is present in the Aragon and Chicontepec.

CIBICIDES CUSHMANI NUTTALL, N. SP.

Plate 25, figures 3, 5, 6

Test plano-convex, the dorsal side flattened or even slightly concave, the ventral side rounded except in the umbilical region which is somewhat depressed; periphery subacute, about ten chambers in the last formed coil; sutures distinct, on the dorsal side limbate, of clear shell material, somewhat broader toward the inner chamber margin, ventrally somewhat depressed or else limbate; wall between the sutures finely punctate; aperture peripheral at the base of the last-formed chamber, elongate, arched, with a slight trace of overhanging lip. Diameter up to 0.5 mm.

This species has been observed to range from the Lower Alazan to Aragon. It is named in honor of Dr. J. A. Cushman.

CIBICIDES TUXPAMENSIS COLE

Plate 25, figures 2, 4

Cibicides tuxpamensis COLE, 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 19, Pl. 1, figs. 2, 3; Pl. 3, figs. 5, 6.

The range of this species is from Lower Alazan to Aragon.

CIBICIDES GRIMSDALEI NUTTALL, N. SP.

Plate 25, figures 7, 8, 11

Test small, plano-convex, dorsally practically flat, ventrally much elevated. Border sharp, no umbilicus on either surface, finely perforate.

Dorsally with about two visible whorls with short, gently curved, limbate sutures. Ventrally with fairly thick limbate sutures, which are not depressed, the last whorl only being visible with about ten chambers. Aperture small, arched, near the dorsal peripheral margin. Average diameter 0.4 to 0.5 mm.

The above species is, as far as is at present known, restricted to the Aragon. It is named for T. Grimsdale, who collected most of the material described.

CIBICIDES SUBSPIRATA NUTTALL, N. SP.

Plate 25, figures 9, 10, 14

Test biconvex, rostraliform, dorsally slightly elevated, ventrally more convex; border acute with a narrow flanged keel. Dorsally with two visible whorls, chambers finely perforate, about ten in the last whorl; sutures narrow, not very distinct, gently curved. Ventrally with a central boss of clear shell substance, generally of small size; sutures distinct, depressed, strongly curved. Aperture a short arched slit, extending over the peripheral margin to the base of the last chamber. Average diameter 0.6 mm.

This species resembles *Truncatulina ungeriana* var. *radiata* Toulou²⁰ from which it is distinguished by the externally visible earlier chambers on the dorsal surface and the more strongly curved sutures on the ventral surface. *Cibicides mckannai* Galloway and Wissler²¹ appears to be synonymous with this last variety. *Truncatulina spirata* Seguenza²² has a different aperture and more whorls on the dorsal surface. This species has been observed in the Aragon and Chicontepec.

CIBICIDES AFF. ALLENI (PLUMMER)

Truncatulina allenii PLUMMER, 1926, Univ. Texas Bull. 2644, p. 144, Pl. 10, figs. 4 a-c.

Forms closely related to this species occur, which show variation in the convexity of the dorsal surface and the amount of secondary shell development on the same surface.

²⁰Jahrb. K. K. Geol. Reichsanst., Vol. 64 (1915), p. 657, Pl. 39, fig. 16.

²¹Jour. Pal., Vol. 1 (1927), p. 65.

²²Atti. R. Acc. Lincei, Ser. 3, Vol. 6 (1880), pp. 91, 149, Pl. 14, fig. 4.

CIBICIDES PYGMAEA (HANTKEN)

Plate 25, figures 12, 13

Truncatulina pygmaea HANTKEN, 1875, Mitth. Jahrb. Ungar. Geol. Anst., Vol. 4, Pl. 10, fig. 8.

Cibicides pygmaea CUSHMAN AND APPLIN, 1926, Bull. Am. Assn. Petrol. Geol., Vol. 10, p. 179, Pl. 3, fig. 14.

The specimens referred to this species from the Aragon are very smooth and finely perforate, with the sutures on both surfaces not clearly visible. The border is subacute and the ventral umbilical area filled with shell substance, as in specimens figured by Brady.²³

PULVINULINELLA (?) CULTER VAR. MEXICANA COLE

Pulvinulinella culter CUSHMAN, 1927, Jour. Pal., Vol. 1, p. 167, Pl. 26, figs. 8, 9.

Pulvinulinella culter var. *mexicana* COLE, 1927, Bull. Am. Pal., Vol. 19, No. 51, p. 31, Pl. 1, figs. 15, 16; 1928, Bull. Am. Pal., Vol. 14, No. 53, p. 15.

This species ranges from the lower part of the Alazan to the Aragon. It appears doubtful if *Planorbulina culter* Parker & Jones should be referred to *Pulvinulinella*, the aperture in the genotype of the latter being very different from that of the former species.

²³Rept. Voy. *Challenger*, Zool., Vol. 9 (1884), Pl. 105, figs. 9, 10.