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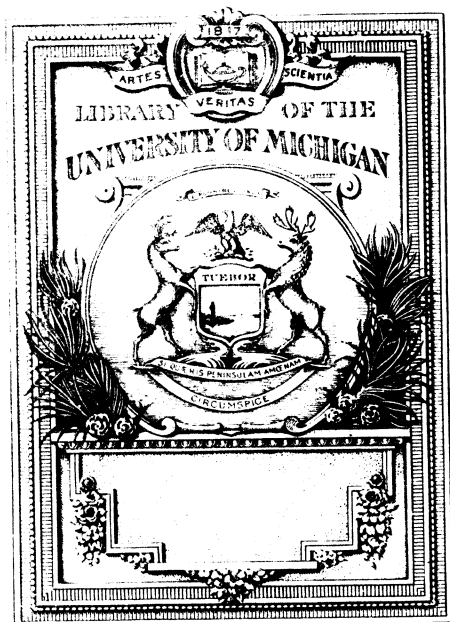
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The Tertiary Foraminifera of Porto Rico

J. J. Galloway and Caroline E. Heminway



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THE TERTIARY FORAMINIFERA OF PORTO RICO

BY J. J. GALLOWAY* AND CAROLINE E. HEMINWAY†

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INTRODUCTION

On the island of Porto Rico, rocks of Tertiary age outcrop in two east-west belts on the north and south sides of the large area of Cretaceous igneous and metamorphic rocks which compose the greater part of interior Porto Rico. The northern area of Tertiary rocks is made up of five formations which strike nearly east-west and dip gently northward. The younger formations overlap to the east so that at the eastern end of the north shore of the island only the Quebradillas, the uppermost Tertiary formation, is present, while in the northwestern part of the island all five formations are found. In order of descending age, these formations are the Quebradillas, the Los Puertos, the Cibao, the Lares, and the San Sebastian, the basal part of which, sometimes called the Collazo shale, lies unconformably on the Cretaceous basement rocks.

The Southern area of Tertiary rocks includes two formations, an older one, the Juana Diaz, which probably corresponds in age to the San Sebastian of the north shore, and a younger formation, the Ponce, which probably is the equivalent of several of the north shore formations.

The exact position of these various formations within the Tertiary is still not well substantiated, although their local relationships are

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clear. For the present, we are accepting the age assignments made by Meyerhoff in his recent work on the geology of Porto Rico.¹

	North Shore	Thickness
Lower Miocene.....	Quebradillas limestone.....	700-1500
	Los Puertos limestone.....	600-1000
Upper Oligocene.....	Cibao limestone.....	250-1000
	Lares limestone.....	1200-1300
Middle Oligocene.....	San Sebastian formation.....	700

The Ponce formation of the south shore is considered upper Oligocene and lower Miocene in age. Its thickness is about 2,000 feet, while the underlying Juana Diaz is reported as up to 3,000 feet in thickness.

CHARACTERISTICS OF THE FAUNA

The total foraminiferal assemblage from the Tertiary of Porto Rico represents 25 families, 99 genera with 275 species and varieties,—88 of which are new. With the exception of the very small fauna from the Lares formation, the north shore formations are all of about the same size. The Ponce formation of the south shore is thought to represent a greater stratigraphic interval than any single one of the north shore formations and this idea is supported by the greater size of the Ponce fauna,—both as to number of families and as to number of genera and species.

TABLE 1

Formation	No. of families	No. of genera	No. of species	No. of species restricted to the formation	
San Sebastian.....	15	34	75	23	31%
Lares.....	5	6	10	2	20%
Cibao.....	15	34	64	29	45%
Los Puertos.....	11	24	48	10	21%
Quebradillas.....	16	34	66	13	20%
Ponce.....	21	60	180	114	63%

An examination of the number of species in each formation which is restricted to that formation illustrates again the greater time interval represented by the Ponce formation, and demonstrates the closer relationship between the various north shore formations than between any one of these formations and the south shore formation.

The accompanying check list (TABLE 2) shows the occurrence of the various species in the north shore and south shore formations.

¹ Meyerhoff, H. A. Monog. Univ. Porto Rico, ser. B. no. 1. 1933.

TABLE 2

CHECK LIST OF THE NORTH SHORE AND SOUTH SHORE FORMATIONS

	North Shore		South Shore	
	Upper Olig.	Lower Mio.	Upper Olig. and Lower Mio.	
	{	{	{	
	Lares	Cibao	Ponce	
	San Sebastian	Los Puertos	Quebradillas	
LAGYNIDAE				
Pseudarcella patella n. sp.	X			
ASTORRHIZIDAE				
Rhabdammina irregularis W. B. Carpenter.				X
SPIRILLINIDAE				
Spirillina vivipara Ehrenberg.		X		X
Patellina corrugata Williamson.				X
MILIOLIDAE				
Spiroloculina antillarum d'Orbigny.			X	X
Spiroloculina elongata d'Orbigny.			X	
Spiroloculina oculina n. sp.			X	
Quinqueloculina akneriana d'Orbigny.	X	X		
Quinqueloculina apiculata n. sp.	X			
Quinqueloculina audacula n. sp.			X	
Quinqueloculina laevigata d'Orbigny.	X			
Quinqueloculina maculata n. sp.	X			
Quinqueloculina philippi Reuss.			X	
Quinqueloculina ponceana n. sp.				X
Quinqueloculina pygmaea Reuss.	X		X	
Quinqueloculina seminum (Linné)	X	X		
Quinqueloculina vulgaris d'Orbigny.	X		X	X
Triloculina austriaca d'Orbigny.	X		X	X
Triloculina brongniartiana d'Orbigny.			X	X
Triloculina cervicula n. sp.	X			
Triloculina elliptica n. sp.	X			
Triloculina gibba d'Orbigny.	X		X	X
Triloculina inflata d'Orbigny.	X		X	X
Triloculina laevigata d'Orbigny.	X		X	X
Triloculina longissima n. sp.	X			
Triloculina oblonga (Montagu)		X		X
Triloculina quadrilateralis (d'Orbigny)	X		X	
Triloculina tricarinata d'Orbigny.				X
Miliolinella circularis (Bornemann)			X	X
Pyrgo bougainvillei (d'Orbigny)	X			
Pyrgo clypeata (d'Orbigny)	X	X	X	X
Pyrgo inornata (d'Orbigny)	X		X	X
Pyrgo lunula (d'Orbigny)	X		X	X
Pyrgo oblonga (d'Orbigny)	X	X	X	X
Pyrgo peruviana (d'Orbigny)	X	X	X	X
Pyrgo subspherica (d'Orbigny)	X		X	X
Pyrgoella globulus (Bornemann)				X
Massilina decorata Cushman			X	
Massilina inaequalis d'Orbigny.			X	
Hauerina sansebastianensis n. sp.	X			
SORITIDAE				
Dendritina prelegans n. sp.			X	
Peneroplis carinatus d'Orbigny.	X			X
Peneroplis proteus d'Orbigny.	X		X	X
Archaias aduncus (Fichtel & Moll)	X		X	X
Archaias angulatus (Fichtel & Moll)	X		X	X
Archaias compressus d'Orbigny.	X			

TABLE 2 (Continued)

	Middle Olig.	North Shore		South Shore
		Upper Olig.	Lower Mio.	Upper Olig. and Lower Mio.
	San Sebastian	Lares Cibao	Los Puertos Quebradillas	Ponce
TROCHAMMINIDAE				
<i>Trochamminoides approximatus</i> n. sp.			X	
LITUOLIDAE				
<i>Cyclammina acutidorsata</i> (Hantken)				X
ATAXOPHRAGMIIDAE				
<i>Valvulina oviedoiana</i> d'Orbigny	X			X
<i>Valvulammina cornucopia</i> n. sp.	X			X
<i>Verneuilina mexicana</i> Nuttall				X
<i>Dorothia caribaea</i> Cushman				X
<i>Dorothia cylindrica</i> (Nuttall)				X
<i>Dorothia praelonga</i> (Karrer)				X
<i>Gaudryina asiphonia</i> Andrea				X
<i>Gaudryina glabrata maxima</i> n. var.		X		
<i>Gaudryina karreriana</i> Cushman			X	X
<i>Gaudryina puertoricana</i> n. sp.	X			
<i>Gaudryina</i> (<i>Pseudogaudryina</i>) <i>atlantica</i> (Bailey)				X
<i>Liebusella byramensis</i> (Cushman)				X
<i>Listerella cf. communis</i> (d'Orbigny)				X
<i>Clavulina tricarinata</i> d'Orbigny	X		X	X
<i>Calvulinoides polygonalis</i> n. sp.			X	
<i>Clavulinoides triangularis</i> (Nuttall)				X
TEXTULARIIDAE				
<i>Textularia agglutinans</i> d'Orbigny	X	X		
<i>Textularia articulata</i> d'Orbigny	X			
<i>Textularia broussardi</i> Howe & Wallace				X
<i>Textularia candeana</i> d'Orbigny	X			X
<i>Textularia gramen</i> d'Orbigny	X			
<i>Textularia grenadana</i> Hedberg				X
<i>Textularia indenta</i> n. sp.		X		
<i>Textulariella barrettii</i> (P. & J.)		X	X	X
<i>Vulvulina pachyheilus</i> Hadley		X		X
<i>Vulvulina pennatula</i> (Batsch)				X
NODOSARIIDAE				
<i>Saracenaria arcuata</i> (d'Orbigny)				X
<i>Astacolus insolitus</i> (Schwager)				X
<i>Astacolus ovatus</i> n. sp.		X		
<i>Astacolus subtilus</i> (Nuttall)		X		X
<i>Hemicristellaria fragraria</i> (Gümbel)			X	
<i>Vaginulina faba</i> n. sp.				X
<i>Vaginulina mexicana</i> (Nuttall)				X
<i>Vaginulina siliquioidea</i> n. sp.				X
<i>Marginulina insulensis</i> n. sp.				X
<i>Marginulina subcrassa</i> Schwager				X
<i>Amphicoryne obliqua</i> n. sp.				X
<i>Glandulina comatula</i> (Cushman)				X
<i>Glandulina gallowayi</i> (Cushman)		X		X
<i>Glandulina mauricensis</i> Howe & Roberts				X
<i>Dentalina advena</i> (Cushman)				X
<i>Dentalina halkyardi</i> Cushman				X
<i>Dentalina halkyardi ponceana</i> n. var.				X
<i>Dentalina hillaeformis</i> n. sp.				X
<i>Dentalina multilineata</i> Bornemann				X

TABLE 2 (Continued)

	Middle Olig.	North Shore		South Shore	
		Upper Olig.	Lower Mio.	Upper Olig. and Lower Mio.	
	San Sebastian	Lares	Cibao	Quebradillas	Ponce
NODOSARIIDAE—Continued					
Dentalina semilaevis Hantken					×
Nodosaria halkyardi antillana P. & B.		×			×
Nodosaria longiscata d'Orbigny					×
Nodosaria obliquata (Batsch)					×
Nodosaria pariana Hedberg					×
Nodosaria raphanistrum (Linné)					×
Nodosaria scalaris (Batsch)					×
Nodosaria simplex Silvestri					×
Lagena ampulla n. sp.	×				×
Lagena bullosa n. sp.					×
Lagena impressa n. sp.					×
Lagena nuttalli n. sp.					×
Lagena strumosa Reuss					×
Robulus calliferus (Stache)					×
Robulus chambersi Garrett			×	×	×
Robulus cibaoensis n. sp.			×		×
Robulus convergens (Bornemann)			×		×
Robulus falcifer (Stache)				×	×
Robulus iota (Cushman)					×
Robulus occidentalis torridus (Cushman)					×
Robulus planulus n. sp.			×		×
Robulus plummerae Cole					×
Robulus protuberans (Cushman)					×
Robulus subpapillosus (Nuttall)					×
Lingulina ponceana n. sp.					×
Lingulina semicostata n. sp.					×
Fissurina laevis Seguenza					×
Fissurina marginata (Montagu)					×
POLYMORPHINIDAE					
Polymorphina terquemiana (Fornasini)			×		
Guttulina basalis n. sp.				×	
Apiopterina cylindroides (Roemer)					×
Raphanulina gibba globosa (von Münster)	×				
NONIONIDAE					
Nonion chapapotense Cole	×				
Nonion dilatatum n. sp.			×		
Nonion multiporatum n. sp.			×		
Nonion nicobarense Cushman			×	×	×
Nonion pompilioides (Fichtel & Moll)			×		×
Nonion subgrateloupi n. sp.	×			×	×
Pseudononion papillatum n. sp.			×		
Nonionella modesta n. sp.	×				
Pullenia bulloides (d'Orbigny)					×
Elphidium lanieri (d'Orbigny)					×
Elphidium lens n. sp.	×				
Elphidium lobatum n. sp.		×		×	
Elphidium nautilloideum n. sp.	×			×	
Elphidium owenianum (d'Orbigny)	×		×	×	×
Elphidium poeyanum (d'Orbigny)	×	×		×	
Elphidium puertoricense n. sp.	×			×	
Elphidium sagrai (d'Orbigny)	×		×	×	×
Elphidium sagrai crassum n. var.	×			×	×
Antillesina marielensis (Palmer)	×				×

TABLE 2 (Continued)

	North Shore		South Shore	
	Middle Olig.	Upper Olig.	Lower Mio.	Upper Olig. and Lower Mio.
	San Sebastian	Lares	Cibao	Ponce
			Los Puertos	Quebradillas
ROTALIIDAE				
<i>Globorotalia menardii</i> d'Orbigny				×
<i>Lamarckina echinata</i> n. sp.				×
<i>Valvulineria maclureaformis</i> n. sp.		×		×
<i>Valvulineria nuttalli</i> Palmer & Bermudez				×
<i>Valvulineria palmarealis</i> Nuttall				×
<i>Valvulineria paucilocula</i> (Cushman)			×	×
<i>Eponides advena</i> Cushman		×		×
<i>Eponides ellisorae</i> Garrett				×
<i>Eponides exiguus</i> Brady	×			×
<i>Eponides ornatissimus</i> n. sp.	×	×	×	×
<i>Eponides parantillarum</i> n. sp.				×
<i>Eponides pulvinus</i> n. sp.		×		×
<i>Eponides repandus</i> (Fichtel & Moll)				×
<i>Eponides ventricosus</i> n. sp.		×		×
<i>Eponides vortex</i> n. sp.		×		×
<i>Gyroidina cf. soldanii</i> d'Orbigny		×		×
<i>Gyroidina stellifera</i> n. sp.				×
<i>Rotalia byramensis</i> Cushman		×		×
<i>Rotalia choctawensis</i> Cushman & McGlamery	×			×
<i>Rotalia mexicana</i> Nuttall				×
<i>Rotalia mexicana mecatepecensis</i> Nuttall				×
<i>Rotalia meyerhoffi</i> n. sp.				×
<i>Rotalia tholus</i> n. sp.				×
<i>Discorbis floridanus</i> Cushman	×		×	×
<i>Discorbis havanensis</i> Cushman & Bermudez			×	×
<i>Discorbis multisectus</i> n. sp.	×			×
<i>Discorbis oligospiratus</i> n. sp.		×		×
<i>Discorbis pelliculatus</i> n. sp.				×
<i>Discorbis subaracanus</i> Cushman	×		×	×
<i>Epistomaria pontifera</i> n. sp.				×
<i>Anomalina alazanensis</i> Nuttall				×
<i>Anomalina nucleata</i> (Seguenza)		×		×
<i>Anomalina pomplioideus</i> n. sp.		×		×
<i>Cycloloculina cubensis</i> Cushman & Bermudez	×		×	×
<i>Cibicides americanus</i> Cushman	×	×		×
<i>Cibicides choctawensis</i> Cushman & McGlamery		×		×
<i>Cibicides floridanus</i> Cushman		×		×
<i>Cibicides io</i> Cushman				×
<i>Cibicides lobatus</i> (d'Orbigny)	×	×	×	×
<i>Cibicides mexicanus</i> Nuttall				×
<i>Cibicides perliculus</i> Nuttall				×
<i>Cibicides pseudoungerianus</i> (Cushman)			×	×
<i>Cibicides scalenus</i> n. sp.		×		×
<i>Cibicides sinistralis</i> Coryell & Rivero		×		×
<i>Cibicides spirolimbatus</i> n. sp.				×
<i>Planulina crassa</i> n. sp.				×
<i>Planulina depressa</i> (d'Orbigny)				×
<i>Planulina marialana</i> Hadley				×
<i>Planulina mexicana</i> Cushman				×
<i>Planulina zigzag</i> n. sp.		×		×
<i>Cibicidella variabilis</i> (d'Orbigny)	×			×
<i>Siphonina advena</i> Cushman	×	×	×	×
<i>Siphonina tenuicarinata</i> Cushman				×
<i>Planorbullinella larvata</i> (Parker & Jones)		×		×

TABLE 2 (Continued)

	North Shore		South Shore and Lower Mio.	
	Middle Olig.	Upper Olig.	Lower Mio.	Upper Olig.
	San Sebastian	Iares Cibao	Los Puertos Quebradillas	Ponce
ACERVULINIDAE				
<i>Rupertia verrucosa</i> n. sp.				X
<i>Carpenteria bulloides</i> n. sp.			XXXX	XXXX
<i>Carpenteria proteiformis</i> Goës.			XXXX	XXXX
<i>Gypsina discus</i> (Goës)	X	X	XXXX	XXXX
<i>Sphaerogypsina globulus</i> (Reuss)			XXXX	XXXX
<i>Sphaerogypsina pilaris</i> (Brady)			XXXX	XXXX
ASTERIGERINIDAE				
<i>Amphistegina angulata</i> (Cushman)			X	X
<i>Amphistegina floridana</i> Cushman & Ponton..	X	X	X	X
CHILOSTOMELLIDAE				
<i>Chilostomella czizeki</i> Reuss.				XXXX
<i>Chilostomella globata</i> n. sp.				XXXX
<i>Chilostomella ovoidea</i> Reuss.				XXXX
<i>Chilostomella urceolus</i> n. sp.				XXXX
<i>Sphaeroidina bulloides</i> d'Orbigny.			X	X
ORBULINIDAE				
<i>Globigerina bulloides</i> d'Orbigny.	X	X	X	X
<i>Globigerina dutertrei</i> d'Orbigny.	X	X	X	X
<i>Globigerina inflata</i> d'Orbigny.				X
<i>Globigerina ouachitaensis</i> Howe & Wallace..		X	X	X
<i>Globigerina pachyderma</i> (Ehrenberg)				X
<i>Globigerina pseudotrilocula</i> White.	X	X		X
<i>Globigerina trilocularis</i> d'Orbigny.	X	X	X	X
<i>Orbulina universa</i> d'Orbigny.	X	X	X	
PEGIDIIDAE				
<i>Sphaeroidinella seminulina</i> (Schwager)			X	
HETEROHELICIDAE				
<i>Pavonina advena</i> Cushman.		X		
<i>Bolivina byramensis</i> Cushman.		X		
<i>Bolivina elongata</i> Hantken.				X
<i>Bolivina heineae</i> n. sp.				X
<i>Bolivina jacksonensis</i> Cushman & Applin.	X			
<i>Bolivina matanzana convexa</i> n. var.	X	X		
<i>Bolivina mexicana aliformis</i> Cushman.				X
<i>Bolivina tectiformis</i> Cushman.				X
<i>Bolivina ventricosa</i> n. sp.				X
<i>Loxostomum hiwanneense</i> Howe.		X		
<i>Loxostomum normale</i> n. sp.		X		
<i>Plectofrondicularia trinitatensis</i> Cushman & Jarvis.				X
<i>Plectofrondicularia vaughani</i> Cushman.				X
BULIMINIDAE				
<i>Reussella glabrata</i> (Cushman)	X		X	X
<i>Bullimina socialis</i> Bornemann.				X
CASSIDULINIDAE				
<i>Cassidulina laevigata</i> d'Orbigny.		X	X	
<i>Cassidulina subglobosa</i> Brady.				X
<i>Cassidulina tricamerata</i> n. sp.				X
<i>Ehrenbergina caribbea</i> n. sp.				X
<i>Ehrenbergina serrata gibbera</i> n. var.				X

TABLE 2 (Continued)

	Middle Olig.	North Shore		South Shore
		Upper Olig.	Lower Mio.	Upper Olig. and Lower Mio.
	San Sebastian	Lares	Cibao	Los Puertos
			Quebradillas	Ponce
UVIGERINIDAE				
<i>Uvigerina bulbacea</i> n. sp.		×		×
<i>Uvigerina elongata</i> Cole.				×
<i>Uvigerina fusiformis</i> n. sp.				×
<i>Uvigerina gallowayi</i> Cushman.		×		×
<i>Uvigerina gardnerae</i> Cushman.				×
<i>Uvigerina mantaensis</i> Cushman & Edwards. .				×
<i>Uvigerina mexicana</i> Nuttall.				×
<i>Uvigerina mexicana bulbosa</i> n. var.				×
<i>Uvigerina mexicana ranunculus</i> n. var.				×
<i>Uvigerina postica</i> n. sp.		×		×
<i>Uvigerina vicksburgensis</i> Cushman & Ellis. .				×
<i>Siphogenerina costotriata</i> n. sp.				×
<i>Siphogenerina cumingsi</i> n. sp.				×
<i>Siphogenerina hubbardi</i> n. sp.				×
<i>Siphogenerina mexicana</i> Cushman.				×
<i>Siphogenerina multicostata</i> Cushman & Jarvis				×
<i>Angulogerina cibaoensis</i> n. sp.		×		
<i>Angulogerina cooperensis</i> Cushman.		×		
<i>Angulogerina decorissima</i> n. sp.			×	
<i>Angulogerina ponceana</i> n. sp.				×
<i>Trifarina bradyi</i> Cushman.				×
PLEUROSTOMELLIDAE				
<i>Pleurostomella bierigi</i> Palmer & Bermudez. .				×
<i>Pleurostomella elliptica</i> n. sp.				×
<i>Pleurostomella gerontica</i> n. sp.				×
<i>Nodosarella constricta granulifera</i> n. var.				×
<i>Nodosarella crassilegans</i> Nuttall.				×
<i>Nodosarella paucistriata</i> Galloway & Morrey		×		×
<i>Nodosarella verneuili</i> (d'Orbigny).		×		×
<i>Ellipsoglandulina exponsa</i> (Brady).				×
<i>Ellipsoidina ellipsoides abbreviata</i> Seguenza. .				×
CAMERINIDAE				
<i>Operculinella sinuata</i> n. sp.			×	
<i>Heterostegina antillea</i> Cushman.	×			
ORBITOIDIDAE				
<i>Lepidocyclus cf. parvula</i> Cushman.	×			×
<i>Lepidocyclus</i> (Nephrolepidina) <i>cf. tournoueri</i>				×
L. & D.	×			×
<i>Miogyopsinoides complanata</i> (Schlumberger). .	×	×	×	×

The following table (TABLE 3) shows the relationship among the faunas of the Porto Rican formations. The numbers show how many species the two formations have in common, while the percentage given is the ratio of this number to the number of species in the smaller of the two formations involved.

TABLE 3

	San Seb.	Lares	Cibao	Los P.	Queb.	Ponce
San Sebastian...	— —	7 70%	21 33%	32 67%	30 45%	39 52%
Lares.....	7 70%	— —	3 30%	6 60%	8 80%	6 60%
Cibao.....	21 33%	3 30%	— —	11 23%	20 31%	28 44%
Los Puertos.....	32 67%	6 60%	11 23%	— —	24 50%	29 60%
Quebradillas.....	30 45%	8 80%	20 31%	24 50%	— —	41 62%
Ponce.....	39 52%	6 60%	28 44%	29 60%	41 62%	— —

Because of the small size of the Lares fauna, the figures for that formation are of no significance. The percentages for the Ponce formation are likewise of rather little significance, except as they show that the Ponce formation covers a wider stratigraphic range than any one of the north shore formations, and that it contains elements which may be correlated with the stratigraphic horizon of each of those formations.

The percentages for the north shore formations show that they have rather closely related faunas, the smallest percentage of correlation being 23% between the Cibao and Los Puertos formations.

In sharp contrast with the figures given above, are figures for the comparison of the Porto Rican formations with Oligocene and Miocene faunas from other areas in the gulf coast and West Indian region. In no case, except for the Ponce formation, was a percentage of more than 14% discovered, although analyses were made with several faunas, among them the Alazan of the Tampico region in Mexico²; the lower Oligocene of Cuba³; the Oligocene of Ecuador⁴; the Miocene of eastern United States⁵; the middle Miocene of Buff Bay, Jamaica⁶; the middle Miocene of Haiti⁷; the middle Tertiary Carapita formation of Venezuela⁸; the Tertiary of Trinidad⁹; and others. The Porto Rican faunas seem, therefore, to be in part provincial, in part pelagic, but in most part cosmopolitan and long ranging. With a few exceptions, which will be mentioned under the discussion of the various formations, they cannot be closely correlated with any faunas as yet published.

Available data on depth distribution¹⁰ of the various families which predominate in the Porto Rican formations lead us to postulate its accumulation at relatively shallow depths. The presence of the

² Nuttall, W. L. F. Jour. Paleont. 6: 3-35. 1932.

³ Palmer, D. K. & Bermudez, P. J. Mem. Soc. Cubana Hist. Nat. 10: 227-316. 1936.

⁴ Galloway, J. J. & Morrey, M. Bull. Am. Paleont. 15: 1-57. 1929.

⁵ Cushman, J. A. & Cahill, E. D. U. S. Geol. Surv. Prof. Pap. 175A: 1-51. 1933.

⁶ Cushman, J. A. & Jarvis, P. W. Jour. Paleont. 4: 353-368. 1930.

⁷ Coryell, H. N. & Rivero, F. C. Jour. Paleont. 14: 324-344. 1940.

⁸ Hedberg, H. D. Jour. Paleont. 11: 661-697. 1937.

⁹ Nuttall, W. L. F. Quart. Jour. Geol. Soc. 84: 57-112. 1928.

¹⁰ Norton, R. D. Bull. Scripps Inst. Oceanog. Tech. ser. 2: 331-388. 1930.

families, Camerinidae, Soritidae, and abundant representatives of the Miliolidae; the common occurrence of such genera, as *Elphidium*, *Gypsina*, *Sphaerogypsina*, and *Clavulina tricarinata*; and the absence of uvigerines or many Nodosariidae in the formations of the north shore, seem to point conclusively to their accumulation in water of less than 60 fathoms. The presence of numerous Uvigerinidae and Nodosariidae at certain localities of the Ponce formation indicates that the south shore formation was deposited, in part, at greater depths.

Certain characteristics of each fauna should be mentioned. In the San Sebastian formation, 69% of the species belong to only four families: 39% to the Miliolidae and Soritidae combined; 15% to the Nonionidae; and another 15% to the Rotaliidae. Many of these species are common or even abundant, so that more than 69% of the fossils found would fall in these four families. These percentages, and the presence of Camerinidae and Orbitoididae, seem to agree with conditions at Norton's Zone A, with depth of 0 to 5 fathoms.

In the Lares formation, 5 of the 10 species are milioloids, 2 are species of *Elphidium*, and 2 are rotaloids.

In the Cibao formation, the dominant family is the Rotaliidae which includes 30% of the total number of species. The Nodosariidae are next with 12% and the Nonionidae third with 11%. The absence of the Soritidae, and the presence of only five species of milioloids, but several species of *Uvigerina*, suggest accumulation at depths comparable to Norton's Zone B which extends from 5 to 60 fathoms. Norton finds none of the uvigerine species at depths of less than 60 fathoms, so it seems probable that depth conditions were near the upper limit of 60 fathoms. The presence of *Elphidium* and *Miogypsinoides* is, however, suggestive of more shallow conditions than that indicated by the rest of the fauna.

The Los Puertos fauna is dominantly porcelaneous, with 53% of the species belonging to the Miliolidae and Soritidae. The Rotaliidae with 9 species, or 19%, are second, and the Nonionidae with 6 species, or 13%, are third. This distribution is almost identical with that of Norton's zone A, with depth 0 to 5 fathoms.

The Quebradillas formation can be assigned to Norton's zone B, with depth 5 to 60 fathoms. The Miliolidae and Soritidae constitute 25% of the number of species, the Rotaliidae another 25%, and the Nonionidae 11%. Since several species of *Elphidium* are present, it is probable that the depth of deposition was about 16 fathoms, since Norton found that *Elphidium* is rare below that depth.

The Ponce fauna is unusually large and upon close inspection it is found to contain elements of both deep and shallow water faunas.

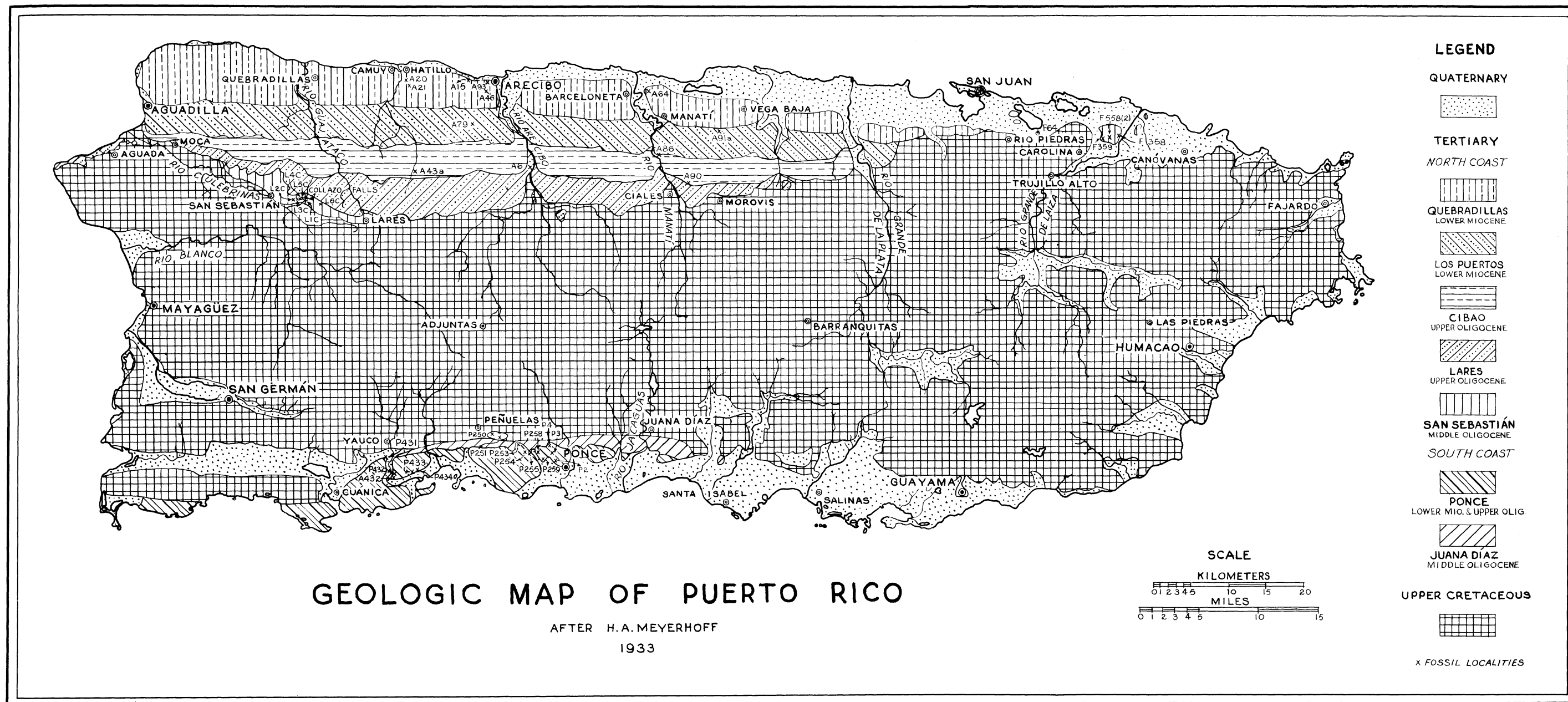


FIGURE 1. Geologic Map of Porto Rico showing localities at which foraminiferal material was collected

As a whole, the Ponce fauna contains 23% *Nodosariidae*, 16% *Rotaliidae*, 9% *Miliolidae*, and 8% *Uvigerinidae*. Smaller percentages, but of importance in the determination of ecologic conditions, are the *Chilostomellidae* with 4 species, the *Globigerinidae* with 7 species, the *Cassidulinidae* with 4 species, the *Nonionidae* with 9 species, and the *Orbitoids* with 3 species. A deep water environment such as Norton's zone D is suggested by the 23% of *Nodosariidae*, the 8% of *Uvigerinidae*, and the presence of *Chilostomellidae*, *Globigerinidae*, and *Cassidulinidae*. But a much shallower environment is indicated by the presence of orbitoids and by the presence of *Archaias* and *Peneroplis*, "which are almost never found below 60 fathoms."

AGE OF THE FORMATIONS

At the initiation of this study it was hoped that new light could be thrown on the exact age of the Porto Rican Tertiary formations and on their correlation with other West Indian and gulf coast localities. The fauna as a whole is a large one and that of the Ponce formation particularly so, but there is a surprisingly low percentage of correlation with other described faunas from the same general region. A formation by formation tabulation of the species and their stratigraphic ranges (TABLE 4) has been made and from these tabulations the age of all the Porto Rican formations is seen to lie in the Oligocene or Miocene, evidently not lower than lower Oligocene, nor higher than middle Miocene. This corroborates the age determinations which were made by Meyerhoff in 1933.

The presence of large numbers of *Elphidium* in all except the very youngest part of the Tertiary succession, namely the Quebradillas and the upper part of the Ponce, is unusual since *Elphidium* is rarely found in any abundance below the Miocene. Other constituents of these faunas, however, are definitely Oligocene,—namely the orbitoids and camerines. These are found in all except the Quebradillas and the upper part of the Ponce formation.

A middle Oligocene age for the San Sebastian is indicated by its more than 10% correlation with species of the Byram of southeastern United States, and by the presence of significant middle Oligocene index fossils, such as *Rotalia choctawensis*, *Heterostegina antillea*, *Miogypsinoides complanata*, and *Lepidocyclina* cf. *parvula*.

The Lares and Cibao formations have fewer reliable index fossils. The middle and upper Oligocene index fossil *Miogypsinoides complanata* is abundant in the Cibao formation, so it seems probable that these formations, which overlie the San Sebastian, are of upper Oligocene age, as postulated by Meyerhoff.

Meyerhoff (1933) assigns a lower Miocene age to both the Los Puertos and the Quebradillas formations. The fauna of the Los Puertos is so totally unlike any other known fauna that we can draw no definite conclusions as to its age, although the presence of *Miogypsinoides complanata* suggests an upper Oligocene rather than a lower Miocene horizon. The Quebradillas formation, however, seems to be late lower Miocene or possibly early middle Miocene in age. This is indicated by the absence of Oligocene markers, namely the larger foraminifera, and by the fairly high degree of correlation between the Quebradillas fauna and the fauna of several middle Miocene localities in the West Indian region,—namely 12% with the lower Miocene of Trinidad, 14% with the middle Miocene of Haiti, and 14% with the middle Miocene of Jamaica.

Evidence of the Oligocene age of some of the Ponce was afforded by the comparisons made with other faunas. The percentage of correlation with Oligocene faunas ranged from 15 to 20%; the percentage of correlation with middle Miocene faunas ranged only from 10 to 12%. The foraminiferal fauna of the Ponce therefore shows both Oligocene and Miocene elements, but the Oligocene trend seems more pronounced, at least for the lower part of the Ponce which is the part of the Ponce most abundantly represented in our collections.

Some of the Ponce is as old as lower Oligocene. The exact percentage of correlation with Oligocene faunas were as follows: 18% with the lower Oligocene of Cuba, 20% with the lower Oligocene of Mexico described by Nuttall, 16% with the lower Oligocene described by Dorr from the Alazan (1933. Jour. Paleont. 7) 15% with the Carapita of Venezuela, of probable upper Oligocene age. A number of specialized forms which occur only in beds of lower Oligocene age furnish additional proof. Among these are *Verneuilina mexicana*, *Dorothia cylindrica*, *Vaginulina mexicana*, *Antillesina marielensis*, *Valvulineria palmarealensis*, *Rotalia mexicana mecatepecensis*, *Uvigerina vicksburgensis*, *Siphogenerina mexicana*, and others.

It is probable that the middle and upper Ponce are much younger than lower Oligocene. The 10 and 12% correlations with middle Miocene faunas suggests that upper Ponce is about lower Miocene in age. An examination of the known stratigraphic ranges of the Ponce species shows two times of most abundant species,—namely the lower Oligocene in which 69 of the Ponce species occur, and the middle Miocene in which 51 of the Ponce species occur. Faunas of other ages include only 25 or fewer of the species which occur in the Ponce (TABLE 4).

TABLE 4 (Continued)

	CIBAO FAUNA		Eocene	Oligocene	Miocene	Pliocene	Pleistocene	Recent
			Lower Middle Upper	Lower Middle Upper	Lower Middle Upper	Upper		
R	Spirillina vivipara		X	X			X	X
R	Quinqueloculina akneriana			X	X	X	X	X
R	Pyrgo clypeata		X	X	X	X	X	X
C	Pyrgo oblonga				X			X
C	Pyrgo peruviana				X			X
R	Gaudryina glabrata maxima n. sp.				X	X	X	X
R	Textularia agglutinans			X	X	X	X	X
R	Textularia indenta n. sp.				X	X	X	X
R	Textulariella barrettii		X		X			X
R	Vulvulina pachyhelius			X	X			
R	Astacolus ovatus n. sp.			X				
R	Astacolus subtilus			X				
R	Glandulina gallowayi			X				
R	Nodosaria halkyardi antillana			X				
R	Robulus chambersi			X	X	X		
R	Robulus cibaoensis n. sp.							
R	Robulus convergens		X	X				X
R	Robulus planulus n. sp.			X				
R	Nonion dilatatum n. sp.							
R	Nonion multiporatum n. sp.							
R	Nonion nicobarense		X	X	X	X	X	X
A	Nonion pompilioides			X	X	X	X	X
R	Pseudononion papillatum n. sp.				X	X	X	X
R	Elphidium owenianum					X	X	X
R	Elphidium sagrai			X		X	X	X
R	Valvulineria maclureiformis n. sp.					X	X	X
R	Valvulineria paucilocula			X				
R	Eponides advena			X				
R	Eponides ornatissimus n. sp.			X				
R	Eponides pulvinus n. sp.							
A	Eponides ventricosus n. sp.							
C	Eponides vortex n. sp.							
R	Gyroidina stellifera n. sp.							
R	Discorbis oligospiratus n. sp.							X
R	Anomalina pompilioides n. sp.		X		X			
C	Cibicides americanus			X	X	X		
R	Cibicides choctawensis			X				
R	Cibicides floridanus		X	X	X	X		X
R	Cibicides lobatus		X	X	X		X	X
R	Cibicides scalenus n. sp.			X			X	
R	Cibicides sinistralis					X		
C	Planulina zigzag n. sp.							
C	Siphonina advena		X	X				
C	Planorbulinella larvata			X				X
C	Sphaerogypsina globulus		X	X	X	X		X
C	Amphistegina floridana			X	X	X		
C	Globigerina bulloides	X	X	X	X	X	X	X
C	Globigerina dutertrei		X	X				X
C	Globigerina ouachitaensis	X	X					
C	Globigerina pseudotriloeba							
C	Globigerina trilocularis			X	X	X		
C	Bolivina byramensis			X	X	X		
C	Bolivina matanzana convexa n. var.			X				
R	Loxostomum hiwanneense			X				
R	Loxostomum normale n. sp.							
R	Cassidulina laevigata						X	X
C	Uvigerina bulbacea n. sp.						X	X
R	Uvigerina gallowayi			X				
R	Uvigerina postica n. sp.							
C	Angulogerina cibaoensis n. sp.							
C	Angulogerina cooperensis		X					
C	Nodosarella paucistriata		X	X	X	X		
C	Nodosarella verneuili			X	X	X		
C	Miogypsinoides complanata			X	X			

[illegible]

ACKNOWLEDGMENTS

We wish at this time to acknowledge our great indebtedness to Professor H. A. Meyerhoff, who, by his careful collection of material from the many localities enumerated above, has made possible the prosecution of this work. To him we owe, also, our knowledge of the relative stratigraphic position of the various collecting localities.

The figures were drawn by the senior author, J. J. Galloway. Valuable assistance in shading the figures was furnished by Frances Beede, Frederick P. Schweers, and J. Bernard Martindale. Drafting of the Porto Rican locality map was done by Frederick P. Schweers.

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All of the types are catalogued and deposited in the Paleontological laboratory at Indiana University.

SYSTEMATIC DESCRIPTION OF SPECIES

Family LAGYNIDAE Schultze 1854

PSEUDARCELLA Spandel 1909

Pseudarcella patella NEW SPECIES

PLATE 1, FIGURES 1a, b

Test unilocular, discoidal, concavo-convex; edge narrowly rounded; dorsal side convex with a small, inconspicuous round knob in the center of the dorsal surface; wall calcareous, readily and completely soluble in dilute acid, hyaline in appearance, pores not observable; wall material not chitinous or arenaceous but calcareous with precisely the same appearance as specimens of hyaline, finely perforate forms such as the *Nodosariidae* and the *Polymorphinidae*; aperture in the center of a circular depression on the concave side of the test, circular in shape. Diameter, from 0.25 to 0.55 millimeter; maximum height, 0.16 millimeter.

Holotype No. 3950, locality A6, Lares formation.

Common at A6 of the Lares formation, from which half a dozen specimens were obtained.

P. patella is larger in diameter and thinner than *P. arenata* Cushman (1930. Fla. Geol. Surv. Bull. 4).

Family **ASTRORHIZIDAE** Brady 1881**RHABDAMMINA** M. Sars 1869*Rhabdammina irregularis* Carpenter

PLATE 1, FIGURE 2

Rhabdammina irregularis Carpenter (1869) Proc. Roy. Soc. London 18: 60.—Cushman (1918) Bull. U. S. Nat. Mus. 104 (1): 17. pl. 8, fig. 1. Recent, Bay of Biscay, Pacific Ocean along western coast of America as far north as Gulf of California, East Indies.
Rhabdammina abyssorum Brady (1884) Rep. Voy. Challenger Zool. 9: 268. pl. 21, fig. 9 only. Recent, northwest of Ireland.

Test unilocular, consisting of a dichotomously or irregularly branching tubular chamber of nearly uniform diameter; wall of firmly cemented sand grains, exterior rather rough, interior more smoothly finished; ends of the tube serving as apertures. Average diameter, 0.83 millimeter; length of figured specimen, about 4 millimeters.

Plesiotype No. 3972, locality P3, Ponce formation.

Common at P3; rare at P2 of the Ponce formation.

Family **SPIRILLINIDAE** Reuss 1861**SPIRILLINA** Ehrenberg 1843*Spirillina vivipara* Ehrenberg

PLATE 1, FIGURES 3a, b

Spirillina vivipara Ehrenberg (1841) Abh. k. Akad. Wiss. Berlin 422. pl. 3, sec. 7, fig. 41. Recent, off coast of Mexico.—Brady (1884) Rep. Voy. Challenger Zool. 9: 630. pl. 85, figs. 1–5. Recent, world wide.—Cushman (1915) Bull. U. S. Nat. Mus. 71 (5): 3. pl. 1, figs. 1, 2. Recent, north Pacific; (1931) Bull. U. S. Nat. Mus. 104 (8): 3. pl. 1, figs. 1–4. Recent, West Indies.

Test discoidal, slightly biconcave, planispiral, composed of a single tubular chamber in several coils, slowly increasing in diameter and only slightly involute; coils flattened and both sides of test somewhat flattened; periphery rounded; spiral suture somewhat depressed; aperture simple at the end of the tubular chamber. Diameter, 0.27 by 0.30 millimeter; thickness, 0.04 millimeter.

Plesiotype No. 3993, locality A86, Cibao formation.

Rare at A86 of the Cibao formation and at P432 of the Ponce formation.

PATELLINA Williamson 1858*Patellina corrugata* Williamson

PLATE 10, FIGURES 5a–c

Patellina corrugata Williamson (1858) Rec. Foram. Great Britain 46. pl. 3, figs. 86–89. Recent, off Great Britain.—Cushman (1930) Contr. Cushman Lab. Foram. Res. 6: 15 pl. 3, fig. 5. Tertiary to Recent; (1931) Bull. U. S. Nat. Mus. 104 (7): 11. pl. 2, figs. 6, 7. Recent, east and west borders of North Atlantic.

Test conical, apical angle nearly 90 degrees; ventral side nearly flat; several whorls of chambers visible on the dorsal side, early tubular chamber obscure but apparently comprising 2 or 3 whorls; later chambers shortening to 2 to a whorl; lobate ornamentation on dorsal side of the chambers, usually attributed to presence of secondary septa or septula, lobes sometimes simple, but more frequently double near the outer edge of the chamber; lower side with secondary deposits in knobs and meandering lines; wall thin, translucent, not definitely perforate; aperture a slit on the ventral side between the last 2 chambers with valvular lip. Diameter, 0.31 millimeter; height, 0.16 millimeter.

Plesiotype No. 3944, locality P432, Ponce formation.

Rare at P432 of the Ponce formation.

P. advena Cushman (1922. U. S. Geol. Surv. Prof. Pap. 129F) is closely related to *P. corrugata* but differs, as stated in the original description, in the much finer division by internal septa and in a lower spire which makes a broad flaring test.

Family MILIOLIDAE d'Orbigny 1839

SPIROLOCULINA d'Orbigny 1826

Spiroloculina antillarum d'Orbigny

PLATE 1, FIGURES 6a-c

Spiroloculina antillarum d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 166. pl. 9, figs. 3, 4. Recent, off Cuba.—Brady (1884) Rep. Voy. Challenger Zool. 9: 155. pl. 10, figs. 21a, b. Recent, south Atlantic.—Cushman (1921) Proc. U. S. Nat. Mus. 59: 63. pl. 14, figs. 14, 15. Recent, off Jamaica; (1932) Bull. U. S. Nat. Mus. 161 (1): 36. pl. 9, figs. 3-5. Recent, tropical Pacific.

Test oval in side view, biconcave, narrowly oval in end view; chambers subcircular in transverse section, rather thick; surface marked by numerous longitudinal striae; aperture terminal at the end of a neck with a plate-like tooth. Length, 1.07 millimeters; width, 0.63 millimeter; thickness, 0.22 millimeter.

Plesiotype No. 3994, locality A79, Los Puertos formation.

Rare at F64 of the Quebradillas formation, and P258 of the Ponce formation. Common at A79 of the Los Puertos formation.

Spiroloculina elongata d'Orbigny

PLATE 1, FIGURES 5a-c

Spiroloculina elongata d'Orbigny (1826) Ann. Sci. Nat. 7: 298, No. 11. Pliocene, Italy.—Fornasini (1904) Mem. R. Accad. Sci. Istit. Bologna Sez. Sci. Nat. VI. 1: 5. pl. 1, figs. 10a-c. (After d'Orbigny's unpublished figure of 1826.)

Test elongate, elliptical in side view; biconcave; back of the test broad, gently rounded; chambers elongate, with rounded back and concave sides in transverse section, tapering from the broadly rounded peripheral back of the chamber toward the center of the test, with an angled or nearly carinate contact between the back and sides of the chambers; aperture round, with plate-like tooth, at the end of a neck. Length, 1.41 millimeters; width, 0.75 millimeter; maximum thickness, 0.61 millimeter.

Plesiotype No. 3995, locality A79, Los Puertos formation.

Rare at A79 of the Los Puertos formation.

Spiroloculina oculina NEW SPECIES

PLATE 1, FIGURES 4a-c

Test regularly oval in side view; oval in end view, sides slightly concave, with carinae at the junction between back and sides of the chambers; chambers closely appressed, 5 visible on one side, 6 on the other side of the test, with portions of the keeled edge of earlier chambers visible on both sides; aperture terminal, round, with a short neck and T-shaped tooth. Length, 1.52 millimeters; width, 0.85 millimeter; thickness, 0.41 millimeter.

Holotype No. 3996, locality A79, Los Puertos formation.

Very rare at A79 of the Los Puertos formation.

S. oculina has fewer chambers and is thicker than *S. excavata* d'Orbigny from the Vienna Miocene.

QUINQUELOCULINA d'Orbigny 1826

Quinqueloculina akneriana d'Orbigny

PLATE 2, FIGURES 1a-c

Quinqueloculina akneriana d'Orbigny (1846) Foram. Foss. Vienne 290. pl. 18, figs. 16-21. Middle Miocene, Vienna.

Quinqueloculina seminulum Cushman (1918) Bull. U. S. Nat. Mus. 103: 78. pl. 28, figs. 1a-c (not figs. 2, 3). Middle Miocene, Panama Canal Zone.

Test elongate, ovate in side view, width $\frac{2}{3}$ length; $\frac{3}{4}$ as thick as wide; edge rounded; chambers distinct, of uniform diameter, nearly circular in cross section, successive chambers enlarging regularly in size; sutures depressed; apertural end without a definite neck; aperture terminal, circular, with a simple tooth. Length, 0.68 millimeter; width, 0.47 millimeter; thickness, 0.33 millimeter.

Plesiotype No. 3961, locality L6C, San Sebastian formation.

Rare at L2C; common at L6C of the San Sebastian formation. Rare at A86 of the Cibao formation.

We are following the generally accepted usage of restricting the name *Q. seminulum* (Linné) to those short, ovate quinqueloculines with subangular edge.

Quinqueloculina apiculata NEW SPECIES

PLATE 2, FIGURES 2a-c

Test about twice as long as wide, $\frac{2}{3}$ as thick as wide; periphery rounded; chambers distinct, lengthening rapidly, somewhat inflated, distal end of last chamber with a short blunt apicule; sutures distinct, moderately depressed; surface of holotype poorly preserved; apertural end of last chamber extended into a neck; aperture terminal, circular, with a narrow, simple tooth. Length, 0.49 millimeter; width, 0.23 millimeter; thickness, 0.14 millimeter.

Holotype No. 3962, locality L6C, San Sebastian formation.

Very rare at L6C of the San Sebastian formation.

This species has resemblance to *Q. laevigata*, but has a definite, distinctive neck.

Quinqueloculina audacula NEW SPECIES

PLATE 1, FIGURES 7a-c

Test somewhat longer than wide; chambers polygonal in transverse section, with conspicuous angles or carinae; back flat or slightly concave between the carinae; sutures distinct, slightly depressed; aperture round, with simple tooth, at the end of a short, round neck. Length, 1.60 millimeters; width, 1.00 millimeter; thickness, 0.67 millimeter.

Holotype No. 3963, locality A79, Los Puertos formation.

Rare at A79 of the Los Puertos formation.

This species has more pronounced peripheral carinae and is less regularly oval in side view than *Q. badenensis* d'Orbigny from the Vienna Miocene.

Quinqueloculina laevigata (d'Orbigny)

PLATE 1, FIGURES 8a-c

Quinqueloculina laevigata d'Orbigny (1826) Ann. Sci. Nat. 7: 301. No. 6. Middle Eocene, Paris Basin; in Barker, Webb, & Berthelot (1839) Hist. Nat. Îles Canaries 2 (2): Foraminifères 143. pl. 3, figs. 31-33. Recent, Canaries.—Cushman (1922) Carnegie Inst. Wash. Publ. 311: 65. pl. 13, fig. 2. Recent, Tortugas; (1935) U. S. Geol. Surv. Prof. Pap. 181: 11. pl. 2, figs. 13-15. Upper Eocene, Mississippi.

Test elongate, subovate in side view, about $2\frac{1}{2}$ times as long as wide, $\frac{2}{3}$ as thick as wide; periphery rounded; chambers distinct, somewhat inflated, enlarging gradually; sutures depressed; surface

poorly preserved; apertural end slightly extended; aperture terminal, circular, with a narrow, simple tooth. Length, 0.81 millimeter; width, 0.38 millimeter; thickness, 0.25 millimeter.

Plesiotype No. 3964, locality L6C, San Sebastian formation.

Common at L6C, L1C, and L2C; rare at L4C and L5C of the San Sebastian formation.

Although named by d'Orbigny in 1826, this species was a *nomen nudum* until 1839, when it was figured by d'Orbigny in his paper on the Foraminifera of the Canaries. In 1905, d'Orbigny's original figure of the species was published by Fornasini. This figure differs from that of *Q. laevigata* in the Canaries paper, but the earlier published figure, that of the Canaries paper, is necessarily taken as the type figure.

Quinqueloculina maculata NEW SPECIES

PLATE 2, FIGURES 3a-c

Test oval in side view, subquadrate in end view, length nearly twice breadth, thickness $\frac{3}{4}$ breadth; periphery angled; chambers distinct, subtriangular in cross section; sutures only slightly depressed; wall of all chambers finely punctate; apertural end not produced; aperture oval. Length, 1.03 millimeters; width, 0.63 millimeter; thickness, 0.45 millimeter.

Holotype No. 3965, locality L6C, San Sebastian formation.

Rare at L4C; common at L6C of the San Sebastian formation.

This species is distinctive in its ornamentation. It much resembles *Massilina jacksonensis* Cushman (1933. Contr. Cushman Lab. Foram. Res. 9) but it has no spiroloculine stage and, in any case, is less compressed. *Q. jamaicensis* Cushman and Jarvis which was described from the Eocene of Jamaica (1931. Contr. Cushman Lab. Foram. Res.) is more compressed and has pits arranged in definite nearly longitudinal lines.

Quinqueloculina philippi Reuss

PLATE 2, FIGURES 4a-d

Quinqueloculina philippi Reuss (1856) Sitz. k. Akad. Wiss. Wien 18: 252. pl. 9, figs. 87a-d. Upper Oligocene, Germany.

Test very slender and elongate, compressed, narrowly oval in end view; edge angled with the suggestion of a keel; length nearly three times the width; width more than twice the thickness; chambers tubular, of fairly uniform diameter; aperture terminal, round, at the end of a definite neck, tooth not seen. Length, 0.73 millimeter; width, 0.26 millimeter; thickness, 0.11 millimeter.

Plesiotype No. 3966, locality A79, Los Puertos formation.

Very rare at A79 and A91a of the Los Puertos formation.

This species is close to *Q. angustissima* which was described by Reuss from the middle Miocene and which occurs also with *Q. philippi* in the upper Oligocene. It differs from *Q. angustissima* in having a distinctly angled edge. The Porto Rican form is slightly more slender than the original figure of *Q. philippi*.

Quinqueloculina ponceana NEW SPECIES

PLATE 2, FIGURES 5a-c

Quinqueloculina angusta Galloway & Morrey (1929) Bull. Am. Paleont. 15 (55): 8. pl. 3, figs. 3a, b. Probably lower Oligocene, Ecuador.

Test small, compressed, elliptical in side view; edge sharply rounded; both apical and apertural ends slightly produced; aperture at end of a short neck, round with a small, simple tooth. Length, 0.42 millimeter; width, 0.21 millimeter; thickness, 0.11 millimeter.

Plesiotype No. 3967, locality P2, Ponce formation.

Very rare at P2 and P254 of the Ponce formation.

Q. ponceana differs from *Q. anguina* Terquem (1878. Mém. Soc. Géol. France III. 1) in that it is shorter, it lacks the conspicuous, rather long neck, and the edge is more sharply rounded.

Quinqueloculina pygmaea Reuss

PLATE 2, FIGURES 7a-c

Quinqueloculina pygmaea Reuss (1859) Denksch. k. Akad. Wiss. Wien 1: 384. pl. 50, fig. 3. Middle Miocene, Austria.

Miliolina pygmaea Brady (1884) Rep. Voy. Challenger Zool. 9: 165. pl. 113, figs. 16a, b. Recent, south Pacific and west coast of South America.

Quinqueloculina seminulum Cushman (1930) Fla. Geol. Surv. Bull. 4: 19. pl. 2, figs. 2a-c (not fig. 1). Middle and upper Miocene, Florida.

Test very slender and elongate, oval in end view; three times as long as wide; thickness two-thirds of the width; periphery rounded; chambers distinct, tubular, of uniform diameter; sutures depressed; apertural end with a slight neck; aperture terminal, circular with a simple tooth. Length, 0.54 millimeter; width, 0.18 millimeter; thickness, 0.12 millimeter.

Plesiotype No. 3968, locality L6C, San Sebastian formation.

Rare at L6C of the San Sebastian formation. Common at A79 of the Los Puertos formation. Rare at F64 of the Quebradillas formation.

Quinqueloculina seminulum (Linné)

PLATE 2, FIGURES 8a-c

Serpula seminulum Linné (1758) Sys. Nat. ed. 10. 786. Recent, Adriatic Sea.*Quinqueloculina seminulum* d'Orbigny (1826) Ann. Sys. Nat. 7: 303. no. 44. Recent, north Atlantic coast of Europe, Adriatic Sea, Mediterranean, Pliocene, Italy.—Cushman (1929) Bull. U. S. Nat. Mus. 104 (6): 24. pl. 2, figs. 1, 2. Recent, northeast coast of North America; (1929) Contr. Cushman Lab. Foram. Res. 5: 60. pl. 9, figs. 16-18; (1933) U. S. Geol. Surv. Prof. Pap. 175A: 9. pl. 2, figs. 2a-c. Middle and upper Miocene, Atlantic coastal plain.

Test short ovate in side view; in end view subovate, edge narrowly rounded to subangular; chambers distinct, of uniform diameter, subtriangular in cross section, successive chambers enlarging regularly in size; sutures distinct, very little depressed; apertural end without a definite neck; aperture terminal, oval, with a simple narrow tooth. Length, 0.90 millimeter; width, 0.67 millimeter; thickness, 0.42 millimeter.

Plesiotype No. 3969, locality L6C, San Sebastian formation.

Rare at L6C of the San Sebastian formation, and at A43a of the Cibao formation.

Quinqueloculina vulgaris d'Orbigny

PLATE 2, FIGURES 6a-c

Quinqueloculina vulgaris d'Orbigny (1826) Ann. Sci. Nat. 7: 302. no. 33. Recent, Mediterranean, Adriatic, Antilles.—Fornasini (1902) Mem. R. Accad. Sci. Istit. Bologna Sez. Sci. Nat. V. 10: 21. fig. 13. (d'Orbigny's unpublished figure of Recent, Adriatic Sea specimen.)—Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129F: 142. pl. 32, figs. 9, 10. Lower Oligocene, Mississippi; (1929) Bull. U. S. Nat. Mus. 104 (6): 25. pl. 2, fig. 3a-c. Recent, eastern Atlantic.

Test small for the genus, short and rather stout, subcircular in side view, rounded triangular in end view; edge narrowly rounded; chambers distinct, subtriangular in cross section, successive chambers increasing rather rapidly in size; sutures distinct, depressed; apertural end not produced; aperture oval, elongate parallel to the plane of coiling of the chamber, with a simple tooth (bifid in d'Orbigny's figure in Fornasini). Length of figured specimen, 0.29 millimeter; width, 0.25 millimeter; thickness, 0.11 millimeter. Average specimen length, 0.56 millimeter; width, 0.43 millimeter; thickness, 0.19 millimeter.

Plesiotype No. 3970, locality L6C, San Sebastian formation.

Rare at L1C, L4C, and L6C of the San Sebastian formation. Common at A79 of the Los Puertos formation. Rare at A15, A93, and F359 of the Quebradillas formation. Rare at P259; common at P258 and P431 of the Ponce formation.

TRILOCULINA d'Orbigny 1826

Triloculina austriaca d'Orbigny

PLATE 3, FIGURES 1a-c

Triloculina austriaca d'Orbigny (1846) Foram. Foss. Vienne 275. pl. 16, figs. 25-27. Middle Miocene, Vienna.

Test irregularly oval in front view, subtriangular in apertural view; chambers unevenly convex, somewhat narrower toward apertural end of each chamber so that only the lower part and one side of the last formed chamber are visible in front view; sutures deep; aperture sub-circular with a broad bifid tooth. Average specimen length, 0.83 millimeter; width, 0.58 millimeter; thickness, 0.70 millimeter.

Plesiotype No. 4006, locality L6C, San Sebastian formation.

Rare at L1C, L2C, L4C; common at L6C of the San Sebastian formation. Common at A6 of the Lares formation. Rare at F64 of the Quebradillas formation, and at P431 of the Ponce formation.

Triloculina brongniartiana d'Orbigny

PLATE 3, FIGURES 2a-c

Triloculina brongniartiana d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 152. pl. 9, figs. 5-7. Recent, off Cuba.

Test rather heavy in appearance, oval in side view, with the last chamber projecting apically beyond the earlier chambers; little compressed in end view; chambers distinct, marked by numerous fine longitudinal striae which extend up onto the neck, about 7 striae on each chamber on each side of the test; aperture at the end of a distinct neck, round with simple, narrow tooth. Length, 1.05 millimeters; width, 0.75 millimeter; thickness, 0.60 millimeter.

Plesiotype No. 4007, locality P258, Ponce formation.

Common at P258 of the Ponce formation.

Bermudez (1935) reports that this species is common in the Recent off northern Cuba but unfortunately gave no figure.

Triloculina cervicula NEW SPECIES

PLATE 3, FIGURES 3a-c

Test elongate, spindle shaped in side view; chambers smoothly rounded in end view; sutures depressed; surface smooth; aperture terminal, at the end of a slender neck, circular, with a simple tooth. Length, 0.43 millimeter; width, 0.21 millimeter; thickness, 0.16 millimeter.

Holotype No. 4008, locality L6C, San Sebastian formation.

Very rare at L6C of the San Sebastian formation.

This species differs from *T. gracilis* in its greater width and from *T. oblonga* in the presence of a conspicuous neck.

This species is not as slenderly proportioned as *T. gracilis* which was described by d'Orbigny from the Recent of Cuba. The presence of a conspicuous neck distinguishes it from *T. oblonga* (Montagu).

The specific name *cervicula* means "a small neck."

***Triloculina elliptica* NEW SPECIES**

PLATE 2, FIGURES 9a-d

Test elongate, slightly tapering, subovate in side view with a slight neck, subtriangular in end view; chambers elongate, with width greater than the thickness; sutures slightly depressed; aperture terminal, nearly circular with lip and small simple tooth. Length, 0.52 millimeter; diameter, 0.22 by 0.23 millimeter.

Holotype No. 4009, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation.

***Triloculina gibba* d'Orbigny**

PLATE 3, FIGURES 4a-c

Triloculina gibba d'Orbigny (1826) Ann. Sci. Nat. 7: 299. no. 3. Recent, Adriatic near Rimini; Pliocene, Castel-Arquato; (1846) Foram. Foss. Vienne 274. pl. 16, figs. 22-24. Middle Miocene, Vienna.

Test ovate in front and side views, approximately a rounded equilateral triangle in end view; chambers curved and symmetrical toward both ends, last chamber wider than preceding chambers so that in front view the last chamber is visible on all sides of the two earlier chambers; outside of chambers flattened; chamber angles rounded; sutures distinct, depressed; surface smooth; aperture crescentic, terminal, without a neck. Average length, 0.74 millimeter; breadth, 0.49 millimeter; thickness, 0.53 millimeter.

Plesiotype No. 4010, locality L4C, San Sebastian formation.

Rare at L1C, L3C, L4C; common at L2C; and abundant at L6C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, at A21 of the Quebradillas formation, and at P255 of the Ponce formation.

***Triloculina inflata* d'Orbigny**

PLATE 3, FIGURES 5a-c

Triloculina inflata d'Orbigny (1846) Foram. Foss. Vienne 279. pl. 17, figs. 13-15. Middle Miocene, Vienna.

Test somewhat elongate, subovate in side and end views; chambers tapering a little toward the apertural end, with thickness and width nearly equal; sutures distinct, somewhat depressed; aperture terminal without definite neck or lip; nearly circular with a simple tooth. Length, 0.49 millimeter; width, 0.29 millimeter; thickness, 0.21 millimeter.

Plesiotype No. 4011, locality L3C, San Sebastian formation.

Very rare at L2C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, at F358 and F359 of the Quebradillas formation, and at P431 of the Ponce formation.

Triloculina laevigata d'Orbigny

PLATE 3, FIGURES 6a-c

Triloculina laevigata d'Orbigny (1826) Ann. Sci. Nat. 7: 300. no. 15. Recent, Mediterranean. —Schlumberger (1893) Bull. Zool. Soc. France 18: 63. pl. 1, figs. 45-47. Recent, Gulf of Marseille. —Fornasini (1905) Mem. R. Accad. Sci. Istit. Bologna Sez. Sci. Nat. VI. 2: 61. pl. 1, fig. 10 (from d'Orbigny's unpublished figure).

Test elongate, subovate in side view, roundly subovate in end view; chambers elongate, tapering toward the proximal end, with width and thickness nearly equal; sutures distinct, depressed; aperture terminal, without a neck, semicircular in shape with a simple tooth. Length, 0.95 millimeter; width, 0.50 millimeter; thickness, 0.33 millimeter.

Plesiotype No. 4013, locality L4C, San Sebastian formation.

Rare at L2C and L4C of the San Sebastian formation, and at A79 of the Los Puertos formation. Very rare at P251 of the Ponce formation.

Triloculina longissima NEW SPECIES

PLATE 3, FIGURES 7a-c

? *Triloculina oblonga* Cushman (not Montagu) (1922) U. S. Geol. Surv. Prof. Pap. 129E: 104. pl. 28, figs. 3, 4. Middle Oligocene, Byram marl, Mississippi.

Test very small, narrowly elongate, subcylindrical; subovate in end view; chambers narrow, slightly larger at the distal end, with thickness and width about equal; sutures distinct, depressed; surface smooth; aperture terminal at end of a very slight neck, semicircular with a bifid tooth. Length, 0.57 millimeter; width, 0.22 millimeter; thickness, 0.12 millimeter.

Holotype No. 4012, locality L6C, San Sebastian formation.

Rare at L4C; common at L6C of the San Sebastian formation.

Triloculina oblonga (Montagu)

PLATE 3, FIGURES 8a-c

Vermiculum oblongum Montagu (1803) Test. Brit. 522. pl. 14, fig. 9. Recent, off British Isles.

Triloculina oblonga d'Orbigny (1826) Ann. Sci. Nat. 7: 300. no. 16. Recent, Adriatic, Mediterranean, North Atlantic, Antilles; middle Eocene to Pliocene, France and Italy; Modèles, no. 95. Calcaire grossier de Paris.—Cushman (1917) Bull. U. S. Nat. Mus. 71 (6): 69. pl. 26, fig. 3, text figs. 35, 36. Recent, north Pacific; (1929) Bull. U. S. Nat. Mus. 104 (6): 57. pl. 13, figs. 4, 5. Recent, widely distributed in Atlantic.

Test olive-shaped, slightly compressed, oval in side view, short oval in end view; chambers elongate, wider aborally; sutures only slightly depressed, those bounding the third chamber frequently oblique to general axis of the test; aperture terminal, without a neck, nearly circular in shape with a narrow simple tooth. Length, 0.43 millimeter; width, 0.20 millimeter; thickness, 0.12 millimeter.

Plesiotype No. 4014, locality L6C, San Sebastian formation.

Rare at L2C and L6C of the San Sebastian formation, at A6 of the Lares formation, at A91a of the Los Puertos formation, at F358 of the Quebradillas formation, and at P431 of the Ponce formation.

Triloculina quadrilateralis d'Orbigny

PLATE 3, FIGURES 9a-c

Triloculina quadrilateralis d'Orbigny (1839), in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 179. pl. 10, figs. 15-17. Recent, off Cuba.—Cushman (1921) Proc. U. S. Nat. Mus. 59: 71. text fig. 11. Recent, off Jamaica.—Cushman & Ponton (1922) Fla. Geol. Surv. Bull. 9: 53. pl. 7, fig. 1. Lower Miocene, Florida.

Test irregularly oval in front view, width less than the thickness, subquadrate in apertural view; axes of chambers not parallel to each other; chambers rather square in section, narrower and less convex at the apertural end of each chamber; chambers flattened but not concave on the back, especially the last two, thus producing the quadrangular outline; angles not carinate; sutures deep; preservation as internal molds, surface smooth; aperture oval with distinct short neck, probably with a bifid tooth. Average specimen length, 0.80 millimeter; width, 0.38 millimeter; thickness, 0.58 millimeter.

Plesiotype No. 4015, locality L6C, San Sebastian formation.

Rare at L2C, L4C, L5C, and L6C of the San Sebastian formation, and at A79 of the Los Puertos formation.

Triloculina tricarinata d'Orbigny

PLATE 3, FIGURES 10a, b

Triloculina tricarinata d'Orbigny (1826), Ann. Sci. Nat. 7: 299. no. 7; Modèles, no. 94. Recent, Red Sea.—Cushman (1917) Bull. U. S. Nat. Mus. 71 (6): 66. pl. 25, figs. 1, 2, text fig. 32. Recent, north Pacific; (1932) Bull. U. S. Nat. Mus. 161 (1): 59. pl. 13, figs. 3a, b. Recent, tropical Pacific.

Test of symmetrical proportions, the edges of the test sharply angled, whole test somewhat longer than wide; in transverse section an equilateral triangle; chambers little inflated, shape of chambers subordinate to that of the test; sutures slightly depressed; aperture without a neck, round with a narrow tooth. Length, 0.43 millimeter; width, 0.29 millimeter; thickness, 0.26 millimeter.

Plesiotype No. 4016, locality P253, Ponce formation.

Rare at P431 and P253 of the Ponce formation.

MILIOLINELLA Wiesner 1931

Miliolinella circularis (Bornemann)

PLATE 4, FIGURES 8a-c

Triloculina circularis Bornemann (1855) Zeitschr. deutsch. geol. Ges. 7: 349. pl. 19, fig. 4 Middle Oligocene, Germany.—Cushman (1929) Bull. U. S. Nat. Mus. 104 (6): 58. pl. 13 figs. 6, 7, pl. 14, figs. 1, 2. Recent, widespread.

Test circular in side view; in end view broadly oval, back rounded; chambers inflated; sutures distinct, depressed; aperture a narrow crescentiform slit. Length, 0.63 millimeter; diameter, 0.57 by 0.65 millimeter.

Plesiotype No. 3997, locality P2, Ponce formation.

Very rare at P2 and P431 of the Ponce formation. Rare at A79 of the Los Puertos formation.

The Porto Rican form is more perfectly circular in side view than is the original figure of this species.

PYRGO Defrance 1824

Pyrgo bougainvillei (d'Orbigny)

PLATE 4, FIGURES 1a-c

Biloculina bougainvillei d'Orbigny (1839) Voy. Amér. Mèrid. 5 (5): Foraminifères 67. pl. 8, figs. 22-24. Recent, off west coast of South America.

Test small for the genus, elongate, oval in front and side views, broadly oval in end view with width about twice the thickness of the test; edge shouldered near the suture; chambers symmetrical, compressed; sutures slightly curved in side view; aperture oval, tooth bifurcate. Length, 0.40 millimeter; width, 0.24 millimeter; thickness, 0.18 millimeter.

Plesiotype No. 3953, locality L6C, San Sebastian formation.

Rare at L4C and L6C of the San Sebastian formation.

Pyrgo clypeata (d'Orbigny)

PLATE 4, FIGURES 2a-c

Biloculina clypeata d'Orbigny (1846) Foram. Foss. Vienne 263. pl. 15, figs. 19-21. Middle Miocene, Vienna.

Test somewhat compressed, oval in front view, narrowly oval in edge and end views; edge shouldered; chambers little inflated; sutures slightly depressed, slightly concave toward the penultimate chamber in edge view; aperture oval with narrow bifid tooth. Length, 0.45 millimeter; width, 0.35 millimeter; thickness, 0.29 millimeter.

Plesiotype No. 3954, locality A79, Los Puertos formation.

Rare at L3C, L4C, L5C, and L6C; common at L2C of the San Sebastian formation. Rare at A6 of the Lares formation, at A86 of the Cibao formation, at A79 of the Los Puertos formation, and at A64 and F358 of the Quebradillas formation.

Pyrgo inornata (d'Orbigny)

PLATE 4, FIGURES 3a-c

Biloculina inornata d'Orbigny (1846) Foram. Foss. Vienne 266. pl. 16, figs. 7-9. Middle Miocene, Vienna.

Test rotund, oval in front and edge views, subcircular in end view, thickness of test equal to or slightly greater than the width; edge rounded; chambers inflated; sutures slightly depressed, curved in side view with the aboral end of the last chamber overlapping and covering the preceding chamber; aperture round with bifid tooth partly filling the opening. Length, 0.48 millimeter; width, 0.33 millimeter; thickness, 0.36 millimeter.

Plesiotype No. 3955, locality A79, Los Puertos formation.

Rare at L4C of the San Sebastian formation and F359 of the Quebradillas formation. Common at A79 of the Los Puertos formation.

Pyrgo lunula (d'Orbigny)

PLATE 4, FIGURES 4a-c

Biloculina lunula d'Orbigny (1846) Foram. Foss. Vienne 264. pl. 15, figs. 22-24. Middle Miocene, Vienna.

Test biconvex, of average size for the genus, nearly circular in front view; biconvex in side view, edge angled; chambers somewhat inflated; aperture narrow and elongate with a broad flat tooth nearly filling the opening. Length, 0.74 millimeter; width, 0.67 millimeter; thickness, 0.45 millimeter.

Plesiotype No. 3956, locality P258, Ponce formation.

Rare at L2C and L6C; common at L3C; abundant at L4C of the San Sebastian formation. Rare at A91a and A79 of the Los Puertos formation. Rare at A93 and F358(2); common at F359 of the Quebradillas formation. Rare at P254 and P432; common at P255 and P258 of the Ponce formation.

P. depressa of d'Orbigny (Model no. 91) is more compressed than *P. lunula*, although the two species have many points of similarity.

***Pyrgo oblonga* (d'Orbigny)**

PLATE 4, FIGURES 5a-c

Biloculina oblonga d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 163. pl. 8, figs. 21-23. Recent, Cuba.

Test small for the genus, moderately elongate, oval in front and side views, subcircular in end view; shoulder near suture rounded; chambers only slightly compressed, wider at the aboral than at the oral end; sutures slightly depressed, curved in side view; aperture oval with a broad tooth. Length, 0.37 millimeter; width, 0.21 millimeter; thickness, 0.26 millimeter.

Plesiotype No. 3957, locality P251, Ponce formation.

Rare at L1C, L2C, L4C; common at L6C of the San Sebastian formation. Common at A6 of the Lares formation. Rare at A43a of the Cibao formation, at A79 of the Los Puertos formation, at F359 of the Quebradillas formation. Rare at P251; common at P431 of the Ponce formation.

P. oblonga is considerably less elongate than *P. elongata* from the Eocene at Gironde, a species with which *P. oblonga* seems to have been confused by many authors. *P. oblonga* also has less symmetrical chambers, which are wider at the aboral than at the oral end. In this characteristic and in the curvature of the suture in edge view, *P. oblonga* differs also from *P. bougainvillei* which was found by d'Orbigny off the west coast of South America.

***Pyrgo peruviana* (d'Orbigny)**

PLATE 4, FIGURES 6a-c

Biloculina peruviana d'Orbigny (1839) Voy. Amér. Mèrid. 5 (5): Foraminifères 65. pl. 9, figs. 1-3. Recent, off Peru.

Test ovoid; oval in front and apertural views; width of test only slightly greater than the thickness; broadly oval or subcircular in side view; shoulder next to suture rounded; chambers strongly inflated, sutures depressed; in side view the line of contact between the

two chambers curving forward due to broadening of the last chamber so that only the last formed chamber is visible at the distal end of the test; last formed chamber noticeably larger and broader than next to last chamber, being wider near apertural end of the test, tapering toward the distal end, and of an inverted pear shape as seen from the front of the test; surface smooth; aperture broadly oval with wide, bifid tooth which is infrequently and poorly preserved. Length, 0.70 millimeter; width, 0.57 millimeter; thickness, 0.54 millimeter.

Plesiotype No. 3958, locality L4C, San Sebastian formation.

Common in the San Sebastian formation at L4C and L6C. Rare at A86 in the Cibao formation, at A91a of the Los Puertos formation, and at P258 of the Ponce formation.

Pyrgo subspherica (d'Orbigny)

PLATE 4, FIGURES 7a-c

Biloculina subspherica d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 162. pl. 8, figs. 25-27. Recent, Cuba and Jamaica.

Pyrgo subspherica Cushman (1929) Bull. U. S. Nat. Mus. 104 (6): 68. pl. 18, figs. 1, 2. Recent, Atlantic, Jamaica, Cuba, Porto Rico, Tortugas, Florida, and Bahamas.

Test small, rotund, broadly oval in front view, slightly longer than wide; width of test only a little greater than the thickness; edge rounded; chambers inflated, more so at posterior end; sutures deep, sinuous in side view; in apertural view chambers semicircular; surface smooth; aperture broadly oval with large bifid tooth that does not fill the aperture. Length, 0.37 millimeter; width, 0.29 millimeter; thickness, 0.29 millimeter.

Plesiotype No. 3959, locality L2C, San Sebastian formation.

Rare at L1C, L3C, L4C, and L5C; common at L2C and L6C of the San Sebastian formation. Abundant at A6 of the Lares formation. Rare at A91a; common at A79 of the Los Puertos formation. Rare at A64, A21, and F359; common at F64 of the Quebradillas formation. Rare at P251 and P434; abundant at P258 of the Ponce formation.

This form is very close to *P. bulloides* (d'Orbigny) from the Recent of Cuba, but is less elongate, has a sinuous suture, broader aperture and characteristic posterior inflation of the chambers as seen in side view.

PYRGOELLA Cushman & White 1936

Pyrgoella globulus (Bornemann)

PLATE 4, FIGURES 9a-c

Biloculina globulus Bornemann (1855) Zeitsch. deutsch. geol. Ges. 7: 349. pl. 19, figs. 3a, b. Middle Oligocene, Hermsdorf.

Test globular, circular in front, side and end views; shoulder rounded near suture; chambers strongly inflated, last chamber larger than the preceding in all dimensions; sutures slightly depressed; concave toward the penultimate chamber in side view; aperture triangular, nearly filled by a triangular tooth. Length, 0.48 millimeter; width, 0.45 millimeter; thickness, 0.45 millimeter.

Plesiotype No. 3960, locality P255, Ponce formation.

Very rare at P255 of the Ponce formation.

P. sphaera d'Orbigny (1839. Voy. Amér. Mérid. 5 (5) Foraminifères) is very similar to this species but differs in proportions of the triangular aperture and in relative size of the two chambers. Both *P. globulus* and *P. sphaera* are rare species.

MASSILINA Schlumberger 1893

Massilina decorata Cushman

PLATE 5, FIGURE 1

Massilina decorata Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129F: 143. pl. 34, fig. 7. Mint Spring Marl, lower Oligocene, Mississippi.—Howe & Wallace (1932) La. Dept. Cons. Geol. Bull. 2: 20. pl. 2, fig. 6. Jackson, upper Eocene, Louisiana.—Cushman (1935) U. S. Geol. Surv. Prof. Pap. 181: 13. pl. 3, figs. 14–16. Jackson, upper Eocene, Mississippi.

Test subovate in side view, slightly longer than wide with apical and apertural ends projecting a little; in edge view much compressed with sides parallel; edge rounded; early milioloid stage small, about 5 chambers in the planispiral portion of the test; surface ornamented by "very fine pits giving a finely granular matte appearance to the test"; aperture terminal, with short, round neck, tooth not known. Length, 0.90 millimeter; width, 0.63 millimeter.

Plesiotype No. 3932, locality A79, Los Puertos formation.

Very rare at A79 of the Los Puertos formation.

Massilina inaequalis d'Orbigny

PLATE 5, FIGURES 2a–c

Massilina inaequalis Cushman (1921) Proc. U. S. Nat. Mus. 59: 72. pl. 17, figs. 12, 13. Recent, off Jamaica.—Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 46. pl. 3, figs. 4a–c. Chipola formation, lower Miocene, Florida.

Test elongate, biconcave, slender with both apical and apertural ends tapering; in end view with flat back forming the thickest part of the test; acute angle between the back and sides of the chambers; aperture at the end of a neck, quadrate in outline with a T-shaped tooth. Length, 1.25 millimeters; width, 0.60 millimeter; thickness, 0.32 millimeter.

Plesiotype No. 3933, locality A79, Los Puertos formation.

Rare at A79 of the Los Puertos formation.

This species might equally well be placed under *Spiroloculina*.

HAUERINA d'Orbigny 1839

Hauerina sansebastianensis NEW SPECIES

PLATE 5, FIGURES 3a-c, and 4a-c

Test discoidal, nearly equally biconvex and biumbilicate, immature specimens relatively more convex; periphery subacute; 4 chambers in last whorl of the adult, 3 in immature forms; chambers subtriangular in shape, increasing rapidly in size, occasionally involute, more commonly with a few milioline chambers showing in the umbilical region; sutures sharply depressed; surface smooth; aperture in the young an elongate slit with bluntly serrate margin extending the full length of the last septal face, in the adult a tuberculate trematophore. Adult specimen diameter, 0.84 by 1.05 millimeters; maximum thickness, 0.37 millimeter.

Holotype No. 3925a, Paratype 3925b, locality L6C of the San Sebastian formation.

Common at L6C of the San Sebastian formation.

This species resembles *H. compressa* d'Orbigny from the Miocene of the Vienna Basin, but is thicker and differs in character of the aperture and in shape of the chambers. It differs from *H. bradyi* Cushman (1917. Bull. U. S. Nat. Mus. 71 (6)) in its greater thickness and different shape of the chambers.

Family SORITIDAE Ehrenberg 1840

DENDRITINA d'Orbigny 1826

Dendritina preëlegans NEW SPECIES

PLATE 5, FIGURES 5a, b

Test compressed, biumbilicate; subcircular to oval in side view, close coiled in the early part tending to become evolute in the later part; edge rounded; chambers about 12 in the last whorl, short and wide, enlarging gradually; sutures distinct, little depressed; wall ornamented with fine longitudinal striae which are not continuous from chamber to chamber; aperture an elongate, oval dendritic opening in the middle of the last septal face. Diameter, 1.00 by 1.33 millimeters; thickness, 0.33 millimeter.

Holotype No. 3889, locality A79, Los Puertos formation.

Common at A79 of the Los Puertos formation.

This new species is closely related to *Peneroplis elegans* d'Orbigny from the Recent of Cuba, but differs in the character of the aperture which is dendritic and not perforate. It differs from *Dendritina antillarum* d'Orbigny, also from the Recent of Cuba, in that it is less involute and the aperture is different. The aperture of *D. preëlegans* is more regularly dendritic and it is restricted to an oval area in the center of the apertural face, not occupying the entire apertural face as it does in *D. antillarum*.

PENEROPLIS Montfort 1808

Peneroplis carinatus d'Orbigny

PLATE 5, FIGURES 6a, b

Peneroplis carinatus d'Orbigny (1839) Voy. Amér. Mérid. 5 (5): Foraminifères 33. pl. 3, figs. 7, 8. Recent.—Cushman (1930) Bull. U. S. Nat. Mus. 104 (7): 36. pl. 12, figs. 7–10, pl. 14, fig. 1. Recent, Atlantic Ocean, West Indies.

Peneroplis pertusus carinatus Cushman (1917) Bull. U. S. Nat. Mus. 71 (6): 87. pl. 37, fig. 4. Recent, north Pacific.

Test subcircular or oval, lenticular, asymmetrical, usually biumbonate, closely coiled and completely involute; periphery slightly lobulate, edge sharply angled; chambers short, 14–18 in the last whorl; sutures strongly recurved, scarcely at all depressed, appearing limbate; surface smooth; aperture a group of pores on the apertural face. Average specimen diameter, 1 millimeter; thickness, 0.40 millimeter.

Plesiotype No. 3945, locality L6C, San Sebastian formation.

Common at L1C, rare at L2C, L3C, L4C, and L6C of the San Sebastian formation. Rare at F358 of the Quebradillas formation and at P258 of the Ponce formation.

P. carinatus differs from *P. proteus* in that the chambers are involute and do not become evolute and flaring.

Peneroplis proteus d'Orbigny

PLATE 5, FIGURES 7a, b

Peneroplis protea d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 60. pl. 7, figs. 7–11. Recent, off Cuba and Jamaica.

Peneroplis dubia d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 62. pl. 6, figs. 21, 22. Recent, off Cuba.

Orbiculina adunca Brady (in part) (1884) Rep. Voy. Challenger Zool. 9: pl. 14, figs. 3, 4. Recent, off Bermuda.

Peneroplis proteus Cushman (1930) Bull. U. S. Nat. Mus. 104, (7): 37. pl. 13, figs. 1–17. Recent, Atlantic Ocean; off north coast Jamaica, Tortugas, Florida, Bermuda, Bahamas. Porto Rico.—Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 71. pl. 10, figs. 7–11, 14. Lower Miocene, Florida.

Test oval or irregular in outline, ovate in edge view, moderately compressed, thickest portion in umbonal region, peripheral portions thinner, often quite flat and compressed; periphery bluntly rounded; chambers numerous, in early involute stage about 9 chambers, short and wide, later chambers becoming semi-annular, evolute and flaring; sutures distinct, slightly depressed, strongly curved; surface smooth; aperture a single row of pores on the apertural face. Diameter of coiled portion, 0.83 millimeter; thickness of coiled portion, 0.43 millimeter; thickness of evolute chambers, 0.10 millimeter.

Plesiotype No. 3946, locality L6C, San Sebastian formation.

Rare at L1C and L6C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, and at A64 of the Quebradillas formation.

ARCHAIAS Montfort 1808

Archaias aduncus (Fichtel & Moll)

PLATE 5, FIGURES 8a-c

Nautilus aduncus Fichtel & Moll (1803) Test. Micr. 115. pl. 23, figs. a-e. Recent, Arabian Sea.

Orbiculina adunca d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 64. pl. 8, figs. 10-16 (not 8, 9). Recent, off Cuba.

Archaias angulatus Cushman (1930) Bull. U. S. Nat. Mus. 104 (7): 46. pl. 16, 17. Recent, Porto Rico, Tortugas, Bermuda.

Test biconvex near the center, rest of the test explanate, very thin; edge truncate; chambers numerous, short and very wide, early ones involute to the center, later ones tending to become annular, the arc of the chamber being around 120 degrees in the young chambers and 180 or more in the adult chambers; aperture consisting of numerous large, closely but irregularly arranged pores covering the entire apertural face. Diameter, 1.56 by 2.06 millimeters; thickness, 0.17 millimeter.

Plesiotype No. 3868, locality P258, Ponce formation.

Abundant at L6C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, and at F359 of the Quebradillas formation. Rare at P251 and P434; common at P258 and P259 of the Ponce formation.

Many authors have discarded this species and have considered these forms as adult forms of the species *A. angulatus*. The Los Puertos material shows specimens of two types, each of which is sufficiently distinct to merit specific rank.

A. aduncus differs from *A. angulatus* in the following ways:

1. larger diameter
2. thinner test, both relatively and actually
3. general appearance: *angulatus* is nautiloid with angled edge, *aduncus* is explanate with truncate edge
4. the arc of chamber width is about 180° (120° minimum) in *aduncus* and only 90° in *angulatus*
5. the last chambers of *angulatus* are involute to the umbilicus

It seems obvious that these cannot be adult forms of *A. angulatus*, particularly on points 2-5 above.

***Archaias angulatus* (Fichtel & Moll)**

PLATE 5, FIGURES 9a, b

Nautilus angulatus Fichtel & Moll (1803) Test. Micr. 113. pl. 22, figs. a-e. Recent, Arabian Sea.

Orbiculina adunca d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 64. pl. 8, figs. 8, 9. Recent, off Cuba.

Test lenticular, nearly bilaterally symmetrical; periphery bluntly rounded; chambers involute; sutures limbate, with transverse connecting ridges corresponding to the secondary septa which are slightly offset in successive chambers and spiral outward toward the periphery; wall calcareous, imperforate; aperture a series of pores in several rows on the apertural face. Diameter, 0.41 to 1.36 millimeters; thickness, 0.25 to 0.70 millimeter.

Plesiotype No. 3869, locality L1C, San Sebastian formation.

Rare at L1C, L4C, and L6C of the San Sebastian formation. Common at A79 of the Los Puertos formation. Rare at F359 of the Quebradillas formation. Common at P258 of the Ponce formation.

***Archaias compressus* (d'Orbigny)**

PLATE 5, FIGURES 10a, b

Orbiculina compressa d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 73. pl. 8, figs. 4-7. Recent, West Indies.—Cushman (1919) Carnegie Inst. Wash. Publ. 291: 70. pl. 7, fig. 6. Bowden formation, Miocene, Jamaica.

Archaias compressus Cushman (1930) Bull. U. S. Nat. Mus. 104 (7): 48. pl. 17, figs. 1, 2. Recent, West Indies; late Tertiary, Jamaica, Florida, Panama.

Test compressed, discoidal, subcircular in outline; chambers involute in early portion, later portion annular; earlier involute portion about twice the thickness of annular part of test; chambers in nucleoconch simple, later chambers with chamberlets; wall calcareous, imperforate; aperture consisting of irregularly arranged pores on the periphery. Diameter of adult form, 1.83 millimeters; thickness, 0.17 millimeter.

Plesiotype No. 3870, locality L1C, San Sebastian formation.

Common at L1C; rare at L6C of the San Sebastian formation.

Family **TROCHAMMINIDAE** Schwager 1877**TROCHAMMINOIDES** Cushman 1910**Trochamminoides approximatus** NEW SPECIES

PLATE 6, FIGURES 1a, b

Test small, subcircular in side view, the two sides nearly exactly alike, biconcave, asymmetrically planispiral, composed of about 5 volutions, each volution embracing about half of the previous volution, and increasing gradually in thickness; periphery moderately lobulate; edge regularly rounded; chambers about 12 in the last volution, increasing gradually in size; sutures distinct, slightly depressed, narrow, mostly nearly straight, some curved slightly outward and backward, discernible from the proloculum outward; the concameration is not due to irregular constrictions but due to normal septation; wall white, very finely arenaceous, consisting of very fine, angular grains of calcite bound together with a small amount of white, calcareous cement; surface finely granular; aperture a narrow arch at the base of the septal face. Diameter, 0.66 millimeter; thickness, 0.12 millimeter.

Holotype No. 4064, locality A91a, Los Puertos formation.

Rare at A91a of the Los Puertos formation.

This species differs from *T. proteus* (Karrer), from the Cretaceous of the Vienna Basin, in lacking an early tubular portion, in having a greater number of whorls, more nearly planispiral symmetry, definite septation and small aperture. It also differs from Recent specimens identified with *T. proteus* Brady (1884. Rep. Voy. Challenger Zool. pl. 40) in the planispiral symmetry of the early spire, more regular concameration, and the smaller aperture, as well as the smaller size and greater number of volutions. It is quite unlikely that the large number of forms from Jurassic, Cretaceous, Tertiary, and Recent ages which have been identified with *T. proteus* (Karrer) actually belong to that species.

Family **LITUOLIDAE** Reuss 1861**CYCLAMMINA** Brady 1876**Cyclammina acutidorsata** (Hantken)

PLATE 6, FIGURES 2a, b

Haplophragmium acutidorsatum Hantken (1868) Magyar. földt. társulat munkálatai 4: 82. pl. 1, figs. 1a, b; (1876) Mitth. Jahrb. k. ungar. geol. Anstalt 4: 12. pl. 1. figs. 1a, b. Upper Eocene and lower Oligocene, Hungary.—Andreae (1884) Abh. geol. Specialkarte Elsaas-Loth. 2 (3): 197. pl. 7, figs. 5a, b. Middle Oligocene, Alsace.

Test planispiral, compressed, nearly completely involute, biumbilicate; periphery bluntly angled, very slightly lobulate; 10–11 chambers in the last whorl; septal face triangular in apertural view; sutures very slightly depressed; wall coarsely arenaceous, made of calcareous sand grains; aperture crescentiform, at base of the last septal face, on the periphery. Diameter, 0.95 millimeter; thickness, 0.32 millimeter.

Plesiotype No. 3887, locality P3, Ponce formation.

Very rare at P3 of the Ponce formation.

Family ATAXOPHRAGMIIDAE Schwager 1877

VALVULINA d'Orbigny 1826

Valvulina oviedoiana d'Orbigny

PLATE 6, FIGURES 3a, b

Valvulina oviedoiana d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 103. pl. 2, figs. 21, 22. Recent, Cuba.—Cushman (1921) Proc. U. S. Nat. Mus. 59: 51. pl. 11, figs. 11–14. Recent, north coast Jamaica; (1922) Carnegie Inst. Wash. Publ. 311: 29. pl. 2, figs. 7, 8. Recent, Tortugas; (1922) Bull. U. S. Nat. Mus. 104 (3): 64. pl. 11, figs. 2–5. Recent, Florida, Bahamas, etc.; (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 10. pl. 2, figs. 4, 5. Recent, Bermuda, Florida, and West Indies.

Test large for the genus, tetrahedral, an inverted three-sided pyramid in shape, initial end pointed, the sides rapidly diverging, losing the three-sided form so that the apertural end is subcircular in shape; chambers triserially arranged, rapidly increasing in size; sutures depressed; wall coarsely arenaceous with much calcareous cement; aperture along the inner margin of the last chamber with a large projecting tooth or valve. Height of test, 1.2 millimeters; diameter of apertural end, 1.01 by 1.20 millimeters.

Plesiotype No. 4026, locality L6C, San Sebastian formation.

Common at L6C; rare at L4C of the San Sebastian formation. Rare at P258 of the Ponce formation.

VALVULAMMINA Cushman 1933

Valvulammina cornucopia NEW SPECIES

PLATE 6, FIGURES 4a–c

Test shaped like a small, twisted cornucopia, widening very rapidly from the pointed initial end; spire of medium height, last whorl constituting about half the height of the test; 4 to 5 chambers in the last whorl (in no case as many as 6), chambers loosely appressed, inflated, increasing rapidly in size in width, but not in length or height; sutures distinct, depressed; wall medium coarsely arenaceous, smoothly

finished with much calcareous cement; aperture large, at the base of the last septal face, with short, wide, valvular tooth; apertural face large, flaring, constituting about half of the last whorl on the ventral side of the test. Height, 0.70 millimeter; diameter of apertural end, 0.90 by 1.13 millimeters.

Holotype No. 4025, locality L6C, San Sebastian formation.

Rare at L4C and L6C of the San Sebastian formation. Common at P258 of the Ponce formation.

This species is very close to *Valvulammina deformis* (d'Orbigny) as figured by Fornasini (1904. Mem. R. Accad. Sci. Istit. Bologna Sez. Sci. Nat. VI. 1) from the Eocene of France, but the test is higher, the chambers are fewer in each whorl and do not increase as rapidly in width, the last chamber is not as large, and the apertural valve is less well formed.

It differs from *V. affinis* Cushman and Bermudez from the Eocene of Cuba (1937. Contr. Cushman Lab. Foram. Res. 13) in having fewer chambers in the last whorl, and more depressed sutures.

VERNEUILINA d'Orbigny 1840

Verneuilina mexicana Nuttall

PLATE 6, FIGURE 5

Verneuilina mexicana Nuttall (1932) Jour. Paleont. 6: 6. pl. 2, figs. 1, 2. Lower Oligocene, Tampico Embayment, Mexico.

Karrerella mexicana Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 9: 130. pl. 15, figs. 13, 14.

Test short, stout fusiform in shape, broadest across the middle of the last three chambers; apertural end rounded, initial end acute; nearly circular in cross section; chambers indistinct, last whorl constituting the major portion of the test; sutures obscure, flush with the surface; wall of medium arenaceous texture; aperture a short, straight or slightly curved oval slit located slightly above and parallel to the base of the last septal face; apertural face slightly concave. Length, 0.77 millimeter; maximum diameter, 0.60 millimeter.

Plesiotype No. 4031, locality P2, Ponce formation.

Rare at P2 and P3 of the Ponce formation, and at A93 of the Quebradillas formation.

We have several complete adult specimens of this species, none of which show an early 4 or 5 chambered stage or an adult 2 chambered stage. It seems probable, therefore, that this is a true *Verneuilina*.

DOROTHIA Plummer 1931**Dorothia caribaea** Cushman

PLATE 6, FIGURES 6a, b

Dorothia caribaea Cushman (1936) Cushman Lab. Foram. Res. Spec. Publ. 6: 31. pl. 5, figs. 3a-c. Recent, Cuba.

Test short and stout, broadly rounded at both ends, sides almost parallel, nearly round in cross section; chambers closely appressed, early whorls with 4 or 5 chambers in a whorl, 2 to 3 pairs in biserial part of the test; sutures slightly depressed, somewhat oblique; wall coarsely arenaceous made of calcite grains with calcareous cement so that the surface is fairly smooth; aperture a high arched opening constricted at the base and extending up onto the last septal face. Length, 1.00 millimeter; width, 0.60 millimeter; thickness, 0.50 millimeter.

Plesiotype No. 3901, locality P255, Ponce formation.

Rare at P255 of the Ponce formation.

Dorothia cylindrica (Nuttall)

PLATE 6, FIGURES 7a-c

Gaudryina cylindrica Nuttall (1932) Jour. Paleont. 6: 7. pl. 2, fig. 7. Lower Oligocene, Mexico.

Dorothia cylindrica Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 88. pl. 9, fig. 25. Lower Oligocene, Mexico.

Test elongate, compressed cylindrical, with triserial part of test slightly trihedral in shape; triserial portion constituting only about $\frac{1}{3}$ or less of the test; chambers closely appressed, 4-5 pairs in the biserial part of the test; sutures narrow, slightly depressed, rather indistinct; wall arenaceous with fine to medium size grains and much cement; aperture a high arch extending up onto the last septal face with low upper lip. Length, up to 1.82 millimeters; diameter, 0.6 millimeter.

Plesiotype No. 3916, locality P2, Ponce formation.

Rare at P2 and P255 of the Ponce formation.

Dorothia praelonga (Karrer)

PLATE 6, FIGURES 8a, b

Gaudryina praelonga Karrer (1877) Abh. k. k. geol. Reichs. 9: 374. pl. 16a, fig. 6. Middle Miocene, Vienna Basin.

Dorothia praelonga Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 90. pl. 10, figs. 2, 3. Miocene, Vienna Basin, and Bulgaria.

Test small, elongate, cylindrical except for a very brief trihedral initial end, nearly circular in cross section; chambers numerous, 6

pairs or more in biserial part of test, closely appressed; sutures distinct, slightly depressed, nearly straight and transverse to axis of test; wall finely arenaceous with much cement, surface smooth; aperture a low arch at the base of the septal face. Length, 0.88 millimeter; breadth, 0.30 millimeter; thickness, 0.34 millimeter.

Plesiotype No. 4046, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

GAUDRYINA d'Orbigny 1839

Gaudryina asiphonia Andreae

PLATE 7, FIGURES 1a, b

Gaudryina siphonella asiphonia Andreae (1884) Abh. Geol. Specialkarte Elsass-Loth. 2 (3): 200. pl. 7, fig. 7. Middle Oligocene, Alsace.

Gaudryina asiphonia Nuttall (1932) Jour. Paleont. 6: 7. pl. 2, fig. 2. Lower Oligocene, Tampico Embayment, Mexico.—Hadley (1934) Bull. Am. Paleont. 20 (70A): 8. pl. 1, fig. 6. Oligocene, probably upper, north coast of Cuba.

Test of average size for the genus, elongate, slightly tapering, oval in cross section; triserial portion very short constituting only about $\frac{1}{4}$ of the length of the test; 4 pairs of chambers in the biserial portion of the test, these chambers subglobular in shape, more inflated than the chambers in triserial part of the test; sutures distinct, depressed in biserial part of test; wall finely arenaceous, surface rather smooth; aperture an arched opening on the inner margin of the last septal face. Length, 1.10 millimeters; breadth, 0.45 millimeter; thickness, 0.35 millimeter.

Plesiotype No. 4045, locality P2, Ponce formation.

Rare at P2 and P3 of the Ponce formation.

Specimens of *G. asiphonia* from Porto Rico are larger than those reported by Nuttall from Mexico, which were only 0.60 millimeter long.

Gaudryina glabrata maxima NEW VARIETY

PLATE 7, FIGURES 2a, b

Test large, stout, early triserial portion very short, later biserial portion constituting most of the test; test lozenge shaped in cross section; chambers numerous, quite distinct, with the lower side excavated so that the test has a transversely rugose appearance; early and middle portion without the transverse rugae but with papillae which more or less obscure the sutures; sutures depressed, nearly horizontal or slightly convex toward the aperture in the middle; wall arenaceous with much cement; surface moderately rough; aperture an elongate, low arch at the base of the last septal face. Length of figured speci-

men, 1.11 millimeters; breadth, 0.7 millimeter; thickness, 0.45 millimeter.

Plesiotype No. 4050, locality A43a, Cibao formation.

Common at A43a of the Cibao formation.

This variety differs from *G. glabrata* (Cushman) (1937. Cushman Lab. Spec. Publ. 7) in the much larger size and the presence of papillae.

***Gaudryina karreriana* Cushman**

PLATE 7, FIGURES 6a, b

Gaudryina karreriana Cushman (1936) Cushman Lab. Foram. Res. Spec. Publ. 6: 8. pl. 1, figs. 18a, b. Miocene, Hungary.

Test large for the genus, elongate, tapering, enlarging abruptly at the initial end which is rather sharp, enlarging more gradually toward the apertural end; the early triserial portion of the test comprising about 2/5 of the test, trihedral in shape with rounded angles, the remaining biserial portion quadrangular to subcircular in cross section; 2 or usually 3 pairs of chambers in the biserial part of the test; sutures narrow, slightly depressed, nearly horizontal; wall of medium arenaceous texture with much cement; surface moderately rough; aperture a low arched opening on the inner margin of the last septal face. Length, 2.21 millimeters; breadth, 1.20 millimeters; thickness, 1.18 millimeters.

Plesiotype No. 3917, locality P2, Ponce formation.

Rare at A20 of the Quebradillas formation. Rare at P2 and P255 of the Ponce formation.

***Gaudryina puertoricana* NEW SPECIES**

PLATE 7, FIGURES 7a, b

Test small, flattened triangular in the early portion, becoming thicker and rounded in the later portion; triserial portion about half the length of the test; two sides flat, the third rounded; angles sharp but not keeled; chambers indistinct, not inflated except the last two; sutures flush with the surface, inconspicuous, thickened with calcite in the triserial portion; wall very finely arenaceous, composed of calcareous grains and calcareous cement, white in color; surface rather smooth; aperture a small, low arch at the base of the last septal face. Length, 0.33 millimeter; width, 0.20 millimeter.

Holotype No. 3918, locality L6C, San Sebastian formation.

Very rare in the San Sebastian formation at L6C only.

This species differs from *G. atlantica* (Bailey) as figured by Bailey

and also by Cushman (1937. Cushman Lab. Foram. Res. Spec. Publ. 7) in being much smaller, having a relatively shorter triserial portion, less inflated chambers, more inconspicuous sutures, finer wall material, flat apertural face, and absence of keels on the angles of the test.

Gaudryina (Pseudogaudryina) atlantica (Bailey)

PLATE 7, FIGURES 3a, b

Textularia atlantica Bailey (1851) Smiths. Contr. 2: 12. pl., figs. 38–43. Recent, off northeast coast USA.

Gaudryina (Pseudogaudryina) atlantica Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 7: 95. pl. 14, figs. 4, 5. Recent, off northeast coast of USA; Miocene, Jamaica.

Test large, elongate, tapering gradually from the pointed initial end; triangular in section; sides concave, edges angled; chambers distinct, not inflated although last chamber or two may be slightly rounded; sutures slightly depressed; wall coarsely arenaceous, surface rather smoothly finished; aperture an elongate arch in a reentrant of the inner margin of the last septal face. Length 1.52 millimeters; diameter, 0.7 millimeter.

Plesiotype No. 4085, locality P3, Ponce formation.

Very rare at P3 of the Ponce formation.

G. jacksonensis Cushman (1926. Contr. Cushman Lab. Foram. Res. 2) seems quite close but has more concave sides, stronger carinae, more chambers, and is made of finer material than *G. atlantica*.

LIEBUSELLA Cushman 1933

Liebusella byramensis (Cushman)

PLATE 6, FIGURES 9a, b

Clavulina byramensis Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129-E: 92. pl. 16, fig. 1; (1923) U. S. Geol. Surv. Prof. Pap. 133: 22. pl. 2, fig. 3. Oligocene, Mississippi.

? *Clavulina cylindrica* Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 245. pl. 14, figs. 3–5, pl. 19, figs. 1, 2. Lower Oligocene, Cuba.

Liebusella byramensis Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 164. pl. 19, figs. 16–18. Lower Oligocene, coastal plain U. S. and Mexico.

Test elongate subcylindrical, circular in transverse section; early portion of test triserial and slightly bulbous, major portion of test uniserial with 2–4 chambers which constitute about two-thirds of the length of the test; wall of the test very thick, composed of agglutinated calcareous grains which are mainly small hyaline foraminifera such as *Bolivina* and *Globigerina*, not labyrinthic or vesicular but appearing so on eroded surfaces; interior of the chambers in transverse section shows indefinite radial projections extending inward a short distance but chamber interiors are not labyrinthic; surface arena-

ceous but smoothly finished with a great deal of calcareous cement; aperture round, terminal and central at the end of a tapering neck-like projection of the last chamber. Length, 1.81 to 2.71 millimeters; maximum diameter, 0.71 to 0.86 millimeter.

Plesiotype No. 4132, locality P255, Ponce formation.

Rare at P3 and P255 of the Ponce formation.

This Porto Rican species has decided resemblances to *Cubanina alavensis* Palmer (1936. Mem. Soc. Cubana Hist. Nat. **10**) and it is uncertain just what the significant differences may be. These specimens are more like the topotypes figured by Cushman (1937. Monog. Valvulinidae) than like the original figure of *L. byramensis*.

LISTERELLA Cushman 1933

Listerella cf. communis (d'Orbigny)

PLATE 6, FIGURES 10a, b

Clavulina communis d'Orbigny (1826) Ann. Sci. Nat. **7**: 268, No. 4. Recent, Adriatic; Miocene, France; Pliocene, Italy; (1846) Foram. Foss. Vienne 196. pl. 12, figs. 1, 2. Middle Miocene, Vienna.—Cushman & Jarvis (1930) Jour. Paleont. **4**: 356, pl. 32, fig. 4. Miocene, Jamaica.

Listerella communis Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. **8**: 148. pl. 17, figs. 4–9. Miocene to Recent, Mediterranean region.

Test elongate, subcylindrical; chambers few, height in uniserial part of test about $\frac{2}{3}$ the diameter; sutures distinct, slightly depressed; wall finely arenaceous, smoothly finished; aperture terminal, round, occasionally with a very short neck. Length, up to about 1.50 millimeters; average diameter, 0.27 millimeter.

Plesiotype No. 4056, locality P255, Ponce formation.

Rare to common at P2 and P255 of the Ponce formation.

Our specimens do not have the early part preserved.

CLAVULINA d'Orbigny 1826

Clavulina tricarinata d'Orbigny

PLATE 7, FIGURES 8a, b

Clavulina tricarinata d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 111. pl. 2, figs. 16–18. Recent, Cuba.—Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. **8**: 22. pl. 3, figs. 1–3. Recent, West Indian region; Miocene, Florida.

Clavulina cf. C. tricarinata Cushman & McGlamery (1938) U. S. Geol. Surv. Prof. Pap. **189D**: 104. pl. 24, fig. 3. Middle Oligocene, Mississippi.

Test elongate, tapering, increasing in diameter toward the apertural end, triangular in cross section, sides concave; chambers numerous, triserial portion short, 3 to 7 chambers in uniserial part of test;

chambers of triserial part of test obscure, those of the uniserial part more distinct, each extended posteriorly over the preceding chamber on the angulations of the test; sutures in uniserial part distinct, slightly depressed with a goniatic outline due to the aboral deflection of the chambers; wall arenaceous but smoothly finished; aperture terminal, nearly circular, without a neck, with large valvular tooth. Length, up to 1.52 millimeters; maximum diameter, 0.54 millimeter.

Plesiotype No. 3885, locality L3C, San Sebastian formation.

Rare at all San Sebastian localities, except L2C. Common at A79 of the Los Puertos formation. Rare at F64 and F359 of the Quebradillas formation. Rare at P254, P255, P259, and P432; abundant at P258 of the Ponce formation.

CLAVULINOIDES Cushman 1936

Clavulinoides polygonalis NEW SPECIES

PLATE 7, FIGURES 4a, b

Test small, consisting of a triangular early third, a middle polygonal portion of variable length, and a terminal round portion; chambers closely appressed, about 3 in the middle part and 1 to 3 in the apertural part; sutures obscure, nearly flush with the surface; wall very finely arenaceous with a moderate amount of cement; surface rather smooth but distinctly granular; aperture terminal, polygonal, oval or round, with raised rim. Length, 0.75 millimeter; diameter, 0.3 millimeter.

Holotype No. 4091, locality F64, Quebradillas formation.

Rare at F64 of the Quebradillas formation.

This form resembles Cole's species *C. guayabalensis* (1927. Bull. Am. Paleont. 14), but differs in lacking the concave sides, in having 3 to 6 sides, and in having a round terminal portion.

Clavulinoides triangularis (Nuttall)

PLATE 7, FIGURES 5a, b

Clavulina triangularis Nuttall (1932) Jour. Paleont. 6: 8, pl. 2, fig. 4. Lower Oligocene, Mexico.

Clavulinoides jarvisi Cushman (1936) Cushman Lab. Foram. Res. Spec. Publ. 6: 23, pl. 3, figs. 18a, b. Miocene, Trinidad; (1937) Cushman Lab. Foram. Res. Spec. Publ. 7: 135, pl. 19, figs. 3-5. Miocene, Trinidad, and Venezuela.

Clavulinoides triangularis Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 7: 133, pl. 18, figs. 31, 32. Lower Oligocene, Mexico.

Test triangular in section throughout, sides flat to slightly concave, angles subacute; sides of test nearly parallel; triserial portion short, a

little inflated, uniserial portion constituting most of the test, but containing few chambers, 2 to 4; chambers closely appressed, obscure; sutures indistinct, slightly depressed; wall finely arenaceous with much cement, surface rather smooth; aperture terminal, round or oval. Length, up to 1.7 millimeters; diameter, up to 0.65 millimeter.

Plesiotype No. 4086, locality P3, Ponce formation.

Rare at P2; common at P254; abundant at P3 and P255 of the Ponce formation.

We see no reliable distinction between *C. triangularis* and *C. jarvisi* Cushman.

Family **TEXTULARIIDAE** d'Orbigny 1846

TEXTULARIA Defrance 1824

Textularia agglutinans d'Orbigny

PLATE 8, FIGURES 2a-c

Textularia agglutinans d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 144. pl. 1, figs. 17, 18, 32-34. Recent, Cuba.—Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129E: 89. pl. 14, figs. 1a, b. Upper Oligocene, Mississippi; (1922) Bull. U. S. Nat. Mus. 104 (3): 7. pl. 1, figs. 4, 5. Recent, West Indies.—Cushman & Cahill (1933) U. S. Geol. Surv. Prof. Pap. 175A: 7. pl. 1, figs. 8a, b. Miocene, Florida, North Carolina, Virginia, Maryland.

Test elongate, tapering, slightly compressed; ovate in apertural view; edge rounded; chambers inflated, increasing gradually in height toward the apertural end, 7-8 pairs of chambers in average tests; sutures distinct, depressed, except in earliest portion of test; wall rather coarsely arenaceous but smoothly finished, consisting in Porto Rican material of calcareous grains; aperture a flat arch at the base of the last septal face. Length, 0.82 millimeter; width, 0.44 millimeter; thickness, 0.32 millimeter.

Plesiotype No. 3996, locality L1C, San Sebastian formation.

Rare at L2C, L3C, L6C; common at L1C of the San Sebastian formation. Common at A43a of the Cibao formation.

These Porto Rican specimens differ from typical *T. agglutinans* in being slightly more compressed. Nuttall makes the same comment on his specimens of *T. agglutinans* from the Lower Miocene of Trinidad. The first few chambers are more compressed than the rest of the test, with an almost subangular edge. In general there are fewer chambers than in typical *T. agglutinans*.

Textularia articulata d'Orbigny

PLATE 8, FIGURES 1a, b

Textularia articulata d'Orbigny (1846) Foram. Foss. Vienne 250. pl. 15, figs. 16–18. Middle Miocene, Vienna.—Cushman (1933) U. S. Geol. Surv. Prof. Pap. 175A: 8. pl. 1, figs. 12a, b. Miocene, Virginia, Maryland; upper Miocene, Florida.

Test of average size for the genus, elongate, both ends pointed, gradually tapering, slightly compressed, ovate in apertural view; periphery subangular; chambers inflated, increasing gradually in height toward the apertural end; sutures distinct, depressed except in earlier half of test; wall rather coarsely arenaceous but smoothly finished; aperture a low arch at the base of the last septal face. Length, 1.20 millimeters; width, 0.50 millimeter; thickness, 0.34 millimeter.

Plesiotype No. 3998, locality L1C, San Sebastian formation.

Rare at L5C; common at L1C of the San Sebastian formation.

Textularia broussardi Howe & Wallace

PLATE 8, FIGURES 3a, b

Textularia broussardi Howe & Wallace (1932) La. Dept. Cons. Geol. Bull. 2: 18. pl. 1, fig. 3. Upper Eocene, Louisiana.

Test short and thick, subtriangular in side view, oval in apertural view; edge slightly angular near the apex, becoming broadly rounded toward the apertural end; chambers 4 to 5 pairs, the early ones indistinct, the later ones inflated; sutures distinct only between the later chambers; wall finely but distinctly arenaceous; surface rather smooth for the genus; aperture a low slit at the base of the apertural face, with indistinct lip. Length, 1.2 millimeters; breadth, 1.1 millimeters; thickness, 0.8 millimeter.

Plesiotype No. 4092, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

The Porto Rican specimens differ from the Louisiana ones mainly in the finer wall texture.

*Textularia candeana** d'Orbigny

PLATE 8, FIGURES 5a–c

Textularia candeana d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 143. pl. 1, figs. 25–27. Recent, Cuba, Martinique, St. Thomas.

Textularia candeana Cushman (1921) Proc. U. S. Nat. Mus. 59: 50. pl. 11, figs. 7, 8. Recent, north coast Jamaica; (1922) Carnegie Inst. Wash. Publ. 311: 23. pl. 2, fig. 2. Recent, Tortugas; (1922) Bull. U. S. Nat. Mus. 104 (3): 8. pl. 1, figs. 1–3. Recent, West Indies.—Cole & Gillespie (1930) Bull. Am. Paleont. 15 (57B): 5. pl. 2, fig. 11. Middle Oligocene, Mexico.—Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 41. pl. 8, figs. 4a, b. Miocene, Florida.

* The correct spelling of this species is evidently *candeana*. Incorrectly spelled "*candeiana*" by d'Orbigny in 1839, he corrected the spelling to "*candeana*" in the Spanish edition of his Cuba paper in 1840.

Test elongate, club shaped, broadly oval in apertural view, early part of test narrow and much compressed, edge angled; near apertural end test widens and thickens rapidly and edge becomes broadly rounded; chambers numerous, compressed in early part of test, much inflated in last part; sutures distinct, depressed, except in earlier compressed part of test where the sutures are flush; wall rather coarsely arenaceous; aperture a slit at the base of the last septal face. Length, 0.69 millimeter; width, 0.56 millimeter; thickness, 0.40 millimeter.

Plesiotype No. 3999, locality L3C, San Sebastian formation.

Rare at L2C and L3C of the San Sebastian formation, and at P258 of the Ponce formation.

Textularia gramen d'Orbigny

PLATE 8, FIGURES 4a-c

Textularia gramen d'Orbigny (1846) Foram. Foss. Vienne 248. pl. 15, figs. 4-6. Middle Miocene, Vienna.—Cushman (1930) Fla. Geol. Surv. Bull. 4: 17. pl. 1, figs. 5a, b. Middle and upper Miocene, Florida.—Cushman & Cahill (1933) U. S. Geol. Surv. Prof. Pap. 175A: 7. pl. 1, figs. 9a, b. Miocene, Florida and northward.

Test small, width about $\frac{2}{3}$ the length, expanding rapidly from the initial end; edges angled; about 8 pairs of chambers very little inflated except for the last one or two; sutures inconspicuous, nearly flush with the surface, oblique; wall finely arenaceous, composed of small calcareous grains with much calcareous cement; surface smooth to slightly roughened; aperture a narrow arch at the base of the last septal face. Length, 0.73 millimeter; width, 0.47 millimeter; thickness, 0.27 millimeter.

Plesiotype No. 4003, locality L1C, San Sebastian formation.

Common at L1C and L2C of the San Sebastian formation.

Textularia grenadana Hedberg

PLATE 8, FIGURES 6a, b, and 7

Textularia grenadana Hedberg (1937) Jour. Paleont. 11: 667. pl. 90, figs. 5a, b, 6. Upper Oligocene, Venezuela.

Test lanceolate in side view, compressed in early part of test with biconvex cross section, becoming thicker and ovoid in cross section near the apertural end; edge subangular in early part of the test, narrowly rounded in later part; periphery slightly lobulate; chambers closely appressed, 15 or more pairs, overlapping nearly half of their width; sutures distinct, slightly depressed, nearly horizontal near the periphery; wall very finely arenaceous, surface smooth; apertural face truncate; aperture a low, transverse arch. Length of largest

specimen, 1.6 millimeters; width, 0.6 millimeter; thickness, 0.4 millimeter.

Plesiotypes No. 4002a, b, locality P3, Ponce formation.

Rare at P2, P3, P254, and P255 of the Ponce formation.

***Textularia indenta* NEW SPECIES**

PLATE 8, FIGURES 8a-c

Textularia rugosa Brady (not Reuss) (1884) Rep. Voy. Challenger Zool. 9: 363. pl. 42, fig. 24 (not 23). Recent, Pacific.—Cushman (1921) Bull. U. S. Nat. Mus. 100 (4): 114. pl. 23, figs. 3, 4. Recent, Pacific.

Test large, rather stout, sides and edges nearly parallel throughout most of the test; roughly hexagonal in cross section; chambers biserially arranged throughout, numerous, about 10 pairs, closely appressed; chambers with distinct lobes at the basal border, one or two on each side of the test; sutures distinct, recurved adorally between the lobes; wall rather coarsely arenaceous with much cement, smoothly finished; surface irregular due to the apically projecting lobes which form a series of deep indentations; aperture a low, elongate opening at the inner margin of the last-formed chamber in a slight re-entrant. Length of holotype, 1.77 millimeters; width, 0.81 millimeter; thickness, 0.61 millimeter.

Holotype No. 4051, locality A43a, Cibao formation.

Rare at A43a of the Cibao formation.

Forms similar to this species have been found many times and have usually been confused with Reuss's species, which he called *Plecanium rugosum* (1869. Sitz. Akad. Wiss. Wien 59). Reuss shows a form with fairly straight sutures without the lobate extensions which characterize *T. indenta*. Brady (1884) gives two figures of a form which he calls *Textularia rugosa* (Reuss), neither of them being *T. rugosa* as described and figured by Reuss. The forms figured by Brady, with the lobate projections and irregularly excavated chambers seem to be identical with that found by us in the Cibao formation, for which we here propose the name *indenta*.

Cushman proposed the name *Gaudryina rugulosa* (1932. Bull. U. S. Nat. Mus. 161 (1)) and placed both of Brady's figures in synonymy, but it is evident from Cushman's type figure that he had in mind a form in which the test has conspicuous, nearly horizontal corrugations separated by "excavated" areas.

It is probable that the genus is *Textularia*, since a section of the earliest part of the test showed nothing but biserial chambers. The sections made show no indication of septula, so the species cannot

be *Textulariella*, although it looks very much like Hofker's figure of *Textularia rugosa*.

TEXTULARIELLA Cushman 1927

Textulariella barrettii (Jones & Parker)

PLATE 7, FIGURES 9a, b

Textularia barrettii Jones & Parker (1863) Rep. Brit. Assoc. Newcastle Meeting, 80, 105.

Recent, Jamaica; (1876) Ann. Soc. Mal. Belg. 11: 99. woodcut. Miocene, Jamaica.

Textularia pseudotrochus Cushman (1922) Bull. U. S. Nat. Mus. 104 (3): 21. pl. 5, figs. 1-3. Recent, West Indies and southeast U. S.

Textulariella barrettii Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 66. pl. 7, figs. 5-8. Miocene, Jamaica, and Santo Domingo; Recent, Florida and West Indies.

Test forming a low broad cone with height and breadth nearly equal, the apical end bluntly angled, the apertural end flattened or concave; about 5 pairs of chambers in the biserial part of the test, the interior of the chambers divided by partitions which extend inward from the periphery; aperture a low elongate arch at the base of the last chamber. Width, 1.00 millimeter; thickness, 0.95 millimeter; height, 0.95 millimeter.

Plesiotype No. 4004, locality A86, Cibao formation.

Rare at A86 of the Cibao formation, at A21 and A93 of the Quebradillas formation, and at P432 of the Ponce formation.

The Porto Rican specimens are smaller than those typically referred to as *T. barrettii*, although Cushman mentions small individuals of this species from the Miocene of Venezuela.

VULVULINA d'Orbigny 1826

Vulvulina pachyheilus Hadley

PLATE 7, FIGURES 10a, b

Vulvulina pachyheilus Hadley (1934) Bull. Am. Paleont. 20 (70A): 7. pl. 1, figs. 2-4. Oligocene, probably upper, Cuba.—Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 241. pl. 14, figs. 12, 13, 16. Lower Oligocene, Cuba.

Test tapering from the pointed initial end with greatest breadth near the apertural end; in cross section diamond shaped thinning from the thickened central portion to an acute edge; chambers numerous, short and wide, biserial throughout except for the final chamber which is uniserial; sutures nearly straight, forming an oblique angle with the edge of the test, slightly elevated, except for the last one which is depressed; wall made of fine arenaceous material with much cement; surface smooth; aperture terminal, a fissurine slit with thickened lip. Length of figured specimen, 0.92 millimeter; breadth, 0.60 millimeter; thickness, 0.20 millimeter. Maximum length, 1.75 millimeters.

Plesiotype No. 4032, locality A93, Quebradillas formation.

Common at A86 of the Cibao formation. Rare at A93 of the Quebradillas formation. Rare at P3 and P254; common at P2 and P255 of the Ponce formation.

Vulvulina pennatula (Batsch)

PLATE 7, FIGURES 11a, b

Nautilus (*Orthoceras*) *pennatula* Batsch (1791) Conch. Seesandes no. 13, pl. 4, figs. 13a-d. Recent, Adriatic.

Bigennerina capreolus Nuttall (1928) Quart. Jour. Geol. Soc. London 84: 73. pl. 3, fig. 2. Upper Eocene and lower Miocene, Trinidad.

Bigennerina pennatula Nuttall (1928) Quart. Jour. Geol. Soc. London 84: 73. pl. 3, fig. 3. Lower Miocene, Trinidad.

Vulvulina pennatula Cushman (1932) Contr. Cushman Lab. Foram. Res. 8: 76. pl. 10, figs. 1-5. Recent, West Indies; Pliocene, Sicily.

Test compressed, elongate, the microspheric form widening gradually from a rather sharp apical end, the megaspheric form wider at the apical end; sides of the test biconvex outward in biserial part of the test, nearly parallel in uniserial part; chambers closely appressed, earliest part of the test planispiral, followed by numerous low, curved biserial chambers, then 1 to 4 higher uniserial chambers; early part of test thicker than uniserial part; edge angled; sutures in planispiral and biserial part of test limbate and raised, depressed in uniserial part of test; wall finely arenaceous, with much cement; surface smooth; aperture terminal, fissurine, parallel to the compression of the test. Dimensions of the figured specimen, which is one of the largest found in the Porto Rican material: length, 2.13 millimeters; width, 1.23 millimeters; thickness, 0.33 millimeter.

Plesiotype No. 4033, locality P2, Ponce formation.

Common at P3 and P254; abundant at P2 and P255 of the Ponce formation.

Family **NODOSARIIDAE** Schultze 1854

SARACENARIA Defrance 1824

Saracenaria arcuata (d'Orbigny)

PLATE 9, FIGURES 6a-c

Cristellaria arcuata d'Orbigny (1846) Foram. Foss. Vienne 87. pl. 3, figs. 34-36. Middle Miocene, Vienna.

Cristellaria acutaureicularis Brady (not Fichtel & Moll) (1884) Rep. Voy. Challenger Zool. 9: 543. pl. 114, fig. 17. Recent, off Australia.

Test subovate in side view, triangular in transverse section, outer peripheral angle sharply rounded, not carinate; chambers closely appressed, early chambers coiled, later chambers evolute, extending

back nearly to the point of coiling of the earlier chambers; sutures flush with the surface, marked by clear shell material; wall smooth; apertural face broad, slightly convex; aperture radiate, at the outer margin of the last septal face. Length, 1.03 millimeters; width, 0.45 millimeter; thickness, 0.38 millimeter.

Plesiotype No. 3982, locality P3, Ponce formation.

Rare at P2, P3, and P254 of the Ponce formation.

This species is much like many forms which have been referred to *acutauricularis* of Fichtel and Moll. It differs from the original of Fichtel and Moll in the absence of a conspicuous keel in the early stages, in the thinner, less inflated test, and in the shape of the apertural face, which is subtriangular in *S. arcuata* and oval in *S. acutauricularis*.

ASTACOLUS Montfort 1808

Astaculus insolitus (Schwager)

PLATE 8, FIGURES 9a, b

Cristellaria insolita Schwager (1866) Novara-Exped. Geol. 2: 242. pl. 6, fig. 85. Pliocene, Kar Nikobar.

Cristellaria crepidula Brady (1884) Rep. Voy. Challenger Zool. 9: pl. 67, fig. 17 (not 19, 20).

Test elongate oval, compressed; edge narrowly rounded; about 10 chambers in the test, last chambers increasing rapidly in length; chambers involute in varying amounts; sutures distinct, flush with the surface, narrowly limbate; aperture terminal, peripheral, round and radiate. Length, 1.05 millimeters; width, 0.42 millimeter; thickness, 0.12 millimeter.

Plesiotype No. 4037, locality P254, Ponce formation.

Rare at P2, P3, P254, and P255 of the Ponce formation.

A. insolita differs from *A. crepidula* of Fichtel and Moll (1798. Test. Micr.) in the irregular overlapping of the chambers in side view.

Astaculus ovatus NEW SPECIES

PLATE 8, FIGURES 10a, b

Test elongate, compressed, the early chambers coiled, later chambers becoming somewhat evolute; about 8 chambers visible, increasing regularly in size; sutures distinct, not depressed; wall smooth; aperture terminal on the outer margin of the last chamber, radial. Length, 0.70 millimeter; width, 0.38 millimeter; thickness, 0.24 millimeter.

Holotype No. 3871, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

Astacolus ovatus differs from *A. crepidula* in being less elongate and thicker.

***Astacolus subtilius* (Nuttall)**

PLATE 8, FIGURES 11a, b

Cristellaria subtilius Nuttall (1932) Jour. Paleont. 6: 11. pl. 1, figs. 13, 14. Lower Oligocene, Mexico.

Test elongate, much compressed; edge subacute, sharper on the back especially in the early part; early part with a narrow keel; chambers distinct, enlarging gradually in length, the last 2 or 3 not reaching back to the preceding whorl; sutures narrow, oblique, flush with the surface, very slightly limbate; aperture round and radiate, at the outer margin of the last chamber. Length, 0.71 millimeter; width, 0.26 millimeter; thickness, 0.07 millimeter.

Plesiotype No. 3872, locality A86, Cibao formation.

Rare at A86 of the Cibao formation and at P255 of the Ponce formation.

HEMICRISTELLARIA Stache 1864

***Hemicristellaria fragaria* (Gümbel)**

PLATE 9, FIGURES 7a, b

Marginulina fragaria Gümbel (1870) Abh. k. bay. Akad. Wiss. München Math.-Phys. Cl. 10: 635. pl. 1, figs. 58a, b (not c). Eocene, northern Alps.

Test elongate, planispirally coiled in early portion, most of the test evolute with sutures curved but tending to become at right angles to axis of the test; test oval in transverse section, angled on outer margin, carinate when one of the costae comes on the edge of the test; chambers closely appressed, not inflated; sutures flush with the surface, obscured by the ornamentation; test ornamented by longitudinal costae and elongate nodes which in places merge into continuous costae, the nodes are also in transverse ranks marking the chambers; aperture near the outer edge of the last chamber, produced, with short slit extending onto the septal face, and with vestigial radiations. Length, 1.42 millimeters; width, 0.6 millimeter; thickness, 0.32 millimeter.

Plesiotype No. 4053, locality A21, Quebradillas formation.

Common at A21; rare at A20 of the Quebradillas formation.

VAGINULINA d'Orbigny 1826

***Vaginulina faba* NEW SPECIES**

PLATE 9, FIGURES 3a-c

Marginulina sp. Howe & Wallace (1932) La. Dept. Cons. Geol. Bull. 2: 34. pl. 7, fig. 3. Upper Eocene, Louisiana.

Test large, elongate, bean shaped, oval in section; about 15 chambers in the test, rather short in comparison with their width, enlarging very gradually; edges angled in early part of test, later narrowly rounded; sutures flush with the surface, narrow in early part becoming broad and limbate in evolute part of test; aperture large, round and radiate, at the outer edge of the septal face. Length, 1.81 millimeters; width, 0.51 millimeter; thickness, 0.25 millimeter.

Holotype No. 4024, locality P3, Ponce formation.

Very rare at P3 of the Ponce formation.

Vaginulina mexicana Nuttall

PLATE 9, FIGURES 4a, b

Vaginulina elegans mexicana Nuttall (1932) Jour. Paleont. 6: 16. pl. 3, figs. 12, 16. Lower Oligocene, Alazan, Mexico.—Palmer & Bermudez (1936) Mem. Cubana Hist. Nat. 10: 277. pl. 14, figs. 23, 24. Lower Oligocene, Cuba.

Test large, elongate, compressed; test bifurcated, the early coiled portion being much smaller than the later evolute part of the test; rectilinear portion of the test sharply rounded on the outside, sharply angled on the inside, frequently with a narrow keel; sutures conspicuously raised along the middle of each side of the test; chamber width greater than the length, thickness and length being about the same; aperture oval, vestigially radiate, located at the outer margin of the last septal face. Length of broken specimen, 2.0 millimeters; width, 0.9 millimeter; thickness, 0.56 millimeter.

Plesiotype No. 4090, locality P3, Ponce formation.

Very rare at P2 and P3 of the Ponce formation.

Vaginulina siliquoidea NEW SPECIES

PLATE 9, FIGURES 5a, b

Vaginulina legumen elegans Cushman (1923) U. S. Geol. Surv. Prof. Pap. 133: 30. pl. 4, fig. 8. Lower and Middle Oligocene, Mississippi and Alabama.—?Cole (1927) Bull. Am. Paleont. 14 (51): 21. pl. 3, fig. 10 (not 11). Guayabal, middle Eocene, Mexico.

Test small, elongate, oval in cross section; about 7 chambers in the test, enlarging gradually in size; sutures flush with the surface, marked by clear shell material, wide, greatest width on apertural side of the test; sutures slightly convex upward, nearly at right angles to the axis of the test; last chamber shouldered on one side, with the aperture on the other side which is slightly produced; aperture small, round, obscurely radiate. Length, 0.70 millimeter; width, 0.20 millimeter; thickness, 0.10 millimeter.

Holotype No. 4052, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

V. siliquoidea is quite different from *V. elegans* d'Orbigny (Model no. 54) in that it lacks the raised sutures. It differs from *V. legumen* (Linné) in its smaller size, fewer chambers, and the absence of a spine.

MARGINULINA d'Orbigny 1826

Marginulina insulensis NEW SPECIES

PLATE 9, FIGURES 1a-c

Test elongate with nearly parallel sides; transverse section subtriangular, with the angles rounded; early part close coiled, last 3 or 4 chambers uncoiled, only those in the uncoiled part inflated; sutures gently curved in the early coiled part of the test, oblique in the rest of the test meeting the periphery at an angle of about 45 degrees, nearly flush with the surface in the early part of the test, slightly depressed between the uncoiled chambers; aperture nearly terminal or toward the outer margin of the last septal face, round and radiate. Length, 0.76 millimeter; width, 0.21 millimeter; maximum thickness near apertural end of test, 0.16 millimeter.

Holotype No. 4062, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Marginulina subcrassa Schwager

PLATE 9, FIGURES 2a, b

Marginulina subcrassa Schwager (1866) Novara-Exped. Geol. 2: 240. pl. 6, fig. 82. Pliocene, Kar Nikobar.

Marginulina eximia (?) Cushman (1939) Contr. Cushman Lab. Foram. Res. 15: 56. pl. 9, figs. 27, 28. Eocene, submarine core off eastern North America.

Test slightly curved, stout, circular in cross section; chambers in early part coiled, later part uncoiled, uniserial; chambers closely appressed, the last chamber fairly elongate, tapering to the aperture; sutures oblique, slightly depressed, more so on the concave side of the test; surface smooth; aperture produced, radiate, terminal on convex side of the test. Length, 0.85 millimeter; diameter, 0.29 millimeter.

Plesiotype No. 4057, locality P2, Ponce formation.

Rare at P2, P254, and P255 of the Ponce formation.

AMPHICORYNE Schlumberger 1881

Amphicoryne obliqua NEW SPECIES

PLATE 9, FIGURES 8a, b

Test bifurcated, the outer edge sharply angled, the early part compressed consisting of several chambers arranged as in *Vaginulina*, later part nodosarian, not compressed, consisting of only one globular chamber; sutures somewhat depressed; surface ornamented by diagonal costae, about 18 on the last chamber and fewer on the vaginuline part of the test; costae discontinuous across the sutures; a few costae extend up onto the lower part of the neck, the upper part of which is ornamented with a few obscure horizontal rings; aperture terminal, round, not definitely radiate. Length, 0.73 millimeter; width, 0.27 millimeter.

Holotype No. 3861, locality P2, Ponce formation.

Very rare at P2 of the Ponce formation.

This species differs from *A. falx* (Jones and Parker) (1860. Quart. Jour. Geol. Soc. London 16) particularly in the oblique and discontinuous costae.

GLANDULINA d'Orbigny 1839

Glandulina comatula (Cushman)

PLATE 10, FIGURES 6a-c; PLATE 11, FIGURES 1a, b

Nodosaria comatula Cushman (1923) Bull. U. S. Nat. Mus. 104 (4): 83. pl. 14, fig. 5. Recent, Gulf of Mexico, West Indies, Caribbean.—Nuttall (1928) Quart. Jour. Geol. Soc. London 84: 84. pl. 5, fig. 3. Lower Miocene, Trinidad.

Test short and stout, gradually enlarging from the first chamber, initial end broadly rounded, usually with a short, stubby spine, apertural end tapering to the aperture; chambers few, 2 to 5, slightly inflated, gradually enlarging; sutures obscure, slightly depressed; surface ornamented by numerous low, rounded, longitudinal costae, continuous from chamber to chamber, close together, 35-45 on the last-formed chamber; in the adult, the apertural end of the last chamber may be smooth; aperture terminal, central, distinctly radiate. Length, 1.20 millimeters; diameter, 0.35 millimeter.

Plesiotypes No. 3919a, b, locality P2, Ponce formation.

Common at P2; rare at P3 and P255 of the Ponce formation.

Glandulina gallowayi (Cushman)

PLATE 11, FIGURES 2a, b

Glandulina comata Galloway & Morrey (1929) Bull. Am. Paleont. 15 (55): 13. pl. 1, fig. 7a, b. Lower Oligocene, Ecuador.

Pseudoglandulina gallowayi Cushman (1929) Contr. Cushman Lab. Foram. Res. 5: 87. pl. 13, fig. 13. Oligocene, or Miocene, Ecuador.

Test pyriform, maximum diameter above the middle of the test, form ratio 1.4; initial end subacute, apertural end conical; chambers few, obscure, uniserial in arrangement; sutures obscure; surface ornamented by 20 to 24 high, rather heavy, round costae which are continuous from the apical end to near the apertural end; apertural face smooth; aperture terminal, slightly produced, round, with radiating slits. Length, 0.55 millimeter; diameter, 0.41 millimeter.

Plesiotype No. 3951, locality A86, Cibao formation.

Rare at A86 of the Cibao formation and P254 of the Ponce formation.

Although forms which are identified as *Lagena strumosa* Reuss occur in the Porto Rican material, they do not come from the same localities as the specimens of *G. gallowayi* and, in any event, it seems improbable that they could be young specimens of *G. gallowayi* as was stated by Cushman in 1929 for the following reasons:

1. The shape of the apical end of the test is different in the two forms, that of *G. gallowayi* being much more tapering.
2. The aperture is distinctly radiate in *G. gallowayi* but is not in *L. strumosa*.

Glandulina mauricensis Howe & Roberts

PLATE 10, FIGURE 7

Pseudoglandulina mauricensis Howe & Roberts (1939) La. Dept. Cons. Geol. Bull. 14: 48. pl. 6, fig. 10. Middle Eocene, Louisiana.

Test small, stout, circular in cross section, composed of two spheroidal chambers, last chamber overlapping about a third of the earlier one; suture depressed; initial chamber with an apical spine; aperture terminal, round and radiate. Length, 0.38 millimeter; diameter, 0.22 millimeter.

Plesiotype No. 4047, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

DENTALINA d'Orbigny 1839

Dentalina advena (Cushman)

PLATE 9, FIGURES 9a, b

Nodosaria advena Cushman (1923) Bull. U. S. Nat. Mus. 104 (4): 79. pl. 14, fig. 12. Recent, Gulf of Mexico, Caribbean Sea, and off northeastern U. S.
Dentalina communis Cushman & Cahill (1933) U. S. Geol. Surv. Prof. Pap. 175A: pl. 5, fig. 2. Miocene, Florida.

Test elongate, slender, slightly tapering, slightly curved, circular in cross section; chambers numerous, about 7 in the complete test, those near the apertural end inflated a little; sutures oblique, slightly

depressed, more so on the convex edge of the test; surface smooth, unornamented; aperture radiate, eccentric, nearer the concave side of the test. Length, 1.55 millimeters; diameter, 0.28 millimeter.

Plesiotype No. 3895, locality P254, Ponce formation.

Rare at P2, P254, and P255 of the Ponce formation.

Many forms which have been referred to *D. communis* (d'Orbigny) probably belong to *D. advena*. The features of d'Orbigny's species are well shown by Fornasini in his reproduction of d'Orbigny's unpublished figure (1898. Mem. R. Accad. Sci. Ist. Bologna V. 7) in which the test has 12 chambers and an apical spine.

D. advena bears a strong resemblance to *D. debilis* Hantken (1875. Mitt. Jahr. k. ungar. geol. Anstalt 4 (1)).

***Dentalina halkyardi* Cushman**

PLATE 9, FIGURES 10a, b

Dentalina halkyardi Cushman (1933) Contr. Cushman Lab. Foram. Res. 9: 9. pl. 1. fig. 20. Upper Eocene, South Carolina and Biarritz.

Test elongate, very slightly tapering; chambers about 5, subglobular, the early ones more closely appressed than the later ones; early sutures obscure, nearly flush with the surface of the test, later sutures depressed; surface conspicuously ornamented, the early chambers ornamented by discontinuous longitudinal costae, about 7 visible on each side of the test, the next chambers with spinose projections developing at the apical ends of the interrupted costae, the last chamber with a series of fine pustules in longitudinal lines; aperture round, terminal and slightly produced, not definitely radiate. Length, 1.00 millimeter; diameter of last chamber, 0.30 millimeter.

Plesiotype No. 3892, locality P2, Ponce formation.

Very rare at P2 of the Ponce formation.

***Dentalina halkyardi ponceana* NEW VARIETY**

PLATE 9, FIGURES 11a, b

Test elongate, tapering, slightly arcuate, circular in cross section; apical end blunt, with a short, stout spine; about 8 chambers in the test, increasing slowly in size, early chambers slightly wider than long, last chamber nearly equidimensional; first few chambers very slightly inflated, sutures nearly flush with the surface; later chambers inflated, widest near the basal part of each chamber, separated by depressed sutures; surface ornamented by 12-14 diagonal costae which are continuous on the first 3-4 chambers and which extend to the

final chamber; costae become discontinuous after the first 4 chambers with apically pointing spines or prickles on the costae of penultimate chamber and finally break up into spines on the lower two-thirds of the last chamber, apertural third of the final chamber being unornamented; apertural end of final chamber slightly produced, aperture eccentric, round and radiate. Length, 2.37 millimeters; diameter, 0.53 millimeter.

Holotype No. 3893, locality P3, Ponce formation.

Rare at P2, P3, and P255 of the Ponce formation.

This variety differs from *D. halkyardi* Cushman (1933. Contr. Cushman Lab. Foram. Res. 9) in the strongly oblique character of the longitudinal costae, the presence of an apical spine, and the presence of separate spines on the final chamber only.

Dentalina hillaeformis NEW SPECIES

PLATE 9, FIGURE 12

Nodosaria pauperata Cushman (not d'Orbigny) (1923) Bull. U. S. Nat. Mus. 104 (4): pl. 14, fig. 13. Recent off northeastern U. S.

Test stout, curved, with short apical spine; round in cross section; chambers few, 4 to 5, somewhat inflated; sutures narrow, slightly oblique, slightly depressed, more so on the convex side of the test; aperture terminal, radiate, eccentric. Length, 0.73 millimeter; diameter, 0.18 millimeter.

Holotype No. 3890, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

D. hillaeformis (sausage-shaped) differs from *D. pauperata* d'Orbigny (1846. Foram. Foss. Vienne) in having fewer chambers, and short, stouter test.

Dentalina multilineata Bornemann

PLATE 9, FIGURE 13

Dentalina multilineata Bornemann (1855) Zeitsch. deutsch. geol. Ges. 7: 325. pl. 13, fig. 12. Middle Oligocene, Germany.—Cushman (1927) Jour. Paleont. 1: 152. pl. 24, figs. 7, 8. Lower Oligocene, Alazan, Mexico.—Nuttall (1932) Jour. Paleont. 6: 14. pl. 3, fig. 5. Lower Oligocene, Alazan, Mexico.

Test elongate, slender, with apical spine; chambers elongate; sutures slightly depressed; surface ornamented by numerous continuous, rather fine, longitudinal costae which are oblique on the first few chambers; apertural end not observed. Length of broken specimen, 1.5 millimeters; diameter, 0.25 millimeter.

Plesiotype No. 4035, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

Dentalina semilaevis Hantken

PLATE 9, FIGURE 14

Dentalina semilaevis Hantken (1876) Magyar kir. földt. int. évkön. 4: 32. pl. 4, fig. 6, pl. 12, fig. 13. Lower Oligocene, Hungary.—Nuttall (1932) Jour. Paleont. 6: 15. pl. 3, fig. 8. Lower Oligocene, Mexico.

Test slender, elongate, slightly arcuate; chambers numerous, about 12 in the adult test; sutures oblique to the main axis of the test, limbate, flush with the surface in most of the test, being slightly depressed between the last few chambers; surface ornamented by about 14 oblique, longitudinal costae, which extend from the apical end as far as the lower half of the last or next to the last chamber; aperture not preserved on the Porto Rican specimens. Length of broken specimen, 1.7 millimeters; diameter, 0.3 millimeter.

Plesiotype No. 3894, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

NODOSARIA Lamarck 1812**Nodosaria halkyardi antillana** Palmer & Bermudez

PLATE 10, FIGURE 2

Nodosaria halkyardi antillana Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 269. pl. 16, fig. 3. Lower Oligocene, Cuba.

Test incomplete; last chamber top-shaped, tapering abruptly at the apertural end to a distinct, rather long neck, with ring-like costae; surface of the test ornamented by about 15 sharp, longitudinal costae which extend from the base of the neck about half the length of the chamber, terminating in spines; surface of the lower half of the chamber irregularly papillate and hispid; aperture terminal, round. Diameter of the test, 0.37 millimeter.

Plesiotype No. 4060, locality A86, Cibao formation.

Very rare at A86 of the Cibao formation.

The Porto Rican form has fewer costae and less globular chambers than the type figure of *N. halkyardi antillana*.

Nodosaria longiscata d'Orbigny

PLATE 11, FIGURE 8

Nodosaria longiscata d'Orbigny (1846) Foram. Foss. Vienne 32. pl. 1, figs. 10–12. Middle Miocene, Vienna.—Nuttall (1928) Quart. Jour. Geol. Soc. 84: 81. pl. 4, fig. 13. Lower Miocene, Trinidad.—Hedberg (1937) Jour. Paleont. 11: 671. pl. 91, figs. 3, 4. Oligocene, Venezuela.

Test slender, stem-like except for the inflated first chamber; first chamber globular, succeeding chambers indistinct, much smaller in

diameter, cylindrical in shape; sutures obscure, flush with the surface, at right angles to the length of the test; surface smooth; apertural end not found. Length, 1.5 millimeters; diameter of globular chamber, 0.32 millimeter; diameter of stem-like portion of test, 0.2 millimeter.

Plesiotype No. 3934, locality P3, Ponce formation.

Rare at P3 and P254 of the Ponce formation.

Nodosaria obliquata (Batsch)

PLATE 11, FIGURE 5

Nautilus (Orthoceras) obliquatus Batsch (1791) Conch. Seesands pl. 2, figs. 5a-d. Recent, Rimini.

Nodosaria obliquata Cushman (1931) Contr. Cushman Lab. Foram. Res. 7: 65. pl. 8, figs. 15-19. Recent, Rimini.—Hadley (1934) Bull. Am. Paleont. 20 (70A): 12. pl. 1, fig. 13. Oligocene, probably upper, Cuba.

Test elongate, curved, blunt apically with a stout spine; tapering at the apertural end; 7 chambers, somewhat longer than wide, becoming slightly more elongate toward the apertural end of the test; sutures obscure, flush between the early chambers, depressed between the last few chambers; surface ornamented with 8-10 low, longitudinal, oblique costae, extending from the apical end to the lower part of the last chamber, the upper part of the last chamber being smooth; aperture terminal, round, not definitely radiate. Length, 1.4 millimeters; diameter, 0.18 millimeter.

Plesiotype No. 3935, locality P3, Ponce formation.

Very rare at P3 of the Ponce formation.

The Porto Rican form is similar to *N. vertebralis*, but it is nearer the topotype figure of *N. obliquata* given by Cushman (1931. pl. 8, fig. 19). It differs from the original figures by Batsch in the fewer costae.

Nodosaria pariana Hedberg

PLATE 11, FIGURE 7

Nodosaria longiscata Cole & Ponton (1930) Fla. Geol. Surv. Bull. 5: 33. pl. 6, fig. 4. Lower Oligocene, Florida.

Nodosaria pariana Hedberg (1937) Jour. Paleont. 11: 672. pl. 91, fig. 5. Oligocene, Venezuela.

Test small, elongate, consisting of a bulbous proloculum and from 2 to 5 keg-shaped chambers of smaller diameter than the proloculum; sutures slightly depressed, obscure, transverse; surface smooth; the proloculum is provided with a large apical spine; aperture not seen in the fragmentary specimens. Length of incomplete specimen, 0.7 millimeter; diameter of later chambers, 0.2 millimeter.

Plesiotype No. 4099, locality P254, Ponce formation.
Rare at P254 of the Ponce formation.

Nodosaria raphanistrum (Linné)

PLATE 11, FIGURE 6

Nautilus raphanistrum Linné (1758) Sys. Nat. ed. 10. 710. Recent.

Nodosaria raphanistrum Cushman (1918) Bull. U. S. Nat. Mus. 103: 59. pl. 21, fig. 10. Oligocene, Panama Canal Zone.—Nuttall (1928) Quart. Jour. Geol. Soc. 84: 82. pl. 4, fig. 21. Lower Miocene, Trinidad; (1932) Jour. Paleont. 6: 16. pl. 3, fig. 10. Lower Oligocene, Mexico.

Test large, long and stout, tapering very slightly if at all; circular in cross section; chambers a little wider than high, slightly inflated, enlarging gradually; sutures depressed; surface ornamented by about 14 prominent, heavy ribs which are continuous across the sutures and extend up to the aperture; aperture terminal, round, slightly produced. Length of broken specimen, 2.5 millimeters; diameter, 1.3 millimeters.

Plesiotype No. 4097, locality P3, Ponce formation.
Rare at P3 and P255 of the Ponce formation.

Nodosaria scalaris (Batsch)

PLATE 10, FIGURE 4

Nautilus (Orthoceras) scalaris Batsch (1791) Conch. Seesandes 91. pl. 95, figs. B–M. Recent, Adriatic.

Nodosaria scalaris Brady (1884) Rep. Voy. Challenger Zool. 9: 510. pl. 63, figs. 28–31. Recent, Pacific, north Atlantic.

Test cylindrical, composed of few, nearly spherical chambers; apical end blunt, usually with an apical spine; chambers increasing rather rapidly in size; sutures depressed; surface ornamented by numerous longitudinal costae, 10–12 visible from one side of the test; aperture terminal, round, faintly radiate, at the end of a fairly long neck. Length, 0.85 millimeter; diameter, 0.38 millimeter.

Plesiotype No. 3936, locality P255, Ponce formation.
Rare at P2, P254, and P255 of the Ponce formation.

Nodosaria simplex Silvestri

PLATE 10, FIGURE 3

Nodosaria simplex Silvestri (1872) Atti. Accad. Gioenia Sci. Nat. III. 7: 95. pl. 11, figs. 268–272. Pliocene, Italy.—Cushman (1923) Bull. U. S. Nat. Mus. 104 (4): 68. pl. 14, fig. 10. Recent, western Atlantic.

Nodosaria sp. Cushman (1933) Bull. U. S. Nat. Mus. 161 (2): 14. pl. 3, fig. 11. Recent, tropical Pacific.

Test short, consisting of only two chambers, closely appressed; suture depressed; apical end with a short, slender spine; apertural end constricting rapidly to form a tapering neck; apertural end of neck broken. Length, 0.62 millimeter; diameter, 0.30 millimeter.

Plesiotype No. 4061, locality P2, Ponce formation.

Very rare at P2 of the Ponce formation.

LAGENA Walker & Boys 1784

Lagena ampulla NEW SPECIES

PLATE 11, FIGURES 9a, b

Orulina tenuis Bornemann (1855) Zeitsch. deutsch. Geol. Ges. 7: 317. pl. 12, fig. 3*a, b (not fig. 3a, b which we here select as the type of Bornemann's species). Middle Oligocene, Hermsdorf.

Test flask shaped, nearly circular in cross section, body of test subcylindrical; neck moderately long, gradually contracted from the body of the test; surface ornamented with 10 medium sized costae which begin at or near the apex and extend up onto the beginning of the neck; upper part of neck unornamented; apical end broadly rounded; aperture simple, round, terminal. Length, 0.42 millimeter; diameter, 0.17 millimeter.

Holotype No. 3926, locality L6C, San Sebastian formation.

Rare at L1C, L2C, and L6C of the San Sebastian formation, and at P2 of the Ponce formation.

This species differs from *L. amphora* Reuss (1862. Sitz. k. Ak. Wiss. Wien 46 (1)) in having fewer costae, a shorter neck, and a more abruptly tapering apertural end. *L. raricosta* (d'Orbigny) (1839. Voy. Amér. Mèrid. 5 (5): Foraminifères) is less elongate and has a shorter neck. *L. tenuis* (Bornemann), as designated above, is similar neither in shape nor ornamentation.

Lagena bullosa NEW SPECIES

PLATE 11, FIGURES 10a, b

Test spheroidal with long neck and short, blunt apical spine; surface covered with round knobs of different sizes, the neck covered with short, transverse ridges; aperture terminal, round, without phialine lip, but with radial petaloid depressions. Length, 0.7 millimeter; diameter, 0.47 millimeter.

Holotype No. 4079, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Although there are numerous spinose forms of *Lagena* the com-

bination of the knobby surface, rugose neck, and apical spine seems not to have been recognized. It may have evolved from a *Lagenonodosaria*, such as the form figured by Brady in the Challenger Report (pl. 63, fig. 16).

Lagena impressa NEW SPECIES

PLATE 10, FIGURES 10a-c

Test small, globular with flat base and conical apertural end, broadly oval in end view; surface ornamented with a whorl of small costae on one side, suggestive of a finger print, and with small, vertical, dividing and anastomosing costae on the opposite side; aperture small, terminal, round, neither radiate nor with a neck or phialine lip. Length, 0.5 millimeter; breadth, 0.44 millimeter; thickness, 0.36 millimeter.

Holotype No. 4094, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

The ornamentation of this species is similar to that of *L. curvilineata* (Cushman (1923) Bull. U. S. Nat. Mus. 104 (4): pl. 2, figs. 5-7), but the species are otherwise dissimilar.

Lagena nuttalli NEW SPECIES

PLATE 10, FIGURES 8a, b

Lagena sulcata Nuttall (not Walker & Jacob) (1928) Quart. Jour. Geol. Soc. London 84: 79. pl. 4, fig. 3. Oligocene and Miocene, Trinidad.

Test subglobose, slightly longer than wide, with large, inflated neck, constricted at the base and tapering rapidly to the apertural end; apical end broadly rounded, with a few inconspicuous spinose projections; surface of the test ornamented by about 26 fine, longitudinal costae which extend from the base of the test to the apertural end of the neck; sometimes decreasing by merging and sometimes increasing by implantation; aperture terminal, round, without lip. Length, 0.53 millimeter; diameter, 0.35 millimeter.

Holotype No. 4054, locality P254, Ponce formation.

Rare at P2 and P254; common at P255 of the Ponce formation.

Lagena strumosa Reuss

PLATE 10, FIGURES 9a, b

Lagena strumosa Reuss (1858) Zeitsch. geol. Ges. 434; (1863) Sitz. Akad. Wiss. Wien 46 (1): 328. pl. 4, fig. 49. Oligocene, Pletzpuhl, Germany.

Lagena striata strumosa Cushman (1913) Bull. U. S. Nat. Mus. 71 (3): 20. pl. 7, figs. 7-10. Recent, Pacific; (1918) Bull. U. S. Nat. Mus. 103: 58. pl. 21, fig. 7. Lower Gatun formation, middle Miocene, Panama Canal Zone.

Test subglobular; apical end with a short stout spine; apertural end with an elongate neck; surface of the test ornamented with about 30 low, round costae, several of which extend up onto the neck; costae terminate near the base of the test with spinose projections; aperture terminal, round, at the end of an elongate neck. Length, 0.61 millimeter; diameter, 0.36 millimeter.

Plesiotype No. 4055, locality P255, Ponce formation.

Common at P255; rare at P3 of the Ponce formation.

ROBULUS Montfort 1808

Robulus calliferus (Stache)

PLATE 11, FIGURES 12a, b

Cristellaria callifera Stache (1864) Novara-Exped. Geol. 1: 236. pl. 23, figs. 15a, b. Middle Tertiary, Auckland.

Test round, strongly biconvex, with a narrow, angled keel of clear shell material; 9 to 10 chambers in the last whorl, enlarging very gradually in size; sutures flush with the surface, marked by broad bands of clear shell material, curved, merging at the center with a small umbonal area of clear shell material; aperture peripheral, at the outer margin of the last septal face, a narrow slit extending down into the last septal face, finely radiate on the outer sides, not on the septal face. Diameter, 1.1 millimeters; thickness, 0.67 millimeter.

Plesiotype No. 4096, locality P2, Ponce formation.

Rare at P2 and P254 of the Ponce formation.

This species is similar to *R. arcuatostratus carolinianus* Cushman (1933. Contr. Cushman Lab. Foram. Res. 9) but differs in being thicker, with narrower keel, flush sutures, and non-protruding aperture.

Robulus chambersi Garrett

PLATE 12, FIGURES 1a, b

Robulus chambersi Garrett (1939) Jour. Paleont. 13: 576. pl. 65, figs. 8, 9a, b. Middle Tertiary, Texas.

Robulus clericii Coryell & Rivero (1940) Jour. Paleont. 14: 332. pl. 43, figs. 7a-b. Middle Miocene, Haiti.

Test thick, lenticular, biumbonate; edge angled with narrow keel of clear shell material; 5 to 6 chambers in the last whorl; sutures limbate, flush with the surface or slightly raised, sharply curved near the umbonal region, then oblique to the periphery; umbonal region filled with clear shell material; aperture radiate at outer margin of the last chamber with a short, narrow slit extending down onto the last

septal face. Diameter, up to 0.73 by 0.85 millimeters; thickness, 0.45 millimeter.

Plesiotype No. 3973, locality P254, Ponce formation.

Common at A86 of the Cibao formation. Rare at A21; common at A20 of the Quebradillas formation. Rare at P3 and P254; common at P251 of the Ponce formation.

As was stated by Garrett, *R. chambersi* differs from *R. clericii* (Fornasini), "in having fewer chambers, very prominent sutures and prominent umbones".

Robulus cibaoensis NEW SPECIES

PLATE 12, FIGURES 8a, b

Test subcircular tending to be pentagonal in side view, thick discoidal in edge view; 5 to 6 chambers in the last whorl, last chamber most inflated especially in apertural view; sutures flush with the surface except between the last two chambers where it is a little depressed; edge with narrow keel; aperture at the outer margin of the last septal face, elongate and radiate; apertural face very wide, with strongly convex sides. Diameter, 0.48 by 0.56 millimeters; thickness, 0.35 millimeter.

Holotype No. 4036, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

R. cibaoensis is somewhat similar to Brady's figure of *Cristellaria articulata* (1884. Rep. Voy. Challenger Zool.) but it is thicker, has fewer chambers, and a wider apertural face.

Robulus convergens (Bornemann)

PLATE 12, FIGURES 3a, b

Cristellaria convergens Bornemann (1855) Zeitsch. deutsch. geol. Ges. 7: 327. pl. 13, fig. 16. Middle Oligocene, Germany.—Brady (1884) Rep. Voy. Challenger Zool. 9: 546. pl. 69, figs. 1-4. Recent, Atlantic and Pacific Oceans.—Cushman (1923) U. S. Geol. Surv. Prof. Pap. 133: 28. pl. 4, fig. 2. Lower Oligocene, Mississippi and Alabama; (1927) Jour. Paleont. 1: 152, pl. 23, fig. 12. Alazan, lower Oligocene, Mexico.
Lenticulina convergens Cole & Gillespie (1930) Bull. Am. Paleont. 15 (57B): 7. pl. 3, fig. 1. Middle Oligocene, Meson formation, Mexico.

Test lenticular, biconvex; broadly oval in side view; edge subangular with narrow margin of clear shell material; about 6 chambers in the last whorl, enlarging rather rapidly, with the lateral faces of the last chamber drawn together so as to form an extremely narrow septal face; sutures limbate, rather oblique, flush with the surface of the test; aperture radiate at the outer margin of the last chamber with a slit extending down onto the last septal face. Diameter, 0.83 by 1.10 millimeters; thickness, 0.40 millimeter.

Plesiotype No. 3974, locality P3, Ponce formation.

Rare at A86 of the Cibao formation. Common at P3, P254, and P255 of the Ponce formation.

Robulus falcifer (Stache)

PLATE 12, FIGURES 5 and 6

Cristellaria falcifer Stache (1864) Novara-Exped. Geol. 1: 240. pl. 23, figs. 19a, b. Upper Eocene, Auckland.

Cristellaria subalata Chapman (1926) New Zealand Geol. Surv. Paleont. Bull. 11: 65. pl. 4, fig. 19 (not 25, 26). Upper Eocene, New Zealand.

Test nearly circular in side view, close coiled, biconvex; edge sharply angled with a narrow keel; 9 to 11 chambers in the last whorl, increasing very slowly in size; sutures strongly curved, limbate and raised, ending in a raised umbonal area; aperture peripheral, at the outer margin of the last septal face, radiate, with a slit extending down into the last septal face. Diameter, 0.53 by 0.60 millimeter; thickness, 0.33 millimeter.

Plesiotypes No. 4074a and b, locality A21, Quebradillas formation.

Abundant at A21 of the Quebradillas formation.

Robulus iota (Cushman)

PLATE 12, FIGURES 7a, b

Cristellaria iota Cushman (1923) Bull. U. S. Nat. Mus. 104 (4): 111. pl. 29, fig. 2. Recent, Atlantic; (1930) Fla. Geol. Surv. Bull. 4: 25. pl. 4, fig. 1. Miocene, Florida.

Test large, circular in side view, gently biconvex, with umbonal bosses of clear shell material; edge acute with thin carina of clear shell material; chambers 12-13 in the adult whorl, short and wide; sutures flush with the surface, limbate, radial near the umbonal region, curving more and more to the periphery; aperture at the outer margin of the last septal face, radiate outside, with a slit extending down onto the septal face. Diameter, 1.7 millimeters; thickness, 0.6 millimeter.

Plesiotype No. 3976, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Our specimens differ from typical *R. iota* in lacking the wide, sharp keel. They are much like the Florida Miocene specimens.

Robulus occidentalis torridus (Cushman)

PLATE 12, FIGURES 4a, b

Cristellaria occidentalis torrida Cushman (1923) Bull. U. S. Nat. Mus. 104 (4): 105. pl. 25, fig. 1. Recent, Gulf of Mexico.

Robulus occidentalis torrida Cushman & Jarvis (1930) Jour. Paleont. 4: 357. pl. 32, figs. 8a, b. Miocene, Jamaica.

Test biconvex, umbonate with relatively small umbonal filling of clear shell material where sutures converge; edge angled with keel of clear shell material about 0.17 millimeter wide; 5-6 chambers in last whorl, subtriangular in shape, enlarging gradually; sutures curved, broadly limbate, flush with the surface; aperture a slit just below the outer point of the last chamber, radiate on the outer edge. Average dimensions: diameter, 1.24 by 1.48 millimeters; thickness, 0.68 millimeter.

Plesiotype No. 4096, locality P3, Ponce formation.

Common at P2, P3, and P255 of the Ponce formation.

***Robulus planulus* NEW SPECIES**

PLATE 11, FIGURES 14a, b

Test small, compressed, nearly flat on the sides, biumbilicate, consisting of about 2 whorls of chambers, all visible on both sides of the test; chambers 6 to 7 in the last whorl, enlarging gradually, slightly inflated; sutures distinct, limbate, with limbation continuing along the periphery forming a narrow border, outside of which is a narrow, flat keel set off from the border by a square shoulder; surface smooth; septal face concave; aperture a narrow slit extending down into the septal face, finely but distinctly radiate outside, the throat of the aperture showing through the clear shell material. Diameter, 0.42 by 0.61 millimeters; thickness, 0.12 millimeter.

Holotype No. 3979, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

This pretty little species is distinctive in its much compressed test, and shouldered and flanged edge. This form might be placed in the genus *Planularia* by some students of Foraminifera, but that genus is evolute and triangular in side view and more like *Vaginulina* than *Robulus*, as an inspection of the type figure will demonstrate.

***Robulus plummerae* Cole**

PLATE 12, FIGURES 9a, b

Robulus plummerae Cole¹ (1928) Bull. Am. Paleont. 14 (53): 8. pl. 3, fig. 10. Upper Eocene, Chapopote formation, Mexico.

Test small, subcircular, strongly biconvex, involute beyond umbo; edge acute with narrow keel which narrows orad and disappears on the last chamber; chambers few, 4 or 5 in the last whorl; sutures flush with the surface, gently curved, bordered with clear shell material, meeting in the umbonal region but not making a boss; sur-

face smooth; apertural face crescentic, concave; aperture a narrow triangular slit extending down into the septal face, finely radiate laterally. Diameter, 0.53 by 0.66 millimeter; thickness, 0.35 millimeter.

Plesiotype No. 3977, locality P254, Ponce formation.

Rare at locality P254 of the Ponce formation.

Cole's description and figure are inadequate for certain recognition of his species. Our specimens are smaller but seem otherwise identical. This species reminds one of *Cristellaria crassa* d'Orbigny (1846. Foram. Foss. Vienne), and the Cuban specimens referred to that species by Palmer and Bermudez (1936. Mem. Soc. Cubana Hist. Nat. 10: 252), which they say is "without any robuline slit". In our experience species of "*Cristellaria*" with a round aperture are extremely rare or probably nonexistent, excepting strongly evolute forms properly referable to other genera. All discoidal forms have robuline apertures.

***Robulus protuberans* (Cushman)**

PLATE 11, FIGURES 13a, b

Cristellaria protuberans Cushman (1918) Bull. U. S. Nat. Mus. 103: 61. pl. 22, fig. 2. Lower Culebra formation, Oligocene, Panama Canal Zone.

Test large, biconvex but thin; the umbonal region ornamented with large, round knobs; edge angled with prominent keel of clear shell material which narrows and disappears on the last chamber; chambers essentially planispiral in arrangement, tending to become evolute, 10 in the last whorl; chambers inflated, separated by deep, nearly radial sutures; aperture produced near the outer margin of the last septal face, radiate outside, with a small slit extending down onto the apertural face and becoming oval; apertural face flat, narrowly elliptical. Maximum diameter, 2.75 millimeters; thickness, 0.30 millimeter.

Plesiotype No. 3980, locality P2, Ponce formation.

Very rare at P2 of the Ponce formation.

The specimen figured is a little asymmetrical. It is interesting to note that the species which most closely resembles this unusual form of *Robulus* is *Cristellaria karrer* Rzehak from the Miocene of Czechoslovakia. *R. protuberans* differs in that it has more chambers, a narrower keel, and is more evolute.

***Robulus subpapillosus* (Nuttall)**

PLATE 12, FIGURES 2a, b

Cristellaria subpapillosa Nuttall (1932) Jour. Paleont. 6: 12. pl. 1, fig. 12. Lower Oligocene, Mexico.

Test biconvex, ovate in side view, tending to become evolute; edge acute, without distinct keel, but with thin, flat, short, spinose projections at the ends of most of the sutures; 9 to 10 chambers in the last whorl, increasing more rapidly in width than in length; sutures distinct, depressed or flush with the surface between the last few chambers, slightly raised with beadlike ornamentation between the earlier chambers of the last whorl, the beads larger near the umbo; septal face flat, narrow; aperture at the outer margin of the last septal face, slightly produced, large, oval and coarsely radiate. Length, 1.28 millimeters; width, 0.9 millimeter; thickness, 0.44 millimeter.

Plesiotype No. 4095, locality P3, Ponce formation.

Rare at P3 and P255 of the Ponce formation.

R. subpapillosa differs from *R. gutticostatus* (Gümbel) in that it has no keel. Although not figured, the forms referred to *Cristellaria gutticostata* by Palmer and Bermudez from the Lower Oligocene of Cuba probably belong to this species. They state that, "specimens referred to this species differ from the type in the development of short, peripheral spines, frequently without an intervening flange" (1936. Mem. Soc. Cubana Hist. Nat. 10).

Young specimens of *R. subpapillosus* are like *R. brevispinosus* (Nuttall) (1928. Quart. Jour. Geol. Soc. London 84).

LINGULINA d'Orbigny 1826

Lingulina ponceana NEW SPECIES

PLATE 11, FIGURES 11a, b

Test moderately compressed; smoothly ovate, not lobulate, in side view, slightly longer than wide, apical and apertural ends equally rounded, greatest width midway of the test; biconvex in cross section, edge narrowly rounded with a border of clear shell material; chambers few, usually 4, increasing rapidly in size as added, the lower margin of each chamber slightly overhanging the preceding chamber along the periphery; sutures flush with surface of test except for the last one which is slightly depressed; wall smooth and polished; aperture terminal, an elongate slit parallel to the compression of the test. Length, 1.50 millimeters; width, 1.27 millimeters; thickness, 0.63 millimeter.

Holotype No. 3927, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

This species most closely resembles *L. cubensis* Cushman and Bermudez from the Eocene of Cuba (1937. Contr. Cushman Lab. Foram. Res. 13) but differs in its larger size, in the absence of a "distinct, sharp keel", and the absence of any coiled early stage.

Lingulina semicostata NEW SPECIES

PLATE 10. FIGURES 11a, b

Test ovate in side view, thickly elliptical in end view, composed of two chambers, the latter one constituting about two-thirds of the test; edge sharply rounded; sutures depressed; earlier chamber ornamented with narrow, low costae, those near the edge being continuous across the rounded base of the test; later chamber smooth and unornamented except for 5 obscure costae paralleling each edge of the chamber, the middle one being the widest; aperture an elongate slit, terminal and parallel to the compression of the test. Length, 0.85 millimeter; width, 0.72 millimeter; thickness, 0.54 millimeter.

Holotype No. 3928, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

FISSURINA Reuss 1850**Fissurina laevis** Seguenza

PLATE 11, FIGURES 3a, b

Fissurina laevis Seguenza (1862) Foram. Monotal. Miocen. Messina 58. pl. 2, figs. 22, 23. Miocene, Italy.

Test oval in side view; edge sharply angled with two small subsidiary carinae; surface smooth; aperture terminal, fissurine. Length, 0.31 millimeter; width, 0.27 millimeter; thickness, 0.20 millimeter.

Plesiotype No. 4043, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Fissurina marginata (Walker & Boys)

PLATE 11, FIGURES 4a, b

Serpula (Lagena) marginata Walker & Boys (1784) Test. Min. 2. pl. 1, fig. 7. Recent, England. *Vermiculum marginatum* Montagu (1803) Test. Brit. 524.

Test oval in side view, the basal end broadly rounded, apertural end tapering; thick elliptical in end view; entire test bordered by a thin, moderately wide keel of clear shell material; surface smooth; aperture terminal, fissurine, bordered by a thickened lip, and with the sides of the neck excavated. Length, 0.54 millimeter; width, 0.37 millimeter; thickness, 0.17 millimeter.

Plesiotype No. 4044, locality P254, Ponce formation.

Rare at P254 and P255 of the Ponce formation.

Family **POLYMORPHINIDAE** d'Orbigny 1846**POLYMORPHINA** d'Orbigny 1826**Polymorphina terquemiana** Fornasini

PLATE 13, FIGURES 3a-c

Polymorphina amygdaloides terquemiana Fornasini (1902) Mem. Accad. Istit. Sci. Bologna V. 9: 72, fig. 25 (in text). Pliocene, Island of Rhodes.

Sigmomorphina semitecta terquemiana Cushman (1930) Proc. U. S. Nat. Mus. 77 (6): 129, pl. 33, figs. 4, 5, pl. 34, figs. 2, 3, pl. 35, fig. 1. Recent, Mediterranean; Pliocene, Italy; Miocene, France; Eocene, France, Alabama, Georgia.

Test elongate oval in side view, with abruptly tapering initial end and more rounded apertural end, maximum width of the test about midway of the length of the test; in apertural view somewhat compressed; chambers elongate, all extending down nearly to the base, with earlier chambers showing on both sides of the test; sutures scarcely depressed, distinct between the last few chambers; aperture terminal, elliptical, radiate. Length, 0.45 millimeter; width, 0.25 millimeter; thickness, 0.19 millimeter.

Plesiotype No. 4088, locality A79, Los Puertos formation.

Rare at A79 of the Los Puertos formation.

GUTTULINA d'Orbigny 1839**Guttulina basalis** NEW SPECIES

PLATE 13, FIGURES 4a-c

Test elongate oval in side view, maximum width slightly below the middle, tapering to the apertural end, flat at the base; chambers elongate, most of the chambers reaching back beyond the proloculum, the last chamber reaching only about half way back to the base; final chamber most inflated; sutures slightly depressed in the early part of the test, strongly depressed between the last chambers; aperture terminal, round and obscurely radiate. Length, 0.79 millimeter; width, 0.24 millimeter; thickness, 0.22 millimeter.

Holotype No. 4049, locality A21, Quebradillas formation.

Rare at A21 and A64 of the Quebradillas formation.

The Porto Rican species differs from *G. kishinouyei* Cushman and Ozawa (1930. Proc. U. S. Nat. Mus. 77 (6)) in flat apical end and much shorter final chamber.

APIOPTERINA Zborzewski 1834**Apiopterina cylindroides** (Roemer)

PLATE 13, FIGURES 1a-c

Polymorphina cylindroides Roemer (1838) Neues Jahrb. Min. Geol. Pal. 385. pl. 3, fig. 26. Middle Oligocene, Germany.

Pyrulina cylindroides Cushman & Ozawa (1930) Proc. U. S. Nat. Mus. 77 (6): 56. pl. 14, figs. 1-5. Cretaceous to Recent; Eocene and Miocene of Trinidad; Velasco shale, upper Cretaceous, Mexico.

Test small, slender, elongate fusiform, greatest breadth slightly above the middle; chambers elongate, scarcely overlapping, each succeeding chamber farther removed from the base; sutures depressed, distinct; wall smooth; aperture terminal, small, radiate. Length, 0.48 millimeter; width, 0.17 millimeter; thickness, 0.10 millimeter.

Plesiotype No. 4089, locality P259, Ponce formation.

Very rare at P259 of the Ponce formation.

RAPHANULINA* Zborzewski 1834**Raphanulina gibba globosa** (von Münster)

PLATE 13, FIGURES 2a-c

Polymorphina globosa von Münster in Roemer (1838) Neues Jahrb. Min. Geol. Pal. 386. pl. 3, fig. 33. Oligocene and Miocene, northern Germany.

Globulina gibba globosa Cushman & Ozawa (1930) Proc. U. S. Nat. Mus. 77 (6): 64. pl. 17, figs. 8, 9. Recent, northern Atlantic, Mediterranean, southern Pacific; Tertiary, Europe, southeastern U. S., Mexico and Central America.

Test subglobular, broadly oval in cross section; chambers few, 3 or 4 visible; sutures narrow, flush with the surface of the test; aperture terminal, radiate. Length, 0.58 millimeter; width, 0.45 millimeter; thickness, 0.36 millimeter.

Plesiotype No. 3971, locality L2C, San Sebastian formation.

Rare at L2C; common at L5C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, and at A64 of the Quebradillas formation.

Family **NONIONIDAE** Reuss 1860**NONION** Montfort 1808**Nonion chapapotense** Cole

PLATE 13, FIGURES 8a, b

Nonion chapapotensis Cole (1928) Bull. Am. Paleont. 14 (53): 210. pl. 1, figs. 18, 19. Upper Eocene, Mexico.—Cushman (1939) U. S. Geol. Surv. Prof. Pap. 181: 6. pl. 2, figs. 1-3. Upper Eocene, southeastern U. S.

* *Raphanulina* is incorrectly called *Globulina* by most authors, although Zborzewski's name is valid and has priority by five years.

Test small for the genus, slightly compressed; nearly circular in side view, periphery smooth; oval in apertural view; back evenly rounded; umbilical areas filled with clear shell material around which is a groove; 8 chambers in the last whorl, increasing gradually in size; sutures narrow, flush with the surface and marked by clear shell material, gently curving, nearly radial; apertural face slightly convex, median height two-thirds the width; aperture a low arched slit at the base of the last chamber. Diameter, 0.3 millimeter; thickness, 0.13 millimeter.

Plesiotype No. 3937, locality L6C, San Sebastian formation.

Very rare at L6C of the San Sebastian formation.

Our specimens have fewer chambers and smaller umbos than the types of this species.

***Nonion dilatatum* NEW SPECIES**

PLATE 13, FIGURES 6a-c

Test small, broadly ovate in side view with lobulate periphery; ovate in apertural view, bilaterally symmetrical or nearly so, involute beyond the umbilical area on both sides of the test with lobate extensions of the last chamber covering both umbilical areas; back broadly rounded; chambers planispirally arranged, inflated, rapidly enlarging, 6 to 7 in the last whorl; sutures only slightly curved, depressed; aperture at the base of the apertural face on the periphery not reaching to the umbilical areas, in shape a low arch with small upper lip. Diameter, 0.35 by 0.42 millimeters; thickness, 0.29 millimeter.

Holotype No. 4081, locality A43a, Cibao formation.

Rare at A43a of the Cibao formation.

***Nonion multiporatum* NEW SPECIES**

PLATE 13, FIGURES 7a-c

Test oval in side view with lobulate periphery; not quite planispirally coiled, involute just to umbilicus but umbilicate on both sides; chambers rapidly enlarging, particularly in thickness, about 6 in the last whorl; surface smooth and very finely perforate; sutures strongly depressed and slightly curved on both sides; aperture a series of small, round pores at the base of the septal face. Length, 0.35 millimeter; breadth, 0.22 millimeter; thickness, 0.22 millimeter.

Holotype No. 4083, locality A43a, Cibao formation.

Rare at A43a of the Cibao formation.

This is one of the few species of *Nonion* which has a series of pores instead of the usual crescentic aperture.

Nonion nicobarense Cushman

PLATE 10, FIGURES 1a, b

- Nonionina umbilicatula* Brady (1884) Rep. Voy. Challenger Zool. 9: 726. pl. 109, figs. 8, 9. Recent, West Indies and all oceans.—Cushman (1914) Bull. U. S. Nat. Mus. 71 (4): 24. pl. 17, fig. 1a-c. Recent, all oceans; (1918) U. S. Geol. Surv. Bull. 676: 69. pl. 26, fig. 6a, b. Middle Miocene, Maryland.—Cushman & Applin (1926) Bull. Am. Assoc. Pet. Geol. 10: 182. pl. 10, figs. 14, 15. Upper Eocene, Texas.
- Nonion umbilicatulus* var. Cushman (1927) Jour. Paleont. 1: 156. pl. 25, figs. 12, 13. Lower Oligocene, Mexico.
- Nonion cf. umbilicatulus* var. Cole (1927) Bull. Am. Paleont. 14 (51): 23. pl. 5, fig. 6. Eocene, Guayabal formation, Mexico.
- Nonion nicobarensis* Cushman (1936) Contr. Cushman Lab. Foram. Res. 12: 67. pl. 12, fig. 9a, b. Pliocene, Kar Nicobar.

Test small for the genus, subcircular in side view, periphery smooth not lobulate; subelliptical in apertural view; back rounded; test biumbilicate; 9–11 chambers in the last whorl, gradually increasing in size; sutures nearly radial, slightly curved, meeting the umbilical ring at an angle of about 60°; sutures flush with the surface, limbate and fusing around the umbilicus to form a continuous limbate ring; wall smooth, coarsely perforate; apertural face convex, nearly equidimensional; aperture a narrow elongate arch on the inner margin of the last septal face, with strong lip. Diameter, 0.24 by 0.32 millimeters; thickness, 0.18 millimeter.

Plesiotype No. 3938, locality P254, Ponce formation.

Rare at A43a and A86 of the Cibao formation, at A21 of the Quebradillas formation, and at P254 of the Ponce formation.

Nonion pompilioides (Fichtel & Moll)

PLATE 14, FIGURES 1a, b

- Nautilus pompilioides* Fichtel & Moll (1798) Test. Micr. 31. pl. 2, figs. a-c. Recent, Mediterranean; Pliocene, Italy.
- Nonionina pompilioides* Brady (1884) Rep. Voy. Challenger Zool. 9: 727. pl. 109, figs. 10–11. Recent, widespread.
- Nonion pompilioides* Galloway & Morrey (1929) Bull. Am. Paleont. 15 (55): 43. pl. 6, figs. 15a, b. Lower Oligocene, Ecuador.—Cushman (1929) Contr. Cushman Lab. Foram. Res. 5: 89. pl. 13, figs. 25a, b. Middle Tertiary, Ecuador, Venezuela, and Trinidad.

Test of average size for the genus, very thick; subcircular in side view, nearly as broad as long, closely coiled; broadly ovate in apertural view; back smooth, broadly rounded; umbilici moderately large and deep; 6–8 chambers in last whorl, enlarging slowly and uniformly in all dimensions; sutures narrow, nearly radial, marked by clear shell material, flush with the surface except between the last few chambers where they are slightly depressed; wall smooth, polished, coarsely perforate; apertural face convex, subrectangular in shape, much wider than high; aperture an elongate arch at base of the apertural face.

Diameter of average specimen, 0.38 by 0.47 millimeters; thickness, 0.37 millimeter.

Plesiotype No. 3939, locality P2, Ponce formation.

Rare at A86 of the Cibao formation. Common at P2, P3, P254, and P255; rare at P431 of the Ponce formation.

Nearly all of the Porto Rican specimens are slightly asymmetrical. This is shown in figures by various authors and this slight degree of asymmetry seems to be permissible in the genus *Nonion*, since there is no umbilical extension of the last chamber on either side of the test.

***Nonion subgrateloupi* NEW SPECIES**

PLATE 14, FIGURES 2a, b, and 3a, b

Test of average size for the genus; ovate in side view, periphery smooth; elliptical in edge view; edge rounded, more sharply so in early portion of the last whorl; umbilici small, ornamented by about 30 rather small papillae; chambers 12–13 in the last whorl, elongate, increasing most rapidly in a radial direction, last few chambers tending to uncoil; sutures very little depressed, gently curved; wall smooth, polished, very finely perforate; apertural face convex, with slightly convex or nearly parallel sides, height nearly twice the width; aperture a narrow arch at base of the apertural face. Length, 0.57 millimeter; width, 0.37 millimeter; thickness, 0.23 millimeter.

Holotypes No. 3940a, b, locality L5C, San Sebastian formation.

Rare at L4C; common at L5C of the San Sebastian formation. Abundant at A79 of the Los Puertos formation.

Rare at P251; common at P259; abundant at P253 and P258 of the Ponce formation.

This species is thicker than typical *N. grateloupi* (d'Orbigny) from the Recent of Cuba, and has distinctive papillate ornamentation in the umbilical region. There are obvious similarities between this and the topotype figures of *N. elongatum* (d'Orbigny) as figured by Cushman (1939. U. S. Geol. Surv. Prof. Pap. 191), but *N. subgrateloupi* has a more compressed test and less pronounced umbilical filling.

PSEUDONONION Asano 1936

***Pseudononion papillatum* NEW SPECIES**

PLATE 14, FIGURES 4a–c

Test asymmetrical, broadly oval in side view, narrowly oval in edge view; chambers arranged in a very low, nearly planispiral coil, early whorls showing on one side, umbilicate on the other side with

papillate filling of secondary shell material which extends out for a varying distance along the sutures; edge evenly rounded; periphery slightly lobulate; about ten chambers in the last whorl; sutures distinct, gently curved, slightly depressed; wall very finely perforate; aperture a low arch with lip on the inner periphery at the base of the last septal face, not extending into the umbilicus. Diameter, 0.41 by 0.55 millimeter; thickness, 0.29 millimeter. Other specimens range up to 0.7 millimeter in diameter.

Holotype No. 4072, locality A43a, Cibao formation.

Abundant at A43a of the Cibao formation.

Since the test is asymmetrical and therefore not *Nonion*, and none of the chambers extend into the umbilicus as they do in *Nonionella*, these specimens are referred to Asano's new genus, *Pseudononion* (1936. Trans. Paleont. Soc. Japan 15). The form resembles *Globorotalia* except for the nonionine aperture.

NONIONELLA Cushman 1926

Nonionella modesta NEW SPECIES

PLATE 13, FIGURES 5a-c

Test broadly ovate and very little lobulate in side view; narrowly oval in edge view; dorsal side partially involute, umbilicate, with a small part of the spire showing; ventral side involute with a narrow, raised, lobate extension of the last chamber covering the umbilicus; back evenly rounded, becoming more broadly rounded in the latter part of the last whorl; 9-10 chambers in the last whorl, slightly inflated in last 2 or 3 chambers, increasing gradually in height and more rapidly in width (radially) as added; sutures distinct, gently curved, slightly depressed between last few chambers; wall smooth, finely perforate; apertural face convex, elongate, with subparallel sides; aperture a narrow arch at the base of the last chamber on the periphery, extending onto the ventral side. Length, 0.30 millimeter; width, 0.21 millimeter; thickness, 0.12 millimeter.

Holotype No. 3941, locality L1C, San Sebastian formation.

Rare at L3C and L6C; common at L1C of the San Sebastian formation.

This form has more chambers and is thinner than *N. pauciloba* Cushman (1935. Contr. Cushman Lab. Foram. Res. 11). It has fewer chambers and is less lobulate than *N. auris* (d'Orbigny) (1839. Voy. Amer. Merid.). It is not typical *N. pseudo-auris* Cole (1931. Fla. Geol. Surv. Bull. 6) since it has more chambers and is more com-

pressed. *N. modesta* is not trochoid on the dorsal side as *N. danvillensis* Howe and Wallace (1932. La. Dept. Cons. Geol. Bull. 2).

PULLENIA Parker & Jones 1862

Pullenia bulloides (d'Orbigny)

PLATE 15, FIGURES 4a, b

Nonionina bulloides d'Orbigny (1826) Ann. Sci. Nat. 7: 293. Pliocene, Italy; (1846) Foram. Foss. Vienne 107. pl. 5, figs. 9-10. Middle Miocene, Vienna.

Pullenia spheroides Cushman (1924) Bull. U. S. Nat. Mus. 104 (5): 40. pl. 8, figs. 3, 4. Recent, western Atlantic.

Pullenia bulloides Galloway & Morrey (1929) Bull. Am. Paleont. 15 (55): 43. pl. 6, fig. 16. Lower Oligocene, Ecuador. ♀

Test small, globular, bilaterally symmetrical with axial and equatorial diameters nearly equal; 4 chambers in the last whorl enlarging gradually; sutures nearly flush, narrow, almost radial; wall very finely perforate; aperture a narrow slit at the base of the low septal face with narrow upper lip. Diameter, 0.31 millimeter; thickness, 0.28 millimeter.

Plesiotype No. 4087, locality P254, Ponce formation.

Rare at P254 and P255 of the Ponce formation.

ELPHIDIUM Montfort 1808

Elphidium lanieri (d'Orbigny)

PLATE 14, FIGURES 7a, b

Polystomella lanieri d'Orbigny (1839) in De la Sagra, Hist. Phy. Pol. Nat. Cuba Foraminifères 54. pl. 7, figs. 12, 13. Recent, Cuba.

Elphidium lanieri Cushman (1939) U. S. Geol. Surv. Prof. Pap. 191: 55. pl. 15, fig. 4. Recent, Florida, Jamaica, Cuba; Miocene, Cuba.

Test of medium size, lenticular, subcircular in side view, elliptical in edge view with sharply rounded back, sharper in young stages; periphery smooth, not lobulate; umbilical regions filled, forming the greatest thickness of the test but forming a continuous smooth line with the sides; chambers not inflated, short, closely appressed, 18-20 or more chambers in the last whorl; sutures curved slightly, marked by elongate septal bridges, about 10 between the last two chambers on one side of the test, separated by oval depressions; septal bridges slightly oblique, merging into oblique ridges; umbilical filling ornamented by numerous pores, nodes or irregular welts; aperture consisting of several small round openings at the base of the apertural face. Diameter, 0.71 by 0.88 millimeter; thickness, 0.55 millimeter.

Plesiotype No. 4102, locality P258, Ponce formation.

Abundant at P258 and P259 of the Ponce formation.

This species is larger than *E. sagrai* and the edge is narrower.

Elphidium lens NEW SPECIES

PLATE 14, FIGURES 10a, b

Test rather large, subcircular in side view, periphery not lobulate; elliptical in edge view, thickness less than half the diameter, back narrowly rounded; umbilical region evenly umbonate and filled with clear shell material bearing 10–15 irregularly arranged subcircular pits; umbilical filling separated by a distinct, shallow, curved depression from the chambers of the last half volution; chambers closely appressed, 28–30 in the last whorl; sutures not depressed at the periphery but depressed slightly toward the umbo, marked by 15–20 septal bridges between the last 2 chambers on one side of the test; septal bridges very short, about $\frac{1}{2}$ chamber in length, and only slightly elongate in direction of coiling enclosing elliptical depressions; septal bridges of successive sutures form lines that spiral outward from the umbonal region; aperture a series of pores at the base of the last septal face, and several pits on the last septal face. Diameter, 0.83 by 0.98 millimeter; thickness, 0.42 millimeter.

Holotype No. 3905, locality L4C, San Sebastian formation.

Abundant at L5C and L6C; common at L3C and L4C; rare at L2C of the San Sebastian formation.

E. lens differs from *E. craticulatum* (Fichtel & Moll) (1798. Test. Micr.) in the smaller size, fewer chambers, thinner test, rounded edge, smaller umbonal region, and more curved sutures. It is possible that *Polystomella craticulata* Cushman (not Fichtel & Moll) (1918. Bull. U. S. Nat. Mus. **103**) from the Culebra formation of the Panama Canal Zone should be placed in synonymy with *E. lens*. The Panama Canal form seems to differ only in having about 40 instead of 28–30 chambers in the last whorl.

E. lens differs from *E. lanieri* (d'Orbigny) from the Recent of Cuba in being relatively thinner and in being elliptical rather than diamond shaped in edge view, with smaller umbonal region and more chambers. It differs from *E. chapmani* Cushman (1936. Contr. Cushman Lab. Foram. Res. **12**) in its elliptical not rhomboidal edge view, in its higher apertural face, and in its smaller test.

Elphidium lobatum NEW SPECIES

PLATE 14, FIGURES 8a, b

Test small for the genus, nearly involute with a slight umbilicus, subelliptical in side view, early part of test much thinner than the later part where inflation of the last few chambers increases rapidly; periphery lobate; back broadly rounded; chambers numerous, 9–10 in the last whorl, increasing rapidly in size, inflated, last chamber becoming nearly circular in apertural view, except for the impressed zone of the previous whorl; sutures distinct, sharply depressed, smoothly curved, marked by a series of broad retral processes and 8–10 small semi-circular depressions; aperture a row of pores at the inner margin of the last septal face. Diameter, 0.17 to 0.45 millimeters; thickness, 0.23 to 0.27 millimeters.

Holotype No. 3906, locality A6, Lares formation.

Rare at A6 of the Lares formation and at F359 of the Quebradillas formation.

The specific name *lobatum* refers to the markedly lobate outline of the test in side view.

This species differs from *E. poeyanum* in that the chambers are more inflated, the sutures are more depressed, the periphery is more lobate, and the shape of the apertural face is more nearly circular.

Elphidium nautiloideum NEW SPECIES

PLATE 14, FIGURES 5a, b

Test small for the genus, nautiloid, sides nearly parallel in edge view, subcircular in side view, not lobulate, except very slightly in the last few chambers; back makes a parabolic curve with the sides of the test; umbilici about $\frac{1}{4}$ the diameter of the test, depressed and papillate; chambers distinct, 12–15 in the last whorl; sutures slightly curved, radial, only a little depressed, marked by inconspicuous, short retral processes and small oval depressions, 12–15 between the last two chambers on one side of the test; surface smooth; wall finely perforate; height of the apertural face in median line about $\frac{2}{3}$ the maximum width which comes in line with base of last septal face on the periphery; aperture a series of pores at the base of the last septal face, and a few scattered pores on the septal face. Average specimen, 0.34 by 0.41 millimeter in diameter and 0.21 millimeter thick. Maximum size, 0.45 by 0.49 millimeter; thickness, 0.21 millimeter.

Holotype No. 3907, locality L5C, San Sebastian formation.

Rare at L2C, L5C, and L6C; common at L1C of the San Sebastian formation. Rare at F64 of the Quebradillas formation.

E. nautiloideum differs from *E. poeyanum* (d'Orbigny) in the more numerous chambers and less lobulate periphery; from *E. australe* Cushman and Parker (1931. Proc. U. S. Nat. Mus. **80** (3)) in having less depressed sutures and less papillate ornamentation; and from *E. incertum* (Williamson) (1858. Recent Foram. Gt. Brit.) in having papillate umbilici, more chambers, nearly radial sutures and more retral processes.

***Elphidium owenianum* (d'Orbigny)**

PLATE 14, FIGURES 9a, b

Polystomella Oweniana d'Orbigny (1839) Voy. Amér. Mérid. **5** (5): Foraminifères 30. pl. 3, figs. 3, 4. Recent, "coast of Patagonia, to the south of the Rio Negro."

Elphidium owenianum Cushman (1930) Bull. U. S. Nat. Mus. **104** (7): 21. pl. 8, figs. 10-12. Recent, Falkland Islands.

Test of medium size for the genus, lenticular; periphery subacute; margin entire, with narrow keel; test lenticular in peripheral view, greatest thickness at the umbilical regions which are not distinctly umbonate but are filled with clear shell material, usually pitted; chambers numerous, distinct, 16-20 in the last whorl; sutures limbate, with elongate, rod-like retral processes which extend almost the entire height of the chamber; near the periphery the limbate sutures curve posteriorly and merge with a keel of clear shell material; in a normal ephebic form about 15 retral processes between the last two chambers on one side of the test; apertural face subtriangular; aperture consisting of round pores at the base of the septal face and scattered round openings on the apertural face. Average specimen, 0.71 by 0.81 millimeter in diameter and 0.28 millimeter thick. Figured specimen, 0.64 by 0.72 millimeter in diameter and 0.28 millimeter thick.

Plesiotype No. 3908, locality L5C, San Sebastian formation.

Rare at L1C; common at L2C, L4C, L5C, and L6C; abundant at L3C of the San Sebastian formation. Rare at A43a; common at A86 of the Cibao formation. Abundant at A79 of the Los Puertos formation. Rare at P254 of the Ponce formation.

This form is with difficulty distinguishable from *E. crispum*. *E. owenianum* is smaller, less umbonate, and more definitely keeled.

***Elphidium poeyanum* (d'Orbigny)**

PLATE 14, FIGURES 6a, b

Polystomella Poeyana d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 55. pl. 6, figs. 25, 26. Recent, Cuba, Jamaica.—Cushman (1922) Carnegie Inst. Wash. Publ. 311: 55. pl. 9, figs. 9, 10. Recent, Tortugas.

Elphidium poeyanum Cushman (1930) Bull. U. S. Nat. Mus. 104 (7): 25. pl. 10, figs. 4, 5. Recent, West Indies; (1933) U. S. Geol. Surv. Prof. Pap. 175A: 21. pl. 7, figs. 7a, b. Miocene, West Indies and coastal plain of eastern U. S.

Test small for the genus, compressed, subcircular in side view, with lobate margin, oval in peripheral view; back rounded; umbilical regions slightly depressed; 8–11 chambers in the last whorl, distinct, slightly inflated; sutures nearly radial, slightly depressed, marked by short, broad septal bridges and oval pores, 12–15 between the last two adult chambers on one side of the test; surface smooth; apertural face about as high as wide; aperture a series of rounded openings at the base of the septal face and a few scattered pores on the septal face. Diameter, 0.27 by 0.33 millimeter; thickness, 0.14 millimeter. Maximum size: diameter, 0.38 by 0.45 millimeter; thickness, 0.28 millimeter.

Plesiotype No. 3909, locality L1C, San Sebastian formation.

Common at L1C; rare at L3C of the San Sebastian formation. Rare at A6 of the Lares formation. Common at A79 of the Los Puertos formation. Rare at F359; common at F64 and F358 of the Quebradillas formation. Rare at P255; common at P258 and P259 of the Ponce formation.

Elphidium puertoricense NEW SPECIES

PLATE 15, FIGURES 2a, b

Test subcircular in side view, margin entire, slightly lobulate in last few chambers; sides nearly parallel in apertural view; back broadly rounded; umbilici small, very slightly depressed, with small tubercles; chambers 12–15 in last whorl, in last portion distinct, very little inflated; sutures not depressed except between the last few chambers, marked by long, narrow septal bridges which are continuous over the early part of the test to form ridges slightly oblique to the periphery, in a normal ephebic form about 16–20 septal bridges between the last two chambers on one side of the test; depressions between septal bridges very narrow and long, usually in a double series; apertural face wider than high; aperture a series of small round openings at the base of the apertural face, and scattered pores on the septal face. Diameter, 0.54 by 0.68 millimeter; thickness, 0.38 millimeter.

Holotype No. 3911, locality L6C, San Sebastian formation.

Rare at L1C, L2C, L5C, and L6C; common at L4C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, and at F359 of the Quebradillas formation. Common at P259 of the Ponce formation.

This species differs from *E. sagrai* in being larger, and broader and flatter along the back; the apertural face is lunate in outline, not subtriangular; the number of septal bridges along the sutures is greater, 18 instead of 7 or 8 as in *sagrai*; the ridges formed by the continuous septal bridges in the early part of the test are finer and not as conspicuously spiral as in *E. sagrai*.

E. puertoricense differs from *E. sagrai crassum* in having a more lobulate outline, in being umbilicate instead of umbonate, and in having more septal bridges (15–18 instead of 10–12) which are not as clearly continuous from chamber to chamber and are not raised into ridges.

***Elphidium sagrai* (d'Orbigny)**

PLATE 15, FIGURES 3a, b

Polystomella Sagra d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 55. pl. 6, figs. 19, 20. Recent, Cuba.

Elphidium sagram Cushman (1929) Bull. U. S. Nat. Mus. 104 (7): 24. pl. 9, figs. 5, 6. Recent, West Indies; late Tertiary, West Indies, Florida.—Cushman (1933) U. S. Geol. Surv. Prof. Pap. 175A: 22. pl. 7, figs. 9a, b. Miocene of West Indies, Florida, North Carolina.

Test small for the genus, not compressed, subcircular in side view, subovate in edge view, widest portion of test in last chamber midway between umbilicus and periphery; periphery not lobate; edge rounded; umbilical regions somewhat depressed; chambers numerous, 10–12 in last adult whorl, last formed chambers slightly inflated; sutures not depressed except between last 2 or 3 chambers and marked by retral processes which are continuous over early part of test to form spiral ridges, oblique to the periphery; aperture a series of small round openings at base of the apertural face. Diameter, 0.27 by 0.36 millimeter; thickness, 0.20 millimeter.

Plesiotype No. 4139, locality L1C, San Sebastian formation.

Rare at L2C, L3C, and L5C; common at L1C and L6C of the San Sebastian formation. Rare at A86 of the Cibao formation. Common at A79 of the Los Puertos formation. Rare at F64, A46, and A15; common at F358; abundant at F359 of the Quebradillas formation. Common at P258 and P259 of the Ponce formation.

This species was evidently named by d'Orbigny for his patron, De la Sagra, and the form of the specific name should therefore be *sagrai* instead of *sagra* or *sagram*.

There is considerable individual variation within this species. The larger individuals are thicker in proportion, have more septal bridges and a broader apertural face. All intermediate stages may be found.

Elphidium sagrai crassum NEW VARIETY

PLATE 15, FIGURES 1a, b

Test of medium size for the genus, little compressed; periphery not lobulate; edge broadly rounded, more rounded near the apertural end; chambers numerous, 11–12 in the last whorl; sutures not depressed, rather obscure, marked by longitudinal septal bridges which form continuous ridges with a somewhat spiral pattern on the earlier portions of the test; depressions between septal bridges are narrow and slit-like; 14 septal bridges between last 2 chambers on each side of test; apertural face lunate, twice as wide as high; aperture a row of round pores at base of last septal face. Diameter, 0.36 by 0.43 millimeters; thickness, 0.27 millimeter.

Holotype No. 3910, locality L1C, San Sebastian formation.

Rare at L1C, L2C, and L6C of the San Sebastian formation. Rare at A91a; common at A79 of the Los Puertos formation. Rare at F64 and F358; common at F359 of the Quebradillas formation. Rare at P258, P259, and 434 of the Ponce formation.

E. sagrai crassum differs from *E. chipolense* (Cushman) (1921. U. S. Geol. Surv. Prof. Pap. 128B 72. pl. 11, fig. 23) in being smaller and thicker. It differs from *E. sagrai* (d'Orbigny) in that the sutural depressions of *E. sagrai crassum* are more elongate, and the apertural face is more lunate without the sharply rounded peripheral angle. It differs from *E. puertoricense* in that the spiral costae are stronger, and the test thickens more rapidly. It differs from *E. rugosum* (d'Orbigny) from the Vienna Basin Miocene in being thicker and in the resultant different shape of the apertural face.

ANTILLESINA NEW GENUS

Genotype, *Nonion ? marielensis* Palmer (1936) Mem. Soc. Cubana Hist. Nat. 10: 127. text figs. 1–3. Lower Oligocene, Cuba.

Test free, planispiral throughout, involute, non-umbilicate, becoming more embracing as more chambers are added; round on the back; chambers numerous, 4 to 7 in the last whorl, inflated; sutures depressed; wall calcareous, finely perforate; surface costate; aperture absent or represented by small pores on the septal face. Length, 0.24 to 0.50 millimeter. Shallow water marls. Eocene of Egypt, Oligocene of West Indies.

Although we have about 40 specimens, many of them well preserved, not one shows a crescentic aperture and even the pores on the septal face are scarcely larger than the pores elsewhere on the test.

This species and the form figured by Schwager as *Polystomella* ? *obscura* from the Eocene of Egypt (1883. Paleontogr. **30** (2): 138. pl. 27, figs. 2a-c) are the only known members of this new genus.

The significant characteristics of this genus, whereby it differs from *Nonion*, are its aperture, its completely involute test, and its costate ornamentation. The most closely related genus is *Pullenia*, rather than *Nonion*. *Antillesina* differs from *Pullenia* only in its porous aperture and costate ornamentation.

Antillesina marielensis (Palmer)

PLATE 10, FIGURES 12a, b and 13a-c

Nonion ? *marielensis* Palmer (1936) Mem. Soc. Cubana Hist. Nat. **10**: 127. text figs. 1-3. Lower Oligocene, Cuba.

Test small, mature specimens nearly spherical; back broadly rounded; 4 to 6 chambers in the last whorl, increasing rapidly in size, inflated; the axial diameter of the last chamber varies from 3 to 5 times that of the earliest, smallest chamber in the last whorl; chambers planispirally arranged, involute to umbilicus, or more, the later chambers progressively more embracing with a smaller number in the latest whorl; in apertural view the maximum thickness of the final chamber is seen, and it is about three times the thickness of the earliest chamber of the last whorl; sutures depressed, nearly radial; apertural face convex, low and broad; aperture obscure, evidently consisting of the scattered pores on the last septal face; wall hyaline, finely perforate; surface of test ornamented by numerous fine, narrow, low, longitudinal costae which continue down onto the last septal face but which are not continuous across the sutures, 7 to 10 costae on each side of the test, more prominent on the last few chambers. Diameter, 0.24 by 0.31 millimeter; thickness, 0.24 millimeter.

Plesiotypes No. 4063, locality L1C, San Sebastian formation, and No. 3943, locality P254, Ponce formation.

Rare at L1C of the San Sebastian formation. Abundant at P254 and P255; rare at P2, P3, and P258 of the Ponce formation.

Family **ROTALIIDAE** Reuss 1860**GLOBOROTALIA** Cushman 1927**Globorotalia menardii** (d'Orbigny)

PLATE 16, FIGURES 5a-c

Rotalia menardii d'Orbigny (1826) Ann. Sci. Nat. 7: 273. no. 26; Model no. 10. Recent, Adriatic.

Pulvinulina menardii Brady (1884) Rep. Voy. Challenger Zool. 9: 690. pl. 103, figs. 1, 2. Recent, world wide.—Nuttall (1928) Quart. Jour. Geol. Soc. London 84: 101. pl. 7, fig. 20. Oligocene and lower Miocene, Trinidad.

Globorotalia menardii Cushman (1930) Fla. Geol. Surv. Bull. 4: 60. pl. 12, fig. 1. Middle and upper Miocene, Florida.—Nuttall (1932) Jour. Paleont. 6: 29. pl. 4, fig. 16. Lower Oligocene, Mexico.—Hadley (1934) Bull. Am. Paleont. 20 (70A): 25. pl. 3, figs. 12, 13. Oligocene, Cuba.—Coryell & Rivero (1940) Jour. Paleont. 14: 336. pl. 42, figs. 34, 35. Middle Miocene, Haiti.

Test compressed, moderately convex on the ventral side, less convex on the dorsal side; edge with a conspicuous, rounded keel; test generally oval in side view, periphery lobulate, the lobulation being more pronounced in the last few chambers; early whorls showing on the dorsal side, involute and umbilicate on the ventral side; 5 to 7 chambers in the last whorl, increasing rather rapidly in size; sutures distinct, gently curved on the dorsal side, nearly radial ventrally; slightly depressed on the ventral side, limbate and flush or slightly raised on the dorsal side; ventral surface near aperture covered with granulations; aperture large, ventral, opening into the umbilicus with a slight valvular lip. Diameter, 0.68 by 0.88 millimeter; thickness, 0.36 millimeter.

Plesiotype No. 4082, locality A21, Quebradillas formation.

Common at A21; abundant at A93 of the Quebradillas formation.

LAMARCKINA Berthelin 1831**Lamarckina echinata** NEW SPECIES

PLATE 15, FIGURES 5a-c

Test minute, oval in side view, pyriform in edge view, biconvex, dorsal side moderately convex, ventral side deep, with large umbilicus; periphery lobulate and spinose; edge sharply rounded to broadly rounded; whorls about 2, rapidly enlarging; chambers about 5 in the last whorl, rapidly increasing in size in all dimensions as added, the last chamber making up about half the test on the ventral side; sutures on both sides obscure, slightly curved and slightly depressed, not limbate; surface covered with small, close-set spines, variable in size, largest on the last chamber and on the margin and back, smallest on the ventral septal face; wall finely but conspicuously per-

porate, the perforations not covered by the spines but continuing between them as the spines are built; aperture a low arch at the base of the septal face, at one side of the umbilicus but opening into it, with small upper lip. Longest diameter, 0.36 millimeter; thickness of last chamber, 0.24 millimeter.

Holotype No. 4111, locality P4, Ponce formation.

Rare at P4 of the Ponce formation.

This species is most like "*Discorbina*" *tuberculata* Balkwill & Wright, but differs in the larger umbilicus, more highly spinose surface; the pores do not emerge at the ends of the spines, and the aperture is farther toward the periphery.

VALVULINERIA Cushman 1926

Valvulineria maclureaformis NEW SPECIES

PLATE 16, FIGURES 1a-c

Test oval in side view, with nearly smooth periphery; biconvex, the dorsal side nearly flat, ventral side very deep; edge narrowly rounded to truncate in the last chambers; chambers not inflated, about 7 in the last whorl, enlarging rapidly radially and in thickness but not in length; less than 2 whorls; sutures on the dorsal side strongly and regularly curved, limbate and slightly raised, marked by broad bands of clear shell material; sutures on the ventral side slightly curved, slightly raised, marked by broad bands of clear shell material; ventral side with large, deep umbilicus; dorsal side with a slight amount of secondary wall material, thickest near the middle, slightly obscuring the spire; wall finely but distinctly perforate; aperture a slit opening into the umbilicus and extending less than half way towards the periphery, partly covered by a valvular lip. Diameter, 0.73 millimeter; thickness, 0.45 millimeter.

Holotype No. 4113, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

This form somewhat resembles forms which have been included in *Cibicides* (1935. U. S. Geol. Surv. Prof. Pap. **181**: pl. 23), but neither the aperture nor the mural pores are like those of *Cibicides*. The specific name was suggested because of the resemblance of this form to the gastropod genus *Maclurites*.

Valvulineria nuttalli Palmer & Bermudez

PLATE 16, FIGURES 2a-c

? *Cancris sagra* Nuttall (1932) Jour. Paleont. 6: 27. pl. 6, figs. 6, 7. Lower Oligocene, Mexico.
Valvulineria nuttalli Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 300. pl. 19, figs. 3-5. Lower Oligocene, Cuba.
Valvulineria inaequalis Coryell & Rivero (1940) Jour. Paleont. 14: 338. pl. 43, figs. 26a-c. Middle Miocene, Haiti.

Test large, biconvex, elongate oval in side view, narrowly elliptical in edge view; periphery smooth; edge narrowly rounded; about 2 whorls in the test, earlier whorls visible on the dorsal side, involute on the ventral side with chambers terminating in slightly elevated lobes around the umbilicus; chambers enlarging rather rapidly in all three dimensions, closely appressed, 7 to 8 in the last whorl; sutures narrow, on dorsal side flush with the surface, slightly curved between early chambers, tending to become radial between the last few chambers, on ventral side radial, depressed near the umbilicus; aperture obscure due to poor preservation, opening into the umbilicus and covered by a valvular process. Length, 1.29 millimeter; width, 0.73 millimeter; thickness, 0.49 millimeter.

Plesiotype No. 4028, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

As stated by Palmer and Bermudez, *V. nuttalli* differs from *V. inaequalis* (d'Orbigny) (1839. Voy. Amer. Merid. 5 (5)) in having "fewer chambers in the final whorl and a more broadly oval outline in side view".

Valvulineria palmarealensis (Nuttall)

PLATE 16, FIGURES 3a-c

Globorotalia palmarealensis Nuttall (1932) Jour. Paleont. 6: 30. pl. 7, figs. 1-3. Lower Oligocene, Mexico.

Test somewhat compressed, biconvex, ventral side more so than the dorsal; edge narrowly rounded; test broadly oval in side view, periphery smooth; dorsally with two whorls visible, ventrally umbilicate; 9 chambers in the last whorl, enlarging rather rapidly; sutures distinct, gently curved on the dorsal side, nearly radial on the ventral side; sutures narrowly limbate, flush with the surface; wall finely perforate; aperture ventral, opening into the umbilicus and extending part way to the periphery, with a large, lobate, overhanging valvular extension of the last chamber. Diameter, 0.60 millimeter; thickness, 0.27 millimeter.

Plesiotype No. 4029, locality P3, Ponce formation.

Very rare at P2 and P3 of the Ponce formation.

This species is very close to *Valvulineria nuttalli*, which was described by Palmer and Bermudez from the Oligocene of Cuba. Both forms were found by Nuttall in the Alazan of Mexico and it may be that better suites of specimens will show that they are the same species. *V. nuttalli*, "differs in having fewer chambers, a more oval outline in side view and a greatly enlarged final chamber".

***Valvulineria paucilocula* Cushman**

PLATE 16, FIGURES 4a-c

Valvulineria paucilocula Cushman (1935) Contr. Cushman Lab. Foram. Res. 11: 37. pl. 5, figs. 7a-c. Lower Oligocene, Mississippi.

Test oval in side view, narrowly ovate in edge view; back broadly rounded; periphery lobate; chambers distinct, inflated, typically 5 in the last whorl, enlarging rapidly, last chamber constituting about one-third of the test, particularly on the ventral side; dorsally with the early whorls depressed below the final whorl; ventrally umbilicate; sutures distinct, depressed, oblique and slightly curved on the dorsal side, nearly radial on the ventral side; wall conspicuously perforate except for a clear area above the aperture on each chamber on the ventral side of the test; aperture at the base of the last chamber opening into the umbilical vestibule with a slight valvular projection of the last chamber. Diameter, 0.54 by 0.70 millimeter; thickness, 0.40 millimeter.

Plesiotype No. 4030, locality P4, Ponce formation.

Rare at A79 of the Los Puertos formation and at A43a of the Cibao formation. Common at P431; abundant at P4 of the Ponce formation.

This species differs from *V. cubana* Palmer and Bermudez from the Eocene of Cuba (1936. Mem. Soc. Cubana Hist. Nat. 10) in the open umbilicus and absence of fingerlike processes near the umbilicus; also the last chamber is larger than in *V. cubana*.

EPONIDES Montfort 1808

***Eponides advena* (Cushman)**

PLATE 17, FIGURES 5a-c

Rotalia advena Cushman (1923) U. S. Geol. Surv. Prof. Pap. 133: 46. pl. 7, figs. 4-6. Lower Oligocene, Alabama.

Eponides advena Cole & Ponton (1930) Fla. Geol. Surv. Bull. 5: 42. pl. 11, figs. 11, 12. Lower Oligocene, Florida.

Test nearly circular in side view, unequally biconvex, the ventral side the deeper; periphery not lobulate; edge bluntly angled; 5 to 6

chambers in the last whorl, not inflated, enlarging gradually; whorls about 3, the earlier ones on the dorsal side covered with secondary material, the last whorl barely discernible; ventral side with small umbilical depression, not covered with secondary material; sutures on the dorsal side narrowly limbate, flush with the surface, oblique and tangential to the previous whorl; sutures on the ventral side nearly straight and radial, slightly depressed; surface on both sides smooth; aperture a small arch midway between umbilicus and periphery, at the base of the septal face, with slight upper lip. Diameter, 0.8 millimeter; thickness, 0.5 millimeter.

Plesiotype No. 4104, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

The form figured by Palmer and Bermudez from the Oligocene of Cuba (1936. Mem. Soc. Cubana Hist. Nat. **10**: pl. 19, figs. 16, 17) as *E. nana* (Reuss), is almost identical with the Porto Rican form here referred to *E. advena*, the differences being the smaller size, and as stated in their description, "ventral surface umbonate", although this does not seem particularly conspicuous in their figure.

***Eponides ellisorae* Garrett**

PLATE 17, FIGURES 4a-c

Eponides ellisorae Garrett (1939) Jour. Paleont. **13**: 579. pl. 66, figs. 6-8. Middle Tertiary, Texas.

Test subcircular, with slightly lobulate periphery, biconvex, a little deeper on the ventral side, with small umbilicus; edge angled but not carinate; whorls 2 to 3, those on the dorsal side obscured by a slight secondary deposit; chambers about 6 in the last whorl, enlarging very little as added; ventral sutures nearly radial and slightly curved, very little depressed and not limbate; dorsal sutures slightly curved, tangential to the previous whorl, flush with the surface and marked by clear shell material which runs out onto the periphery; surface smooth; aperture an elongate slit extending from near the umbilicus to near the periphery, enlarging outwardly, with strong upper lip. Diameter, 0.67 millimeter; thickness, 0.41 millimeter.

Plesiotype No. 4100, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This species bears obvious resemblances to "*Pulvinulina*" *byramensis* Cushman (1922. U. S. Geol. Surv. Prof. Pap. **129E**) and to *Rotalia advena* Cushman ((1923) U. S. Geol. Surv. Prof. Pap. **133**),

but differs from both in the lobulate periphery, sharper edge, and less dorsal deposit.

Eponides exiguus (Brady)

PLATE 17, FIGURES 1a-c

Pulvinulina exigua Brady (1884) Rep. Voy. Challenger Zool. 9: 696. pl. 103, figs. 13, 14. Recent, Atlantic and Pacific Oceans.

Eponides exigua Cushman (1931) Bull. U. S. Nat. Mus. 104 (8): 44. pl. 10, figs. 1, 2. Recent, north Atlantic.

Test small for the genus, about equally biconvex; edge bluntly angled; slightly lobulate in dorsal view, usually 6 chambers in the last whorl, about $2\frac{1}{2}$ whorls in the test; chambers of uniform shape, gradually increasing in size as added, slightly inflated ventrally; spiral suture on dorsal side marked by clear shell material; sutures on the dorsal side obliquely curved, flush with the surface, marked by clear shell material, on the ventral side nearly radial and somewhat depressed; aperture obscure, apparently a narrow slit at the inner margin of the last formed chamber on the ventral side. Diameter, 0.28 by 0.32 millimeter; thickness, 0.13 millimeter.

Plesiotype No. 3912, locality L2C, San Sebastian formation.

Rare at L2C and L3C of the San Sebastian formation.

Eponides ornatissimus NEW SPECIES

PLATE 17, FIGURES 2a-c

Test delicate, planoconvex, dorsal side convex, ventral side flat with relatively large round or oval umbilical depression; edge angled; test nearly circular in side view, periphery not lobulate but with minute irregularities where the costae reach the periphery; as many as 3 whorls in the test, all visible from the dorsal side, only the last whorl from the ventral side, 12 to 15 chambers in the last whorl, enlarging very slowly; sutures radial but sharply curved near the periphery on both sides of the test; wall finely perforate; dorsal side of test conspicuously ornamented by raised spiral sutures and radial costae which are not continuous from whorl to whorl and which approximate the position of the sutures and usually bifurcate near the periphery with one branch following the curvature of the sutures; aperture a low slit at the base of the last chamber on the ventral side extending from midway of the base of the septal face nearly to the periphery; aperture obscure in most of the specimens. Diameter, 0.23 by 0.28 to 0.38 by 0.41 millimeter; thickness, 0.11 millimeter.

Holotype No. 3913, locality L2C, San Sebastian formation.

Common at L2C of the San Sebastian formation. Rare at A43a

and A86 of the Cibao formation. Common at A79 of the Los Puertos formation. Rare at P2 of the Ponce formation.

There are strong resemblances between *E. ornatissimus* and "*Planulina*" *camagueyana* Bermudez from the Eocene of Cuba (1927. Mem. Soc. Cubana Hist. Nat. 11). *E. ornatissimus* has fewer chambers, more regular ornamentation on the dorsal side, and is smaller in size.

Eponides parantillarum NEW SPECIES

PLATE 18, FIGURES 1a-c

Eponides antillarum Cushman & Jarvis (1930) Jour. Paleont. 4: 364. pl. 33, figs. 14a-c, pl. 34, fig. 2. Miocene, Jamaica.

Test biconvex, usually with dorsal side more convex than the ventral; edge angled, with narrow keel, nearly circular in dorsal or ventral view, periphery smooth, or very slightly lobate in the last few chambers; about $3\frac{1}{2}$ whorls in the test, early ones obscure on the dorsal side of the test, only those of the last whorl being distinct; 6 to 7 chambers in the last whorl, enlarging slowly, closely appressed; sutures on the dorsal side flush with surface, oblique, narrowly limbate, on ventral side nearly radial, flush, or slightly depressed near the periphery, becoming limbate and raised near the umbilical region where they become fused into a ring surrounding a small but deep umbilical depression; aperture an elongate arch with lip at the base of the last chamber on the ventral side midway between the umbilicus and periphery. Diameter varies from 0.36 by 0.41 to 0.84 by 0.93 millimeter; thickness, 0.30 to 0.54 millimeter.

Holotype No. 3914, locality A21, Quebradillas formation.

Rare at A93; common at A20; abundant at A21 of the Quebradillas formation. Rare at P3 of the Ponce formation.

This species is related to *E. antillarum* (d'Orbigny) from the Recent of Cuba, but differs consistently in several respects. The sutures on the dorsal side are more oblique, the last whorl is narrower, and the periphery is not lobulate. Several other species from Eocene-Oligocene formations of the Gulf Coast and West Indian region are similar in some respects. Most of these lack the characteristic raised limbate ornamentation of the ventral side. Those that have similar ornamentation differ in having radial, not oblique dorsal sutures, as *E. mexicana* Cushman (1925. Am. Assoc. Petr. Geol. 9) and *E. guayabalensis* Cole (1927. Bull. Am. Paleont. 14), or in having more chambers as in *E. byramensis cubensis* Palmer and Bermudez (1936. Mem. Soc. Cubana Hist. Nat. 10).

Specimens at P3 which are referred to this species differ consistently in that they are much more flat on the dorsal side. This may be a variety of *E. parantillarum* or may merely show the extreme individual variation of the species.

***Eponides pulvinus* NEW SPECIES**

PLATE 18, FIGURES 2a-c

Test subcircular in side view, unequally biconvex, slightly convex on the ventral side, strongly convex to conical on the dorsal side; periphery not lobulate; edge sharply angled; whorls about 4, on the ventral side involute leaving a very small umbilicus, the earlier whorls on the dorsal side covered by smooth secondary wall material, obscuring the spire; 5 chambers in the last whorl, increasing slowly in size; sutures on the ventral side nearly radial, very slightly curved, flush with the surface excepting between the last few chambers where they are depressed; sutures on the dorsal side somewhat limbate, slightly curved and tangential to the earlier whorls; surface of both sides smooth; aperture a slit at the base of the septal face extending and widening from near the umbilicus to two-thirds of the way to the periphery, with prominent upper lip. Diameter, 0.65 millimeter; thickness, 0.35 millimeter.

Holotype No. 4103, locality A15, Quebradillas formation.

Common at A86 of the Cibao formation. Rare at A15 of the Quebradillas formation.

This species differs consistently from *E. advena* (Cushman) (1923. U. S. Geol. Surv. Prof. Pap. **133**) in being deeper on the dorsal side and shallower on the ventral side. It has fewer chambers and is higher dorsally than *E. jacksonensis* (Cushman and Applin) (1935. U. S. Geol. Surv. Prof. Pap. **181**).

***Eponides repandus* (Fichtel & Moll)**

PLATE 17, FIGURES 3a-c

Nautilus repandus Fichtel & Moll (1798) Test. Micr. 35. pl. 3, figs. a-d. Recent, Mediterranean.

Eponides repandus Montfort (1808) Conch. Syst. 1: 127. 32e genre. Recent, Mediterranean.—Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 92. pl. 13, figs. 9a-c. Lower Miocene, Florida; Recent, off Florida and the West Indies.

Pulvinulina repanda Brady (1884) Rep. Voy. Challenger Zool. 9: 684. pl. 104, figs. 18a-c. Recent, widespread.

Test subcircular, with slightly lobulate periphery, biconvex, slightly deeper on the ventral side; edge sharp and narrowly carinate; chambers 6 to 7 in the last whorl, closely appressed, flat on the dorsal

side, slightly inflated on the ventral side, the last chamber with a lobed extension; sutures strongly curved and raised on the dorsal side, moderately curved and depressed on the ventral side; wall finely perforate, with scattered large pores on the last septal face; aperture an arch at the base of the septal face, highest near the umbo, without upper lip. Diameter, 1.1 millimeters; thickness, 0.5 millimeter.

Plesiotype No. 4093, locality A21, Quebradillas formation.

Rare at A21 of the Quebradillas formation.

Our specimens lack the ventral limbate sutures usually ascribed to this species, and have an umbonal lobe not seen in Brady's figure in the Challenger Report. They are much like the Florida Miocene specimens.

Eponides ventricosus NEW SPECIES

PLATE 18, FIGURES 3a-c

Test subcircular in side view, strongly and almost equally convex, the dorsal side smoothly hemispherical, the ventral side slightly convex just beneath the periphery; periphery smooth, but sometimes slightly lobulate in the last few chambers; edge sharply angled to sharply rounded, sometimes appearing keeled, whorls about 3, narrow, only the last one or part of the last one visible on the dorsal side, which is covered with a smooth, mottled secondary deposit; chambers 11 to 13 in the last whorl, enlarging gradually; ventral side with strong, smooth, imperforate umbo; dorsal sutures slightly curved, oblique, broadly limbate but not raised, the spiral suture also limbate but not raised; ventral sutures curved, narrowly limbate, flush with the surface, except for the last few which may be broadly depressed; ventral surface finely mottled; wall finely perforate, the perforations seeming to continue through the secondary deposit on both sides of the test; appearing on the dorsal umbo as coarse puncta, so that the form might be mistaken for Cibicides; aperture a low arch midway between umbo and periphery, with slight upper lip. Diameter, 0.5 millimeter; thickness, 0.33 millimeter.

Holotype No. 4116, locality A86, Cibao formation.

Abundant at A86 of the Cibao formation. Rare at A21 of the Quebradillas formation, and at P251 and P259 of the Ponce formation.

Eponides vortex NEW SPECIES

PLATE 18, FIGURES 4a-c

Test biconvex, somewhat compressed, central portion of dorsal and ventral sides inflated with last whorl thinner, forming a somewhat

explanate border; ventral side umbonate; early whorls on the dorsal side obscure, 10 chambers in the last whorl, short and wide, enlarging very gradually in size; periphery not lobate; edge sharp; sutures strongly and nearly equally curved on both sides of the test, nearly flush with the surface and marked by clear shell material, the last few on the ventral side raised; wall very finely perforate; aperture a low arch near the periphery on the inner margin of the last chamber on the ventral side, with lip. Diameter, 0.83 millimeter; thickness, 0.36 millimeter.

Holotype No. 3915, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

This species is quite distinctive, but has some points of resemblance to "*Anomalina*" *subtenuissima* Nuttall (1928. Quart. Jour. Geol. Soc. London **84**). It differs in being thicker, without depressed sutures, and with a narrower final whorl on the dorsal side of the test.

GYROIDINA d'Orbigny 1826

Gyroidina cf. *soldanii* d'Orbigny

PLATE 15, FIGURES 7a-c

Gyroidina soldanii d'Orbigny (1826) Ann. Sci. Nat. 7: 278. no. 5, Modèles no. 36. Recent, Adriatic.

Test small, subcircular in top view, dorsal side nearly flat, the last whorl flat or depressed, the earlier whorls slightly convex, ventral side unusually deep for the genus, with a moderately large umbilicus; chambers about 6 in the last whorl; dorsal sutures slightly curved and moderately oblique, not depressed or raised, obscured by a slight deposit of secondary material; ventral sutures slightly curved, nearly radial, flush with the surface, narrow; entire surface smooth; aperture a long slit at the base of the septal face midway between umbilicus and periphery, with small upper lip. Diameter, 0.64 millimeter; thickness, 0.5 millimeter.

Plesiotype No. 4114, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

This form is unusually deep ventrally and has fewer chambers than most other species of the genus. There are fewer chambers in the last whorl, and the dorsal surface of the final whorl is more flattened than in d'Orbigny's model of *G. soldanii*.

Gyroidina stellifera NEW SPECIES

PLATE 15, FIGURES 6a-c

Test subcircular in side view, biconvex, thick dorso-ventrally, dorsal side moderately convex, ventral side very convex; periphery not lobulate; edge sharply angled; whorls about 3; chambers about 6 in the last whorl, enlarging gradually; sutures on the dorsal side curved and long, oblique, tangential to the earlier whorl, limbate but scarcely raised, the spiral suture limbate and raised; dorsal side covered with a smooth secondary deposit obscuring the sutures, thicker over the earlier whorls; ventral sutures slightly curved, scarcely depressed, nearly flush with the surface; ventral side smooth, with secondary deposit around the small umbilicus, raised, in the form of a star, with a lobe just posterior to each suture; aperture a small arch at the base of the septal face, midway between umbilicus and periphery, with slight upper lip. Diameter, 0.76 millimeter; thickness, 0.53 millimeter.

Holotype No. 4105, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

ROTALIA Lamarck 1804

KEY TO THE PORTO RICAN SPECIES

- A. Whorls involute on dorsal side *R. meyerhoffi*, page 381.
- AA. Whorls not embracing on dorsal side
 - B. Test domed on dorsal side *R. tholus*, page 382.
 - BB. Test about equally biconvex
 - C. Periphery strongly spinose *R. byramensis*, page 378.
 - CC. Periphery not strongly spinose
 - D. Dorsal surface nearly smooth *R. mexicana*, page 380.
 - DD. Dorsal surface rough; edge not keeled
 - E. Ventral ornamentation regular
 - R. mexicana mecatepecensis*, page 380.
 - EE. Ventral ornamentation irregular
 - R. choctawensis*, page 379.

Rotalia byramensis Cushman

PLATE 19, FIGURES 1a-c

Rotalia byramensis Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129E: 99. pl. 23, fig. 1. Middle Oligocene, Mississippi.—Cushman & McGlamery (1938) U. S. Geol. Surv. Prof. Pap. 189D: 110. pl. 27, fig. 3. Middle or upper Oligocene, Alabama.

Test unequally biconvex, ventral side the deeper; periphery lobulate, with a short peripheral spine on each chamber located slightly anterior to the midpart of the chamber; chambers rotaloid in

arrangement, not involute on the dorsal side, 6 to 7 in the last whorl; earlier whorls on the dorsal side covered by secondary material, making a prominent boss; only the last whorl visible on the ventral side; sutures on the dorsal side slightly curved, limbate and flush with the surface; sutures on the ventral side radial, narrow and depressed, particularly between the last few chambers; in the umbilical region there is a circular boss with the sutures ending in a depressed ring around it; surface finely papillate on the dorsal side, coarsely papillate near the periphery on the ventral side; aperture a low arch at the base of the septal face between the umbilicus and the periphery, without definite lip. Diameter, 0.5 millimeter; thickness, 0.24 millimeter.

Plesiotype No. 4106, locality P431, Ponce formation.

Common at P431 of the Ponce formation.

The Porto Rican specimens seem to differ somewhat from the original figures of *R. byramensis*, particularly in the much smaller size (0.5 millimeter instead of 2 millimeters), fewer chambers, and less pointed chambers, but inasmuch as the Choctaw Bluff forms, which seem identical with the Porto Rican form, have been referred to this species, we are for the present placing our material in this species.

***Rotalia choctawensis* Cushman & McGlamery**

PLATE 19, FIGURES 2a-c

Rotalia choctawensis Cushman & McGlamery (1938) U. S. Geol. Surv. Prof. Pap. 189D: 110. pl. 27, fig. 4. Middle Oligocene, Alabama.

Test subcircular in side view, biconvex, the ventral side slightly deeper; periphery irregular; edge bluntly angled; ventral side with round, prominent umbo; 10 to 12 chambers in the last whorl, gradually enlarging, somewhat irregular in size; sutures on the dorsal side slightly curved, raised, obscure; sutures on the ventral side nearly radial, depressed; surface on both sides, more on the dorsal side, covered with secondary wall material in irregular, lumpy masses; aperture a small slit at the base of the septal face, about midway between umbo and periphery, with slight upper lip. Diameter, 0.56 millimeter; thickness, 0.31 millimeter.

Plesiotype No. 4107, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation.

This species is scarcely distinguishable from *R. mexicana*, differing mainly in the rougher surface. It is noteworthy that *R. choctawensis* does not occur in the Ponce formation, which has at least five other

species of *Rotalia*, nor does any other species of *Rotalia* occur in the San Sebastian formation, so far as our collections show.

***Rotalia mexicana* Nuttall**

PLATE 19, FIGURES 3a-c

Rotalia mexicana Nuttall (1928) Jour. Paleont. 2: 374. pl. 50, figs. 6-8. Upper Eocene, Mexico.

Test subcircular in side view, biconvex, deeper on the ventral side; edge angled to sharply rounded; periphery even and papillate except for the last few chambers which are extended radially into blunt points, giving an angularly lobate outline to the test; whorls not involute on the dorsal side; 10 to 12 chambers in the last whorl, obscure on the dorsal side, distinct on the ventral side, not inflated; sutures slightly curved and flush dorsally, nearly radial and conspicuously depressed ventrally, meeting near the umbilicus to form a narrow, depressed ring around an umbonal boss of clear material; surface of the dorsal side smooth or granular; surface of the ventral side papillate near the periphery and granulate with small, irregular depressions up to the central boss; aperture a narrow slit at the base of the septal face between umbo and periphery, nearer the periphery, without definite lip. Diameter, 0.6 millimeter; thickness, 0.45 millimeter.

Plesiotype No. 4109, locality P253, Ponce formation.

Common at P4, P253, and P432 of the Ponce formation.

Our specimens are uniformly deeper ventrally than dorsally. Nuttall states, "the dorsal side strongly convex and the ventral flattened". He may have been using the words "dorsal" and "ventral" in the opposite sense from that of general usage, or have made an error. Otherwise, our form is very similar to Nuttall's.

***Rotalia mexicana mecatepecensis* Nuttall**

PLATE 19, FIGURES 4a-c

Rotalia sp. Cushman (1927) Jour. Paleont. 1: 166. pl. 26, fig. 5. Alazan Clays, Eocene or lower Oligocene, Mexico.

Rotalia mexicana mecatepecensis Nuttall (1932) Jour. Paleont. 6: 26. pl. 4, figs. 11, 12. Lower Oligocene, Mexico.

Test large, biconvex, ventral side the deeper; subcircular in side view; periphery smooth but papillate in the early part of the last whorl becoming slightly lobate in the later part; edge subangular in young specimens to narrowly rounded in adult; 11 to 13 chambers in the last whorl, enlarging gradually; test involute to umbo on the ventral side, with a large round or oval central boss and several small

bosses of clear shell material; dorsal side with some of the later chambers distinct, the last half whorl usually raised above the earlier whorls, the earlier whorls and much of the last whorl covered with secondary wall material in a rough and papillate manner; ventral side covered with secondary material, thickest near the periphery, making an intricate pattern of radial and concentric knobs; sutures on the ventral side distinct, radial, depressed particularly toward the umbo; sutures on the dorsal side slightly curved, obscure except for the last few chambers where they are depressed; aperture a short slit at the base of the septal face, nearer the periphery than the umbo, obscured by the secondary deposit, without definite lip. Diameter, 1.15 millimeters; thickness, 0.58 millimeter. The largest specimens are nearly 2 millimeters in diameter.

Plesiotype No. 4075, locality P431, Ponce formation.

Abundant at P431 of the Ponce formation.

This variety differs from *R. mexicana* in the rougher surface, and from *R. choctawensis* (1938. U. S. Geol. Surv. Prof. Pap. 189D) in the regularity of the ventral ornamentation.

***Rotalia meyerhoffi* NEW SPECIES**

PLATE 20, FIGURES 1a-c

Test small, oval in side view, the later part of the last whorl being very broad radially; biconvex and biumbonate, the ventral side more strongly convex, involute more than half the width of a whorl on the dorsal side, tending to become evolute on the ventral side, exposing more than the last whorl to view; periphery not particularly lobulate but with a slight projection at the anterior periphery of the last few chambers where there is a short spine; edge angular in the last few chambers, somewhat rounded by papillate secondary wall tissue in most of the last whorl; whorls few; chambers 9 to 11 in the last whorl, increasing gradually in length, very broad radially, only those of the last whorl, or less, visible on the dorsal side due to secondary shell material which covers the earlier whorls and makes an umbo; ventrally the umbilical region is filled by a boss of clear shell material; surface smooth on the ventral side, granulate on the dorsal side and papillate on and near the periphery on both sides of the test; sutures on the ventral side nearly radial, narrow and depressed, on the dorsal side slightly curved, limbate and more or less raised; aperture a narrow slit at the base of the last septal face between the umbo and the periphery, nearer the periphery, with small upper lip. Diameter, 0.7 millimeter; thickness, 0.32 millimeter.

Holotype No. 4108, locality P431, Ponce formation.

Common at P431 of the Ponce formation.

This species differs from all associated species of *Rotalia*, and from nearly all other species of the genus, in being partially involute on the dorsal side, yet with very wide chambers radially. It most nearly resembles *R. aculeata* (d'Orbigny) (1846. *Foram. Foss. Vienne* pl. 8).

We take pleasure in naming this species for Dr. Howard A. Meyerhoff, Professor of Geology at Smith College, who has devoted many years to the study of the geology of Porto Rico, and who collected the foraminiferal material for the present study.

***Rotalia tholus* NEW SPECIES**

PLATE 20, FIGURES 2a-c

Test subcircular in side view, dome shaped in edge view, slightly convex ventrally, strongly convex, domal or even campanulate dorsally; edge angled but not keeled; periphery slightly lobulate, a little irregular but not erose; chambers 9 to 10 in the last whorl, increasing gradually in size, not inflated; whorls not involute on the dorsal side, the earlier ones obscured by strongly papillate or knobbed secondary shell material, most marked on the sutures; ventral side with a strong umbilical plug of clear shell material, separated by a groove from the chambers; sutures on the dorsal side gently curved, limbate and flush with the surface or raised, only those of the last whorl distinct; sutures on the ventral side slightly depressed, more so at the inner ends, not limbate, nearly straight, radial; surface of the ventral side unornamented except for a crescentic addition of secondary material on the inner ends of the chambers; aperture a slit at the base of the septal face, midway between umbo and periphery, without upper lip. Diameter, 0.55 millimeter; thickness, 0.33 millimeter.

Holotype No. 4110, locality P431, Ponce formation.

Common at P431 of the Ponce formation.

This species differs from *R. alabamensis* Cushman and McGlamery (1938, U. S. Geol. Surv. Prof. Pap. 189D) in the flatter ventral side, more domed dorsal side, more chambers, and smoother, non-keeled edge. The specific name refers to the cupola or dome-shaped dorsal side of the test, from the Latin noun, *tholus*.

DISCORBIS* Lamarek 1804

Discorbis floridanus Cushman

PLATE 21, FIGURES 5a-c

Discorbis floridana Cushman (1922) Carnegie Inst. Wash. Publ. 311: 39, pl. 5, figs. 11, 12. Recent, Tortugas; (1933) U. S. Geol. Surv. Prof. Pap. 175A: 29, pl. 9, figs. 12, 13. Middle and upper Miocene, southeastern U. S.

Test planoconvex, dorsal side convex, ventral side flat, or a little concave; edge narrowly rounded; test oval in side view, somewhat lobulate; 5-6 chambers in the last whorl, increasing gradually in size; sutures on the dorsal side obliquely curved, slightly depressed except for the earlier ones which are narrowly limbate, sutures on the ventral side nearly radial, depressed; wall finely but conspicuously perforate; aperture an elongate low arch at the base of the last chamber on the ventral side extending from the umbilicus nearly to the periphery. Diameter, 0.41 by 0.50 millimeter; thickness, 0.16 millimeter.

Plesiotype No. 3897, locality L5C, San Sebastian formation.

Rare at L1C and L5C of the San Sebastian formation, and at A79 of the Los Puertos formation.

Discorbis havanensis Cushman & Bermudez

PLATE 20, FIGURES 3a-c

Discorbis havanensis Cushman & Bermudez (1937) Contr. Cushman Lab. Foram. Res. 13: 19, pl. 2, figs. 15, 16. Eocene, Cuba.

Test compressed, round in side view, with lobulate periphery; dorsal side moderately convex and umbonate, ventral side flat or slightly convex; edge acute with narrow keel; chambers distinct, 4 to 5 in the last whorl, increasing gradually in size as added, not inflated on the dorsal side, slightly inflated on the ventral side, the last chamber extending nearly a third of the circumference of the test; dorsal sutures distinct, strongly curved, limbate but little raised, distinct in the last whorl, the earlier whorls usually covered by a secondary deposit; ventral sutures narrow, depressed, slightly curved, usually bordered on one or both sides by thin lines of secondary tissue extending outward from the umbilicus; umbilicus modified by addition of secondary tissue, leaving several small, lobate depressions; the exact forms made by the ventral secondary tissue varies considerably from specimen to specimen; wall finely perforate on both sides; aperture a slit opening into the umbilicus, covered by a thin, valvular

* The gender of *Discorbis* is masculine since the Latin word *orbis* is masculine. Adjectival specific names should therefore have a masculine ending, a point which has been generally overlooked heretofore.

flap extending from the inner, middle edge of the last chamber. Diameter, 0.74 by 0.64 millimeter; thickness, 0.24 millimeter.

Plesiotype No. 4112, locality P258, Ponce formation.

Abundant at A79 of the Los Puertos formation. Common at F64 and F359 of the Quebradillas formation. Rare at P259; abundant at P258 of the Ponce formation.

Perhaps this species belongs in the genus *Globorotolia*.

***Discorbis multisectus* NEW SPECIES**

PLATE 20, FIGURES 4a-c

Test planoconvex, dorsal side convex forming a low cone, ventral side umbilicate, chambers only slightly convex, with general ventral surface slightly concave; edge bluntly angled; nearly 3 whorls in the test, 4 chambers in the last whorl, enlarging gradually, last chamber occupying more than a third of the periphery of the test; ventral margin of last chamber lobulate due to apertural recess, previous apertural recesses covered with a flap of shell material; sutures on the dorsal side narrow, obliquely curved, not limbate, flush with the surface except for the last one which is slightly depressed, sutures on the ventral side slightly depressed, primary sutures short, nearly radial, secondary sutures with sigmoid curve; wall distinctly, but not coarsely, perforate; aperture large, ventral, near the umbilicus. Average diameter, 0.31 by 0.36 millimeter; thickness, 0.16 millimeter.

Holotype No. 3898, locality L5C, San Sebastian formation.

Common at L5C; rare at L3C of the San Sebastian formation.

This species seems related to the *D. mirus-orbicularis* group. It differs from *D. mirus* Cushman (1922. Carnegie Inst. Wash. Publ. 311) in having a smooth, not lobulate outline; nonlimbate, more oblique dorsal sutures; fewer chambers, and a smaller test. It differs from *D. orbicularis* (Terquem) (1876. Ess. Anim. Plage Dunkerque (2)) in being less circular, and in having less elongate chambers.

The specific name *multisectus* refers to the secondary sutures on the ventral side.

***Discorbis oligospiratus* NEW SPECIES**

PLATE 21, FIGURES 1a-c

Discorbina globularis Flint (not d'Orbigny) (1899) Ann. Rept. U. S. Nat. Mus. 1897: 327. pl. 72, fig. 2. Recent, off Florida.

Test of average size for the genus, planoconvex, nearly flat on the ventral side, convex on the dorsal side; on dorsal side somewhat involute, early whorls depressed; umbilicate on the ventral side, the

lobate inner ends of the chambers forming a star-shaped umbilicus; periphery smooth; edge subangular in early part of the test becoming broadly rounded and shouldered on the dorsal side in most of the last whorl of the test; six chambers in the last whorl, enlarging rapidly in thickness, the last chamber constituting nearly a third of the test on the ventral side; sutures distinct, marked by a filling of clear shell material, curved on both sides of the test, flush with the surface except between the last two chambers where it is depressed; aperture an arched opening near the umbilicus on the ventral side of the test, partially covered by a thin, plate-like extension of the chamber. Diameter, 0.64 by 0.80 millimeter; thickness 0.46 millimeter.

Holotype No. 3899, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

***Discorbis pelliculatus* NEW SPECIES**

PLATE 21, FIGURES 6a-c

Test small, nearly circular in side view; dorsal side low conical with concave slopes and prominent umbo; ventral side slightly convex to flat, not concave, with low, median umbo; periphery smooth, not lobulate; edge angled but neither sharp nor carinate; chambers very broad, 4 in last whorl, the last comprising more than one-third of the circumference of the test, each ventral chamber with an umbonal extension, similar to those seen in *Tetrataxis*; whorls about three, the early ones obscure; dorsal sutures curved and tangential to the earlier whorl, narrow and flush with the surface, the last one or two slightly depressed, only those of the last whorl visible; ventral sutures obscure, consisting of two outward curves and one inward curve, narrow and flush with the surface; wall very finely perforate, as seen after removal of the pellicle by acid; surface matt mostly covered on both sides by a thin smooth layer or pellicle of opaque shell material, thickest on the dorsal umbo; aperture a small, thin arch in the front, outer curve of the ventral part of the last chamber, not under the umbilical extension. Diameter, 0.69 millimeter; thickness, 0.30 millimeter.

Holotype No. 4141, locality A21, Quebradillas formation.

Common at locality A21 of the Quebradillas formation.

This species is obviously similar to several forms as yet included in *D. orbicularis* (Terquem), particularly the Florida Miocene form (1932. Fla. Geol. Surv. Bull. 9), but it differs from more typical forms of *D. orbicularis* (such as Brady 1884. Rep. Voy. Challenger Zool. 9: pl. 88, fig. 5, from the Bermudas, and Cushman 1931. Bull. U. S. Nat. Mus. 104 (8): pl. 6, fig. 3, from Jamaica) in lacking the concave

ventral side, the carinate edge and the coarse perforations, and in the presence of the umbos and the pellicle of secondary shell material.

***Discorbis subaraucanus* Cushman**

PLATE 21, FIGURES 2a-c

Discorbis subaraucana Cushman (1922) Carnegie Inst. Wash. Publ. 311: 41. pl. 7, figs. 1, 2. Recent, Tortugas.—Cole & Gillespie (1930) Bull. Am. Paleont. 15 (57B): 11. pl. 3, figs. 2, 3. Middle Oligocene, Meson, Mexico.—Cushman (1935) U. S. Geol. Surv. Prof. Pap. 181: 43. pl. 18, figs. 1a-c. Upper Eocene, Alabama.

Test planoconvex, very slightly convex on the dorsal side, and nearly flat on the ventral side except for the last chamber which is somewhat inflated and the concave depression in the umbilical region; edge subacute; two and a half whorls in the test, 6 to 7 chambers in the last whorl, early chambers enlarging gradually in size, last few chambers enlarging more rapidly, the last chamber in the adult form being arcuate on the dorsal side, and constituting nearly $\frac{1}{3}$ of the ventral side of the test; sutures on both sides, and early part of spiral suture on the dorsal side marked by clear shell material, last few sutures more narrowly limbate; sutures obliquely curved on the dorsal side, flush with the surface except for the last few which are slightly depressed, sutures on the ventral side curved, more so in the earlier part of the test; wall finely but conspicuously perforate; aperture a slit at the base of the last chamber on the ventral side extending from the umbilicus to near the periphery, with a slight lip. Diameter, 0.40 by 0.45 millimeter; thickness, 0.16 millimeter.

Plesiotype No. 3900, locality L5C, San Sebastian formation.

Rare at L2C and L3C; common at L5C of the San Sebastian formation. Abundant at A79 of the Los Puertos formation. Common at P258 of the Ponce formation.

EPISTOMARIA Galloway 1933

***Epistomaria pontifera* NEW SPECIES**

PLATE 24, FIGURES 2a-c

Discorbina polystomelloides Heron-Allen & Earland (1915) Trans. Zool. Soc. London 20 (2): pl. 52, figs. 19-23. Recent, Kerimba Archipelago.

Test rotaloid, convex on the dorsal side, with depressed spire, concave on the ventral side, broadly oval in side view; periphery lobulate; back smoothly rounded; chambers 7 to 8 in the last whorl, inflated, increasing rapidly in size as added; whorls about 2; early whorls on the dorsal side separated from the last whorl by a depressed spiral suture; on the ventral side secondary shell material forms

triangular places over part of each chamber converging at the umbilicus; dorsal sutures nearly radial, distinct, depressed, marked by clear shell material; ventral sutures depressed, radial, narrow between the secondary deposits; between the chambers on the back of the test there are one or two retral processes or septal bridges similar to those in *Elphidium*; wall coarsely and plainly perforate, the perforations continuing through the ventral secondary deposits; aperture a wide slit at the base of the septal face, usually closed by secondary material, and elongate secondary apertures between the chambers on both sides near the periphery, the accessory apertures being outlined by thin bands of clear shell material; there are no accessory apertures at the outer edges of the triangular umbilical plates. Diameter, 0.87 by 0.62 millimeter; thickness, 0.33 millimeter, for the medium-sized figured specimen.

Holotype No. 4115, locality P258, Ponce formation.

Common at P258 of the Ponce formation.

This species differs from the Recent Arctic species, *E. rimosa* (Parker and Jones) (1865. Phil. Trans. Roy. Soc. London **155**) in having septal bridges and lacking the openings at the outer ends of the triangular umbilical plates. The septal bridges are similar to those in *D. polystomelloides* (Parker and Jones), but are fewer, there are fewer chambers, and the deposits are thinner and smoother.

Our form seems to be identical with the form identified with *Discorbina polystomelloides* by Heron-Allen and Earland, from the Kerimba Archipelago, in an extraordinary provincial fauna.

ANOMALINA d'Orbigny 1826

Anomalina alazanensis Nuttall

PLATE 22, FIGURES 1a-c

Anomalina alazanensis Nuttall (1932) Jour. Paleont. **6**: 31. pl. 8, figs. 4, 8, 9. Lower Oligocene, Mexico.—Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. **10**: 311. pl. 19, figs. 11–13. Lower Oligocene, Cuba.

Test plano-convex, dorsal side slightly convex, ventral side flat or slightly concave; periphery smooth, not lobate; edge rounded; chambers more involute on the ventral side, dorsal side showing $2\frac{1}{2}$ whorls, ventral side showing about $1\frac{1}{2}$ whorls; about 14 chambers in the last whorl, enlarging very slowly in size; sutures conspicuous, limbate, slightly raised, gently curved on both sides of the test; spiral sutures not raised; wall coarsely perforate; aperture a narrow arch at the base of the last chamber on the periphery and extending about one chamber

length onto the dorsal side. Diameter, 0.67 by 0.55 millimeter; thickness, 0.20 millimeter.

Plesiotype No. 3866, locality P3, Ponce formation.

Very rare at P3 and P254 of the Ponce formation.

Anomalina nucleata (Seguenza)

PLATE 22, FIGURES 2a-c

Truncatulina nucleata Seguenza (1880) Atti R. Accad. Lincei III. 6: 64. pl. 7, fig. 8. Lower Miocene, Italy.

Truncatulina trinitatis Nuttall (1928) Quart. Jour. Geol. Soc. London 84: 97. pl. 7, figs. 3, 5, 6. Upper Eocene to Miocene, Trinidad.

Cibicides nucleata Galloway & Morrey (1929) Bull. Am. Paleont. 15 (55): 31. pl. 4, fig. 9. Lower Oligocene, Ecuador.

Cibicides trinitatis Nuttall (1932) Jour. Paleont. 6: 33. pl. 7, fig. 9. Lower Oligocene, Mexico.—Hadley (1934) Bull. Am. Paleont. 20 (70A): 29. pl. 4, figs. 10, 11. Upper Eocene and Oligocene, Cuba.

Anomalina nucleata Coryell & Rivero (1940) Jour. Paleont. 14: 334. pl. 44, figs. 2a-c. Middle Miocene, Haiti.

Test subcircular in side view, biconvex and biumbonate, nearly planispiral, dorsal side moderately convex, ventral side strongly convex; periphery smooth, not lobulate; edge sharply to evenly rounded; involute on both sides, more so on the ventral side; on the dorsal side the last whorl is wide, the early whorls covered by a thick, flat or convex boss of clear shell material; chambers 12 to 15 in the last whorl, enlarging gradually as added; dorsal sutures gently curved, strongly raised and marked by clear shell material between the early chambers of the last whorl, somewhat depressed between the last few chambers; ventral sutures gently curved, flush or slightly raised, merging into a thin or thick layer of transparent secondary material covering the early whorls and making an umbo; wall coarsely and conspicuously perforate, some of the pores showing in the limbate sutures and in the bosses; aperture a low arch at the base of the septal face on the inner periphery and extending a short distance toward the ventral umbo and dorsally for a distance of several chambers between the last two whorls, with slight upper lip. Diameter, 0.73 millimeter; thickness, 0.37 millimeter.

Plesiotype No. 4041, locality P254, Ponce formation.

Rare at P251 and P254 of the Ponce formation, and at A93 of the Quebradillas formation.

We include this form in *Anomalina* because of the nearly planispiral coiling and because the spire on neither side is completely covered by the last whorl. Other forms similar or identical with this species are *Anomalina umbonata* Cushman (in Howe 1939. La. Dept. Cons. Geol. Bull. 14) and *Anomalina nolani* Hedberg (1937. Jour. Paleont. 11).

There is considerable variation in the amount of sutural limbation and thickness of the umbos in this species (or these species), depending more on the ontogenetic age of the specimens than on the geologic age. They all occur between the middle Eocene and middle Miocene.

***Anomalina pompilioides* NEW SPECIES**

PLATE 22, FIGURES 3a-c

Anomalina grosserugosa Cole (not Gümbel) (1928) Bull. Am. Paleont. **14** (53): 18. pl. 1, figs. 16, 17. Upper Eocene, Chapapote formation, Mexico.—Nuttall (not Gümbel) (1928) Quart. Jour. Geol. Soc. London **84**: 99. pl. 7, fig. 18 (not 19). Upper Eocene and lower Miocene, Trinidad.

Test small for the genus, nearly bilaterally symmetrical, subcircular in side view; periphery lobate; broadly elliptical in edge view, back broadly rounded; involute on ventral side, not completely involute on dorsal side; chambers inflated, rather large, regularly and gradually enlarging, 5 to 6 in the last whorl; sutures radial, nearly straight, depressed; wall coarsely perforate; aperture a low arch on the inner margin of the last septal face on the periphery; apertural face convex, lunate in shape, slightly more than twice as wide as its median height. Diameter, 0.32 by 0.39 millimeter; thickness, 0.23 millimeter.

Holotype No. 3867, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

This species differs from *A. grosserugosa* (Gümbel) (1870. Abh. k. bay. Akad. Wiss. München Math. Phys. Cl. **10**) in its greater thickness and fewer chambers.

As Thalmann pointed out in 1932, Brady's specimens in the Challenger Report are not true *A. grosserugosa* (Gümbel), but neither are they the same as this Porto Rican species. Brady's form has more chambers in the last whorl, *i. e.* eight.

CYCLOLOCULINA Heron-Allen & Earland 1908

***Cycloloculina cubensis* Cushman & Bermudez**

PLATE 21, FIGURES 3a, b, and 4

Cycloloculina cubensis Cushman & Bermudez (1936) Contr. Cushman Lab. Foram. Res. **12**: 61. pl. 11, figs. 15, 16. Eocene, Cuba.

Test discoidal, compressed, the two sides much alike; edge narrowly rounded; about 5 rapidly enlarging chambers in the early part of the test, followed by 3 to 6 annular chambers; sutures indistinct except near the periphery where they are slightly depressed; surface finely granular and ornamented by scale-like additions of secondary tissue, most prominent on the last chamber, and radial depressions, the

scales and radial depressions of each chamber independent of those on adjacent chambers, giving a crenulate appearance to the inner margins of the chambers; aperture not observed. Diameter, 0.57 millimeter; thickness, 0.12 millimeter.

Plesiotypes No. 3888, locality L3C, San Sebastian formation, and No. 3886, locality A79, Los Puertos formation.

Rare at L3C; common at L4C of the San Sebastian formation. Rare at P254, P255, and P431 of the Ponce formation. Common at A79, Los Puertos formation.

CIBICIDES Montfort 1808

KEY TO THE PORTO RICAN SPECIES

- A. Ventral side umbilicate, without umbo of secondary material
 - B. Involute nearly to spire on dorsal side
 - C. Test oval; later chambers gradually lengthening
C. choctawensis, page 391.
 - CC. Test round; later chambers rapidly lengthening
C. americanus, page 390.
 - BB. Not involute on dorsal side
 - C. Test round; later chambers gradually enlarging
 - D. Without dorsal umbo.....*C. mexicanus*, page 394.
 - DD. With dorsal umbo.....*C. io*, page 392.
 - CC. Test oval; later chambers rapidly enlarging
 - D. Periphery strongly lobate.....*C. lobatus*, page 393.
 - DD. Periphery slightly lobate.....*C. scalenus*, page 396.
 - AA. Ventral side strongly umbonate with secondary material
 - B. Last whorl wide, tending to be involute dorsally
 - C. Dorsal secondary ornamentation weak
C. pseudoungerianus, page 395.
 - CC. Dorsal secondary ornamentation strong..*C. floridanus*, page 392.
 - BB. Last whorl narrow, not involute dorsally
 - C. Spiral suture not raised; dorsal deposit thin
 - D. Whorls less than 3; pores very coarse
C. perlucida, page 394.
 - DD. Whorls more than 3; pores coarse..*C. sinistralis*, page 396.
 - CC. Spiral suture raised.....*C. spirolimbatus*, page 397.

Cibicides americanus (Cushman)

PLATE 24, FIGURES 3a-c

Truncatulina americana Cushman (1918) U. S. Geol. Surv. Bull. 676: 63. pl. 20, figs. 2, 3, pl. 21, fig. 1. Miocene, Atlantic coastal plain, U. S.

Cibicides americanus Cole & Gillespie (1930) Bull. Am. Paleont. 15 (57B): 14. pl. 4, fig. 4. Meson formation, Mexico, middle Oligocene.—Cushman & Cahill (1933) U. S. Geol. Surv. Prof. Pap. 175A: 34. pl. 13, figs. 2a-c. Miocene and Oligocene of Atlantic coastal plain; late Tertiary of California, Panama, and northern South America.

Test small for the genus, planoconvex, dorsal side nearly flat, ventral side moderately convex; edge subacute; periphery smooth except for the last few chambers which are slightly lobulate; 8 to 11 chambers in the last adult whorl, rather rapidly increasing in size; in most specimens the last few chambers do not extend to the umbilicus either dorsally or ventrally; sutures distinct, slightly limbate on both sides in the early chambers, slightly depressed between later chambers; wall smooth, coarsely perforate; aperture at the base of the septal face extending onto the dorsal side only one chamber width and extending to the umbilicus on the ventral side; aperture with slight lip. Diameter of figured specimen, 0.29 by 0.38 millimeter; thickness, 0.13 millimeter. Maximum diameter, 0.50 millimeter.

Plesiotype No. 3952, locality L1C, San Sebastian formation.

Common at L1C and L2C of the San Sebastian formation. Rare at A86 of the Cibao formation.

Cibicides choctawensis Cushman & McGlamery

PLATE 23, FIGURES 1a-c

Cibicides choctawensis Cushman & McGlamery (1938) U. S. Geol. Surv. Prof. Pap. 189D: 111. pl. 28, fig. 6. Oligocene, Alabama.

Test small, subcircular or broadly oval in dorsal view, planoconvex, dorsal side flat or slightly concave and nearly or quite involute to the middle of the spire, ventral side very convex, with small umbilicus, with truncate base and nearly straight sides, increasing rapidly in thickness with successive chambers; edge square to subacute, but not keeled; periphery smooth, not lobulate; chambers about 9 in the last whorl, increasing gradually in size, the last few increasing more rapidly in all dimensions; sutures on the dorsal side strongly curved, slightly limbate, flush with the surface but depressed near the center of the spire; ventral sutures very little curved, limbate, flush with the surface except the last few which are a little depressed; surface smooth; wall finely but conspicuously perforate; aperture a small arch at the base of the septal face on the inner periphery, with upper lip, continuing on the dorsal side between the last four chambers and the previous whorl. Diameter, 0.37 millimeter; thickness, 0.15 millimeter.

Plesiotype No. 4117, locality A43a, Cibao formation.

Common at A43a of the Cibao formation.

This form is more involute on the dorsal side and is much more finely perforate than is true of typical *Cibicides*.

Cibicides floridanus (Cushman)

PLATE 23, FIGURES 2a-c

Truncatulina floridana Cushman (1918) U. S. Geol. Surv. Bull. 676: 62. pl. 19, fig. 2. Miocene, Florida.—Nuttall (1928) Quart. Jour. Geol. Soc. London 84: 98, pl. 7, figs. 14, 16. Miocene, Trinidad.

Truncatulina lobatula ornata Cushman (1918) U. S. Geol. Surv. Bull. 676: 61. pl. 18, figs. 1, 2. Miocene, Florida, Virginia.

Cibicides floridana Cushman (1931) Bull. U. S. Nat. Mus. 104 (8): 122. pl. 23, figs. 3-5. Recent, off Florida; (1930) Fla. Geol. Surv. Bull. 4: 61. pl. 12, fig. 3. Miocene, Florida.

Cibicides cf. *floridana* Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 315. pl. 20, figs. 1-3. Lower Oligocene, Cuba.

Cibicides floridanus Coryell & Rivero (1940) Jour. Paleont. 14: 334. pl. 44, figs. 10a-c. Middle Miocene, Haiti.

Test small, subcircular in side view, equally biconvex or rather flat dorsally and strongly convex ventrally; edge subacute; periphery smooth, not lobulate, with border of clear shell material; the last whorl broad dorsally, tending to become involute, the early whorls covered with a thick, secondary deposit; ventral side with strong umbo of hyaline secondary material; chambers 10 to 12 in the last whorl, increasing slowly in length and thickness but more rapidly in width; dorsal sutures gently curved, limbate and raised, except for the last few which may be depressed; ventral sutures gently curved, limbate and raised, merging with the umbo and the border; wall coarsely perforate, the pores enlarged by the secondary material on the dorsal side; aperture a small arch, with upper lip, at the base of the septal face on the inner periphery, extending dorsally for a distance of one or two chambers. Diameter, 0.45 millimeter; thickness, 0.2 millimeter.

Plesiotype No. 4118, locality A86, Cibao formation.

Common at P2, P4, and P254 of the Ponce formation. Abundant at A86 of the Cibao formation. Common at A20 and A21 of the Quebradillas formation.

This species is characterized by the strong secondary deposits in the form of covered spire and raised spiral and radial sutures. It has the wide last whorl which is partially involute on the dorsal side, also seen in *C. pseudodoungerianus* and *C. io*.

Cibicides io Cushman

PLATE 22, FIGURES 4a-c

Cibicides pseudoungeriana io Cushman (1931) Bull. U. S. Nat. Mus. 104 (8): 125. pl. 23, figs. 1, 2. Recent, off Florida.

Cibicides io Coryell & Rivero (1940) Jour. Paleont. 14: 334. pl. 44, fig. 11. Miocene, Haiti.

Test subcircular in side view, nearly flat on the dorsal side, convex on the ventral side; periphery not lobulate; edge sharply rounded to

broadly rounded; whorls few, about two, the last whorl on the dorsal side increasing rapidly in width, considerably involute, the early whorls covered by secondary material, separated by a groove from the limbate and raised spiral suture; ventral side with small umbilicus, but without umbo of secondary material; chambers about 10 in the last whorl, enlarging gradually in length but rapidly in width as added; sutures on the dorsal side slightly curved, limbate and raised, except the last ones which may be slightly depressed; ventral sutures very little curved, nearly radial, narrowly limbate and flush with the surface or slightly depressed; aperture a low, broad arch at the base of the septal face, on the inner periphery, extending slightly ventrally and dorsally, with narrow upper lip. Diameter, 0.56 millimeter; thickness, 0.22 millimeter.

Plesiotype No. 4123, locality A21, Quebradillas formation.

Rare at A21 of the Quebradillas formation.

This species lacks the ventral umbo and raised sutures of *C. floridanus*, but has a dorsal umbo.

Cibicides lobatus (d'Orbigny)

PLATE 24, FIGURES 4a-c

Truncatulina lobata d'Orbigny (1839) in Barker, Webb & Berthelot, Hist. Nat. Îles Canaries 2 (2): Foraminifères 134. pl. 2, figs. 22-24. Recent, Canaries.

Truncatulina lobatula d'Orbigny (1846) Foram. Foss. Vienne 168. pl. 9, figs. 18-23. Middle Miocene, Vienna.—Brady (1884) Rep. Voy. Challenger Zool. 9: 660. pl. 92, fig. 10, pl. 93, fig. 1 (not 4 and 5). Recent, all latitudes.—Cushman (1918) U. S. Geol. Surv. Bull. 676: 16. pl. 1, fig. 10. Pliocene, North Carolina.

Cibicides lobatula Cushman (1931) Bull. U. S. Nat. Mus. 104 (8): 118. pl. 21, figs. 3a-c. Recent, north Atlantic.

Cibicides lobatulus Cushman (1935) U. S. Geol. Surv. Prof. Pap. 181: 52. pl. 22, fig. 4 (not 5 and 6). Upper Eocene, southeastern U. S.—Cole & Gillespie (1930) Bull. Am. Paleont. 15 (57B): 15. pl. 4, fig. 2. Middle Oligocene, Mexico.

Test of average size for the genus, planoconvex, flat or concave on the dorsal side, convex on the ventral side; periphery only slightly lobate; edge acute; chambers somewhat inflated, increasing gradually in size, 4 to 8 in the last whorl; sutures flush with the surface, curved and marked by clear shell material on the dorsal side, on the ventral side depressed, nearly radial; wall coarsely perforate; aperture on the periphery with slight lip, and extending both dorsally and ventrally along the base of the last chamber. Diameter of figured specimen, 0.65 by 0.74 millimeter; thickness, 0.20 millimeter.

Plesiotype No. 3884, locality L4C, San Sebastian formation.

Rare at L1C, L4C, and L5C of the San Sebastian formation, and at A43a and A86 of the Cibao formation. Abundant at A79 of the Los Puertos formation. Rare at A21 and F64 of the Quebradillas forma-

tion. Rare at P3, P251, and P254; common at P258, P431, and P432 of the Ponce formation.

C. lobata (d'Orbigny) is distinct from *C. lobatulus* (Walker and Jacob), the type figure of which is conspicuously lobate.

***Cibicides mexicanus* Nuttall**

PLATE 22, FIGURES 5a-c

Cibicides mexicana Nuttall (1932) Jour. Paleont. 6: 33. pl. 9, figs. 7-9. Lower Oligocene, Mexico.

Test plano-convex, dorsal side flattened except for a moderate convexity of the early whorls, the last whorl being flat or even slightly concave, ventral side strongly convex, hemispherical; edge subacute, shouldered; early whorls indistinct on the dorsal side due to a thin layer of secondary shell material; 9 to 11 chambers in the last whorl, enlarging gradually in size; chambers involute ventrally, with slight umbilical depression; sutures gently curved, somewhat oblique on the dorsal side, gently curved radial on the ventral side, marked by clear shell material on both sides of the test, flush with the surface or slightly depressed on the dorsal side, flush or slightly raised on the ventral side; wall coarsely perforate; aperture an elongate slit at the base of the septal face running from the periphery less than half way to the umbilicus, and extending on the dorsal side between the last two whorls for a distance of about 4 chambers, with upper lip. Diameter, 0.95 millimeter; thickness, 0.6 millimeter.

Plesiotype No. 3924, locality P3, Ponce formation.

Abundant at P2 and P255; rare at P251 and P3 of the Ponce formation.

***Cibicides perlucidus* Nuttall**

PLATE 23, FIGURES 4a-c

Cibicides perlucida Nuttall (1932) Jour. Paleont. 6: 33. pl. 8, figs. 10-12. Lower Oligocene, Mexico.

Test subcircular in side view, unequally biconvex, dorsal side slightly elevated, ventral side strongly convex; edge subacute to sharply rounded; periphery smooth, not lobulate; chambers 9 to 11 in the last whorl, enlarging gradually as added; whorls few, only two or a little more, the last not involute beyond the periphery of the previous whorl, the early whorls slightly obscured by a thin, smooth secondary deposit; spiral suture flush, bordered by a thick band of clear shell material; dorsal sutures narrowly limbate and flush with the surface; ventral sutures narrowly limbate and slightly depressed, merging

with the central boss of clear shell material; wall very coarsely and conspicuously perforate, the wall material being translucent; aperture a low arch at the base of the septal face, on the inner periphery, with slight lip, and extending a short distance ventrally and dorsally. Diameter, 0.77 millimeter; thickness, 0.4 millimeter.

Plesiotype No. 4119, locality P251, Ponce formation.

Rare at P251 of the Ponce formation.

This species differs from *C. floridanus* and *C. pseudoungerianus* in the narrower last whorl which does not tend to be involute, and in lacking the thick, secondary deposit on the dorsal side. It has fewer whorls and is deeper ventrally than *C. pseudoungerianus sinistralis* and *C. pseudoungerianus evolutus*. *C. mexicanus* is hemispherical ventrally, whereas *C. perlucidus* is conical.

Cibicides pseudoungerianus (Cushman)

PLATE 23, FIGURES 5a-c

Truncatulina pseudoungeriana Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129E: 97. pl. 20, fig. 9. Middle Oligocene, Mississippi.

Cibicides pseudoungeriana Cushman (1931) Bull. U. S. Nat. Mus. 104 (8): 123. pl. 22, figs. 3-7. Recent, Atlantic.

Test small, biconvex, slightly more convex on the ventral side, subcircular in side view; periphery not lobulate, with border of clear shell material; edge angled to sharply rounded; whorls 2 to 3, usually coiled dextrally, the last one only slightly overlapping earlier whorls; early whorls on the dorsal side covered by a thin, smooth layer of shell material; ventral side with large umbo of clear shell material; chambers 9 to 11 in the last whorl, gradually enlarging in size as added; sutures on both sides gently curved, narrowly limbate, flush with the surface excepting on the ventral side between the last few chambers, where they are slightly depressed; aperture a small arch, with upper lip, at the base of the septal face on the inner periphery, continuing a short distance ventrally and for a distance of two or three chambers dorsally. Diameter, 0.43 millimeter; thickness, 0.23 millimeter.

Plesiotype No. 4120, locality A79, Los Puertos formation.

Rare at A79 of the Los Puertos formation.

This species is not well defined and not definitely recognizable, since several different forms have been included in it by its author. It is scarcely distinguishable from *C. floridanus*. As we distinguish the species, *C. pseudoungerianus* has little limbation and thin secondary deposits; *C. floridanus* has strong limbation on both sides, thick

secondary deposit on the dorsal side in which the mural pores are enlarged. The difference in number of chambers and relative convexity is not significant.

***Cibicides scalenus* NEW SPECIES**

PLATE 23, FIGURES 3a-c

Test very small, oval in side view, dorsal side flat or slightly convex, ventral side very convex, with small umbilicus; whorls about 2; chambers about 8 in the last whorl, increasing gradually up to the last few chambers when the chambers increase very rapidly in all dimensions; edge sharp, but not keeled; periphery smooth up to the last few chambers when it becomes lobulate, bordered by clear shell material; sutures on the dorsal side gently curved, limbate but not raised, the spiral suture being both limbate and raised; ventral sutures strongly curved, the outer ends limbate but not raised; wall conspicuously perforate; aperture a small arch on the inner periphery at the base of the last septal face, with upper lip, extending on the dorsal side for a distance of about two chambers. Diameter, 0.32 millimeter; thickness, 0.16 millimeter.

Plesiotype No. 4121, locality A43a, Cibao formation.

Rare at 43a of the Cibao formation.

The Porto Rican form resembles *C. westi* Howe (1939. La. Dept. Cons. Bull. 14), but *C. scalenus* is less conical on the ventral side, and the ventral sutures are not strongly sigmoid.

***Cibicides sinistralis* Coryell & Rivero**

PLATE 24, FIGURES 5a-c

Cibicides sinistralis Coryell & Rivero (1940) Jour. Paleont. 14: 335. pl. 44, figs. 12a-c. Middle Miocene, Haiti.

Test subcircular in side view, nearly equally biconvex, coiled sinistrally; periphery not lobulate; edge subangular; whorls $3\frac{1}{2}$, gradually enlarging, not overlapping the earlier whorls on the dorsal side; chambers 10 to 11, gradually enlarging; dorsal side covered by a thin, transparent secondary deposit; ventral side with strong umbo of clear shell material; dorsal sutures curved, slightly limbate but not raised; ventral sutures slightly curved, the later one sometimes sigmoid, narrowly limbate but flush with the surface; wall coarsely but not conspicuously perforate; aperture a small arch at the base of the septal face on the inner periphery, with upper lip, extending a very short distance ventrally and extending dorsally for a distance of 2 or 3 chambers. Diameter, 0.43 millimeter; thickness, 0.23 millimeter.

Plesiotype No. 4101, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

This species differs from *C. floridanus* and *C. pseudoungerianus* in having a narrower last whorl which does not overlap earlier whorls on the dorsal side. It differs from *C. perlucida* in the fewer whorls and less conspicuous pores. It differs from *C. pseudoungerianus evolutus* (1935. Contr. Cushman Lab. Foram. Res. **11**: 64. pl. 9, fig. 11) only in coiling to the left. The sinistral coiling seems to be of little significance, in view of the fact that many species of Foraminifera coil normally both sinistrally and dextrally. It must be admitted, however, that there are races, varieties or even species, which coil in only one direction for a given locality and geologic age.

***Cibicides spirolimbatus* NEW SPECIES**

PLATE 25, FIGURES 1a-c

Test of medium size for the genus, subcircular in side view, biconvex and biumbonate, the ventral side slightly deeper; periphery not lobulate; edge sharply rounded, not keeled; whorls about 4, unusually narrow for the genus, not increasing much in width as growth proceeds, not overlapping on the dorsal side; about 12 chambers in the last whorl, gradually increasing in size as added; dorsal sutures slightly curved, moderately oblique, more and more limbate toward the center of the test, but not much raised, the spiral suture limbate and raised with clear shell material; the growth of the secondary material on the sutures obscures the spire especially toward the center but leaving the mural perforations in the reduced rhomboidal areas corresponding to the chambers; sutures on the ventral side slightly curved, narrowly limbate and flush with the surface, merging into the umbo of clear shell material; aperture a low arch just below the periphery with upper lip, extending on the dorsal side between the whorls for a distance of one or two chambers. Diameter, 0.87 millimeter; thickness, 0.40 millimeter.

Holotype No. 4122, locality A93, Quebradillas formation.

Rare at A93 of the Quebradillas formation.

This species differs from *C. mundula* (Brady, Parker and Jones) (1890. Trans. Zool. Soc. London **12**) in being ventrally umbonate, in the curved sutures and the aperture not on the inner periphery. The narrow whorls and spiral limbation are characteristic.

PLANULINA d'Orbigny 1826

Planulina crassa NEW SPECIES

PLATE 25, FIGURES 2a-c

Test nearly circular in side view, compressed in edge view yet rather thick, dorsal side flat or slightly concave, ventral side flat or slightly convex; back flat or slightly concave, a little oblique to the two sides; whorls 2 to 3, scarcely at all involute on the ventral side, slightly involute on the dorsal side; chambers 9 to 10 in the last whorl, increasing gradually in size as added; sutures on the dorsal side much curved and strongly raised, merging with the raised border; ventral sutures strongly curved and raised; wall coarsely perforate, the ventral surface strongly granulate between the sutures and on the sutures, and finely granulate on the dorsal surface over the early whorls; aperture at the base of the septal face on the inner periphery, with upper lip, not extending onto the ventral side but extending onto the dorsal side between the last two whorls for a distance of one or two chambers. Diameter, 0.45 millimeter; thickness, 0.13 millimeter.

Holotype No. 4065, locality A21, Quebradillas formation.

Abundant at A21; rare at A15; common at A20 and A93 of the Quebradillas formation.

This species differs from *P. ariminensis* d'Orbigny in that it is much thicker and the chambers are narrower in proportion to their length.

Planulina depressa (d'Orbigny)

PLATE 25, FIGURES 3a-c

Truncatulina depressa d'Orbigny (1839) Voy. Amér. Mérid. 5: Foraminifères 39. pl. 6, figs. 4-6. Recent, off South America.

Planulina depressa Cushman (1930) Fla. Geol. Surv. Bull. 4: 60. pl. 12, fig. 2. Miocene, Florida.

Test large, subcircular in side view, much compressed, concavo-convex to plano-convex, ventral side moderately convex but without an umbilical boss of secondary shell material; edge sharply angular; periphery lobulate, more strongly so in the last half whorl, with narrow, limbate border; some of the earlier whorls show on both sides of the test, the early dorsal spire covered with a thin, granular, secondary deposit; chambers short and wide, a little inflated on the ventral side, enlarging more rapidly in width than in length or thickness, about 9 in the last whorl; ventral sutures most distinct between the chambers of the last half whorl where they are conspicuously depressed, nearly radial near the center of the test, sharply curved near the periphery; dorsal sutures strongly curved, flush with the surface or slightly de-

pressed, slightly limbate on the outer end where the limbation merges into the border; wall moderately coarsely perforate; aperture a small, high arch, with strong upper lip, at the base of the septal face on the inner periphery, extending onto the dorsal side for a distance of 3 or 4 chambers. Diameter, 1.38 millimeters; thickness, 0.26 millimeter.

Plesiotype No. 4124, locality P255, Ponce formation.

Rare at P255 of the Ponce formation.

***Planulina marialana* Hadley**

PLATE 25, FIGURES 4a-c

Planulina wuellerstorfi Nuttall (not Schwager) (1932) Jour. Paleont. 6: 31. pl. 4, figs. 14, 15. Lower Oligocene, Mexico.

Planulina marialana Hadley (1934) Bull. Am. Paleont. 20 (70A): 27. pl. 4, figs. 4-6. Oligocene, probably upper, Cuba.—Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 313. pl. 20, figs. 10-12. Lower Oligocene, Cuba.

Test large, nearly circular, biconvex, much compressed; periphery smooth, except for the last few chambers; edge angled, with narrow peripheral keel of clear shell material, more distinct on the earlier chambers of the last whorl; dorsal side of test showing $2\frac{1}{2}$ to 3 rapidly widening whorls, ventral side involute nearly to umbilicus; chambers short and wide, 10 to 12 in the final whorl of the adult; dorsal sutures broadly curved, limbate, usually raised with the raised limbation more conspicuous on the early whorls; ventral sutures broadly curved, the later ones sigmoid, limbate, usually raised; the largest specimens umbilicate; wall coarsely perforate; aperture at the base of the last chamber on the inner periphery, extending a short distance onto the dorsal side between the last two whorls. Diameter, 1.52 millimeter; thickness, 0.25 millimeter.

Plesiotype No. 4125, locality P2, Ponce formation.

Rare at P251; common at P3 and P255; abundant at P2 and P254 of the Ponce formation.

It is quite possible that the forms figured by Hadley (umbonate, 9 chambers) and that figured by Palmer and Bermudez (umbilicate, 12 to 14 chambers) represent two different species, both of which are represented in the Porto Rican material.

***Planulina mexicana* Cushman**

PLATE 26, FIGURES 3a-c

Planulina mexicana Cushman (1927) Contr. Cushman Lab. Foram. Res. 3: 113. pl. 23, figs. 5a, b. Alazan, upper Eocene and lower Oligocene, Mexico.—Cole & Ponton (1930) Fla. Geol. Surv. Bull. 5: 47. pl. 6, fig. 2. Lower Oligocene, Florida.—Nuttall (1932) Jour. Paleont. 6: 31. pl. 7, fig. 7. Lower Oligocene, Alazan, Mexico.—Hadley (1934) Bull. Am. Paleont. 20 (70A): 28. pl. 4, fig. 12. Oligocene, Cuba.

Planulina cocoaensis cooperensis Cushman (1933) Contr. Cushman Lab. Foram. Res. 9: 20. pl. 2, fig. 12; (1935) U. S. Geol. Surv. Prof. Pap. 181: 52. pl. 22, fig. 8. Upper Eocene, South Carolina.

Test large, much compressed, complanate, sides flattened; edge narrowly rounded, not keeled; periphery slightly lobulate; early whorls visible on both sides of the test, becoming less involute with age, the final half whorl just touching the preceding whorl; chambers short and evenly curved, 7 to 8 in the last whorl; sutures distinct, sharply curved, limbate, flush with the surface or very slightly raised except between the last few chambers where they are depressed; wall coarsely perforate; aperture a low arch with slight lip at the base of the last chamber extending on the dorsal side about half a chamber length. Diameter, 0.82 by 1.04 millimeter; thickness, 0.11 millimeter.

Plesiotype No. 4066, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This is one of the least involute species of the genus, the complete spire being visible on both sides of the test.

Planulina zigzag NEW SPECIES

PLATE 26, FIGURES 4a-c

Test oval in side view, much compressed, nearly planispiral, the dorsal side flat, or with slight spiral depression inside the last whorl, rarely slightly convex, as in the specimen figured; ventral side slightly convex, with large, shallow umbilical depression; edge truncate or slightly concave, with sharp, continuous keel of clear shell material extending from the dorsal side, the ventral side with discontinuous keel formed by the outer edges of the sutural limband; periphery smooth, formed by the dorsal keel; dorsal sutures nearly straight, radial, limbate and raised, the limband continuing in a zigzag line from chamber to chamber, just inside the carina, the spiral suture limbate but not raised, sometimes depressed; whorls about 2, only slightly involute on each side; eight chambers in the last whorl, enlarging rapidly, not inflated; ventral sutures limbate and strongly raised, straight, radial, the raised limband continuing in a conspicuous zigzag line around the outer edge of the chambers, somewhat inside the dorsal carina, not joining to form a continuous carina; the radial and zigzag ridges on both sides of the test have fine, longitudinal striae on them; wall very coarsely and conspicuously perforate where the preservation is good; surface smooth, except for the raised ridges; septal face finely granulate; aperture a short slit at the base of the septal face, not continuing onto either dorsal or ventral side, with

slight upper lip. Diameter, 0.53 by 0.72 millimeter; thickness, 0.11 millimeter.

Holotype No. 4126, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

It is probably that *P. zigzag* is related to *P. alavensis* Palmer (1938. Mem. Soc. Cubana Hist. Nat. 12: 345, 346, text fig.), but *P. zigzag* differs in the zigzag line of the peripheral limbation and the absence of peripheral secondary apertures.

CIBICIDELLA Cushman 1927

Cibicidella variabilis (d'Orbigny)

PLATE 24, FIGURES 1a-c

Truncatulina variabilis d'Orbigny (1826) Ann. Sci. Nat. 7: 279. no. 8; refers to 22 plates of illustrations by Soldani, 1789-1798. Recent, Mediterranean.—Parker, Jones & Brady (1871) Ann. Mag. Nat. Hist. IV. 8: 177. pl. 12, fig. 138. (One of Soldani's figures, on which d'Orbigny named his species.)—Terquem (1878) Mém. Soc. Géol. France III. 1: 20. pl. 1, figs. 18-25. Upper Pliocene, Isle of Rhodes.

Test large, ovate in side view; periphery lobulate; edge round; dorsal side irregularly concave; ventral side strongly convex and umbilicate; chambers 6 or 7 in the last formed whorl, inflated ventrally and sometimes dorsally, enlarging rapidly in all dimensions, especially the last few chambers, the last few chambers distorted but still retaining their normal position in a rotaloid coil, sometimes tending to become evolute; dorsal sutures flush and limbate in the early test, depressed in the later portion; ventral sutures strongly depressed, nearly linear and radial; wall coarsely perforate, about 0.01 millimeter in diameter, with little if any secondary material; aperture a single, high arch, with upper lip, on the inner periphery at the base of the septal face. Length, 1.36 millimeter; width, 0.85 millimeter; thickness, 0.2 millimeter. Some specimens are much larger and thicker.

Plesiotype No. 4127, locality L4C, San Sebastian formation.

Common at L4C; rare at L6C of the San Sebastian formation.

Our specimens are all much alike and not much removed from the ancestral *Cibicides*, and are like the figures in the references above. They are not like the figure in d'Orbigny's Canaries paper, nor like the specimens from the Miocene of Florida (1932. Fla. Geol. Surv. Bull. 9: pl. 15).

SIPHONINA Reuss 1850

Siphonina advena Cushman

PLATE 26, FIGURES 1a-c

Siphonina advena Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129E: 98. pl. 22, figs. 1, 2. Middle Oligocene, Mississippi; (1927) Proc. U. S. Nat. Mus. 72 (20): 7. pl. 1, fig. 7. Oligocene, gulf coast and Mexico.—Cole & Ponton (1930) Fla. Geol. Surv. Bull. 5: 43. pl. 11, figs. 7, 8. Lower Oligocene, Florida.

Test of moderate size, subcircular to oval in side view, biconvex, the ventral side slightly more convex; periphery not lobulate; edge subangular, not keeled; chambers in about 2 whorls, 4 to 5 in the last whorl, enlarging gradually; dorsal sutures obscure, slightly curved and oblique, flush with the surface, somewhat broadened with clear shell material; ventral sutures distinct, narrow, slightly curved, radial, a little depressed; wall very coarsely and conspicuously perforate, except over the early dorsal spire where the pores are obscure; aperture peripheral, slightly ventral, elliptical with short neck and phialine lip. Diameter, 0.42 millimeter; thickness, 0.2 millimeter.

Plesiotype No. 3988, locality A20, Quebradillas formation.

Rare at L1C and L5C of the San Sebastian formation, and at A6 of the Lares formation. Common at A43a and A86 of the Cibao formation. Rare at A79 of the Los Puertos formation. Rare at A15, A93, and F358; common at A20; abundant at A21 of the Quebradillas formation. Rare at P251 and P432 of the Ponce formation.

Siphonina tenuicarinata Cushman

PLATE 26, FIGURES 2a-c

Siphonina tenuicarinata Cushman (1927) Jour. Paleont. 1: 166. pl. 26, figs. 11, 12. Lower Oligocene, Alazan, Mexico; (1929) Contr. Cushman Lab. Foram. Res. 5: 100. pl. 14, fig. 9. Middle Tertiary, Venezuela and Trinidad.—Hedberg (1937) Jour. Paleont. 11: 679. pl. 92, fig. 4. Oligocene, Venezuela.—Coryell & Rivero (1940) Jour. Paleont. 14: 337. pl. 43, figs. 22, 29. Middle Miocene, Haiti.

Test asymmetrically coiled, biconvex, the ventral side slightly more so; edge acute with a wide keel of clear shell material, in which there are pores extending out from the edge of the chamber; whorls about 3; chambers about 5 in the last whorl, increasing uniformly in size, the last ones somewhat inflated on the ventral side; dorsal sutures nearly straight, tangential to the previous whorl, flush with the surface and very obscure; ventral sutures slightly curved, radial, flush with the surface and obscure excepting the last one or two, which may be slightly depressed; wall moderately coarsely but conspicuously perforate; aperture slightly below the periphery on the ventral side,

elliptical, with very short neck and broad lip. Diameter, 0.6 millimeter; thickness, 0.26 millimeter.

Plesiotype No. 4128, locality P254, Ponce formation.

Rare at P2 and P255; common at P254, Ponce formation.

PLANORBULINELLA Cushman 1927

Planorbulinella larvata (Parker & Jones)

PLATE 26, FIGURES 5a-c

Planorbulina vulgaris larvata Parker & Jones (1860) Ann. Mag. Nat. Hist. III. 5: 294. Recent.
Planorbulina larvata Parker & Jones (1865) Phil. Trans. 155: 380. pl. 19, figs. 3a, b. Recent,
 Indian Ocean.—Brady (1884) Rep. Voy. Challenger Zool. 9: 658. pl. 92, figs. 5, 6. Recent,
 south Pacific—"exclusively tropical."—Hadley (1934) Bull. Am. Paleont. 20 (70A): 30. pl.
 5, fig. 9. Upper Oligocene, Cuba.

Test subdiscoidal, more flattened on attached dorsal side; chambers in central part of test covered by laminae and fine, elongate knobs, only the chambers of the outermost whorl being unobscured; edge rounded; apertures oval, two to each chamber, at the ends of the chamber in the median line. Diameter, 0.88 to 1.44 millimeter; thickness, 0.15 millimeter

Plesiotype No. 3947, locality A21, Quebradillas formation.

Abundant at A86 of the Cibao formation. Rare at A20; abundant at A21 of the Quebradillas formation.

Family ACERVULINIDAE Schultze 1854

RUPERTIA Wallich 1877

Rupertia verrucosa NEW SPECIES

PLATE 27, FIGURES 9a-c

Test large, attached in life by the concave dorsal side, irregularly tuberoso, not columnar; early chambers close coiled like *Cibicides* for one whorl or more, followed by irregularly arranged chambers forming a tuberoso mass of round or elongate, loosely or closely appressed chambers; wall calcareous, thick, coarsely perforate; surface in the young smooth, showing the closely spaced, large pores; in the adult the surface is usually covered with a rough, nodular deposit of secondary calcareous, shell material; aperture a slit or large irregular arch at the base of the last septal face, with upper lip, never on the upper side of the test, nor tubular. Diameter, up to 4 millimeters; height, up to 3 millimeters. Diameter of figured specimen, 3.1 millimeters; height, 3 millimeters.

Holotype No. 4130, locality P4, Ponce formation.

Abundant at P4 of the Ponce formation.

This species differs from *R. stabilis* Wallich in the tuberoso rather than columnar and bulbous shape, in the rough coating of secondary shell material in the adult test, in the lateral rather than terminal position of the aperture, and in the larger size.

CARPENTERIA Gray 1858

Carpenteria bulloides NEW SPECIES

PLATE 27, FIGURES 1 to 4

Test multilocular, irregularly cylindrical or columnar in the adult, globigerinoid in the young; chambers subglobular, increasing gradually in size from the apical, attached end, and arranged in an alternating series, 6 chambers in the adult test; sutures distinct, depressed; test attached in life, the place of attachment being on the first 2 or 3 chambers as shown by the cicatrix; aperture with a short neck of clear, imperforate shell material located on the side of the test opposite the point of attachment, in the adult terminal, not opening into the sutures or into an umbilical depression; aperture in the young oval in shape with a short flaring neck, in the adult round with a short conical neck; surface with large pores which are emphasized by deposits of secondary shell material, pores missing and the surface of the test smooth around the neck. Length of adult specimen, 1.61 millimeters; diameter, 1.21 millimeters.

Holotypes No. 3881a, b, c, d, locality A21, Quebradillas formation.

Common at A21 of the Quebradillas formation.

C. bulloides lacks the broad basal attachment of *C. lithothamnica* Uhlig from the middle Eocene of West Galicia (1886. Jahrb. Geol. Reichsanstalt **36**: 189. pl. 5, figs. 1, 2). It resembles even more closely *C. alternata* Chapman and Crespín from the middle Tertiary of Victoria (1930. Proc. Roy. Soc. Victoria **43** (1): 99. pl. 5, figs. 9, 10) but differs in the coarsely perforate character of its surface and in the position and character of its aperture.

We are not satisfied with the generic disposition of this species, but do not wish to redefine the genus at this time.

Carpenteria proteiformis Goës

PLATE 27, FIGURE 5

Carpenteria balaniformis proteiformis Goës (1882) Kongl. Svensk. Vet. Akad. Handl. **19**: 94. pl. 6, figs. 208–214, pl. 7, figs. 215–219. Recent, Caribbean Sea.

Carpenteria proteiformis Cushman (1931) Bull. U. S. Nat. Mus. **104** (8): 140. pl. 26, fig. 1. Recent, West Indies.

Test attached by a flat base, tending to be columnar, the basal portion more or less spreading; chambers inflated, the later chambers making an irregular subcylindrical column of several chambers which may be low or higher with staggered uniserial chambers; wall coarsely perforate, with a cellular, areolate surface suggestive of the mushroom *Morchella esculenta*; aperture circular, often with a tubular neck which is imperforate; position of aperture variable and several chambers may show apertures at once. Length of incomplete specimen, 2.0 millimeters; diameter, 1.0 millimeter.

Plesiotype No. 4131, locality A21, Quebradillas formation.

Common at A21; rare at A46 of the Quebradillas formation. Common at P431 and P432 of the Ponce formation.

Our specimens are not as elongate as specimens usually considered typical of this species, and the wall is more coarsely cellular or reticulate. Perhaps they belong with *C. utricularis*. The species of *Carpenteria* vary so widely that it is difficult to identify any of them.

GYPSINA Carter 1877

Gypsina discus (Goës)

PLATE 28, FIGURE 4

Tinoporos vesicularis Goës (not P. and J.) (1882) Kongl. Svenska Vet. Akad. Handl. My Följd 19: 104. pl. 7, figs. 245-247. Recent, Caribbean Sea.

Gypsina vesicularis discus Goës (1896) Bull. Mus. Comp. Zool. 21: 74. pl. 7, figs. 4-6. Recent, west coast Central America.

Test discoidal, biconvex; nearly circular in side view; edge sharply rounded; surface conspicuously reticulate, due to the chambers, the outer walls of which are usually broken away; the test consists of chambers added eccentrically around a small, coiled nucleoconch; the chambers are higher in the median region than on the flatter sides of the test; there is no median layer of chambers, as in the orbitoids, and the chambers are not in rays, as in *Sphaerogypsina*; the chambers are oval or subrhomboidal, as seen from the outside of the test and in parallel sections, averaging 0.13 millimeter in longer diameter; height of chambers, as seen in cross section, averaging 0.06 millimeter; wall finely perforate; apertures, other than the perforations, absent. Diameter of test, up to 3 millimeters; thickness, up to 1 millimeter.

Plesiotype No. 4129, locality A21, Quebradillas formation.

Common at A21; rare at F359, Quebradillas formation. Rare at P4, Ponce formation.

The Tertiary Porto Rican specimens seem to be identical with the specimens figured by Goës, in the reference above.

SPHAEROGYPSINA Galloway 1933

Sphaerogypsina globulus (Reuss)

PLATE 27, FIGURE 7

Ceripora globulus Reuss (1847) Haidinger's Naturwiss. Abh. 2: 33. pl. 5, fig. 7. Middle Miocene, Austria.

Gypsina globulus Brady (1884) Rep. Voy. Challenger Zool. 9: 717. pl. 101, fig. 8. Recent, British Islands.—Cushman (1919) Carnegie Inst. Wash. Publ. 291: 44. pl. 4, fig. 7. Upper Oligocene or early Miocene, Santo Domingo; (1935) U. S. Geol. Surv. Prof. Pap. 181: 54. pl. 23, figs. 4, 5. Upper Eocene, southeastern U. S.

Sphaerogypsina globulus Galloway (1933) Manual of Foraminifera 309. pl. 28, figs. 13, 14.

Test small, spheroidal; surface pustulose, or pitted, with a more or less regular polygonal network formed by the walls of the outside chambers; wall finely perforate, with no distinct aperture other than the perforations. Diameter, 0.27 to 1.11 millimeters.

In cross section the chambers are seen to be rotaloid in the early portion with a microspheric nucleocoenoch (no megaspheric observed although several sections were made); the later chambers are concentrically arranged in radial lines, enlarging mainly in width, very little in height toward the periphery; the later chambers are nearly equidimensional, circular or subcircular in shape near the center of the test, becoming more rectangular or oval near the periphery, the elongation being parallel to the periphery with maximum length up to $1\frac{1}{2}$ times the height; average diameter of chambers, 0.044 millimeter; average height, 0.033 millimeter; layers of chambers relatively few, 8 to 14, outside of the nucleocoenoch.

Plesiotype No. 3889, locality F358, Quebradillas formation.

Rare at L1C, L3C, and L4C of the San Sebastian formation. Common at A86 of the Cibao formation. Rare at F358 of the Quebradillas formation. Rare at P2; common at P432 and P433 of the Ponce formation.

Our specimens are identical in all respects with topotypes from the Miocene Leithakalk near Vienna, Austria.

Sphaerogypsina pilaris (Brady)

PLATE 27, FIGURE 8

Tinoporus pilaris Brady (1876) Ann. Soc. Mal. Belg. 11: 103. Miocene, Jamaica.

Gypsina globulus Hill (1899) Bull. Mus. Comp. Zool. 34: 147. Miocene, Jamaica.

Gypsina globulus (Reuss) var. *pilaris* Cushman (1919) Carnegie Inst. Wash. Publ. 291: 44. pl. 9, figs. 1, 2. Miocene, Cuba.

Test spherical, large, the surface appearing almost smooth when observed megascopically, under the microscope with a coarsely areolate or pustulose surface showing the outlines of the outer chambers; wall

finely but conspicuously perforate, with no aperture other than the perforations. Diameter, up to 3.2 or 4 millimeters.

In cross section the microspheric nucleoconch is rotaloid, with later chambers added concentrically and arranged in radial lines; the radial tiers of chambers are conspicuous in natural cross sections of broken specimens as well as in laboratory sections; the later chambers are very numerous, in many concentric layers; chambers oval in shape, elongate parallel to the periphery with the length about twice the height, averaging 0.14 millimeter in diameter, height 0.067 millimeter.

Plesiotype No. 3990, locality P258, Ponce formation.

Common at A21, F359, and A64 of the Quebradillas formation. Abundant at P258 of the Ponce formation. *S. pilaris* occurs also in abundance in the calcareous strata 8.5 kilometers west of Isabel II on the north shore of the Island of Vieques, just east of Porto Rico. Meyerhoff correlates these beds with the upper part of the Ponce formation.

S. pilaris differs from *S. globulus* in being generally larger in size, with much coarser areolation on the surface; in cross section the chambers are much more numerous, more closely appressed radially, and elongate rather than nearly equidimensional in shape.

Family **ASTERIGERINIDAE** d'Orbigny 1839

AMPHISTEGINA d'Orbigny 1826

Amphistegina angulata (Cushman)

PLATE 28, FIGURES 6a-c

Asterigerina angulata Cushman (1919) Carnegie Inst. Wash. Publ. 291: 45. pl. 13, figs. 1a-c.
Lower Miocene or upper Oligocene, Santo Domingo.

Test rotaliform, nearly circular in side view; dorsal side moderately convex, convexity variable; ventral side strongly convex to conical; acutely angled at the edge but not carinate; about 14 chambers in the last whorl, of nearly uniform size; sutures flush with the surface, marked by clear shell material; sutures on dorsal side obliquely recurved, on ventral side "with the sutures ending in an angle about midway between the center and the periphery, from which a secondary chamber is developed to the umbilical region, alternating with the main chambers; umbilical region solid, of clearer shell material" than the chamber walls; surface smooth except for fine papillae on the ventral side around the aperture and extending along the periphery; aperture rather long and narrow at the base of the last chamber on

the ventral side of the test. Diameter, 0.67 (young specimens) to 1.38 millimeters; thickness, up to 0.83 millimeter.

Plesiotype No. 3862, locality F359, Quebradillas formation.

Common at F358; abundant at F359 of the Quebradillas formation. Common at P259 and 433; rare at P434; abundant at P258 of the Ponce formation.

Only one whorl shows on the dorsal side of the test, not all the whorls of the spire as in *Asterigerina*.

Amphistegina floridana Cushman & Ponton

PLATE 28, FIGURES 5a-c

Amphistegina floridana Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 96. pl. 14, figs. 6, 7. Lower Miocene, Florida.

Amphistegina chipolensis Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 96. pl. 15, figs. 1a-c. Lower Miocene, Florida.

Asterigerina choctawensis Cushman & McGlamery (1938) U. S. Geol. Surv. Prof. Pap. 189D: 111. pl. 28, figs. 2a-c. Middle Oligocene, Alabama.

Test planoconvex to biconvex, umbonal region more prominent on the ventral side; edge subacute with slight keel; chambers numerous, 10-15 in the last whorl, increasing slowly in size, frequently with transparent alar prolongations over the umbonal region on the dorsal side of the test through which the earlier whorls are more or less clearly visible; sutures flush with the surface, marked by clear shell material, on dorsal side recurved about half way to the periphery, on ventral side nearly radial to junction with secondary sutures, then curving to the periphery which is met at an angle of about 45 degrees; secondary sutures appearing about midway between umbo and periphery; wall finely perforate; surface smooth except near the base of the aperture and along the periphery for a distance of about two chambers where the surface is strongly papillate; aperture ventral, at the base of the last septal face. Average diameter, 1 millimeter; thickness, 0.50 millimeter.

Plesiotype No. 3863, locality L4C, San Sebastian formation.

Rare at L2C; common at L1C, L3C, L5C; abundant at L4C of the San Sebastian formation. Common at A86 of the Cibao formation. Rare at F359; common at A15, A21, and A93 of the Quebradillas formation. Rare at P2, P3, P4, and 434; common at P431; abundant at P258, P259, and P432 of the Ponce formation.

There seems to be no appreciable difference between this species and *A. chipolensis* which was made at the same time as *A. floridana* and which comes from the same formation although from a slightly lower horizon.

Family **CHILOSTOMELLIDAE** Brady 1881**CHILOSTOMELLA** Reuss 1850**Chilostomella czizeki** Reuss

PLATE 28, FIGURES 3a-c

Chilostomella czizeki Reuss (1850) Denkschr. Akad. Wiss. Wien. 1: 380. pl. 48, fig. 13. Middle Miocene Austria.—Schwager (1877) Boll. R. Com. Geol. Ital. 8: 26. pl., fig. 70. Tertiary, Italy.—Cushman (1926) Contr. Cushman Lab. Foram. Res. 1: 74. pl. 11, fig. 2.

Test small, smoothly elliptical in side view, the sides gently convex, the ends broadly rounded, not quite twice as long as thick, nearly circular in cross section but more sharply curved on the back; the last chamber covering two-thirds to three-fourths of the preceding chamber, the line of contact being deeply concave on the back of the test, sometimes exposing a little of several earlier chambers, including the allomorphinoid chambers and proloculum; wall very finely perforate; surface smooth and sometimes mottled with yellow and white mosaic; aperture a narrow crescent comprising about one-fourth of the circumference of the test, with thick but not strongly everted lip. Length, 0.64 millimeter; diameter, 0.39 millimeter. Some specimens are larger.

Plesiotype No. 4133, locality P254, Ponce formation.

Rare at P254 and P255 of the Ponce formation.

This species resembles *C. cylindroides* Reuss but it is shorter and has more convex sides.

Chilostomella globata NEW SPECIES

PLATE 28, FIGURES 2a-c

Test small, subglobular, the last chamber considerably larger than the previous one and constituting about two-thirds of the external test; subcircular in cross section; the suture line is only slightly concave on the back of the test; wall very finely perforate; surface smooth; aperture a narrow crescentic slit, comprising about one-fourth of the circumference of the test, with large, strongly everted, slightly undulating and fimbriate lip. Length, 0.38 millimeter; diameter, 0.33 millimeter. Other specimens up to 0.8 millimeter in diameter.

Holotype No. 4134, locality P254, Ponce formation.

Rare at P254 and P255 of the Ponce formation.

Chilostomella ovoidea Reuss

PLATE 28, FIGURES 1a-c

Chilostomella ovoidea Reuss (1850) Denkschr. Akad. Wiss. Wien 1: 380. pl. 48, figs. 12a-e. Middle Miocene, Austria.—Cushman (1924) Bull. U. S. Nat. Mus. 104 (5): 2. pl. 1, figs. 2, 3. Recent, Bermuda.

Test ovoid, three-fourths as broad as long, nearly circular in cross section, tapering and more pointed at the apical than at the apertural end; greatest thickness above the middle of the test; the last chamber forms from two-thirds to three-fourths of the outside of the test; the suture line between the last two chambers nearly straight and transverse except for a slight apical bend on the back of the test; wall finely perforate; surface smooth; aperture an arched opening comprising about one-fourth of the circumference of the test, with thick, flaring lip. Length, 0.69 millimeter; diameter, 0.52 millimeter.

Plesiotype No. 4135, locality P255, Ponce formation.

Rare at P255 of the Ponce formation.

Chilostomella urceolus NEW SPECIES

PLATE 27, FIGURES 6a, b

Test ovoid, circular in transverse section, broadly rounded at both apical and apertural ends, $\frac{3}{5}$ as broad as long; greatest width more than twice that at the aperture; last chamber covering practically all of the preceding chamber, the line of contact between the two chambers being straight and at right angles to the axis of the test; wall smooth; aperture curved, at the base of the last chamber with a flaring lip. Length, 1 millimeter; diameter, 0.60 millimeter.

Holotype No. 3883, locality P2, Ponce formation.

Rare at P254, P255, and P4; common at P2 and P3 of the Ponce formation.

This new species resembles *C. ovoidea* Reuss in many respects, but differs in that *C. urceolus* is rounded both apically and aperturally, is more elongate, and the line of contact between the last 2 chambers is not deflected posteriorly as in *C. ovoidea*. It is smaller than *C. grandis* and the suture is without posterior deflection.

SPHAEROIDINA d'Orbigny 1826

Sphaeroidina bulloides d'Orbigny

PLATE 30, FIGURES 1a, b

Sphaeroidina bulloides d'Orbigny (1826) Ann. Sci. Nat. 7: 267, no. 1; Modèles, no. 65. Recent, Adriatic; Pliocene, Italy.—Cushman (1914) Bull. U. S. Nat. Mus. 71 (4): 18, pl. 10, fig. 7, pl. 12, fig. 1. Recent, north Pacific; (1924) Bull. U. S. Nat. Mus. 104 (5): 36, pl. 7, figs. 1-6. Recent, Caribbean, Gulf of Mexico, and western Atlantic from Brazil to Cape Cod.

Test subspherical, exterior formed of a few chambers, usually 4 or 5; chambers slightly inflated, closely appressed; sutures moderately depressed; aperture a small arched opening with a flat tooth at the

inner margin of the last chamber. Diameter, 0.46 by 0.55 millimeter; thickness, 0.40 millimeter.

Plesiotype No. 3991, locality P254, Ponce formation.

Rare at F358 of the Quebradillas formation. Rare at P251, P254, P255, P431; common at P2 and P3 of the Ponce formation.

Family ORBULINIDAE Schultze 1854

GLOBIGERINA d'Orbigny 1826

Globigerina bulloides d'Orbigny

PLATE 29, FIGURES 1a, b

Globigerina bulloides d'Orbigny (1826) Ann. Sci. Nat. 7: 277. no. 1; Modèles no. 76. Recent, Adriatic Sea; (1829-1844) Foraminifères, Guérin-Ménéville's Cuvier, Iconographie, Mollusques 3: 9. pl. 2, fig. 12. Recent, Adriatic.—Brady (1884) Rep. Voy. Challenger Zool. 9: 593. pl. 77, figs. 3-7. Recent, world wide; Cretaceous to Recent.—Galloway & Wissler (1927) Jour. Paleont. 1: 40. pl. 7, fig. 4. Pleistocene, California.—Cole & Gillespie (1930) Bull. Am. Paleont. 15 (57B): 12. pl. 2, fig. 16. Middle Oligocene, Meson formation, Mexico.

Test of average size for the genus, longer than wide, consisting of about $2\frac{1}{2}$ whorls arranged in a trochoid spire; chambers about 12 in number, inflated, somewhat appressed, subglobular, rapidly enlarging, four constituting the last whorl; sutures deeply depressed; wall thick, finely reticulate; aperture large, semicircular, opening into the umbilicus. Length, 0.30 millimeter; width, 0.24 millimeter; thickness, 0.19 millimeter.

Plesiotype No. 3920, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation. Rare at A86; common at A43a of the Cibao formation. Rare at A79 of the Los Puertos formation. Rare at A20 and A21 of the Quebradillas formation. Rare at P2, P254, and P255; common at P3 of the Ponce formation.

Globigerina dutertrei d'Orbigny

PLATE 29, FIGURES 2a, b

Globigerina dutertrei d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 84. pl. 4, figs. 19-21. Recent, off Cuba, Martinique, Guadeloupe.—Brady (1884) Rep. Voy. Challenger Zool. 9: 601. pl. 81, figs. 1a-c. Recent, Antarctic, south Pacific, West Indies.—Cushman (1921) Proc. U. S. Nat. Mus. 59: 55. pl. 12, figs. 7a-c. Recent, north coast Jamaica.

Test rotaliform, low spired, small for the genus; 5 chambers in last whorl; periphery lobulate; chambers inflated, slightly appressed; size of chambers rapidly increasing in early stages, the 5 chambers of the last whorl being more nearly equal in size; sutures depressed; wall finely reticulate; aperture a low arched opening into the umbilicus. Diameter, 0.28 by 0.36 millimeter; thickness, 0.20 millimeter.

Plesiotype No. 3921, locality L1C, San Sebastian formation.

Very rare at L1C of the San Sebastian formation. Rare at A43a; common at A86 of the Cibao formation. Rare at A21 of the Quebradillas formation. Rare at P432; common at P2 and P3 of the Ponce formation.

This species differs from *G. dubia* Egger (1857. Neues Jahrb. Min. Geol. Pal.) in the lower spire.

Globigerina inflata d'Orbigny

PLATE 29, FIGURES 3a-c

Globigerina inflata d'Orbigny (1839) in Barker, Webb & Berthelot, Hist. Nat. Îles Canaries 2 (2): Foraminifères 134. pl. 2, figs. 7-9. Recent, Canaries.—Cushman (1924) Bull. U. S. Nat. Mus. 104 (5): 12. pl. 3, figs. 1-3. Recent, mostly off New England.

Test rotaloid, dorsal side nearly flat, ventral side very deep due to the rapid increase in height of the chambers; periphery moderately lobulate; edge flatly rounded with sharply rounded shoulder; whorls 2 to 3, the last usually having 4 chambers; sutures moderately depressed, slightly curved; wall finely perforate; surface smooth, the older tests covered with small, secondary knobs on the ventral side and on the dorsal early whorls; aperture a high arch on the ventral side extending from umbilicus to periphery, with thin upper lip. Diameter, 0.53 millimeter; height, 0.38 millimeter.

Plesiotype No. 4137, locality P251, Ponce formation.

Rare at P251 of the Ponce formation.

Globigerina ouachitaensis Howe & Wallace

PLATE 29, FIGURES 4a-c

Globigerina ouachitaensis Howe & Wallace (1932) La. Dept. Cons. Geol. Bull. 2: 74. pl. 10, figs. 7a, b. Upper Eocene, Louisiana.—Howe (1939) La. Dept. Cons. Geol. Bull. 14: 83. pl. 12, figs. 18, 19. Middle Eocene, Louisiana.

Test small, subglobular; periphery lobate; about 12 chambers visible on the dorsal side, 4 in the last whorl, differing very little in size in dorsal view, but increasing rapidly in thickness dorso-ventrally; chambers inflated; sutures distinct, depressed; aperture a fairly high opening on the ventral side into the umbilical area, with previous apertures visible in the umbilical depression. Diameter, 0.40 by 0.42 millimeter; thickness, 0.30 millimeter.

Plesiotype No. 4048, locality A21, Quebradillas formation.

Common at A86 of the Cibao formation. Rare at A21 of the Quebradillas formation. Rare at P2, P3, and P251; common at P255 of the Ponce formation.

Globigerina pachyderma (Ehrenberg)

PLATE 29, FIGURES 5a-c

Aristospira pachyderma Ehrenberg (1861) Monatsber. k. preuss. Ak. Wiss. Berlin 303.

Recent, Davis Strait; (1873) Abh. k. Akad. Wiss. Berlin pl. 1. fig. 4.

Globigerina pachyderma Brady (1884) Rep. Voy. Challenger Zool. 9: 600. pl. 114, figs. 19, 20.

Recent, northern oceans.—Heron-Allen & Earland (1909) Jour. Roy. Micr. Soc. 438.

pl. 18, figs. 4, 5. Tertiary, Sussex.—Galloway & Wissler (1927) Jour. Paleont. 1: 43. pl. 7, figs. 13a-c. Pleistocene, California.

Test small, depressed subglobular; periphery slightly lobulate; edge broadly rounded; whorls 2 or 3, the last consisting of 4 subequal chambers, the earlier whorls usually obscured by a secondary, granular deposit; sutures slightly depressed, nearly straight and radial; dorsal side slightly convex, occasionally flat or slightly concave; ventral side very convex, slightly umbilicate; wall coarsely and conspicuously perforate, thick; surface smooth or more usually covered with a secondary deposit of fine granules which obscure the pores; aperture a short, low arch at the base of the last chamber opening into the shallow umbilicus, with thin upper lip. Length, 0.33 millimeter; width, 0.28 millimeter; thickness, 0.26 millimeter.

Plesiotype No. 4138, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

It is surprising to find this boreal species in subtropical deposits. The Porto Rican form seems to be typical in every way.

Globigerina pseudotriloba White

PLATE 29, FIGURES 6a, b

Globigerina pseudotriloba White (1938) Jour. Paleont. 2: 194. pl. 27, figs. 17a, b. Cretaceous to Eocene, Mexico.

Test longer than wide, composed of 2 whorls arranged in a low trochoid spire; chambers inflated, very little appressed, rapidly and regularly enlarging, 3 comprising the last whorl; sutures deep; aperture a semi-circular opening at the base of the last septal face, opening into the umbilical region. Length, 0.29 millimeter; width, 0.21 millimeter; thickness, about 0.15 millimeter.

Plesiotype No. 3922, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation. Common at A43a of the Cibao formation. Common at P3 and P254; abundant at P2 of the Ponce formation.

This species is very similar to *G. triloba* Reuss (1850. Denkschr. k. Akad. Wiss. Wien 1) and has frequently appeared in the literature of that species. Unlike *G. triloba*, *G. pseudotriloba* has only one aperture and that is located on the ventral side.

Globigerina trilocularis d'Orbigny

PLATE 29, FIGURES 7a, b,

Globigerina trilocularis d'Orbigny (1826) Ann. Sci. Nat. 7: 277. no. 2. Miocene, near Bordeaux, France.—Fornasini (1898) Rendi. Sess. R. Accad. Sci. Istit. Bologna 2: 12. pl. 0, fig. 2. (from d'Orbigny's unpublished plates of 1826).—Galloway & Morrey (1929) Bull. Am. Paleont. 15 (55): 10. pl. 3, fig. 9. Lower Oligocene, Ecuador.

Test subglobular, consisting of 6 to 9 chambers arranged in a rotaloid coil of 2 whorls, with 3 chambers in the last whorl; periphery broadly rounded, slightly lobulate; chambers inflated, closely appressed, enlarging rapidly; sutures slightly depressed; wall thick, reticulate; aperture an arched opening at the base of the last chamber opening into the umbilicus. Diameter of average specimen, 0.36 by 0.50 millimeter.

Plesiotype No. 3923, locality L5C, San Sebastian formation.

Rare at L5C of the San Sebastian formation. Abundant at A86 of the Cibao formation. Rare at A15 and A20; common at A21 and A93 of the Quebradillas formation. Rare at P2, P3, P254, and P255 of the Ponce formation.

The Porto Rican forms are very similar to *G. triloculinoides* Plummer ((1926). Univ. Texas Bull. 2644), but lack the peculiar apertural flap of that species.

ORBULINA d'Orbigny 1839

Orbulina universa d'Orbigny

PLATE 30, FIGURE 3

Orbulina universa d'Orbigny in Barker-Webb & Berthelot (1839) Hist. Nat. Îles Canaries 2 (2): Foraminifères 123. pl. 1, fig. 1. Recent, Canaries.—Cushman (1924) Bull. U. S. Nat. Mus. 104 (5): 28. pl. 5, figs. 2-9. Recent, Caribbean Sea, and widely distributed elsewhere.

Test globular, consisting of only one exterior chamber; wall finely reticulate; aperture, when present, a simple round opening. Diameter of test, 0.26 millimeter.

Plesiotype No. 3942, locality L6C, San Sebastian formation.

Rare at L1C and L6C of the San Sebastian formation. Common at A93 of the Quebradillas formation. Rare at A15, A20, and F359 of the Quebradillas formation.

Family **PEGIDIIDAE** Heron-Allen & Earland 1928**SPHAEROIDINELLA** Cushman 1927**Sphaeroidinella seminulina** (Schwager)

PLATE 30, FIGURES 4a, b

Globigerina seminulina Schwager (1866) Novara-Exped. Geol. Theil 2: 256. pl. 7, fig. 112. Pliocene, Kar Nikobar.

Sphaeroidinella dehiscens Cushman (not Parker & Jones) (1924) in part, Bull. U. S. Nat. Mus. 104 (5): 38. pl. 7, figs. 7, 8. Recent, Gulf of Mexico, and Atlantic Ocean.

Test small for the genus, subglobular to broadly ovate, young specimens showing early globigerinoid chambers, adult forms with 3 chambers making up the entire visible portion of the test; sutures in the young test flush or very slightly depressed, the final suture of the adult fissure-like on the ventral side of the test, with jagged edges; wall thick with conspicuous, large pores which in some specimens make the surface rough; aperture a small round opening at the bottom of the fissure-like suture. Length, 0.59 millimeter; diameter, 0.43 by 0.46 millimeter.

Plesiotype No. 3992, locality A21, Quebradillas formation.

Abundant at A21 of the Quebradillas formation.

This species is distinctive in its slight development of a sutural fissure, and the complete absence of a sutural fissure on the dorsal side of the test. No specimens of the form commonly referred to *S. dehiscens* (1865. Phil. Trans. 155) were found, hence it is improbable that these are young or immature specimens of that species.

Family **HETEROHELICIDAE** Cushman 1927**PAVONINA** d'Orbigny 1826**Pavonina advena** Cushman

PLATE 30, FIGURES 2a, b

Pavonina advena Cushman (1923) U. S. Geol. Prof. Pap. 133: 24. pl. 1, fig. 10. Middle Oligocene, Mississippi; (1926) Proc. U. S. Nat. Mus. 67 (25): 22. (Summary of the genus.)

Test very small, probably immature, flabellate, compressed; chambers broadening very rapidly, tending to become annular, most of them arranged in an indefinite biserial manner, the later ones having radial depressions on the inner side (as if it were crimping due to bending of a tube, a feature seen in many bent, tubular forms); sutures slightly depressed, not limbate; wall finely and evenly perforate; surface smooth but minutely granular; apertures absent excepting for the small mural pores on the septal face. Length, 0.24 millimeter; breadth, 0.22 millimeter; thickness, 0.05 millimeter.

Plesiotype No. 4136, locality A6, Lares formation.

Rare at A6 of the Lares formation.

We have only a single specimen of this rare genus and species. It has the fine pores of *P. advena*, differing from most other species of the genus, and lacks the limbate sutures and lateral carina of other species. Our specimen is in shape very similar to the early stages of *P. flabelliformis*, as figured by Heron-Allen and Earland (1915. Trans. Zool. Soc. London **20**: pl. 48, fig. 4). This form bears some resemblance to the early stages of *Cyloloculina*, but the chambers are not arranged in a uniformly spiral manner, and moreover this form does not occur with the numerous specimens we have from the Ponce and San Sebastian formations.

BOLIVINA d'Orbigny 1839

Bolivina byramensis Cushman

PLATE 30, FIGURES 11a, b

Bolivina caelata byramensis Cushman (1923) U. S. Geol. Surv. Prof. Pap. **133**: 19. pl. 1, fig. 9. Middle Oligocene, Mississippi.

Bolivina byramensis Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. **9**: 69. pl. 8, figs. 18-20. Lower and middle Oligocene, southeastern U. S.; lower Oligocene, Texas; Oligocene or Miocene, Venezuela and Trinidad.—Coryell & Rivero (1940) Jour. Paleont. **14**: 341. pl. 44, figs. 17a-c. Middle Miocene, Haiti.

Test small, tapering, about $1\frac{1}{2}$ times as long as wide, rhomboidal in apertural view, oval in side view; edge acute; chambers about 10 pairs, a little inflated near the center of the test becoming more compressed near the edge; sutures oblique, curved, all except the last few obscured by the ornamentation; surface, except for the last 1 or 2 chambers, ornamented by a coarsely reticulate pattern of costae; aperture an elongate slit on the periphery at the base of the last chamber extending up onto the last septal face, bordered by a strong lip. Length, 0.57 millimeter; width, 0.31 millimeter; thickness, 0.13 millimeter.

Plesiotype No. 3872, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

Bolivina elongata Hantken

PLATE 30, FIGURES 5a, b

Bolivina elongata Hantken (1876) A magy. kir. földt. int. évkönyve **4**: 55. pl. 7, fig. 14; (1881) Mitt. Jahrb. k. ungarn. geol. Anstalt **4**: 65. pl. 7, fig. 14. Lower Oligocene, Hungary.—Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. **9**: 51. pl. 6, figs. 31, 32.

Test elongate, very slightly tapering, a little more than three times as long as wide, somewhat compressed; sides flat; edges rounded;

chambers enlarging gradually, about 8 pairs in the megaspheric form of the test; sutures oblique, near the edge of the test curving toward the apex, flush with the surface of the test and limbate except between the last few chambers where the sutures are slightly depressed and less conspicuously limbate; wall finely perforate; aperture an elliptical opening in the last septal face, parallel to the compression of the test and extending upward from the base of the last chamber. Length, 0.73 millimeter; width, 0.22 millimeter; thickness, 0.15 millimeter.

Plesiotype No. 3875, locality P255, Ponce formation.

Very rare at P255 of the Ponce formation.

This species resembles Cushman's figure (1937. pl. 6, fig. 32) of the topotype of *B. elongata* Hantken, although it does not have the striations which are mentioned in the description and which are not shown in the figure of either the type or the topotype.

Bolivina heineae NEW SPECIES

PLATE 30, FIGURES 6a, b, and 7

Test small, regularly oval in side view, thick in the middle and thinning in all directions, widest and thickest part of the test midway between the apical and apertural ends; thickly elliptical in apertural view; chambers indistinct, obscured by the ornamentation, 7 to 9 pairs, low and broad, slightly overlapping, enlarging rather rapidly; sutures oblique, slightly curved, obscured by the ornamentation except for the last one near the apertural end; edge angular; surface ornamented by an anastomosing pattern of longitudinal costae which begin at the apical end, branch and are connected at irregular intervals by oblique cross costae; last chamber unornamented; aperture elongate, narrow, with lip. Length, 0.38 millimeter; width, 0.26 millimeter; thickness, 0.15 millimeter.

Holotypes No. 3874a, b, locality P2, Ponce formation.

Common at P2 of the Ponce formation.

We take pleasure in naming this species for Professor Aida A. Heine who was one of the first paleontologists to take an interest in the foraminifera of Porto Rico.

This species resembles *B. byramensis* Cushman, but is a smaller, thicker, more oval form, not compressed, with reticulation that tends to be more longitudinal. Although *B. heineae* resembles *B. reticulata* Hantken (1875. Mitt. Jahrb. d. k. ung. geol. Anstalt 4) in general shape and size and fineness of reticulation, it differs in being thicker and having more definitely longitudinal costae which almost completely obscure the sutures.

Acid treatment was used to remove the surface ornamentation of one specimen and show the number of chambers and typical bolivine structure of this species.

***Bolivina jacksonensis* Cushman & Applin**

PLATE 30, FIGURES 8a, b

Bolivina jacksonensis Cushman & Applin (1926) Bull. Am. Assoc. Petr. Geol. **10**: 167. pl. 7, figs. 3, 4. Upper Eocene, gulf coastal plain, U. S. and Mexico.—Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. **9**: 57. pl. 7, figs. 17, 18.

Test small, compressed; ovate in side view, gradually tapering, broadest part of test about $\frac{3}{4}$ distance from the apical end; narrowly ovate in apertural view; edge subacute but not carinate; chambers distinct, compressed, 8 or 9 pairs; sutures flush with the surface except between the last few chambers where they are a little depressed, marked by clear shell material, strongly recurved in earlier part of test, nearly straight and oblique to the edge in last part of the test; aperture narrow, at base of the last septal face, extending up toward a terminal position, with slight lip. Length, 0.33 millimeter; width, 0.15 millimeter; thickness, 0.05 millimeter.

Plesiotype No. 3876, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation.

***Bolivina matanzana convexa* NEW VARIETY**

PLATE 30, FIGURES 9a, b, and 10a, b

Test small, subrhomboidal in side view, diamond shaped in end view, bluntly pointed at the apical end and rounded at the apertural end, broadest part of test about $\frac{2}{3}$ of the distance from apical end, near base of the last pair of chambers; edge acutely angled, slightly keeled; about 9 pairs of chambers in the test; sutures strongly curved, slightly raised, marked by clear shell material; wall conspicuously perforate, some of the perforations extending through the limbate sutures; aperture extending from the base of the last septal face to a nearly terminal position, in shape elliptical with a raised rim. Length, 0.39 to 0.43 millimeter; width, 0.23 to 0.28 millimeter; thickness, 0.09 to 0.15 millimeter.

Holotype No. 4038, locality A43a, Cibao formation. Paratype No. 4039, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation. Common at A43a of the Cibao formation.

This variety is almost identical with *B. matanzana* Palmer and Bermudez from the Oligocene of Cuba (1936. Mem. Soc. Cubana Hist.

Nat. 10), but differs in its smaller size and proportionally greater thickness.

***Bolivina mexicana aliformis* Cushman**

PLATE 31, FIGURES 1a, b

Bolivina mexicana aliformis Cushman (1926) Contr. Cushman Lab. Foram. Res. 1: 82. pl. 12, figs. 3, 4. Lower Oligocene, Alazan formation, Mexico; (1937) Cushman Lab. Foram. Res. Spec. Publ. 9: 66. pl. 8, figs. 9, 10. Oligocene, Mexico and Cuba.

Test compressed, much thicker along the median line, elongate, tapering, 1.5 to 2.3 times as long as wide, greatest width near the apertural end; edge acutely angled with a broad, transparent keel, irregular in width, extending around the edges and apical end of the test; chambers numerous, about 12 pairs in the test, those of the early part low and broad, gradually increasing in height so that the last formed chambers are more nearly equidimensional; sutures distinct, limbate, those in the latter part of the test expanded toward the central part of the test; median thickness of the test due to a knoblike inflation of the inner ends of the chambers; wall finely but conspicuously perforate; aperture elongate, narrow, with a slight lip. Length, 0.23 to 1.00 millimeter; width, 0.14 to 0.50 millimeter; thickness, up to 0.20 millimeter.

Plesiotype No. 4040, locality P3, Ponce formation.

Rare at P254 and P255; common at P2 and P3 of the Ponce formation.

B. alazanensis venezuelana Hedberg (1937. Jour. Paleont. 11) from the middle Tertiary Carapita formation of Venezuela has a marked resemblance to this species, but differs in the absence of a broad keel.

***Bolivina tectiformis* Cushman**

PLATE 31, FIGURES 2a, b

Bolivina tectiformis Cushman (1926) Contr. Cushman Lab. Foram. Res. 1: 83. figs. 6a, b. Oligocene, Mexico; (1937) Cushman Lab. Foram. Res. Spec. Publ. 9: 67. pl. 8, figs. 12-14. Oligocene, Mexico.

Test small, elongate, oval in side view, nearly $2\frac{1}{2}$ times as long as wide, rhomboid in apertural view; edge sharply rounded; periphery smooth; chambers closely appressed, about 8 pairs in the test, width greater than the length, enlarging gradually; sutures distinct, slightly curved, limbate, raised, fusing in the median line to form a rounded longitudinal costa or ridge; wall conspicuously but not coarsely perforate; surface of the early portion ornamented by obscure longitudinal grooves and costae; aperture nearly terminal, elliptical, with a thickened lip, extending from the base of the last chamber, up onto

the septal face. Length, 0.40 millimeter; width, 0.17 millimeter; thickness, probably 0.08 or 0.10 millimeter.

Plesiotype No. 3878, locality P2, Ponce formation.

Very rare at P2 of the Ponce formation.

***Bolivina ventricosa* NEW SPECIES**

PLATE 31, FIGURES 5a-c

Test small with slight tendency to twist near the apical end, thickest in the middle of the test about midway of the length, tapering not only to the edges but also toward the apical and apertural ends; test widening more rapidly after the first 3 or 4 pairs of chambers, apical end narrowly rounded, apertural end broadly rounded; edge angled, keeled; chambers closely appressed, about 9 pairs in the test, increasing markedly in width after the first 4 pairs, increasing very gradually in chamber length (*i. e.* adorally), greatest thickness at inner end of each chamber, the chamber thickness increasing rapidly for the first third of the test, decreasing equally rapidly for the last third of the test with maximum thickness of chambers about midway between apical and apertural ends; sutures conspicuously curved, flush with the surface, continuous with the narrow keel of clear shell material that borders the test; aperture narrow, parallel to the compression of the test extending up onto the last septal face from the base of the last chamber on the periphery. Length, 0.35 millimeter; width, 0.30 millimeter; thickness, 0.17 millimeter.

Holotype No. 3879, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This species is quite different from all other species of *Bolivina*, particularly in its unusual thickness and the rapid widening of its test in side view. The shape of *B. ventricosa* suggests *Ehrenbergina*, but the planispirally coiled early portion is lacking and the aperture is straight, narrowly elliptical and nearly terminal, rather than lateral, in position.

LOXOSTOMUM Ehrenberg 1854

***Loxostomum hiwanneense* Howe**

PLATE 31, FIGURES 3a, b

Loxostoma hiwanneense Howe (1930) Jour. Paleont. 4: 329. pl. 27, fig. 7. Lower Oligocene, Mississippi.—Ellisor (1933) Bull. Am. Assoc. Petr. Geol. 17: 1322, 1323. pl. 3, fig. 7. Lower Oligocene, Texas.

Test small, elongate, ovate in side and apertural views, tapering rapidly near the apical end with slight apical spine; edge rounded:

chambers numerous, about 8 pairs; sutures straight, forming an oblique angle with the side of the test, flush with the surface, somewhat obscured by the ornamentation; all except the last chamber of the test ornamented by numerous fine, irregularly sinuous, longitudinal costae which are continuous across the suture lines; aperture small and elliptical, nearly terminal in position. Length, 0.39 millimeter; width, 0.18 millimeter; thickness, 0.11 millimeter.

Plesiotype No. 3929, locality A43a, Cibao formation.

Very rare at A43a of the Cibao formation.

***Loxostomum normale* NEW SPECIES**

PLATE 31, FIGURES 4a, b

Test small, elongate, about $2\frac{1}{2}$ times as long as wide, tapering at both ends, thick and slightly twisted on the axis, widest a little above the middle; periphery slightly lobulate, especially in the early part of the test; edge broadly rounded; chambers slightly inflated, about 5 pairs, increasing rapidly in size, the last chamber uniserial; sutures slightly depressed, oblique and slightly curved; wall very finely perforate; surface smooth; aperture terminal, elongate to ovate, parallel to the sides of the test, with slight lip. Length, 0.43 millimeter; width, 0.16 millimeter; thickness, 0.09 millimeter.

Holotype No. 3930, locality A43a, Cibao formation.

Rare at A43a of the Cibao formation.

This species is close to the Recent species *L. rostrum* Cushman (1933. Contr. Cushman Lab. Foram. Res. **9**: 82. pl. 8, fig. 13) from the tropical Pacific, but differs in that *L. normalis* is smaller, is more tapering at the apical end, and has oblique sutures that become less oblique as chambers are added, rather than more oblique.

PLECTOFRONDICULARIA Liebus 1902

***Plectofrondicularia trinitatensis* Cushman & Jarvis**

PLATE 31, FIGURES 6a, b

Plectofrondicularia trinitatensis Cushman & Jarvis (1929) Contr. Cushman Lab. Foram. Res. **5**: 11. pl. 2, fig. 16. Upper Eocene, Trinidad.

Test lanceolate, sides nearly parallel except toward the apical end where the test is gently tapering, initial end subacute; about 4 pairs of chambers in the early biserial part of the test, most of the test consisting of uniserial chambers which are slightly equitant; uniserial chambers increasing gradually in height; sutures obscured by the ornamentation which consists of several low costae, continuous from

the initial to the apertural end, one on each edge and 4 on either side of the test; apertural end broken off. Length of broken specimen, 0.85 millimeter; width, 0.21 millimeter; thickness, 0.09 millimeter.

Plesiotype No. 4068, locality P3, Ponce formation.

Very rare, only one specimen being found at P3 of the Ponce formation.

***Plectofrondicularia vauhani* Cushman**

PLATE 31, FIGURES 7a, b

Plectofrondicularia vauhani Cushman (1927) Contr. Cushman Lab. Foram. Res. 3: 112. pl. 23, fig. 3. Lower Oligocene, Mexico; (1929) Contr. Cushman Lab. Foram. Res. 5: 92. pl. 13, figs. 21, 22. Middle Tertiary, Ecuador, Venezuela.—Cushman & Jarvis (1930) Jour. Paleont. 4: 361. pl. 33, fig. 4. Miocene, Jamaica.—Hadley (1934) Bull. Am. Paleont. 20 (70): 15. pl. 2, figs. 5, 6. Oligocene, probably upper, Cuba.—Coryell & Rivero (1940) Jour. Paleont. 14: 341. pl. 42, fig. 28. Middle Miocene, Haiti.

Test elongate, compressed, oval in front view, initial end narrow, bluntly pointed; proloculum subspherical followed by several biserially arranged chambers, the major portion of the test consisting of about 5, very slightly inflated, equitant, chambers; sutures marked with clear shell material, slightly depressed; aperture terminal, fissurine, not radiate. Length, 1.13 millimeters; width, 0.35 millimeter; thickness, 0.07 millimeter.

Plesiotype No. 3949, locality P2, Ponce formation.

Very rare at P2, P3, and P254 of the Ponce formation.

The original description of this species states that, "this species is peculiar in the retention of the alternating character of the chambers as shown by the apertures pointing first to one side and then the other in succeeding chambers and the incurved portion of the wall even after the alar projections are developed", but it is evident from subsequent figures published by the originator of *P. vauhani* that this alternating character of the chambers throughout most of the test is not an essential differentiating characteristic. *P. vauhani* is essentially an elongate, oval form of moderate width with relatively few chambers, usually 5 to 7 equitant chambers following a short biserial portion of a few chambers. *P. advena* (Cushman) (1923. Bull. U. S. Nat. Mus. 104 (4)) is very similar, but is narrower and tends to be more irregular, or phylogerontic.

Family BULIMINIDAE Jones 1876

REUSSELLA Galloway 1933

Reussella glabrata (Cushman)

PLATE 31, FIGURES 8a, b

Verneuilina spinulosa glabrata Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129E: 92. Middle Oligocene, Byram, Mississippi.

Reussia spinulosa Cushman & Ponton (not Reuss) (1932) in part, Fla. Geol. Surv. Bull. 9: 84. pl. 12, fig. 15 (not figs. 14, 16.) Arca zone of Choctawhatchee, middle Miocene, Florida.

Test small, inverted pyramidal in shape, 3-sided, greatest diameter near the apertural end; triangular in cross section, the sides somewhat concave; initial end and edges of the test angled, without spines or carinae; chambers closely appressed, regularly triserial in arrangement; sutures narrow, flush with the surface; surface smooth; aperture a small transverse slit at the inner edge of the last chamber. Length, 0.33 millimeter; diameter, 0.20 millimeter; breadth of one face, 0.24 millimeter.

Plesiotype No. 4073, locality A79, Los Puertos formation.

Common at L2C of the San Sebastian formation, and at A79 of the Los Puertos formation. Rare at A21 of the Quebradillas formation, and at P258 of the Ponce formation.

BULIMINA d'Orbigny 1826

Bulimina socialis Bornemann

PLATE 31, FIGURES 9a, b

Bulimina socialis Bornemann (1855) Zeitsch. deutsch. geol. Gesell. 7: 342. pl. 16, fig. 10. Middle Oligocene, Germany.—Cushman (1937) Contr. Cushman Lab. Foram. Res. 13: 36. pl. 4, figs. 1a–c. Middle Oligocene, Germany.

Bulimina ovata Brady (1884) Rep. Voy. Challenger Zool. 9: 400. pl. 50, figs. 13a–b. Recent, north and south Atlantic and Pacific.—White (1929) Jour. Paleont. 3: 49. pl. 5, fig. 11. Mendez, upper Cretaceous, Mexico.—Nuttall (1932) Jour. Paleont. 6: 19. pl. 2, fig. 8. Lower Oligocene, Mexico.

Bulimina sp. Cushman & Applin (1926) Bull. Am. Assoc. Petr. Geol. 10: 169. pl. 7, figs. 10–11. Upper Eocene, Texas.

Test oval in front view, about $1\frac{1}{2}$ times as long as wide, widest about midway between apical and apertural ends, both ends of test rounded; test circular or nearly so in end view; 2 whorls of chambers visible; chambers slightly inflated, the 3 chambers of the last whorl constituting about $\frac{3}{4}$ of the test; sutures distinct, somewhat depressed; wall finely perforate; aperture virguline, with a vertical, curved tooth. Length, 0.60 to 1.16 millimeters; diameter, 0.32 to 0.68 millimeter.

Plesiotype No. 3880, locality P254, Ponce formation.

Rare at P254 and P255; common at P3; abundant at P2 of the Ponce formation.

Since 1846, when *B. ovata* was first named by d'Orbigny, workers on foraminifera have consistently used this name for all smooth specimens of *Bulimina* with generally oval shape in side view, circular cross section, slightly depressed sutures and relatively few chambers. Several authors, among them Cushman in 1922, Nuttall in 1932, and Palmer and Bermudez in 1936, have noted that two types of smooth *Buliminas* have been included in *B. ovata*, namely that of the original figure, and another which differs, "from the original figure of the species in being broader in proportion to the length, with the final whorl of chambers covering about three-fourths of the length of the test". (Palmer & Bermudez p. 287.) A comparison of the Porto Rican specimens with the original figure of *B. socialis* Bornemann and the figures of *B. socialis* published by Cushman in 1937 shows that the non-typical forms of *B. ovata* which have been erroneously included under *B. ovata* should be called *B. socialis*, a name which was proposed by Bornemann in 1855. It is improbable that the thicker type of *Bulimina* which we here call *B. socialis*, is the megaspheric form of *B. ovata* since only the *B. socialis* type occurs in the Porto Rican material, and not both types as would be expected if the two are the megaspheric and microspheric forms of the same species.

B. socialis differs from *B. ovata* in the following respects:

1. the apical and apertural ends are narrowly to broadly rounded in shape, not sharply rounded or angular
2. the test is stouter; the form ratio (length divided by breadth) being 1.4 to 1.90, while *B. ovata* ranges from 2 to 2.4. The type figure of *B. socialis* was 1.57, of *B. ovata* 2.20.

Family CASSIDULINIDAE d'Orbigny 1839

CASSIDULINA d'Orbigny 1826

Cassidulina laevigata d'Orbigny

PLATE 32, FIGURES 1a, b

Cassidulina laevigata d'Orbigny (1826) Ann. Sci. Nat. 7: 282. pl. 15, figs. 4, 5; Model no. 14. Recent.—Brady (1884) Rep. Voy. Challenger Zool. 9: 428. pl. 54, figs. 1-3. Recent, widespread.—Cushman (1918) U. S. Geol. Surv. Bull. 676: 9. pl. 1, figs. 5a, b. Pliocene, North Carolina.

Test lenticular, nearly equally biconvex, biumbonate; nearly circular in side view with slightly lobate outline; edge angled but not carinate; chambers short and wide with nearly parallel edges, about 5 pairs in the last whorl; sutures slightly curved, limbate, flush with the

surface or very slightly depressed near the edge of the test; wall smooth, finely perforate; aperture an elongate virguline slit on the face of the last chamber nearly parallel to the periphery. Diameter, 0.24 by 0.26 millimeter; thickness, 0.13 millimeter.

Plesiotype No. 4142, locality A43a, Cibao formation.

Rare at A43a of the Cibao formation, and at A79 of the Los Puertos formation.

Cassidulina subglobosa Brady

PLATE 32, FIGURES 2a, b

Cassidulina subglobosa Brady (1881) Quart. Jour. Micr. Soc. 21: 60; (1884) Rep. Voy. Challenger Zool. 9: 430. pl. 54, figs. 17a-c. Recent, Atlantic and Pacific Oceans.—Galloway & Morrey (1929) Bull. Am. Paleont. 15 (55): 40. pl. 6, fig. 6. Lower Oligocene, Ecuador.—Hedberg (1937) Jour. Paleont. 11: 680. pl. 92, fig. 5. Upper Oligocene, Venezuela.

Test subglobular, only slightly compressed on the sides; broadly oval in side and edge views; edge broadly rounded; chambers few, 3 pairs in the last whorl, inflated; sutures somewhat depressed; surface smooth, wall finely perforate; aperture a large virguline opening extending up onto the last septal face, obliquely to the plane of coiling. Diameter, 0.40 millimeter; thickness, 0.32 millimeter.

Plesiotype No. 4180, locality P2, Ponce formation.

Rare at P2, P3, and P254 of the Ponce formation.

Cassidulina tricamerata NEW SPECIES

PLATE 32, FIGURES 3a-c

Test subequally biconvex, biumbonate, not quite planispirally coiled, subcircular to broadly oval in side view; periphery very slightly lobulate; edge sharply rounded, not keeled; chambers large, closely appressed, very little inflated, 3 pairs in the last whorl, enlarging rapidly, the last chamber constituting from one-third to two-fifths of the circumference of the test; sutures narrowly limbate, a little depressed, slightly curved, nearly parallel on the two sides of each chamber; wall very finely perforate; surface smooth; aperture a narrow, curved slit in the plane of coiling, extending about one-sixth of the circumference of the test or about one-half the circumferential dimension of the septal face, without upper lip, but with lower, undulating, plate-like tooth; septal face narrow, convex, with outer, inflated rim. Diameter, 0.53 by 0.60 millimeter; thickness, 0.30 millimeter.

Holotype No. 4143, locality P255, Ponce formation.

Rare at P2 and P3; common at P254 and P255 of the Ponce formation.

This species differs from *C. delicata* Cushman (1927. Scripps Inst.

Oceanog. tech. ser. **1**: 168. pl. 6, fig. 5) in the fewer chambers and much shorter aperture. It differs from *C. rarilocula* Cushman (1933. Contr. Cushman Lab. Foram. Res. **9**: 93. pl. 10, fig. 4), from the tropical Pacific, in the less inflated chambers, sharper edge, longer aperture, and larger size. Perhaps *C. "delicatula"* Cushman (obviously an error for "*delicata*") (1929. Contr. Cushman Lab. Foram. Res. **5**: 101. pl. 14, fig. 12, Tertiary, Venezuela) is the same as our species, but the chambers are rather too inflated and the sutures too much curved.

EHRENBERGINA Reuss 1850

Ehrenbergina caribbea NEW SPECIES

PLATE 32, FIGURES 4a-d

Ehrenbergina bradyi Coryell & Rivero (not Cushman) (1940) Jour. Paleont. **14**: 342. pl. 44 fig. 22. Middle Miocene, Haiti.

Test short subtriangular in side view, oval in edge view, pyramidal in apertural view; dorsal side convex, ventral side more strongly convex, with a broad, flat ridge down the center, bounded by concave slopes; edge sharp, with a short, flat spine at the end and upper side of each chamber and a few, small spines on the apical, ventral end; chambers closely appressed, not inflated, about 7 pairs; dorsal sutures curved, overlapping about half their length, limbate, mostly flush with the surface, the middle part of the later ones raised; ventral sutures obscure, nearly flush with the surface, curved and overlapping on the ventral ridge; wall very finely perforate; surface smooth except for the raised sutures and spines on the edge and apical end; aperture a thin, curved slit just under the terminal part of the periphery, nearer the sutural side of the chamber, with thin lower lip. Length, 0.61 millimeter; width, 0.56 millimeter; thickness, 0.30 millimeter.

Holotype No. 4140, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

This species is similar to *E. bradyi* Cushman (1927. Proc. U. S. Nat. Mus. **70** (16): 5. pl. 2, fig. 1.) from deep water of the Pacific, but it lacks the median ventral groove and spines, the fine peripheral spines, and it is shorter. The subtropical middle Tertiary forms from Haiti and Porto Rico seem to be identical, and are readily distinguishable from the cold water Recent forms from the Pacific.

E. navalis Hadley (1934. Bull. Am. Paleont. **20** (70A)) seems very close to *E. caribbea*, but it is more slender, has more delicate spines, and lacks the small spines on the apical, ventral end of the test.

Ehrenbergina serrata gibbera NEW VARIETY

PLATE 32, FIGURES 5a-d

Test subtriangular in dorsal view, oval in edge view, the early part as thick as the later part; biconvex, oval in cross section with the back humped (hence the name *gibbera*), the later part uncoiled and perhaps also the earlier part, the exact nature of which is not determinable because of the addition of spines and other secondary material; edge sharply rounded in the earlier part, angled and slightly carinate in the later part; earlier part with a round spine extending out from the edge of each chamber and other spines on the apical end and on the early, ventral side; chambers 6 to 7 pairs, on the dorsal side short and wide, overlapping each other by about half their width; sutures on the back of the test limbate but flush with the surface, curved in three parts, usually orad, sometimes apicad; ventral sutures depressed, obscured by secondary material; surface smooth except for the spines; aperture elongate, narrow and curved, near the middle of the test, nearly parallel to the margin, with fimbriate lower lip and welt-like upper lip. Length, 0.60 millimeter; width, 0.55 millimeter; thickness, 0.30 millimeter.

Holotype No. 3902, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

This species differs from *E. serrata* Reuss (1850. Denkschr. k. Akad. Wiss. Wien 1: 377. pl. 48, fig. 7), from the Miocene of Austria, in the less definitely coiled and more spinose early stage, the humped back, and fewer chambers.

Family UVIGERINIDAE Galloway & Wissler 1927**UVIGERINA** d'Orbigny 1826**Uvigerina bulbacea** NEW SPECIES

PLATE 33, FIGURES 1, 2

Test small, elongate bulbous, more than twice as long as wide, enlarging rapidly from the rounded apical end to the greatest width, about one-third of the length from the apical end, thence gradually tapering to the aperture; chambers in about 3 whorls, closely appressed, little inflated, regularly triserial in the first third, becoming more inflated and fewer to a whorl up to the terminal chamber which is uniserial; sutures flush and obscure in the first third, depressed and plain in the later two-thirds; wall finely perforate; apical end of the test provided with very small spines, not in lines, the later part of the

last chamber and apertural neck finely granulate; most of the test with fine, low, round costae, not continuous across the sutures, about 20 on one side of the test or 16 to 20 in a width of 0.2 millimeter; last chamber without shoulders, the last chamber tapering into a short neck, without phialine lip. Length, 0.51 millimeter; diameter, 0.21 millimeter. Variation in length from 0.32 to 0.54 millimeter; diameter from 0.18 to 0.24 millimeter; form ratio from 1.8 to 2.7 millimeters, averaging 2.2 millimeters.

Holotype No. 4144, paratype No. 4144a, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

This form is like *U. postica*, with which it occurs, but differs consistently in the following ways: it is smaller, the greatest width is nearer the apical end, the tapering to the aperture is more marked, the spines are smaller on the apical end and absent on the apertural end, and the costae are smaller. We have considered the possibility that one form is megaspheric and the other microspheric, but find no proof. Note the greater magnification of *U. bulbacea*.

Uvigerina elongata Cole

PLATE 33, FIGURE 5

Uvigerina elongata Cole (1927) Bull. Am. Paleont. 14 (51): 26. pl. 4, figs. 3, 4. Middle Eocene, Mexico.—Cushman (1937) Contr. Cushman Lab. Foram. Res. 13: 78. pl. 11, figs. 15, 16. Middle Eocene, Mexico.

Test small, elongate, greatest width below the middle of the test; early chambers closely appressed, enlarging rather rapidly in size, tending to become uniserial in the later part of the test; sutures obscure in the early part of the test, depressed in the later part; surface hirsute, *i. e.* with small fine spines irregularly arranged; apertural end sloping with a neck; aperture terminal, round. Length, 0.52 millimeter; diameter, 0.18 millimeter.

Plesiotype No. 4017, locality P254, Ponce formation.

Rare at P254 and P255 of the Ponce formation.

Uvigerina fusiformis NEW SPECIES

PLATE 33, FIGURE 6

Test small, fusiform, tapering toward both ends, apertural end tapering to the slender, cylindrical neck; chambers about six on a side, rather loosely appressed; sutures distinct, depressed; surface of the last few chambers ornamented by fine, irregularly arranged spines; earlier part of the test with fine spines in vertical lines, apical end of

the test finely spinose; aperture round at the end of a slender, tapering neck, with lip. Length, 0.44 millimeter; diameter, 0.18 millimeter.

Holotype No. 4018, locality P2, Ponce formation.

Rare at P2, P3, P254, and P255 of the Ponce formation.

This species differs from *U. pygmaea* d'Orbigny (1826. Ann. Sci. Nat. 7) in the finer striae. It seems close to *U. elongata*, but is shorter, more regular in shape, and has the spines in lines on the early part of the test.

The specific name *fusiformis* is used because of the fusiform shape of the test.

Uvigerina gallowayi Cushman

PLATE 33, FIGURE 8

Uvigerina alata Galloway & Morrey (not Cushman & Applin) (1929) Bull. Am. Paleont. 15 (55): 38, pl. 6, fig. 1. Oligocene, Ecuador.

Uvigerina gallowayi Cushman (1929) Contr. Cushman Lab. Foram. Res. 5: 94. pl. 13, figs. 33, 34. Oligocene, Ecuador.

Test of medium size, stout fusiform, with pointed apical end and shouldered apertural end; length twice the thickness, greatest thickness above the middle; chambers regularly triserial, closely appressed, little inflated; sutures slightly depressed, marked by clear shell material; surface ornamented with 14 to 16 strong costae which begin below the proloculum, cross the sutures and fade out on the last chamber or two; aperture round with small lip, at the end of a short neck, situated in an encircling depression. Length, 0.75 millimeter; diameter, 0.40 millimeter.

Plesiotype No. 4145, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

Uvigerina gardnerae Cushman

PLATE 33, FIGURES 13a, b

Uvigerina gardnerae Cushman (1926) in Cushman & Applin, Bull. Am. Assoc. Petr. Geol. 10: 175. pl. 8, figs. 16, 17. Upper Eocene, Texas.—Cushman & Edwards (1937) Contr. Cushman Lab. Foram. Res. 13: 79. pl. 11, figs. 19, 20. Upper Eocene, Atlantic and gulf coastal plain.

Test large, stout, widest at or above the middle; ends rounded; chambers regularly triserial, inflated; sutures depressed but indistinct; surface ornamented by about 20 plate-like costae, 5 or 6 in a width of 0.2 millimeter, not continuous with those on adjacent chambers, partly breaking up into spines or disappearing on the last chamber; aperture round, at the end of a short neck, with small lip. Length, 0.83 millimeter; diameter, 0.45 millimeter; form ratio 1.8.

Plesiotype No. 4019, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This form is not, "much elongated, slender", as stated in the descriptions of *U. gardnerae*, and the measurements in the descriptions and in the plates do not agree. *U. gardnerae* belongs to the *U. peregrina* group, but differs in being thicker and shorter, with fewer costae, and absence of a granular surface. It is much like *U. gardnerae cubana* Hadley (1934. Bull. Am. Paleont. **20** (70A)) which lacks spines on the last chamber. It is also much like *U. capayana* Hedberg (1937. Jour. Paleont. **11**: 677. pl. 91), but is much larger and has much coarser costae.

The various groups of species of *Uvigerina* have been insufficiently differentiated for definite recognition.

Uvigerina mantaensis Cushman & Edwards

PLATE 33, FIGURE 7

Uvigerina proboscidea Galloway & Morrey (not Schwager) (1929) Bull. Am. Paleont. **15** (55): 39. pl. 6, fig. 4. Lower Oligocene, Ecuador.

Uvigerina mantaensis Cushman & Edwards (1938) Contr. Cushman Lab. Foram. Res. **14**: 84. pl. 14, fig. 8. Oligocene, Ecuador.

Test stout, about $1\frac{1}{2}$ times as long as wide, broadly fusiform in shape; chambers rather few, inflated; sutures distinct, depressed; wall hispid throughout; shoulders broad; aperture terminal, with a short, cylindrical neck and phialine lip. Length, 0.59 millimeter; diameter, 0.32 millimeter.

Plesiotype No. 4076, locality P3, Ponce formation.

Rare at P3 and P254 of the Ponce formation.

U. mantaensis differs from *U. proboscidea* Schwager (1866. Novara-Exped. Geol. Theil **2**) in that it has a less tapering test and broad, not sloping, shoulders.

Uvigerina mexicana Nuttall

PLATE 33, FIGURE 9

Uvigerina mexicana Nuttall (1932) Jour. Paleont. **6**: 22, pl. 5, figs. 12, 13. Lower Oligocene, Mexico.

Test short, stout fusiform in shape; apical end subacute or pointed; thickest part of the test near or below the middle; lower $\frac{2}{3}$ of the test ornamented by numerous low, round, longitudinal costae, which are continuous from chamber to chamber, and increase by division, less frequently by implantation; last chamber unornamented; early chambers rather obscure, little inflated, last chamber slightly inflated; sutures flush with the surface, obscure in the early part of the test, last few marked by clear shell material; aperture round, at the end of

a short cylindrical neck which is set in a depression or on a flattened area of the last septal face. Length, 0.70 millimeter; maximum diameter, 0.44 millimeter.

Plesiotype No. 4021, locality P2, Ponce formation.

Rare at P2, P3, and P255 of the Ponce formation.

***Uvigerina mexicana bulbosa* NEW VARIETY**

PLATE 33, FIGURE 10

This variety differs from typical *U. mexicana* in being subglobular in shape, and broadly rounded, not tapering at both apical and apertural ends. Length, 0.54 millimeter; diameter, 0.48 millimeter.

Holotype No. 4077, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

***Uvigerina mexicana ranunculus* NEW VARIETY**

PLATE 33, FIGURE 11

Test stout, circular in cross section, more tapering at both ends than typical *U. mexicana*; maximum diameter about midway the length of the test; apical end with a flat, spine-like process formed by the union of several costae; other characteristics like typical *U. mexicana*. Length, 0.92 millimeter; diameter, 0.50 millimeter.

Holotype No. 4022, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

***Uvigerina postica* NEW SPECIES**

PLATE 33, FIGURES 3, 4

Test elongate, about twice as long as wide, bulbous, the later two-thirds converging to the apical end, enlarging rapidly from the apical end to the greatest width below the middle; apical end pointed, sometimes with short apical spine; chambers in about 4 whorls, closely appressed and regularly triserial in the first third of the test, slightly inflated and tending to become biserial in the second third, and considerably inflated and tending to become uniserial in the final third of the test; sutures flush with the surface in the first third of the test, marked by clear shell material, somewhat depressed in the later two-thirds; wall finely perforate; surface of the apical and apertural ends provided with small spines which are not in definite lines; most of the test ornamented by fine, low, round longitudinal costae, not continuous across the sutures, about 20 on one side of the test or 13 in a width of 0.2 millimeter; shoulders of last chamber round and sloping; aper-

ture with a short, tapering neck, not set in a depression, without lip or with a very narrow phialine lip. Length, up to 0.66 millimeter; diameter, 0.30 millimeter. Form ratio (length over diameter) 1.9 to 2.28, averaging 2.1.

Holotype No. 4146a, paratype No. 4146b, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

This species is similar to *U. striata* d'Orbigny in the fine costae, but scarcely deserves comparison. The comparison with *U. bulbacea* is given under that species. The specific name *postica* refers to the enlarged posterior part of the test, above the pointed apical end.

Uvigerina vicksburgensis Cushman & Ellisor

PLATE 33, FIGURES 12a, b

Uvigerina vicksburgensis Cushman & Ellisor (1931) Contr. Cushman Lab. Foram. Res. 7: 54. pl. 7, figs. 7a, b. Lower Oligocene, Texas.—Ellisor (1933) Bull. Am. Assoc. Petr. Geol. 17: pl. 3, fig. 10.—Cushman & Edwards (1938) Contr. Cushman Lab. Foram. Res. 14: 76. pl. 13, figs. 10, 11. Lower Oligocene, gulf coastal plain of U. S. and Mexico.

Test regularly fusiform, over twice as long as wide, greatest width near the middle; chambers in about three whorls, closely appressed, regularly triserial to near the apertural end, where the chambers become biserial and tend to be uniserial; sutures slightly depressed, obscure; surface ornamented, from apex to apertural neck, with about 18 or 20 strong, sharp costae, about 5 in a width of 0.2 millimeter, which curve considerably; some costae are confined to one chamber, others cross the sutures; aperture terminal, round, at the end of a short neck, which is not set in a depression, with small lip. Length, 0.73 millimeter; width, 0.35 millimeter.

Plesiotype No. 4020, locality P251, Ponce formation.

Rare at P251 of the Ponce formation.

This is one of the better characterized species of the genus, with its fusiform shape and part of the costae crossing the sutures.

SIPHOGENERINA Schlumberger 1883

Siphogenerina costostriata NEW SPECIES

PLATE 34, FIGURES 5a, b

Test of medium size, slender, the early part conical, the later part somewhat compressed; the early part sharply rounded, gradually expanding to the broadly rounded apertural end; chambers triserial and closely appressed in the first third of the test, becoming biserial in

the middle third and uniserial in the final third, progressively more inflated from the middle to the oral end; sutures obscure in the first third, depressed in the later two-thirds; surface ornamented with fine striae in the first one-third of the test, about 20 in a width of 0.2 millimeter; the later two-thirds with thin, low costae, 5 to 6 in a width of 0.2 millimeter, between each pair of which there are 2 or 3 much smaller, raised striae; neither the costae nor striae cross the sutures; aperture oval, without phialine lip, at the end of a short neck, which is not set in a depression. Length, 0.78 millimeter; width, 0.26 millimeter; thickness, 0.21 millimeter.

Holotype No. 4147, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This species has just passed from the *Uvigerina* to the *Siphogenerina* stage. It differs from described species of both genera in the two sets of costae, and in other ways.

Siphogenerina cumingsi NEW SPECIES

PLATE 34, FIGURES 6 and 7

Test elongate, subcylindrical; apical end pointed in the more elongate, microspheric form, bluntly rounded in the stouter megaspheric form; triserial stage very short, uniserial stage with about 7 chambers which are about $\frac{2}{3}$ as long as wide; sutures flush with the surface, curved adorally between the costae; wall ornamented by 7 to 8 longitudinal costae, each continuous the length of the test except for the last chamber; apical end spinose; triserial portion of megaspheric test with short costae intercalated between the primary costae; apertural end rounded with a short neck; aperture terminal, round, with slight phialine lip. Dimensions of average megaspheric form: length, 0.94 millimeter; diameter, 0.26 millimeter. Dimensions of figured microspheric form: length, 0.86 millimeter; diameter, 0.26 millimeter. Maximum size of microspheric form: length, 1.26 millimeters; diameter, 0.30 millimeter.

Holotype No. 3983, locality P3, paratype No. 3984, locality P2, Ponce formation. Holotype is megaspheric form; paratype microspheric.

Rare at P3 and P255; common at P2 of the Ponce formation. Both megaspheric and microspheric forms occurred at all three localities.

S. cumingsi differs from *S. spinosa* Bagg (1904. Md. Geol. Surv. Mio.; refigured by Cushman & Cahill, 1933. U. S. Geol. Surv. Prof. Pap. 175A) in the lower costae and more slender test in both megaspheric and microspheric forms, and in the absence of spines on the

costae. The lip is also less flaring. *S. lamellata* Cushman (1918. U. S. Geol. Surv. Bull. 676) has lamellae rather than costae.

This species is named in honor of Professor E. R. Cumings, who, as head of the Department of Geology at Indiana University, has fostered scientific research for many years.

***Siphogenerina hubbardi* NEW SPECIES**

PLATE 34, FIGURE 2

Test elongate, cylindrical, nearly circular in cross section; triserial portion about $\frac{1}{3}$ the length of the test, 4 chambers in uniserial part of the test; apical end either blunt in what is evidently the megaspheric form, or pointed in the microspheric form; most specimens with small spinosities near the apical ends of the costae; chambers slightly inflated, uniserial chambers broader than long; sutures depressed in early part of the test, only slightly depressed in later part; wall ornamented by about 20 longitudinal costae most of which are continuous from chamber to chamber; aperture terminal, circular with rounded lip at the end of a definite neck. Total length, 1.00 millimeter; diameter, 0.30 millimeter; length of neck, 0.06 millimeter.

Holotype No. 3985, locality P2, Ponce formation.

Common at P2, P3, and P255 of the Ponce formation.

S. hubbardi differs from *S. multicostata* Cushman and Jarvis (1929. Contr. Cushman Lab. Foram. Res. 5) in that the costae are continuous from chamber to chamber and the apical spinosity is less pronounced.

This species is named in honor of Dr. Bela Hubbard who has made important contributions to the stratigraphy and paleontology of Porto Rico.

***Siphogenerina mexicana* Cushman**

PLATE 34, FIGURES 1a, b

Siphogenerina mexicana Cushman (1926) Proc. U. S. Nat. Mus. 67 (25): 15. pl. 5, figs. 4a, b. Lower Oligocene, Alazan, Mexico.

Test small, slender, subcylindrical, the first third of the test triserial, tapering from a subacute initial end, the rest of the test uniserial with about 5 rectilinear chambers; chambers distinct, very slightly inflated; sutures distinct, nearly flush with the surface, marked by clear shell material; wall with conspicuous pores, surface ornamented with numerous fine, longitudinal striae; apertural end without a neck, truncate; aperture small, nearly circular, surrounded by a raised rim or lip. Length, 0.75 millimeter; diameter, 0.18 millimeter.

Plesiotype No. 3986, locality P2, Ponce formation.

Rare at P2 and P3 of the Ponce formation.

Siphogenerina multcostata Cushman & Jarvis

PLATE 34, FIGURES 3 and 4

Siphogenerina multcostata Cushman & Jarvis (1929) Contr. Cushman Lab. Foram. Res. 5: 14, pl. 3, fig. 6. Miocene, Trinidad.—Cushman (1929) Contr. Cushman Lab. Foram. Res. 5: 95, pl. 13, fig. 38. Middle Tertiary, Venezuela.—Hadley (1934) Bull. Am. Paleont. 20 (70A): 17, pl. 2, fig. 8. Oligocene, probably upper, Cuba.

Test small, elongate, subcylindrical to fusiform, 3 to 4 times as long as wide, greatest width in the later half of the test; uniserial chambers occupying nearly half the length of the test; chambers distinct, slightly inflated, uniserial chambers shorter than wide, except for the last chamber which is approximately equidimensional; sutures depressed; surface ornamented by 18 to 20 narrow, low, longitudinal costae which extend up to the base of the neck; costae on each chamber usually independent of those on adjacent chambers; costae somewhat spinose on triserial part of the test; apertural end tapering to a short neck; aperture terminal, circular. Length, 0.74 millimeter; diameter, 0.20 millimeter.

Plesiotypes Nos. 3987a and 3987b, locality P254, Ponce formation. Rare at P2 and P254 of the Ponce formation.

The Porto Rican specimens have the phialine lip broken off.

ANGULOGERINA Cushman 1927*Angulogerina cibaoensis* NEW SPECIES

PLATE 34, FIGURES 12a, b

Test small, short, thick, bulbous at the lower end, apical end pointed and rapidly expanding to the greatest width at about two-fifths of the length of the test from the apical end, thence tapering to the apertural end; test triangular throughout, with angled edges; chambers regularly triserial and closely appressed in the early part, becoming biserial and tending to become uniserial, not inflated; sutures indistinct, little depressed; surface smooth at apical and apertural ends, provided with 3 or 4 small, low costae on each face in the middle of the test, about 4 in a width of 0.2 millimeter; the costae do not cross the sutures; aperture oval, at the end of a short neck, with small lip. Length, 0.62 millimeter; width, 0.36 millimeter; form ratio 1.7.

Holotype No. 3864, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

This species is shorter than *A. cooperensis*, with which it occurs, and lacks the apical costae.

Angulogerina cooperensis Cushman

PLATE 34, FIGURES 13a, b

Angulogerina cooperensis Cushman (1935) U. S. Geol. Surv. Prof. Pap. 181: 42. pl. 16, fig. 9.
Upper Eocene, South Carolina.

Test of average size, slender, apical end pointed and rapidly expanding to the greatest width about one-third of the length of the test from the apical end, thence tapering to the apertural end, triangular throughout, with angled edges; chambers regularly triserial in the first third, becoming biserial and the final third uniserial, closely appressed but irregularly inflated; sutures indistinct, little depressed; wall finely perforate; surface ornamented with low, indistinct costae on the first two-thirds, disappearing on the final third, not crossing the sutures, 3 to 6 on each face of the test, 6 in a width of 0.2 millimeter; aperture at the end of a long neck, subtriangular, with slight lip. Length, 0.74 millimeter; width, 0.31 millimeter; form ratio 2.4.

Plesiotype No. 4148, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

The Porto Rican form differs from the type figure of *A. cooperensis* in having the greatest width nearer the apertural end, and in having a longer neck. Such differences may be of varietal or even specific rank, particularly since the Porto Rican form is nearly twice as large as the type specimens from the Eocene.

Angulogerina decorissima NEW SPECIES

PLATE 34, FIGURES 8 to 10

Test small, short fusiform, tending to be bulbous, greatest width a little below the middle of the test; triangular in cross section, sharply angled at the edges; chambers relatively few, closely appressed, flat on the faces of the test; sutures slightly depressed; surface ornamented by numerous striae which cover the entire test up to the base of the neck and are discontinuous from chamber to chamber; neck subtriangular of moderate length; aperture terminal, round, with a slight phialine lip. Length of holotype, 0.53 millimeter; diameter, 0.28 millimeter.

Holotype No. 3865a, paratypes Nos. 3865b and 3865c, locality A21, Quebradillas formation.

Rare at A21 of the Quebradillas formation.

This species has a slight resemblance to *A. albatrossi ornata* Cushman (1932. Contrib. Cushman Lab. Foram. Res. 8), but is more regular

in shape, with striae on all the chambers. It differs from *A. occidentalis* (Cushman) (1933. U. S. Geol. Surv. Prof. Pap. 175A) in having finer striae and less lobulate chambers with triangular cross section throughout the test.

***Angulogerina ponceana* NEW SPECIES**

PLATE 34, FIGURES 11a-c

Test small, stout, $1\frac{1}{2}$ times as long as wide; apical end broadly rounded; apertural end truncate; in end view subtriangular with rounded angles; chambers few, 4 to 6, regularly triserial, somewhat inflated, overhanging previous chambers; sutures depressed deeply in some places and shallow in others, undulating, with the uneven chamber inflation producing a knotty appearance to the test; wall finely perforate; surface ornamented with 9 to 12 low, obscure costae, mostly confined to the early and middle part of the test, all fading out on the last chamber; aperture terminal, with short neck set in an encircling depression in the last septal face, with slight lip. Length, 0.45 millimeter; thickness, 0.33 millimeter.

Holotype No. 4023, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This species differs from *A. naranjoensis* Cushman and Bermudez (1937. Contrib. Cushman Lab. Foram. Res. 13: 16, pl. 1, fig. 56) in the shorter form, broadly rounded apical end, less inflated chambers, and in the presence of low costae. It is much like the paratype of that species (figs. 57, 58), which seems to be costate. The authors say in the original description (p. 17), "wall generally smooth", and in the discussion again, "smooth wall". The costae in the Porto Rican form are so small and inconspicuous that they might be overlooked.

TRIFARINA Cushman 1923

***Trifarina bradyi* Cushman**

PLATE 35, FIGURES 4a, b

Rhabdogonium tricarinatum Brady (1884) Rep. Voy. Challenger Zool. 9: 525. pl. 67, figs. 1-3. Recent, Atlantic Ocean.

Trifarina bradyi Cushman (1923) Bull. U. S. Nat. Mus. 104 (4): 99. pl. 22, figs. 3-9. Recent, Gulf of Mexico, Caribbean Sea, and off southeastern U. S.; (1929) Contr. Cushman Lab. Foram. Res. 5: 96. pl. 13, fig. 39. Middle Tertiary, Venezuela.

Test small, elongate, tapering toward both apical and apertural ends; triangular in cross section, concave on all three sides, with carinae at the three angles running from the initial end to the aperture; chambers triserial for about $\frac{1}{2}$ the length of the test; sutures

not depressed; aperture terminal, round, at the end of a short neck. Length, 0.52 millimeter; diameter, 0.24 millimeter.

Plesiotype No. 4005, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

Family **PLEUROSATOMELLIDAE** Reuss 1860

PLEUROSATOMELLA Reuss 1860

Pleurostomella bierigi Palmer & Bermudez

PLATE 35, FIGURES 2a-c

Pleurostomella bierigi Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 294. pl. 17, figs. 7, 8. Lower Oligocene, Cuba.

Test stout in appearance, oval in side view, nearly circular in end view, apical end obtusely angled or rounded, maximum width about midway of the test; chambers inflated, last one constituting more than half the length of the test; aperture in a depression of the final chamber, an arcuate slit, with subsidiary vertical notch. Length, 0.58 millimeter; width, 0.41 millimeter; thickness, 0.43 millimeter.

Plesiotype No. 4069, locality P3, Ponce formation.

Rare at P3 and P254; common at P2 of the Ponce formation.

The Porto Rican forms are slightly different from the type figures of *P. bierigi* in that they are more rounded at the apical end.

Pleurostomella elliptica NEW SPECIES

PLATE 35, FIGURES 3a, b

Pleurostomella alternans Cushman & Harris (not Schwager) (1927) Contr. Cushman Lab. Foram. Res. 3: 129. pl. 25, fig. 28. Eocene, Trinidad.

Test small, elongate, elliptical to fusiform in shape; 6 to 8 chambers in the test, regularly alternating, increasing gradually in size, little inflated; sutures slightly depressed; surface unornamented; aperture in an oval depression on the side of the last septal face, consisting of a lunate opening with two small teeth on the lower side. Length, 0.66 millimeter; diameter, 0.16 millimeter.

Holotype No. 4070, locality P2, Ponce formation.

Common at P2 of the Ponce formation.

P. elliptica differs from *P. alternans* Schwager (1866. Novara-Exped. Geol. 2: 238. pl. 6, fig. 79, which we here designate as the type of *P. alternans*; not fig. 80) in that the test has fewer chambers, is less tapering and is more rounded at the apical end. It differs from *P. jacksonensis* Cushman and Applin (1926. Bull. Am. Assoc. Petr.

Geol. **10**) in the less pointed apical end and absence of any, "series of depressions in longitudinal lines".

Pleurostomella gerontica NEW SPECIES

PLATE 35, FIGURES 1a-d

Test stout, regularly oval in front view, both apical and apertural ends narrowly rounded; subcircular in end view; 5 to 6 chambers in the test, biserially arranged, enlarging rapidly with the exception of the final chamber which is unusually small, the second and third chambers from the last constituting about $\frac{2}{3}$ of the test; aperture subterminal, an arcuate slit in a slight depression on the septal face. Length, 0.67 millimeter; width, 0.50 millimeter; thickness, 0.46 millimeter.

Holotype No. 4071, locality P2, Ponce formation.

Rare at P2 and P3 of the Ponce formation.

We have several specimens, all of which have the small final chamber and distinctive aperture.

P. gerontica is distinctive in the shape of its stout test, with small final chamber and subterminal, crescentic aperture without a tooth. In general appearance it is very similar to *P. bierigi*, but differs in the small final chamber and in the character of the aperture.

NODOSARELLA Rzehak 1885

Nodosarella constricta granulifera NEW VARIETY

PLATE 35, FIGURES 5a, b

This variety differs from typical *N. constricta* Cushman and Bermudez (1937. Contr. Cushman Lab. Foram. Res. **13**) in having a finely granular surface. Length, 0.83 millimeter; diameter, 0.33 millimeter.

Holotype No. 4059, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Nodosarella crassielegans (Nuttall)

PLATE 35, FIGURES 6a, b

Nodosaria crassielegans Nuttall (1928) Quart. Jour. Geol. Soc. London **84**: 80. pl. 4, figs. 6, 7.
Upper Eocene and lower Miocene, Trinidad.

Test elongate, arcuate, round in section, consisting of 6 to 10 chambers which are longer than thick, and more closely appressed in the early part of the test; sutures transverse, depressed, marked by

clear shell material; apical end of the test with one, rarely two, short, eccentric spines; surface smooth; aperture produced, crescentic. Length, 1.77 millimeters; diameter, 0.26 millimeter.

Plesiotype No. 4078, locality P3, Ponce formation.

Common at P3 of the Ponce formation.

This species differs from *N. paucistriata* Galloway and Morrey in the absence of the septal bridges, and from *N. cocoaensis* (Cushman) in the inflated chambers.

***Nodosarella paucistriata* Galloway & Morrey**

PLATE 35, FIGURES 7 to 9

? *Nodosaria catenulata* Cushman (1923) U. S. Geol. Surv. Prof. Pap. 133: 28. pl. 3, fig. 14. Lower Oligocene, Alabama.

Nodosaria intermittens Nuttall (1928) Quart. Jour. Geol. Soc. London 84: 82. pl. 4, fig. 17. Upper Eocene and lower Miocene, Trinidad.

Nodosarella paucistriata Galloway & Morrey (1929) Bull. Am. Paleont. 15 (55): 42. pl. 6, figs. 12a, b. Lower Oligocene, Ecuador.—Coryell & Rivero (1940) Jour. Paleont. 14: 343. pl. 42, figs. 21–23. Middle Miocene, Haiti.

Ellipsonodosaria verneuili paucistriata Cushman (1929) Contr. Cushman Lab. Foram. Res. 5: 97. pl. 14, figs. 4, 5. Middle Tertiary, Ecuador and Trinidad.

Test elongate, slender, slightly curved; about 11 chambers in the adult test, most of the chambers inflated; sutures depressed, or flush with the surface between the early uninflated chambers; apical end blunt, with a short, stout, eccentric spine; surface unornamented except for about 6 septal bridges on the depressed sutures, flush sutures unornamented; aperture terminal, crescentic in shape, at the end of a neck-like constriction of the last chamber. Length, up to 2.53 millimeters; diameter, up to 0.40 millimeter.

Plesiotypes No. 4058a and 4058b, locality P3; and No. 3891, locality P2, Ponce formation.

Common at A86 of the Cibao formation. Rare at P3; common at P2, P254, and P255 of the Ponce formation.

The septal bridges of this species are very small and easily overlooked.

***Nodosarella verneuili* (d'Orbigny)**

PLATE 35, FIGURES 10a, b

Dentalina verneuili d'Orbigny (1846) Foram. Foss. Vienne 48. pl. 2, figs. 7, 8. Middle Miocene, Vienna.

Ellipsonodosaria verneuili Cushman (1929) Contr. Cushman Lab. Foram. Res. 5: 96. pl. 14, figs. 1–3. Middle Tertiary, Ecuador, Venezuela, Trinidad.—Cushman & Jarvis (1930) Jour. Paleont. 4: 364. pl. 33, fig. 12. Middle Miocene, Jamaica.—Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 295. pl. 18, figs. 1, 2, 14–16. Lower Oligocene, Cuba.

Test slender, elongate, slightly curved, gradually tapering from the initial end which terminates in a spine; early part of the test with

parallel, straight sides, later part with the chambers slightly inflated; chambers increasing rather slowly in size, being usually slightly shorter than wide; sutures distinct, of clear shell material, flush with the surface in the early part of the test and slightly depressed in the later part; apertural end produced; aperture terminal, crescentic, with small, pointed tooth. Length of average specimen, 1.33 millimeters; diameter, 0.25 millimeter.

Plesiotype No. 4034, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

ELLIPSOGLANDULINA Silvestri 1900

Ellipsoglandulina exponens (Brady)

PLATE 36, FIGURES 1a, b

Ellipsoidina exponens Brady (1892) in Jukes-Brown & Harrison, Quart. Jour. Geol. Soc. 48: 198. Upper Tertiary, Barbados.—Guppy (1894) Proc. Zool. Soc. London, 650. pl. 41, fig. 13. Miocene, Trinidad.

Ellipsoglandulina laevigata Silvestri (1900) Att. Rend. R. Acad. Sci. Lett. Arti. Zelanti, Acireale, Me. Cl. Sci. 10: 9. pl. 1, figs. 3–10, 12, 13. Upper Miocene or basal Pliocene, Sicily.

Ellipsoglandulina exponens Nuttall (1928) Quart. Jour. Geol. Soc. 84: 95. pl. 6, fig. 17. Oligocene and Miocene, Trinidad.—Cushman (1928) Contr. Cushman Lab. Foram. Res. 4: 103. pl. 14, fig. 17. Upper Cretaceous, Trinidad.

Ellipsoglandulina principiensis Cushman & Bermudez (1937) Contr. Cushman Lab. Foram. Res. 13: 18. pl. 2, figs. 1–3. Eocene, Cuba.

Test oval in side view, narrowly rounded at the apical end, slightly tapering at the apertural end; chambers 3 to 4, overlapping so that the final chamber constitutes nearly one-half of the test; sutures distinct, slightly depressed; aperture terminal, crescentic. Length, 1.20 millimeters; diameter, 0.70 millimeter.

Plesiotype No. 3903, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

ELLIPSOIDINA Silvestri 1923

Ellipsoidina ellipsoides abbreviata Seguenza

PLATE 36, FIGURES 2 and 3

Ellipsoidina abbreviata Seguenza (1859) Eco. Peloritano II. 5: 14. pl., figs. 5a, b. Miocene, Italy.

Ellipsoidina ellipsoides abbreviata Brady (1868) Ann. Mag. Nat. Hist. IV. 1: pl. 13, fig. 3. Miocene, Italy.—Silvestri (1925) Atti Soc. Ital. Sci. Nat. 64: 51. text fig. 1. Molasse, Tertiary, Italy.

Ellipsoidina ellipsoides Hadley (not Seguenza) (1934) Bull. Am. Paleont. 20 (70A): 19. pl. 2, figs. 18, 19. Oligocene, probably upper, Cuba.

Test smoothly ovoid, apical end slightly more pointed than apertural end; chambers uniserial, enlarging rapidly, last chamber completely embracing earlier chambers; aperture terminal, an arcuate slit with

raised lip; shape of slit varies from a short arc to a short U or V shape. Length, 1.35 millimeters; diameter, 1.17 millimeters.

Plesiotypes No. 3904a and 3904b, locality P2, Ponce formation.

Rare at P3 and P255; abundant at P2 of the Ponce formation.

E. abbreviata is, as the name indicates, much shorter in proportion than *E. ellipsoides* Seguenza (1859. Eco. Peloritano II. 5:).

Family CAMERINIDAE Meek & Hayden 1865

OPERCULINELLA Yabe 1918

Operculinella sinuata NEW SPECIES

PLATE 36, FIGURES 4a-c

Test very small for the genus, compressed, biconvex, biumbonate, nearly bilaterally symmetrical; edge narrowly rounded but not keeled; periphery smooth; whorls about two, involute to umbos, only the last whorl exposed, part of the earlier whorl visible through the clear umbonal material; chambers 10 to 12 in the last whorl; sutures distinct, marked by clear shell material, flush with the surface, strongly curved, meeting the periphery with a small angle, recurved onto the umbo, making the sutures sigmoid in the last half whorl; the two sides of the test nearly identical; wall very finely perforate; aperture a small slit, with small upper lip, at the base of the septal face on the inner periphery, not extending beyond the edge of the test on either side. Diameter, 0.55 millimeter; thickness, 0.16 millimeter.

Holotype No. 4067, locality A21, Quebradillas formation.

Rare at A20 and A21 of the Quebradillas formation.

There are few described species with which to compare this Porto Rican form. It is smaller and has fewer chambers than *O. dia* Cole and Ponton (1930. Fla. Geol. Surv. Bull. 5).

HETEROSTEGINA d'Orbigny 1826

Heterostegina antillea Cushman

PLATE 36, FIGURE 5

Heterostegina antillea Cushman (1919) Carnegie Inst. Wash. Publ. 291: 49. pl. 2, fig. 1b, pl. 5, figs. 1, 2. Middle Oligocene, Antigua; (1921) U. S. Geol. Surv. Prof. Pap. 128E: 131. pl. 20, figs. 13, 14. Middle Oligocene, Antigua, Virgin Islands, St. Croix, Santa Domingo.

EXTERIOR.—Test discoid, eccentrically biumbonate, the central portion 2 to 3 times as thick as the broad, complanate portion; edge sharply rounded; surface ornamented with a smooth boss which is

surrounded by low, oval and elongate papillae, and with raised lines of transversely elongate papillae and discontinuous raised lines along the sutures in the later part of the test; the sutures between the chamberlets are less raised, but are frequently slightly raised at their outer ends and confluent with the raised sutures between the chambers; aperture not observed. Diameter of test, 4 to 6 millimeters; thickness, central part 0.8 to 1 millimeter; thinner edge, 0.33 to 0.4 millimeter.

MEDIAN SECTION.—Chambers short, 20 or more in the last whorl, 0.16 to 0.22 millimeter long in the direction of coiling, broad radially and strongly and evenly curved, meeting the edge with a small angle; chamberlets rectangular, the later ones half as wide as long, 0.2 by 0.1 millimeter, alternating in position with those in prior and succeeding chambers, so that the walls between chambers are markedly zigzag; the earlier chamberlets are wider and shorter than the later ones, the earliest ones being highly arched (ogival) to trapezoidal in shape; proloculum spherical, 0.09 millimeter in diameter, followed by two oval chambers of nearly the same size.

VERTICAL SECTION.—The spherical proloculum and rectangular median chambers are covered with numerous laminae making up the lateral zones; the laminae are composed of vertical fibers of calcium carbonate, and are more transparent at the outer ends of the chambers, with indications of pillars radiating from the proloculum.

Plesiotype No. 4149, locality L3C, San Sebastian formation.

Rare at L3C and L5C of the San Sebastian formation.

In some of the specimens the raised sutures between the chambers and between the chamberlets are more pronounced than in the figured specimen, but not as pronounced as in *H. ocalana* Cushman (1921. U. S. Geol. Surv. Prof. Pap. 128E: pl. 21).

Family ORBITOIDIDAE Schubert 1920

In the San Sebastian and Ponce formations, there occur small specimens of orbitoids, 1 to 3 millimeters in diameter which are very much like *Lepidocyclina parvula* Cushman, and *Lepidocyclina* (*Nephrolepidina*) *tournoueri* Lemoine and Douvillé, as described and figured by Vaughan (1933. Smith. Misc. Coll. 89). While the specimens are insufficient for adequate study description and figures, they are sufficient to demonstrate the Oligocene age of the beds in which they occur.

Lepidocyclina cf. *parvula* Cushman is rare at L4C of the San Sebastian formation, and common at P251 of the Ponce formation.

Lepidocyclina (*Nephrolepidina*) cf. *tournoueri* Lemoine and Douvillé is rare at L4C of the San Sebastian formation, and at P251 of the Ponce formation.

MIOGYPSINOIDES Yabe & Hanzawa 1928

Miogypsinoides complanata (Schlumberger)

PLATE 36, FIGURES 6 to 10

Miogypsina complanata Schlumberger (1900) Bull. Soc. Géol. France III. 28: 330. pl. 2, figs. 13-16, pl. 3, figs. 18-21. Upper Oligocene, France.—Silvestri (1930) Boll. Soc. Geol. Ital. 48: 210; (1923) Boll. Soc. Geol. Ital. 42: pl. 1, fig. 19. Oligocene, Italy.—Nuttall (1933) Jour. Paleont. 7: 176. pl. 24, figs. 7, 9, 11-14. Middle Oligocene, Mexico.

EXTERIOR.—Test flabelliform, irregularly discoidal, nearly equally biconvex, the initial end narrow with smooth outline, the outer margin serrate, due to the large median chambers which are not covered by lateral laminae; surface papillate, the apical portion with very small papillae, about 0.02 millimeter in diameter, the outer portion with papillae more variable in size, 0.03 to 0.08 millimeter in diameter, and the early middle portion with the largest papillae, about 0.1 millimeter in diameter. Only microspheric forms were found. Length, from 0.8 to 2.5 millimeters; width, 0.7 to 2.7 millimeters; thickness, up to 0.35 millimeter.

MEDIAN SECTION.—The coiled nucleoconch of an average specimen (1.3 millimeters in diameter) is located near the periphery at the apex of the test, and consists of a globular proloculum about 0.1 millimeter in diameter, with wall about 0.028 millimeter thick, followed by one to two whorls of chambers; the proloculum and a few slightly smaller chambers, subtriangular to rectangular in shape with radial dimension increasing gradually, are followed by spatulate chambers for a half whorl to a whorl, then by diamond shaped chambers for the remainder of the test.

LONGITUDINAL VERTICAL SECTION.—The median chambers are oval and appressed, about 0.1 millimeter in length and 0.15 millimeter in diameter, constituting about half the thickness of the test; the chamber walls are fibrous crosswise; the lateral laminae are rather thick and transversely fibrous, and traversed by fibrous pillars around the nucleoconch, the pillars appearing at the surface as knobs. There is a light-colored structure at the outer edge of many of the median chambers. No apertures were observed in either median or vertical sections.

Plesiotypes No. 4150a, 4150b, 4150c, and 4150d, locality L4C; and No. 4151, locality L6C, San Sebastian formation.

Rare at L2C and L3C; common at L1C and L6C; abundant at L4C and L5C of the San Sebastian formation. Common at A86 of the

Cibao formation. Abundant at A79 of the Los Puertos formation. Rare at P2 and P4 of the Ponce formation.

The presence of lateral laminae rather than lateral chambers places these specimens in the genus *Miogypsinoidea*. The Porto Rican specimens are smaller than the French types of the species, but are of the same size as the Mexican specimens.

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FOSSIL LOCALITIES

The foraminifera which are described in this paper were collected from 35 different localities and represent all five formations from the northern area, and the Ponce formation from the south shore. All of the collecting localities are marked on the geologic map which accompanies this report.

San Sebastian formation

All of the San Sebastian localities are upper San Sebastian in age and are close together stratigraphically. A 100 foot vertical range just below the Lares would encompass them all, with the exception of the L1C which may be slightly lower.

L1C	Collazo Falls, base of Lower Fall on north side of the road at kilometer 26.7 on San Sebastian-Lares road.
L2C	Outcrop at kilometer 26.6 on San Sebastian-Lares road.
L3C	Outcrop at kilometer 27.1 on San Sebastian-Lares road.
L4C	Outcrops between kilometer 27.2 and 27.4 on San Sebastian-Lares road.
L5C	Outcrops at kilometers 27.7 and 28.7 on San Sebastian-Lares road.
L6C	Outcrop at kilometer 31 on San Sebastian-Lares road.

Lares formation

A6	Small road quarry at kilometer 66.3 on Arecibo-Utuado road, in valley of Rio Arecibo; 2.45 kilometers north of Lares-Cretaceous contact. Approximately middle Lares.
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Cibao formation

A43a	At kilometer 19.8 on Arecibo-Lares road. Lower Cibao, about 150-200 feet above the base.
A86	At kilometer 5.5 on the Manati-Ciales road. Probably upper Cibao.

Los Puertos formation

- A79 At kilometer 13, Los Canos-Bayanez cane railroad. Lower Los Puertos, probably less than 150 feet above the base.
- A91a At kilometer 4, Morovis-Vega Baja road. Upper or upper middle Los Puertos.

Quebradillas formation

- F64 Northernmost of three Tertiary hills lying north of kilometer 3.6 on Río Piedras-Carolina road. Although located in the lower third of the formation, this may not be lower Quebradillas since basal members drop out by overlap to the east.
- A46 About 2.5 kilometers S. S. W. of Arecibo on Hato Abajo road. Middle Quebradillas, possibly lower middle.
- F359 Quarried hillside 0.5 kilometers north of abandoned Central at Hoyo Mulas, north of Canovas-Carolina road. Probably middle Quebradillas.
- F358(2) Outcrop about 1 kilometer southwest of F358, about 100 feet stratigraphically above F359 and below F358. Probably middle Quebradillas.
- F358 Quarry, north of Canovanas and railroad bridge at Central Canovanas, west bank of Río Grande de Loíza. Probably middle Quebradillas.
- A21 At kilometer 2.1-2.2 on road south of Hatillo. Upper middle Quebradillas.
- A20 Roadcut 1.9-2 kilometers south of Hatillo, approximately 75 feet higher in the section than A21. Upper middle Quebradillas.
- A64 Quarry between Barcelonita and Manatí, northeast of San Juan-Arecibo highway, and east of Río Manatí. Upper Quebradillas.
- A15 Quarry 0.3 kilometers south of Arecibo-Hatillo road at 88.2-88.3 kilometers. Upper Quebradillas.
- A93 From quarry at kilometer 0.7, Arecibo-Lares road. Upper Quebradillas.

Ponce formation

Ponce-Peñuelas area

- P251 From kilometer 251.3-251.5 on Peñuelas-Ponce road. Lowest Ponce.
- P4 From kilometer 4.7 on Ponce-Arecibo road, less than 0.7 kilometers from Cretaceous Tertiary contact. Lower Ponce.
- P3 From kilometer 3.7 on Ponce-Arecibo road; higher stratigraphically than P4. Lower Ponce.
- P2 From kilometer 2.8-2.9 on Ponce-Arecibo road; stratigraphically higher than P3. Lower Ponce.
- P253 From kilometer 253.3 on Peñuelas-Ponce road. Lower Ponce, but higher stratigraphically than P251.
- P254 Outcrops between kilometer 254.7 and 254.9 on Peñuelas-Ponce road. Lower Ponce, but higher stratigraphically than P251.
- P255 Outcrop between kilometer 255.1 and 255.2 on Peñuelas-Ponce road. Lower Ponce, but higher stratigraphically than P251.
- P258 Outcrop between kilometer 258.2 and 258.5 on Peñuelas-Ponce road. Higher stratigraphically than P253, P254 and P255. Probably middle Ponce.
- P259 Outcrop at kilometer 259.4 on the Peñuelas-Ponce road. Higher stratigraphically than P253, P254 and P255. Probably middle Ponce.

Río Yaúco section

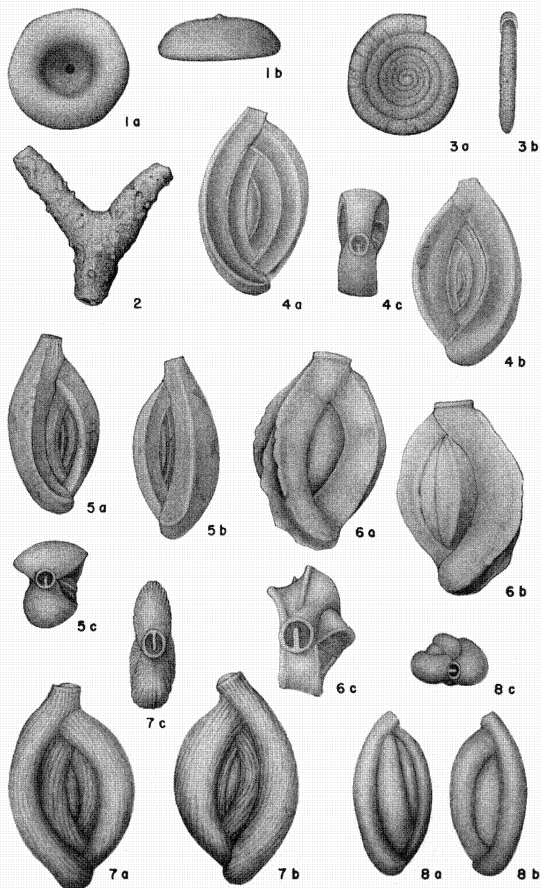
- P431 Approximately 1.3 to 1.4 miles S. S. E. of Yaúco railroad station in shallow cuts along road that follows valley of Río Yaúco. Upper part of lower Ponce.
- P432 Outcrop about 2½ to 3 miles S. S. E. of Yaúco on road that follows valley of Río Yaúco. Lower part of middle Ponce.
- A432 Outcrop 4 to 5 kilometers S. S. E. of Yaúco in valley of Río Yaúco. Lower part of middle Ponce.
- P434 Outcrop east of A432 along American Railroad near kilometer 246.5. About middle part of middle Ponce.
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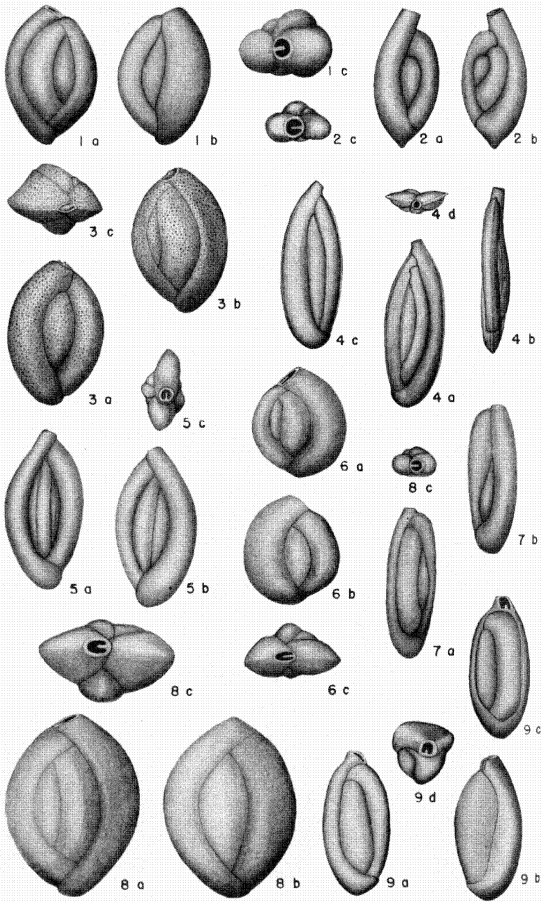
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GALLOWAY AND HEMINWAY: TERTIARY FORAMINIFERA

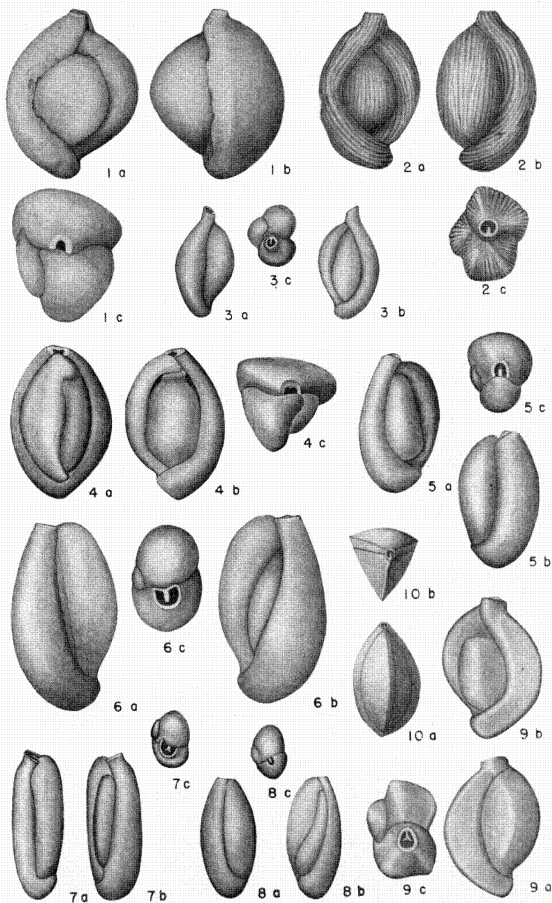
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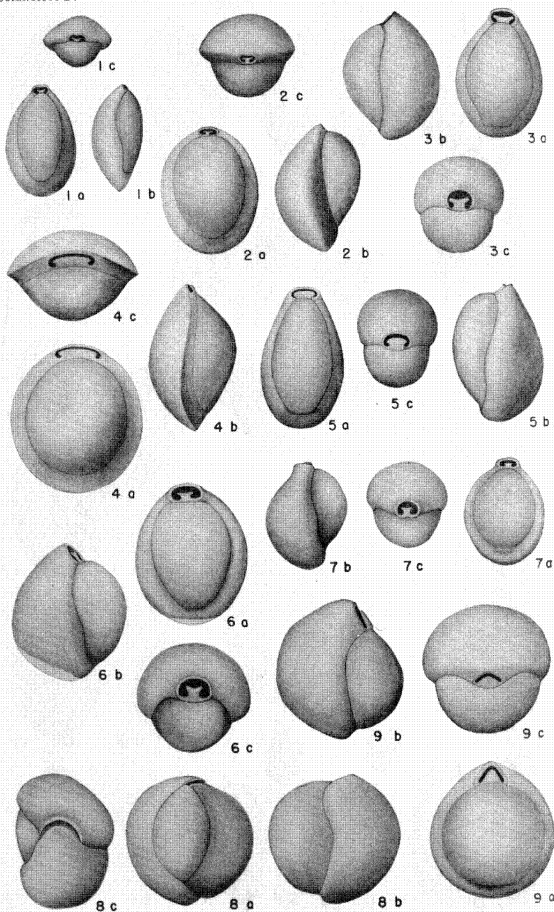


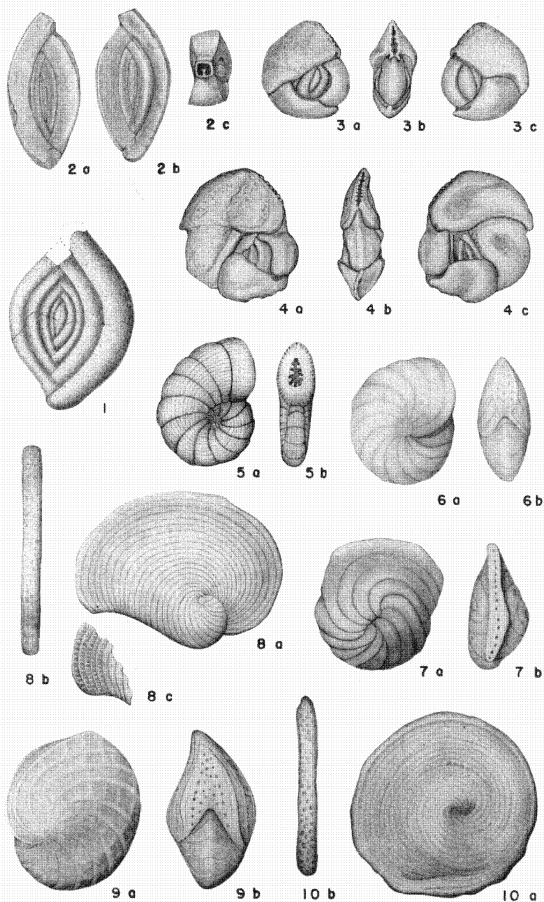
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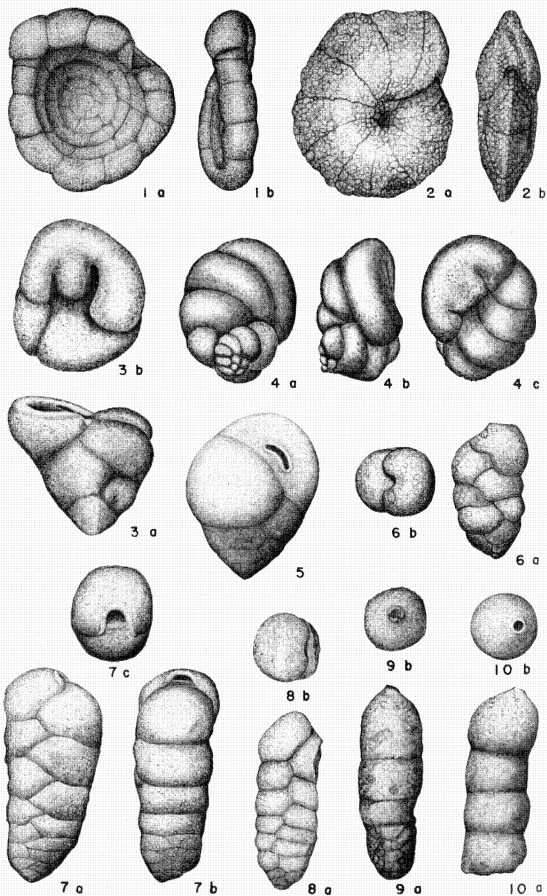
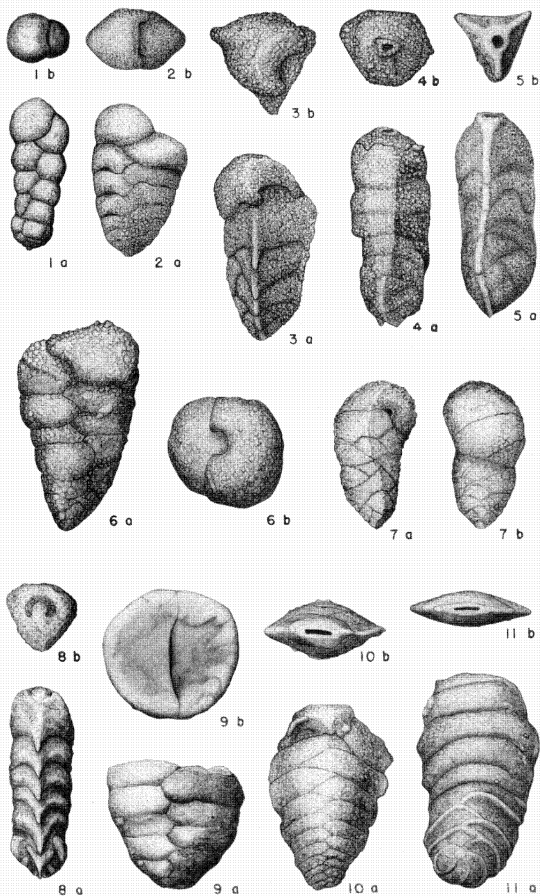


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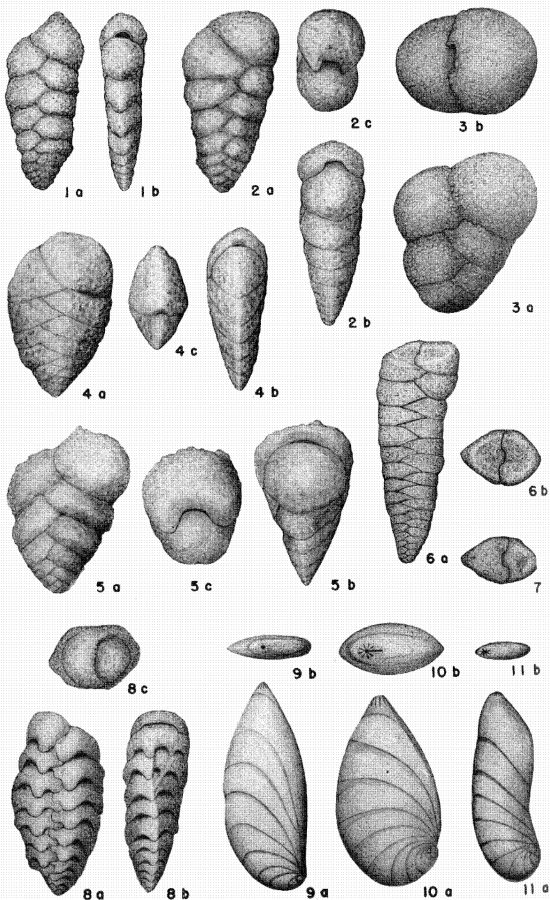
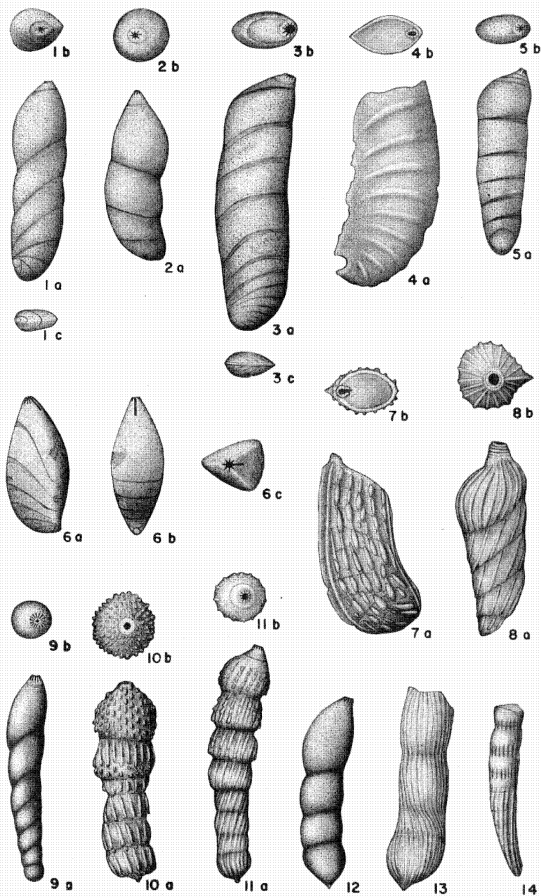


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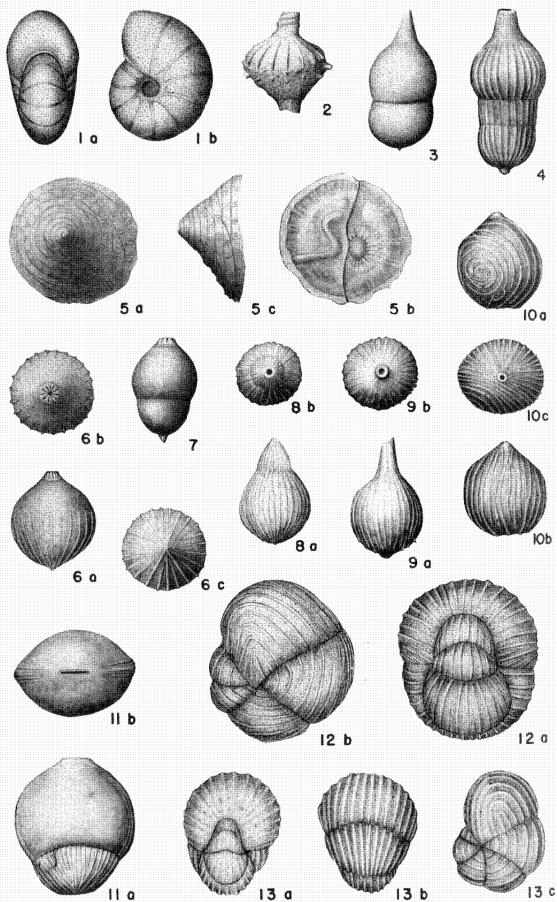
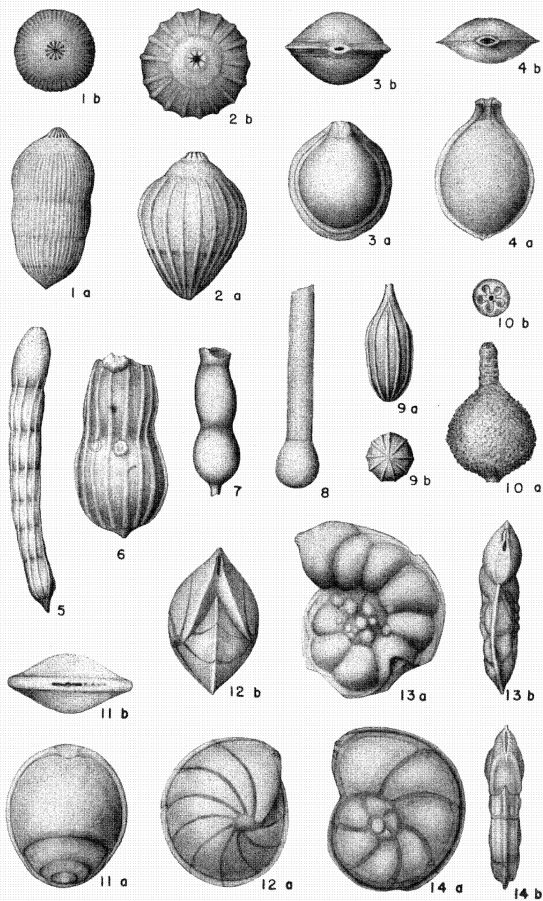


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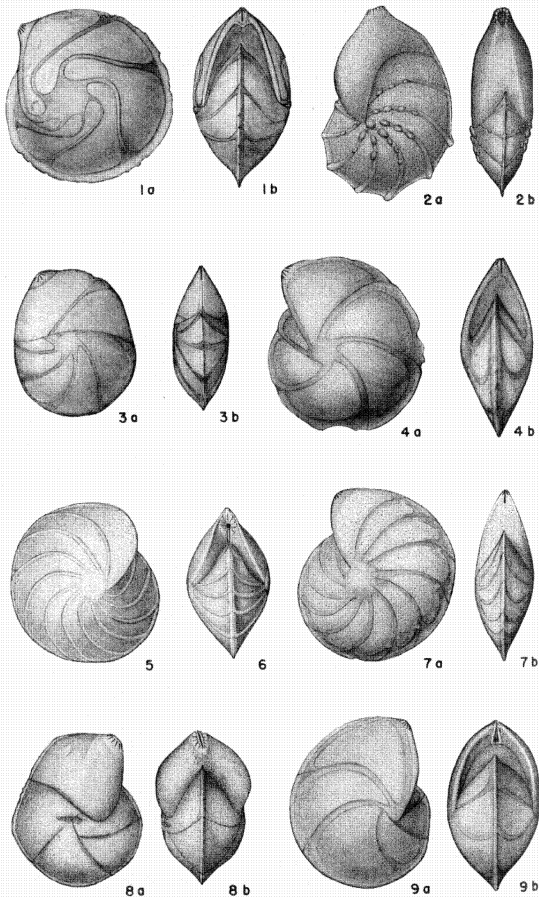
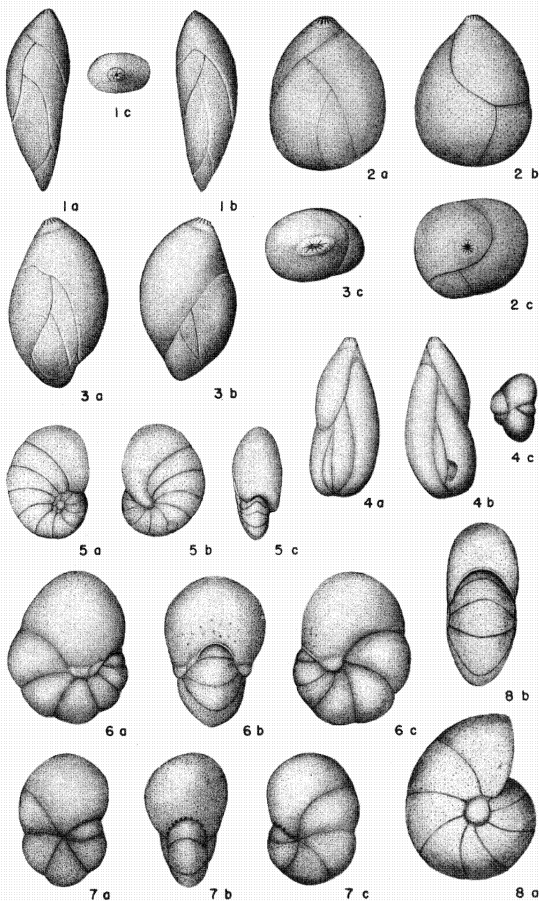


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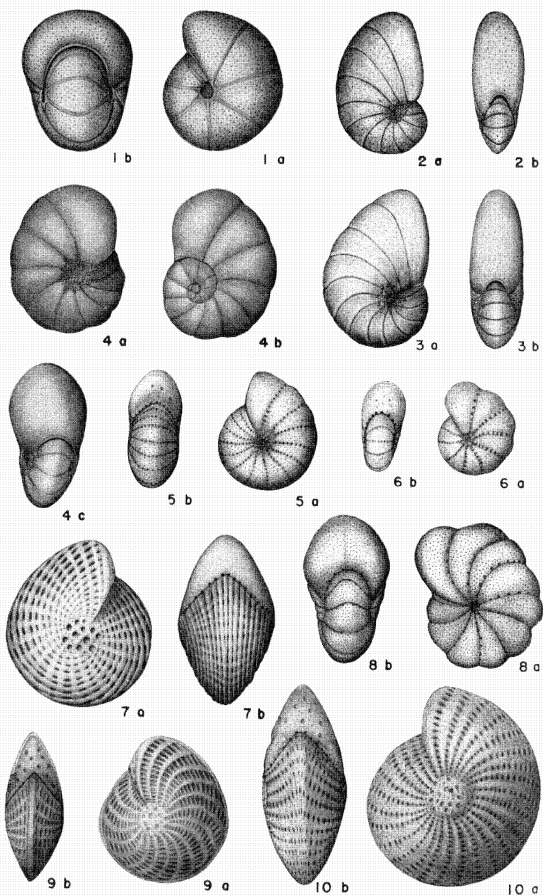
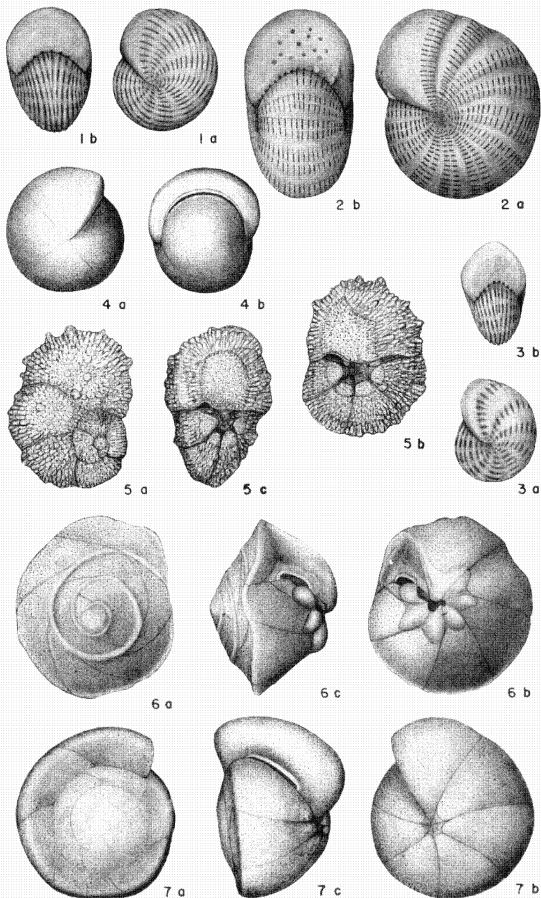


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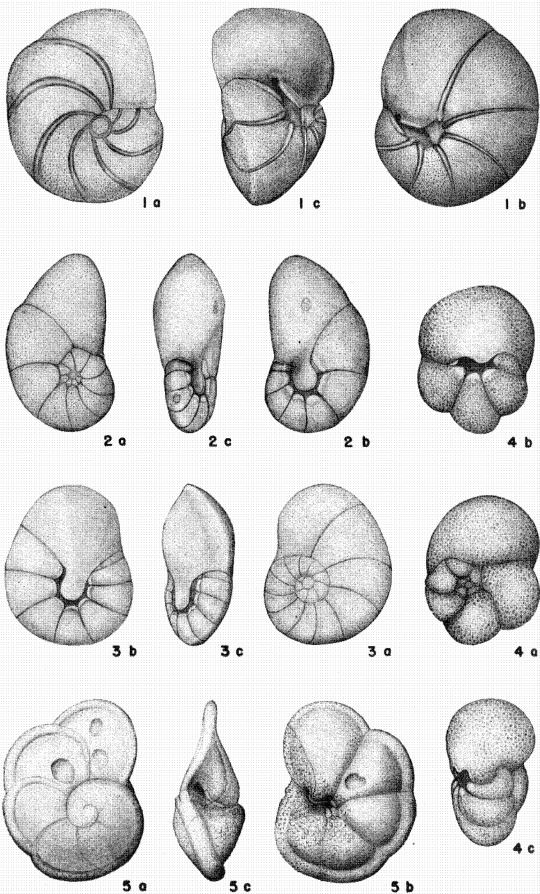


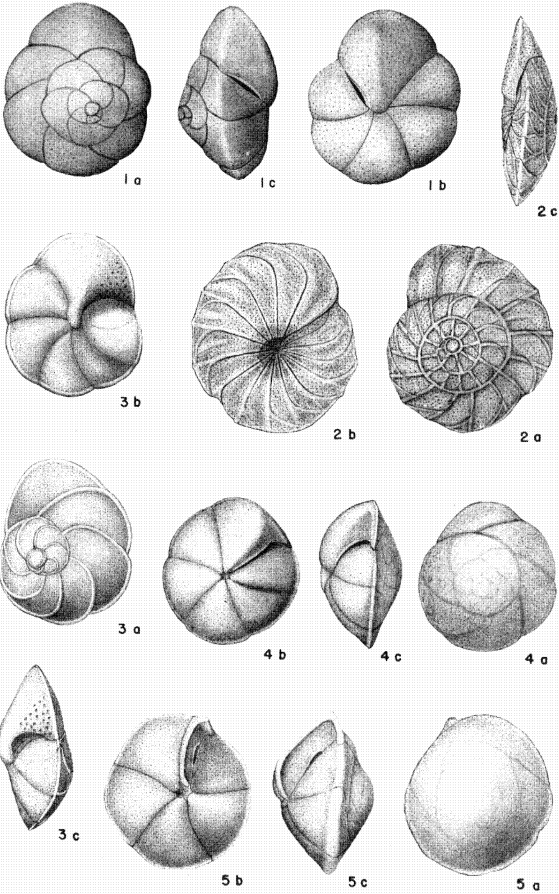
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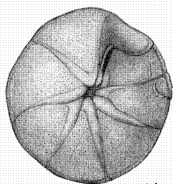
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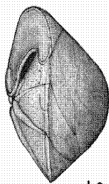
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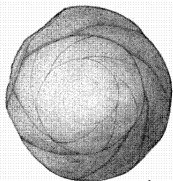




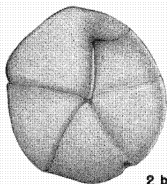
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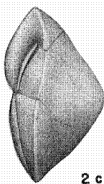
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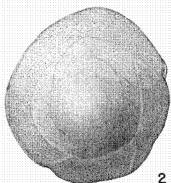
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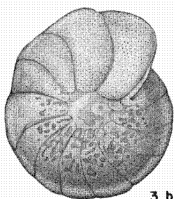
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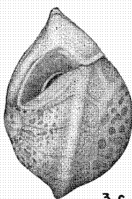
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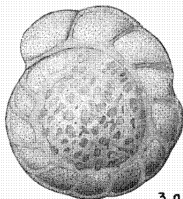
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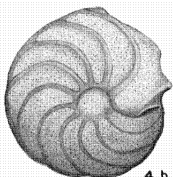
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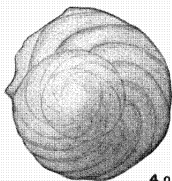
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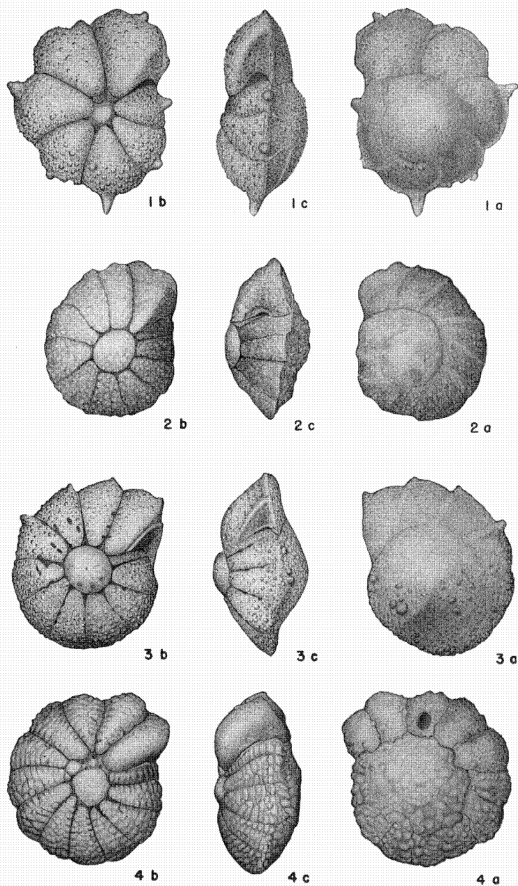
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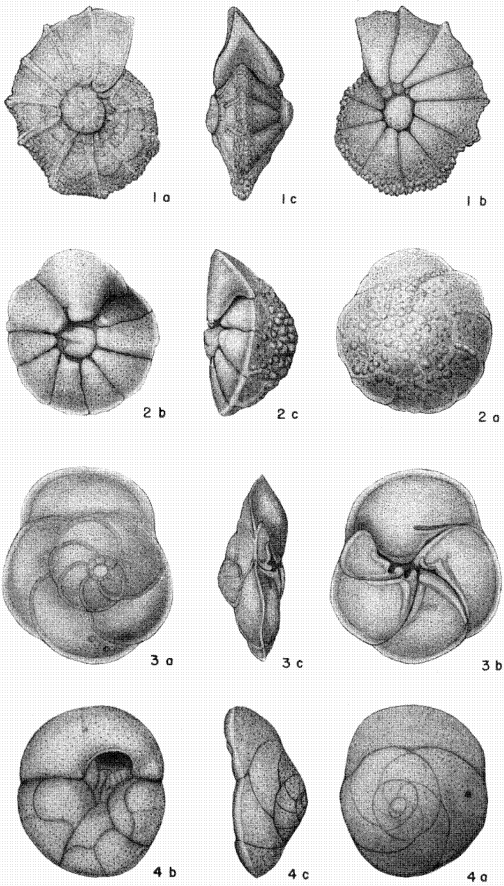
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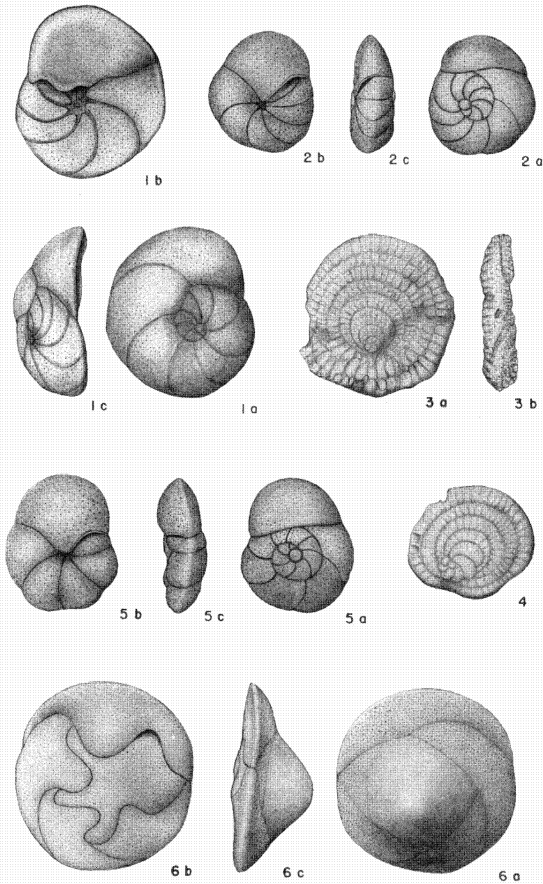
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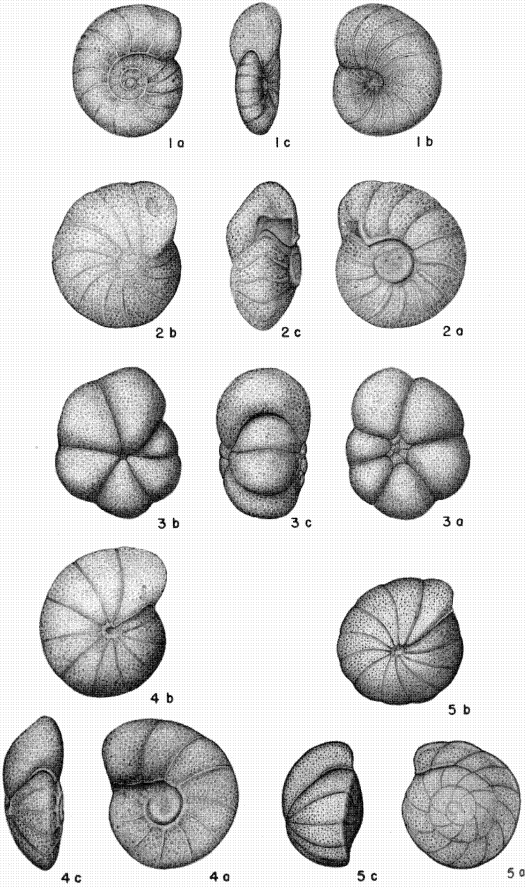


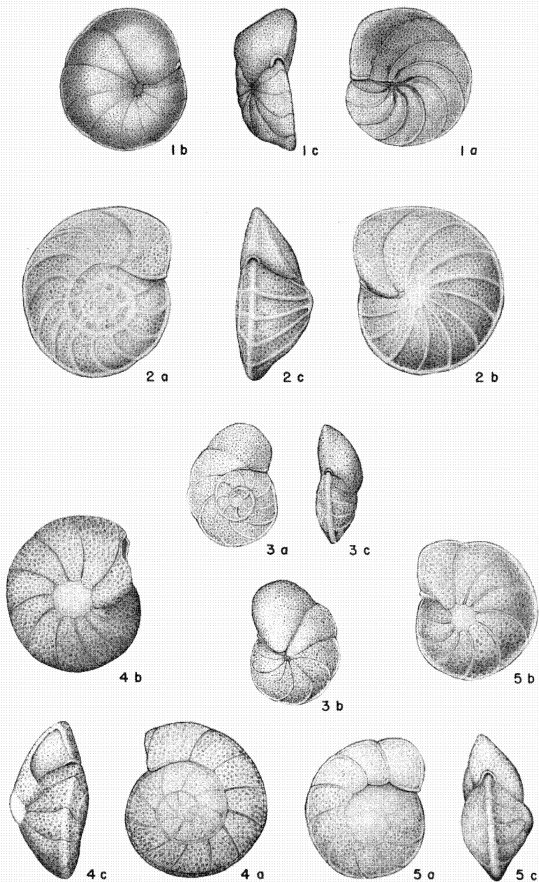
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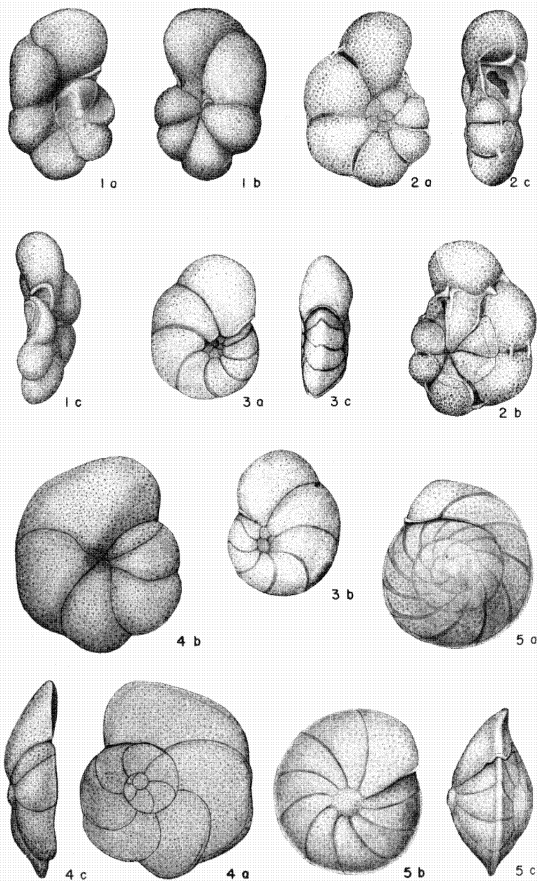
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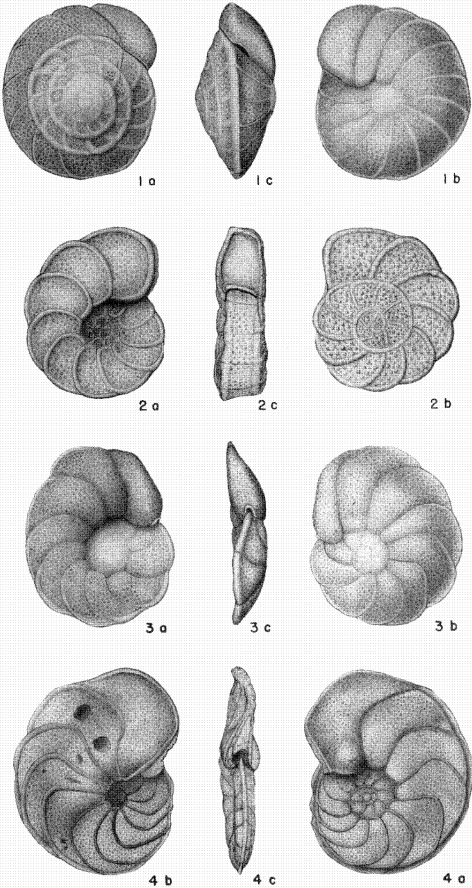
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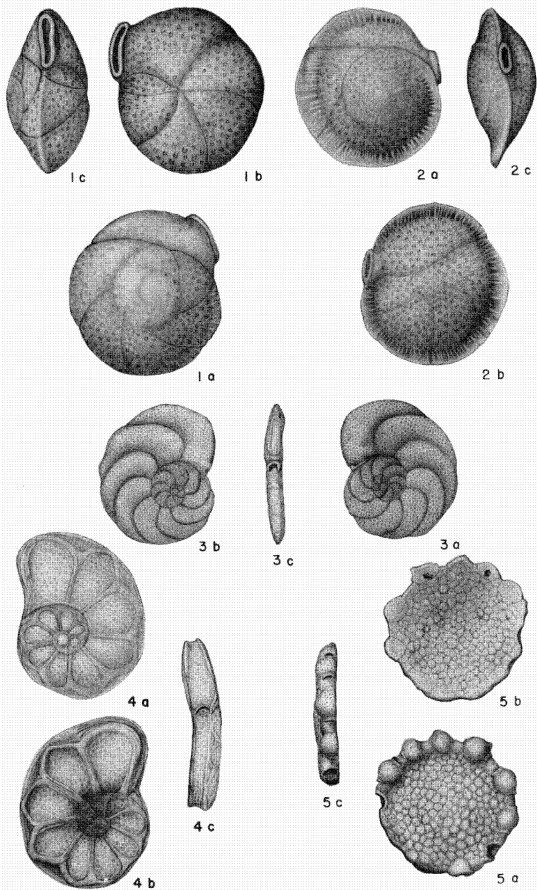


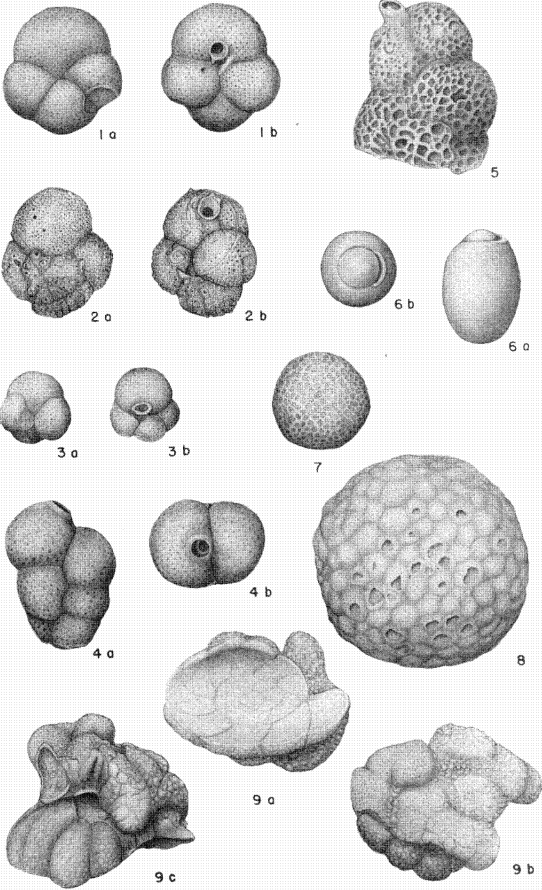
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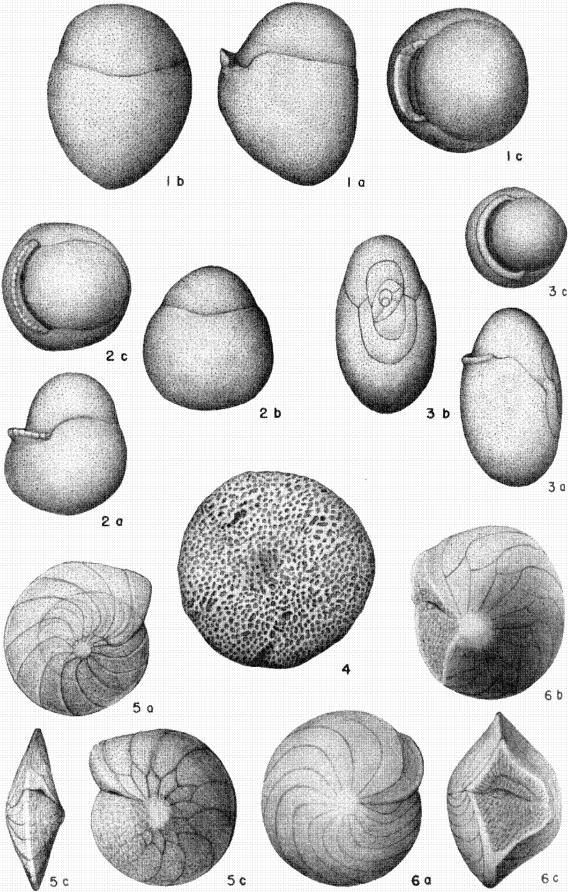
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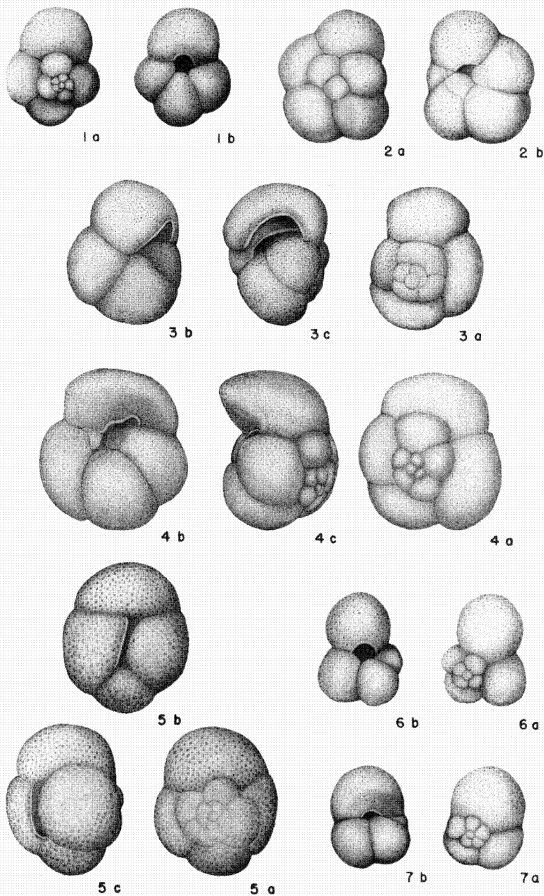
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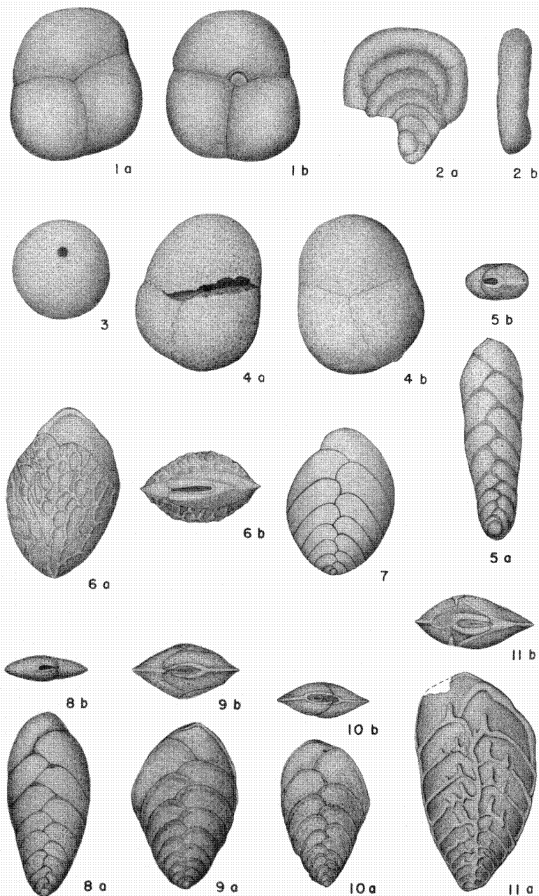
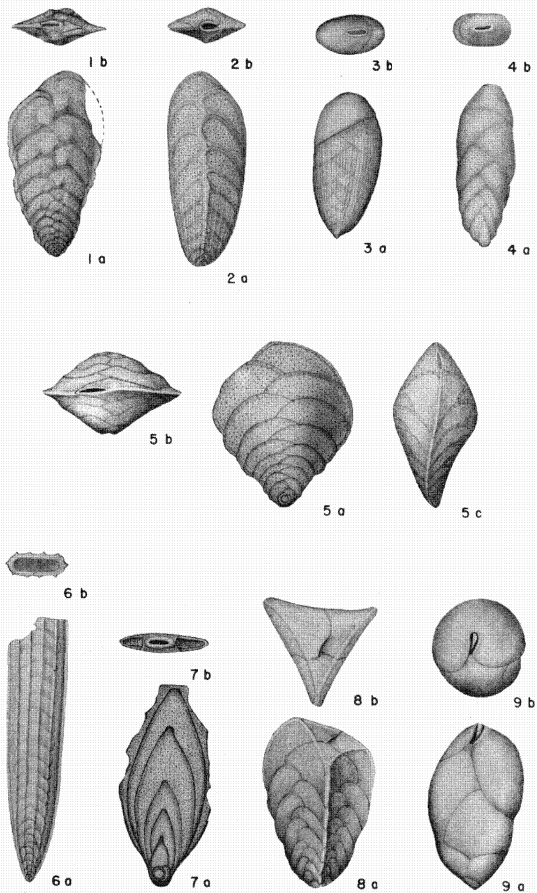


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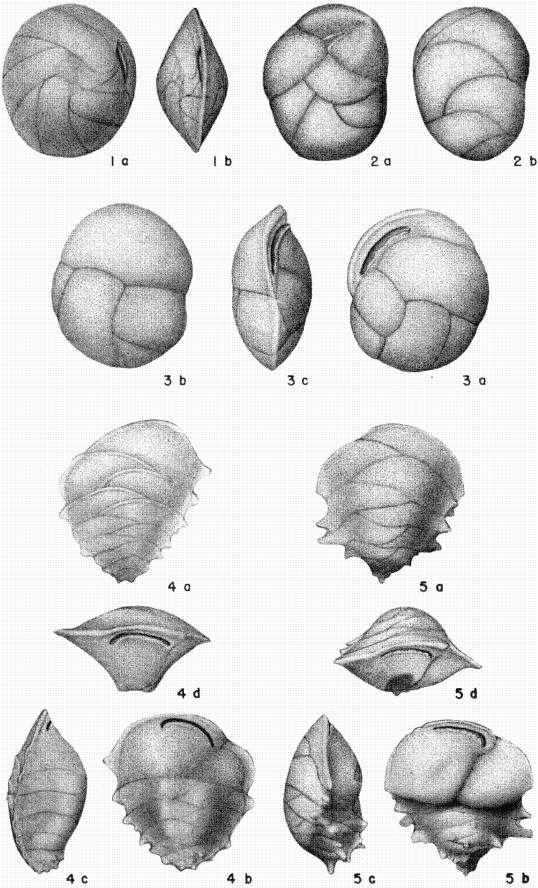
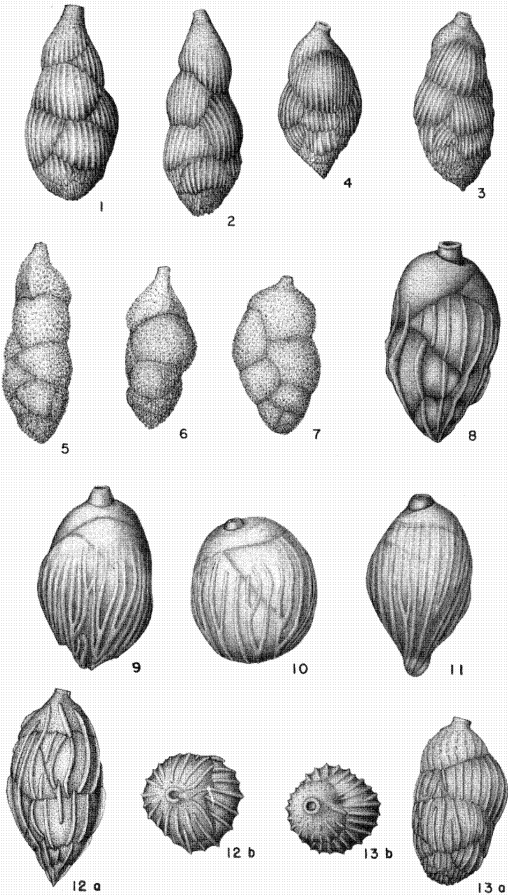


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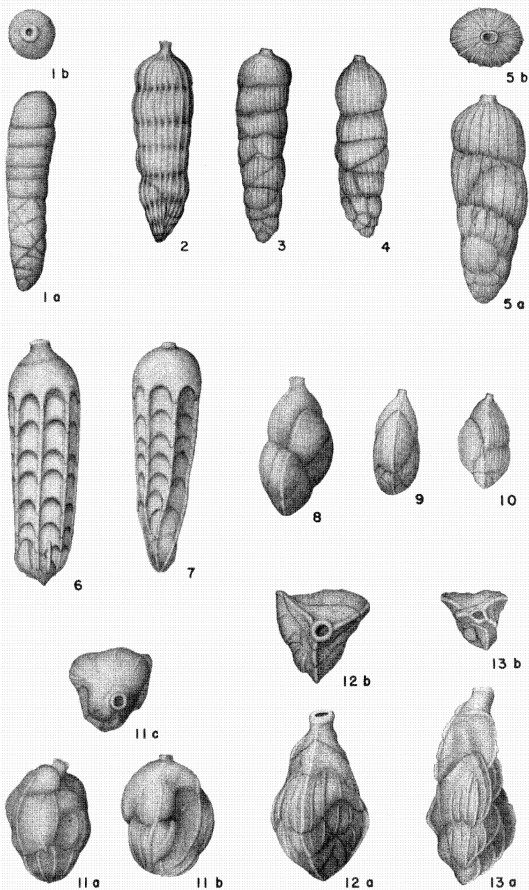


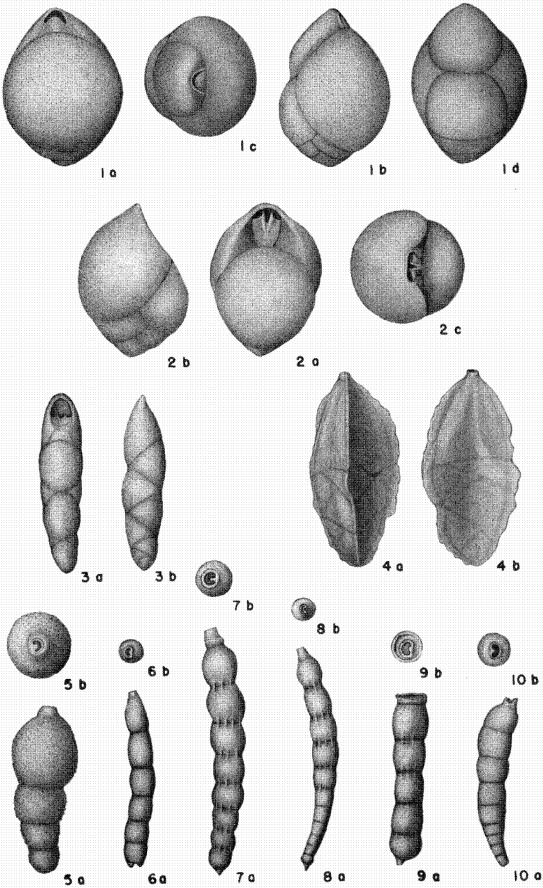
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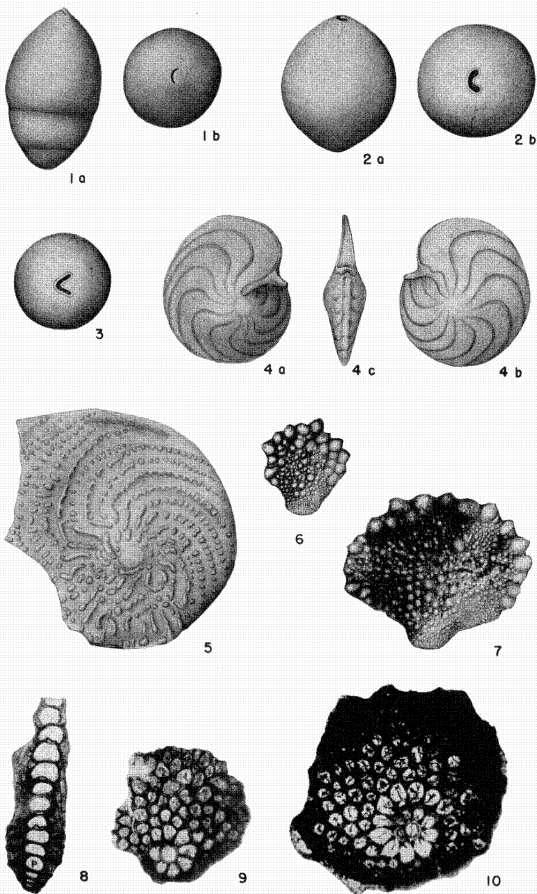


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VOLUME III—Part 4

The Tertiary Foraminifera of Porto Rico

J. J. Galloway and Caroline E. Heminway



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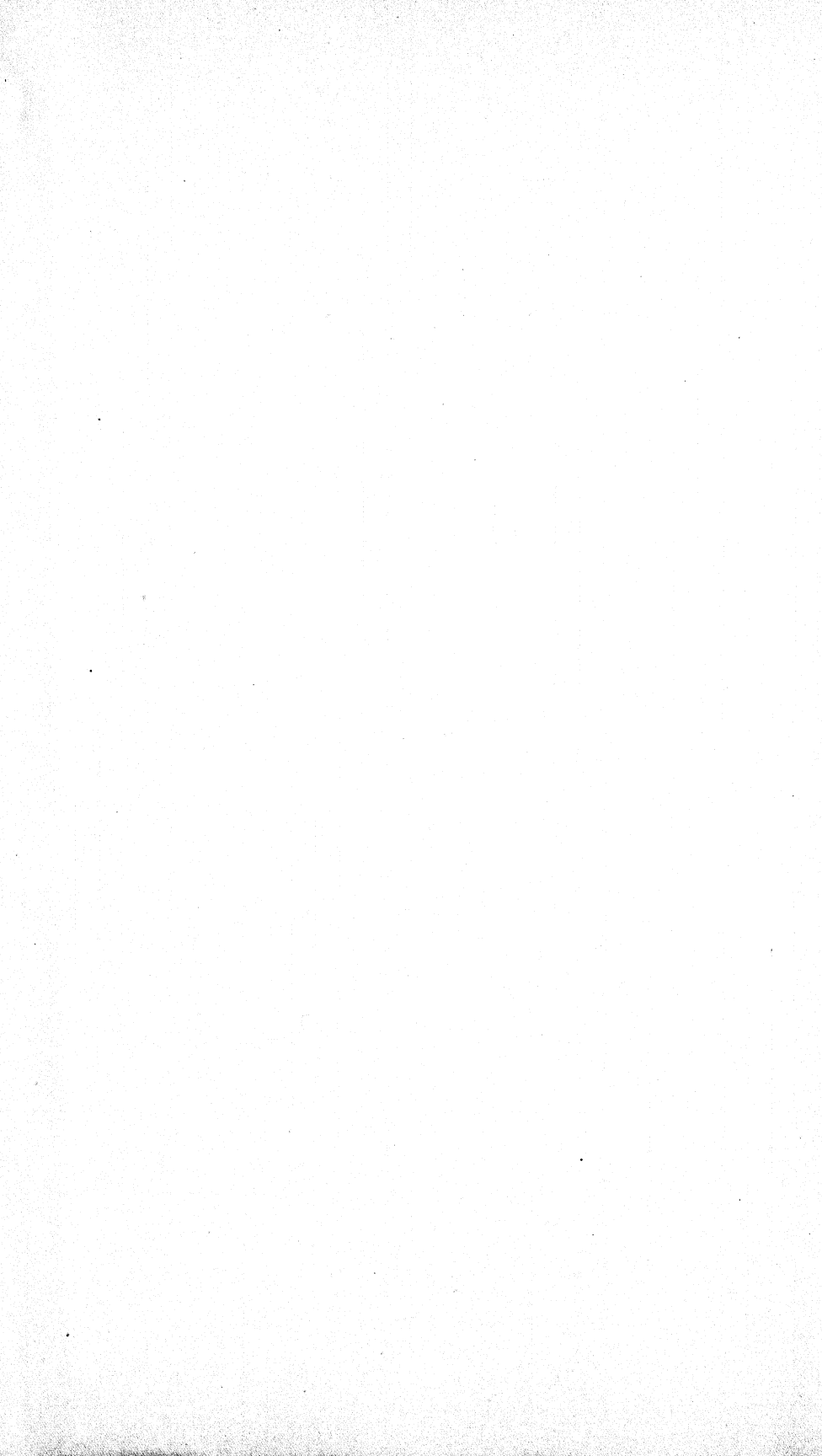
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