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88. STATUS OF MICROPALEONTOLOGY IN TABASCO AND CHIAPAS, (MEXICO)

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INTRODUCTION

The oldest reference to the occurrence of microfossils in Tabasco and Chiapas, southern Mexico, apparently is a short note by Felix and Lenk (1895, pp. 208-209), mentioning that some foraminifera (*Orbitoides, Nummulites* and *Textularia*), one alga (*Lithothamnium*) and fragments of a coral (*Porites*), had been collected in different localities of northern Chiapas (Yajalón, Chilón, Salto de Agua, etc.), south of the state line with Tabasco. On the basis of such evidence, and other data, the authors concluded that Eocene beds (*Eocänschichten*), of the alpine "nummulitic-orbitoidal" facies, were present in that region of México.

Shortly afterwards Aguilera (1897, p. 200) reported the occurrence of "*Fusulina granumavenae* F. Roemer," later on called *F. verneuili* var. *sapperi* Staff, and divided by Dunbar into *Parafusulina sapperi* (Staff) and *P. guatemalensis* Dunbar, in rocks of late Paleozoic age from several localities in southeastern Chiapas (La Nueva, La Vainilla, Las Tres Cruces and Palo María, in the vicinity of Chicomuselo).

Sapper (1896, p. 4; 1899, p. 64) and Aguilera (1907, p. 230) had remarked that "*Fusulina granumavenae* F. Roemer," and other megafossils (brachiopods, crinoids, corals) from the same rocks, pointed towards a Carboniferous age. Recent investigations have shown that there is a thick sequence of Upper Pennsylvanian and Lower-Middle Permian beds in the localities mentioned by these two authors.

In his important contribution to the geology and paleontology of Chiapas and Tabasco, Böse (1905, pp. 22, 28-34, 40-64) added much information on the stratigraphy, tectonics and orogeny of both states, mentioning new occurrences of microfossils of late Paleozoic and Cenozoic ages. He cited fusulinids in southeastern Chiapas (Laja Colorada and Río Cuileo, between Chirimoya and San Juan, near Chicomuselo), other foraminifera (*Nummulites, "Orthophragmina"*), and one alga (*Lithothamnium*), collected in the northern part of the state (Solosuchiapa, Ixtacomitán, Tecpatán, Chilón, Tumbalá, Palenque, Simojovel, etc.) in Tertiary beds.

Böse pointed out the great development of the orbitoidal facies of beds of Eocene age, which at that time were not extensively known on the North-American Continent. He also established two divisions for the Oligocene-Pliocene sequence, a) the Simojovel division, including Oligocene and Miocene beds, more or less rich in fossils, and b) the Tenejapa division, for Pliocene deposits, not very fossiliferous. In the course of years Böse's ideas have been greatly changed, but his pioneering efforts certainly deserve praise, since he was the first to try to integrate the knowledge of geology of Tabasco and Chiapas into an organized scheme.

The advent of the oil industry in southern Mexico at the beginning of this century, gave an impulse to micropaleontological investigations for Tabasco and Chiapas, because of the need of more detailed stratigraphical information for well drilling. Most of this knowledge so gained, was kept confidential, and both states lagged behind in attracting the attention of micropaleontologists. There is only a small number of papers on very concrete problems, in comparison to the extensive contributions on the microfossils of other oil-regions of México.

Vaughan (1924, pp. 808-809, figs. 4 and 5) described two larger foraminifera from undifferentiated Eocene and Upper Eocene of Chiapas, *Lepidocyclina (Polylepidina) chiapasensis* Vaughan and *L. (Polylepidina) adkinsi* Vaughan. Both species had been collected in two localities of northern Chiapas (east of Chilón and Hacienda El Triunfo). Vaughan's paper is most important, because many other large and small foraminifera of eastern and southern Mexico were discussed in their taxonomy, stratigraphic distribution, and correlations with American and European forms.

The occurrence of *Helicolepidina* sp. in the Upper Eocene deposits of Playas River, State of Veracruz, near its boundary with the State of Tabasco, was mentioned by Vaughan (1926, p. 1854). Another large foraminifer, *Lepidocyclina (Lepidocyclina) trinitatis* Douvillé, abundant in the upper Eocene deposits of Salto de Agua-Paso Limar road, vicinity of Palenque, and at a place 4.5 Kms. north and 5.5 Kms. west of Trinidad was also reported by Vaughan (1927-1928, p. 289).

On the taxonomic position of these forms, Galloway (1927-1928, pp. 299-303, textfigs. 1-3, pl. 51) postulated that the subgenus *Polylepidina* Vaughan, 1924, of the genus *Lepidocyclina* Gümbel, 1870, should be recognized as a separate genus, one of the primitive forms of the Orbitoididae, and erected *Polylepidina chiapasensis* Vaughan (= *Lepidocyclina (Polylepidina) chiapasensis* Vaughan) as the genotype.

Three new foraminifera, from Tertiary strata of "the central and eastern portions of the Isthmus of Tehuantepec," were described by Nuttall (1928, pp. 372-376, pl. 50), namely *Cibicides filisolaensis* Nuttall, *Chilostomella mexicana* Nuttall and *Rotalia mexicana* Nuttall, which occur in Tabasco in beds of the same age as in the Isthmus of Tehuantepec.

Another important contribution was the paper by Galloway and Morrey (1931, pp. 329-354, pls. 37-40), in which a number of foraminifera of lower Eocene age (at that time thought to be late Cretaceous) was described. They came from the vicinity of Puente de Piedra, on the Río Puzcatán, 19 Kms. south of Macuspana, Tabasco. Out of a total of 56 species eleven were new, namely, *Pullenia puentepiedraensis, Rotalia puscatanensis, Discorbis tabascoensis, Cibicides cognatus, C. spiropunctatus, Bolivina colemani, B. monilifera, Bulimina callahani, B. tabascoensis, Globulimina sobrina* and *Siphogenerina digitalis,* all described and figured by Galloway and Morrey. This was the largest assemblage of forms ever described at one time from southern Mexico.

The occurrence of larger foraminifera of the family Miogypsinidae in Tabasco and Chiapas was discussed by Thalmann (1932, pp. 285-286). He mentioned that some forms, in association with *"Ledipocyclinen,"* had been collected in Macuspana, Buenavista, Santuario, El Sopo, Río Chacamax (near Palenque) and Tapijulapa, near the state line of Chiapas with Tabasco, in Oligocene beds. At that time, Thalmann thought that the stratigraphic range of Miogypsinidae extended from Middle Oligocene to Lower Miocene, since no findings had been made below or above those levels, and concluded his article with a series of remarks on the distribution of related forms in the world, and their stratigraphic position. Later on, Thalmann (1934a, 446-448) described the occurrence of *Lepidocyclina canellei* Lemoine and R. Douvillé in the Oligocene of Tabasco.

For purposes of comparison in regard to microfaunas of Oligocene age in the coastal plain of Mexico, a paper by Nuttall (1932, pp. 1-35, pls. 1-9) is of great importance. It really deals with forms of the Alazan shales of the Tampico Embayment, but many species occur also in equivalent beds in southern Veracruz and Tabasco, like *Nodosaria vertebralis* (Batsch), *Nonion pompilioides* (Fichtel and Moll), *Gyroidina soldanii* d'Orbigny, *Cibicides cushmani* Nuttall, and others. Great care must be exercised however in correlating beds based on occurrence of certain species between the Tampico Embayment and Tabasco, since lateral variation in facies from one sedimentary basin to another can entirely change the faunas.

In his paper on the regional-stratigraphic distribution of the genus *Globotruncana* Cushman, 1927, Thalmann (1934b) mentioned several localities in southern Mexico, where these foraminifera had been collected in Senonian (Santonian) beds, some of which are in the territory of Tabasco, or very near its boundaries. The localities are: Arroyo Azul, close to its confluence with Chalchijapa River, and La Tronconada, some 25 Km. ESE of Santa Lucrecia (now Jesús Carranza), Veracruz; Arroyo Solosúchil, some 35 Km. ESE of Santa Lucrecia, Veracruz; Uzpanapa River, some 80 Km. SSE of Puerto Mexico (now Coatzacoalcos), Veracruz; Nanchital River, 95 Km. ESE of Puerto Mexico, Cerros Jimbal-Pelón, near Playas River, some 80 Km. ESE of Puerto Mexico.

A number of stratigraphically important foraminifera from southern Mexico, with special reference to the Tertiary of the Isthmus of Tehuantepec, was mentioned by Thalmann (1935, pp. 593-598). Some of the original localities are so close to Tabasco and northwestern Chiapas, that for practical purposes, they should be considered as mere "outliers" of their territories. Oldest Eocene layers occur at Cerro Pelón, where a series of marls and marly sandstones, with a thickness of some 1000 m., underlain by 200 m. of transgressive conglomerate, contain *Anomalina dorri* Cole, *Cibicides cushmani* Nuttall, *Chilostomelloides eocenicus* Nuttall, *Cornuspira* aff. *C. polygyra* Reuss, *Robulus mexicanus* Cushman, *Eponides cerroazulensis* (Cole), *Globorotalia aragonensis* Nuttall, *Glomospira charoides* Parker and Jones, *Hantkenina mexicana* Cushman, *H. longispina* Cushman, *Hastigerinella eocaenica* Nuttall and *"Pulvinulinella" culter* Parker and Jones. These fossiliferous shales also occur at Cerro Nanchital, and in the vicinity of Río Chiquito. The Oligocene includes, a) the Nanchital conglomerates and shales in the vicinity of Cerro Nanchital and other localities, reaching almost 1000 m. in thickness, with *Asterocyclina bontourana* (Hodson), *Lepidocyclina (Polylepidina) adkinsi* Vaughan, and broken individuals of *Hantkenina* sp.; and b) the Depósito beds, some 1500 m. in thickness, at Cascajal, Tigres, La Laja, and vicinity, with *Ammodiscus incertus* (Orbigny), *Anomalina* aff. *A. grosserugosa* (Gümbel), *Bulimina elegans* Orbigny, *Cibicides aknerianus* (Orbigny), *C. pseudoungerianus* (Cushman), *Cyclammina cancellata* Brady, *C. pauciloculata* Cushman, *Ellipsonodosaria subnodosa* (Guppy), *Haplophragmoides coronatus* (Brady), *H. subglobosus* (Sars), *Gaudryina bradyi* Cushman, *Nodogenerina abyssorum* (Brady), *N. schlichti* (Reuss), *Pleurostomella alternans* Schwager, *P. brevis* Schwager and *Rotalia broeckiana* Karrer. The lower Miocene includes, a) the Ixhuatlán beds, at Ixhautlán and nearby localities, with *Bolivina floridana* Cushman, *Cibicides floridanus* (Cushman), *Ceratobulimina contraria* (Reuss), *Nodogenerina knihnitziana* (Karrer), *Uvigerina auberiana* Orbigny and *U. canariensis* Orbigny; b) the Concepción beds, at Concepción, with *Cibicides filisolaensis* Nuttall, *Bolivina subaenariensis* Cushman, *Epistomina elegans* Orbigny, *Gyroidina soldanii* Orbigny, *Marginulina pecketi* Schrodt, *M. elegans* var. *spinosa* Schrodt, *Nodosaria hispida* Orbigny, *Siphogenerina transversa* Cushman and *Textularia mississippiensis* Cushman; and c) the Filisola beds, at Filisola, with *Amphistegina* sp. aff. *A. lessoni* Orbigny, *Cibicides americanus* (Cushman), *Robulus vaughani* Cushman and *R. rotulatus* (Lamarck).

In total, the lower Miocene series reaches a thickness of some 1000 m. The middle Miocene includes, a) the Palmitota beds, at Palmitota, Paraje Solo, Santa Rosa, Tonalá, Punta Gorda, Gavilán and Moloacán, with a thickness of 400 m., and with *Elphidium poeyanum* (Orbigny), *Rotalia beccarii* (Linnaeus) and *Textularia mayori* Cushman; b) the Agueguexquite beds, at Agueguexquite, Santa Rosa and Gavilán, with a thickness of 500 m., and with *Amphistegina floridana* Cushman, *Cibicides concentricus* (Cushman), *C. floridanus* (Cushman), *Robulus americanus* Cushman, *R. americanus* var. *spinosus* Cushman, *R. vaughani* Cushman, *Cuneolina angusta* Cushman, *Elphidium poeyanum* (Orbigny), *Plectofrondicularia mansfieldi* Cushman and Ponton, *Pyrgo denticulata* (Brady), *Reussella spinosa* (Reuss), *Textularia mayori* Cushman, *Textulariella barrettii* Parker and Jones and *T. pseudotrochus* (Cushman); and c) the Punta Gorda beds, at Punta Gorda, south of Coatzacoalcos, Veracruz, with 50-70 m. of sandy marls, with *Elphidium sagra* (Orbigny), *Globulina inaequalis* Reuss, *Rotalia beccarii* (Linnaeus) and *Triloculina oblonga* Orbigny.

Fusulinids of Chiapas were again dealt with by Thompson and Miller (1944, pp. 481-504, 3 figs., pls. 79-84), who described twelve forms indicating a thick sequence of Permian deposits: *Schubertella mullerriedi* Thompson and Miller, *Nankinella?* sp., *Staffella centralis* Thompson and Miller, *Schwagerina chiapasensis* Thompson and Miller, *S. gruperaensis* Thompson and Miller, *S. figueroai* Thompson and Miller, *Schwagerina* sp. A Thompson and Miller, *Schwagerina* sp. B Thompson and Miller, *Schwagerina* sp. C Thompson and Miller, *Paraschwagerina roveloi* Thompson and Miller, *Parafusulina australis* Thompson and Miller, and *Eoverbeekina americana* Thompson and Miller, all from Chicomuselo, Chiapas.

Calcareous algae occurring in northern and central Chiapas, in lower Tertiary levels, were discussed by Maldonado-Koerdell (1951, pp. 217-224, 1 pl.), and one new form was described as *Solenopora chiapasensis* Maldonado-Koerdell, from the lower Eocene (or Paleocene), at Km. 12.5 of the road between Tuxtla-Gutiérrez and Suchiapa, in central Chiapas. Other calcareous algae occur here in brecciated limestone. In this paper, a preliminary attempt is made to review all known forms of calcareous algae in Mexico, among them *Lithothamnium* sp., *Amphiroa* sp., and others, occurring in the northern region of Chiapas in Oligocene-Miocene levels.

STRATIGRAPHY

A second attempt (the first one, as mentioned before, was made by Boese in 1905) to establish a well-founded stratigraphy by field and laboratory studies of Chiapas materials was made by Müllerried (1936, pp. 31-47). Using fusulinids and cephalopods of Upper Paleozoic age, found in limestones at Chicomuselo, as well as other fossils in younger levels, he established a geologic column for the pre-Tertiary formations, especially Upper Pennsylvanian and Permian rocks (with fusulinids), and Jurassic and Cretaceous formations. The Permian fauna of Chiapas was described by Müllerried, Miller and Furnish (1941, pp. 397-406, 1 pl.)

Later on, a detailed study of Chiapas fusulinids by Thompson and Miller (1943, 481-504, 3 figs., pls. 79-84), confirmed Müllerried's views, since the Paleozoic strata of southern Chiapas include different sedimentary rocks of Permian age, which were divided into four units, or formations. The lowermost (probably corresponding to the old Santa Rosa formation of 19th Century geologists) received no particular name; the second unit is the Grupera formation; the third the La Vainilla limestone, and the uppermost the Paseo Hondo formation. In total, these formations are more than 2000 m. in thickness, and may be placed between the Lower Permian and the Leonard, in the type section of Texas.

No Triassic or Lower Middle Jurassic rocks were then definitely known to exist in Chiapas or Tabasco, but in Upper Jurassic strata, the occurrence of radiolarians and small invertebrates was mentioned by Müllerried (1942, pp. 131-132). Only recently, Imlay (1952, pp. 969-970, column 67 in correlation table) reviewed the composition and sequence of Jurassic strata for Tabasco, Chiapas and eastern Veracruz, describing Lower, Middle and Upper Jurassic deposits, but gave no names to them.

Previously, two formations of Cretaceous age had been defined by Ver-Wiebe (1925, pp. 129-133) in Tabasco. The lowermost, or Tuxtla formation, includes the Neocomian and Lower Aptian, and consists mainly of argillaceous shales, sandy shales, and red shales, with thick beds of limestone and sandstone. The uppermost, or San Cristobal formation, is placed in the Upper Cretaceous, made up of shales, marly shales, limestone and dolomite. Between them, Imlay (1944a, pp. 1016-1017; 1944b, 1118-1120) placed the Cobán, or Sierra Madre, limestone, of Albian and Turonian age, with *Orbitolina texana* (Roemer), *miliolids*, and other fossils, which Müllerried had also mentioned in his preliminary report.

Another attempt to correlate Cretaceous outcrops in northern Chiapas and southern Tabasco with other sedimentary basins of eastern Mexico, was made by Salas (1949, pp. 47-65, 4 figs.) for the Macuspana region. In that paper, limestones of Middle Cretaceous age in Chiapas were called Sierra Madre, but in Tabasco differentiated into two units, the Guayal limestone, of Aptian and Albian age, and the Pasomono limestone, of Turonian age. No Coniacian deposits were found during field work, and the Méndez shales, of Upper Senonian-Maestrichtian age, were only known in the subsurface in Tabasco, but not in Chiapas. In the Macuspana region, the Paso Mono limestone is rich in miliolids, which disappear downwards.

A more detailed geologic column for the same region was given by Salas and López-Ramos (1951, pp. 3-56, 3 pls., 2 tables), for Cretaceous and Cenozoic beds. The Albian-Cenomanian limestone was again called the Guayal limestone, but no mention was made of the Paso Mono limestone nor of the Méndez shale (although the corresponding hiatus was fully discussed). The Tertiary formations include Lower Eocene strata, the Chicontepec-Velasco shales (so called by their similarity with the Tampico basin beds of identical age), with a thickness of almost 2000 m.; Middle and Upper Eocene strata, the Puente de Piedra conglomerate, the Chinal shale, the Chinal limestone, and the Chapopote-Tantoyuca shales (also recalling features of other basins), with variable thickness, and Oligocene strata, the Limón conglomerate, the Misopá shale, the Macuspana limestone, and the Encarnación shale, all developed in great thickness. The Miocene, represented by 3000 m. of shaly and sandy beds, very rich in microfossils, shows the following sequence: lower and upper Amate shales, lower Encajonado sandstone, upper Encajonado sandy shale, Zargazal sandstone, with gypsum and peat, and lower and upper Belem shales. The Pliocene-Quaternary include the Tres Puentes coaly shale and peat, and superficial shales of continental character. A very useful columnar table of correlation is appended.

The Tenosique area of Tabasco was discussed by Benavides (1949, pp. 5-26, 3 pls.), with reference to superficial stratigraphy. A thick column of Cenozoic strata is present here, including Eocene limestones and sandy limestones, Oligocene limestones, Miocene calcarous shales and argillaceous sandstones, and Pleistocene gravels.

The subsurface stratigraphy in Tabasco, as demonstrated by the oil-well Comalcalco No. 2, Municipality of Comalcalco, was discussed by Alvarez (1950, pp. 525-532, 1 table). The column includes only Miocene, Pliocene and Pleistocene formations, i.e. the upper Amate shale, the Encajonado sand and sandstone, the Zargazal shale and sandstone, the Belem shale, and Tres Puentes coaly shale, and superficial gravels and shales (called Tierra Colorada formation). The upper Amate, with almost 100 m. in thickness, yield *Lenticulina rotulata* (Lamarck), *Robulus vaughani* (Cushman), *Textularia* aff. *T. mexicana* Cushman, *Robulus clericii* (Fornasini), *Amphistegina lessonii* Orbigny, *Globorotalia menardii* (Orbigny) and *Siphogenerina transversa* Cushman. The Encajonado, more than 800 m. thick, contains *Amphistegina lessonii* Orbigny, *Robulus vaughani* (Cushman), *Lenticulina rotulata* (Lamarck), *Orbulina universa* Orbigny, *Globorotalia menardii* (Orbigny), *Globigerina* sp., *Bulimina inflata* (Seguenza) and *Siphogenerina transversa* Cushman. The Zargazal, more than 600 m., includes *Elphidium poeyanum* (Orbigny), *Quinqueloculina seminulum* (Linnaeus), *Q. lamarckiana* Orbigny, *Bolivina plicatella* Cushman, *Pyrgo* sp. aff. *P. bulloides* (Orbigny), *Reophax* sp., *Lenticulina rotulata* (Lamarck), *Pullenia* sp., *Uvigerina pygmaea* Orbigny, *Robulus vaughani* (Cushman), *Sphaeroidina bulloides* Orbigny and *Eponides umbonata* (Reuss). In the lower Belem beds with more than 500 m. of sediments *Quinqueloculina seminulum* (Linnaeus), *Elphidium* sp. aff. *E. fichtelianum* (Orbigny), *E. poeyanum* (Orbigny), *Rotalia beccarii* (Linnaeus), *Discorbis vilardeboana* (Orbigny), *Amphistegina lessonii* Orbigny, *Cibicides* sp. aff. *C. concentricus* (Cushman), *Orbulina universa* Orbigny, *Buliminella* sp., *Uvigerina pygmaea* Orbigny, *Nonion* sp., *Globigerina* sp. and *G. rubra* Orbigny are found. The upper Belem, with almost 500 m. in thickness, contains *Rotalia* sp. aff. *R. beccarii* (Linnaeus), *Elphidium sagrai* (Orbigny), *E. poeyanum* (Orbigny), *E. incertum* (Williamson), *Discorbis* sp. and a small *Amphistegina.*

All names for stratigraphic units used in southern Mexico really derive from nomenclature established by geologists of oil-companies, prior to the middle thirties, with few exceptions, as shown by Gibson (1936, pp. 276-284, 2 tables). Stratigraphic divisions were based on micropaleontological studies by W. F. L. Nuttall, G. L. Whipple and H. E. Thalmann, who worked with outcrop and well samples from the coastal plain of Tabasco and the Isthmian region. In the course of years slight variations in the nomenclature and arrangement of units were introduced, as knowledge of regional geology advanced. Since then the problems of correlation of beds between different sedimentary basins in the Gulf of Mexico coast, has received a new impetus.

Maldonado-Koerdell (1952), gives a summary of the fusulinid-bearing formations of Upper Carboniferous-Permian age in Mexico and shows the great similarity of these rocks from Sonora to Chiapas, which with minor differences in the Acatita-Delicias area, State of Coahuila, may be considered as isochronous. The Lower Permian levels, in Mexico, as a rule, can be accommodated between the Wolfcamp and the Leonard series of the type section of Texas, i.e. in the *Pseudoschwagerina-Parafusulina* zones.

There is need for a review and correlation of Triassic strata in Mexico. One is in preparation for the marine formations of the northwestern and central States. Triassic strata, with fossils plants, exist in Chiapas, and more will be said in the next section, in regard to their possibilities, but to this date very little information is useful for correlation purposes. The whole of the Jurassic also exists in Chiapas, and Imlay (1943, pp. 1495-1515, figs. 11-13; 1952, 970, column 67 in correlation table) has discussed the lithology of the formations and their fossils. Lower Jurassic rocks of southern Puebla, Oaxaca and Chiapas are identical, and correspond to an extended continental facies, which left a rich array of fossils plants. Middle Jurassic is represented by a mixed continental-marine facies, also common in southeastern Mexico, and Upper Jurassic is similar to equivalent beds in the northern part of the country, with near- and off-shore facies.

As has been already mentioned the Cretaceous system is made up of the Tuxtla formation, the Sierra Madre limestone, and the San Cristóbal formation. In some localities, the Sierra Madre limestone is substituted by the lower-most San Cristobal formation. These formations can be correlated with the Middle and Upper Cretaceous deposits of eastern and southern Mexico, based on numerous fossil faunas as shown by Imlay (1944a, pp. 1016-1017; 1944b, 1118-1120).

The Tertiary system presents still many problems because in spite of relatively abundant scientific contributions, there are many gaps to be filled.

FUTURE STUDIES OF MICROFOSSILS IN TABASCO AND CHIAPAS

An illuminating discussion of the limits, content and applications of Micropaleontology, was recently published by Thalmann (1948, pp. 372-375). Microfossils include all small organisms, whether plants or animals, that are investigated with the help of a binocular microscope in geologic deposits. Thus, the current limited concept of Micropaleontology, as the science of fossil foraminifera applied to the study of stratigraphy, must be replaced by a more logical and comprehensive idea, that of Micropaleontology as the science of all microfossils in their systematic, phylogenetic and paleoecological relationships. Both, the Plant and the Animal Kingdoms supply the raw materials for the true micropaleontologist, who should consider all aspects of their former existence, and derive from them useful indications in the reconstruction of the geologic history of sediments.

In this way, a review of micropaleontological studies and problems in any given region, should include the consideration of all microfossils that are known, or suspected to exist by inference from similar conditions, in their taxonomic and stratigraphic situation. This may sound ambitious, or impossible to fulfill, were it not for the fact that more would be lost by not attempting to discuss problems of regional Micropaleontology in the light of an integrated "totum," than by merely concentrating on isolated, or meaningless groups. Such is the attitude taken in the present case, with all risks met, and with the hope of giving a picture of an area where possibilities still outnumber accomplishments.

a) *Thallophyta.* Calcareous algae have been known from Chiapas since the XIX Century. The Rhodophyta are represented by forms of the Solenoporaceae, Corallinaceae and Melobesiaceae, which are abundant in limestones of Paleoeocene/Eocene, and Oligocene ages. In the former, *Solenopora chiapasensis* Maldonado-Koerdell, *Lithothamnium* sp., and *Amphiroa* sp. occur in the central part of Chiapas, while in the latter, representatives of the genera *Lithothamnium* (Philippi) Foslie, 1898, and related forms, seem to predominate. A revision of slides in the Paleontological Collection of Petróleos Mexicanos (samples collected by Salas and Benavides from northern Chiapas, and by Alvarez and Ayala from the central part of the State) has shown that a rich flora is present in southern Mexico. Chlorophyta also exists in limestones of northern Chiapas and southern Tabasco, since more or less well preserved individuals of *Dactylopora* sp. were seen in the slides. Three Dasycladaceae [*Triploporella fraasi* Steinmann, *T. fraasi* var. *minor* Steinmann, and *Neomeris (Herouvalina) cretacea* Steinmann] were described from entirely similar, and isochronous, limestones at Escamela, near Orizaba, Veracruz, by Steinmann (1899, pp. 189-204, figs. 24-49), with which Upper Senonian limestones of Chiapas share many fossil forms. No other Thallophyta have been recorded from Tabasco or Chiapas, although both States seem to represent a privileged area for the study of fossil calcareous algae.

b) *Charophyta.* A number of *Chara* "seeds" (oogonia of Charophyta) have been observed in shales of Eocene age, north and east of Ocozocuautla, Chiapas, by J. Alvarez and A. Ayala, of the Paleontological Laboratory. It is well known by Mexican micropaleontologists that Charophyta oogonia are frequently found in Oligocene sediments from oil-wells in northeastern Mexico. Unfortunately, no attempt has ever been made to study systematically or stratigraphically these interesting forms.

c) *Bryophyta.* The peats of Upper Tertiary age in the coastal plain of Tabasco could give valuable information for the knowledge of paleoecological conditions in the area. According to Salas and López-Ramos (1951, pp. 38-39), the Zargazal formation is characterized by abundant peat (which never reached the lignitic stage), with non-identifiable plant remains. These deposits undoubtedly correspond to old lagoons, with a rich near-shore vegetation, where Sphagnales and related forms existed, and gave origin to the peaty material. Palynological studies might bring to light many interesting results.

d) *Pteridophyta and Spermatophyta.* Müllerried (1936, p. 37) states that Middle Jurassic strata in central Chiapas contain a rich array of fossil plants, entirely similar to the famous deposits of the Mixteca Alta, in Oaxaca, described by Wieland (1913, pp. 251-281, 2 figs., tables I-III). Several hundred meters of sandy and marly strata, strongly colored red, brown and green, yield fern and cycad remains, representing probably a portion of the old Todos Santos formation of the XIX Century geologists. According to Müllerried (1942, pp. 129-131), these beds are to be placed in the Lower and Middle Jurassic, but according to Imlay (1952, p. 970, column 67 in correlation table) they even include the Callovian (lower Upper Jurassic). Just (1951, pp. 729-735), has shown that in addition to the ordinary megascopic identification, the study of these plant remains involves a detailed anatomical analysis of stems and leaves, as well as of spores and pollen, which have hardly been examined on a basis comparable to those of Paleozoic and Tertiary times.

Tertiary plant remains, mentioned by Salas and López-Ramos (1951, pp. 38-40) in the Encajonado and Zargazal formations (Miocene), and in the Tres Puentes formation (Pliocene), in Tabasco, may have some connection with the fossil flora of Miocene age, from the Isthmus of Tehuantepec, described by Berry (1923). In addition, the study of pollen recovered from those beds could enlarge the understanding of paleocological conditions in the coastal plain of Tabasco during Upper Tertiary times.

e) *Foraminifera.* Except for miliolids found in outcrop samples in northern Chiapas by Müllerried (1936, 1942), the rest of Mesozoic foraminifera are still unknown. At the suggestion of this writer, a group of micropaleontologists of Petróleos Mexicanos, guided by a field-geologist, collected samples in several localities of that State, during September and October of 1951. A number of sections was carefully searched, and a good amount of samples brought to the Paleontological Laboratory, for study by J. Alvarez and A. Ayala, who will report very soon on their findings. Jurassic, Cretaceous, and Lower Tertiary levels have been established on the basis of foraminifera, of which many new forms have appeared, and are being described and illustrated. In the last months of 1952, A. R. Loeblich, Jr., of the U. S. National Museum, also collected in central and eastern Chiapas, and his studies will add to the knowledge of microfossils in that State.

Microfaunas of Cretaceous limestones in Chiapas could be studied in the light of new ideas expounded by Bonet (1952, pp. 180-197, figs. 1A, B and C), who has recognized five biocoenosis in isochronous reef limestones at the Sierra del Abra, in the Tampico basin. Two of them are foraminiferal biocoenosis, a) association of *Nummoloculina,* and b) association of *Orbitolina* (the others are of rudistids). This first is made up almost exclusively of individuals of an undetermined species of that genus, forming the "miliolid" limestone, and ocassionally mixed with *Triloculina, Quinqueloculina, Gyroidina,* and *Orbitolina* cf. *O. texana* (Roemer), with useful paleoecological indications. The second is characterized by individuals of *Orbitolina* and *Dictyoconus,* although they are not always the most abundant, and not always uniformly distributed, but of importance for paleoecological interpretations. A third association, simply designated as "association of microforaminifera," was recognized in calcareous oozes of the inter-reefs. Other lithological features have been used by Bonet to classify reef limstones in eastern Mexico. This contribution is definitely the most serious attempt to introduce order in the anarchy of nomenclature applied to Cretaceous limestones in Mexico, and his proposals should be taken into consideration in the study of similar limestones in Chiapas.

Among the larger foraminifera, fusulinids are important for subdivision of the Upper Paleozoic formations in southern Chiapas. The old Santa Rosa formation probably includes Pennsylvanian strata. Mississippian limestones, with fusulinids, are known from Sonora and Tamaulipas, and there is no reason for their absence in Chiapas. Additional paleoecological indications could be derived from their finding and study in Chiapas. In regard to the larger foraminifera of the Tertiary, Limón-Gutiérrez (1951, pp. 617-630, 16 figs.) has discussed the *"Sorites"* beds of Upper Oligocene age in the Poza Rica area, mentioning *Miogypsina (Miogypsina) gunteri* Cole, *M. (Miolepidocyclina) mexicana* (Nuttall), *Sorites* sp., and associated fauna. The same beds also exist in the Macuspana region of Tabasco, and should be studied more intensively.

As for subsurface Micropaleontology, a group of workers is now checking the range of foraminifera, ostracoda and small mollusks in samples from the José Colomo wells in Tabasco.

f) *Ciliata.* During his studies of Upper Mesozoic limestones in eastern Mexico, Bonet has been able to use calpionellids in the differentiation of Jurassic and Cretaceous rocks. A report is being prepared, and a great advance may be expected in Chiapas from the application of such knowledge to the investigation of dense marine limestones of Upper Jurassic age.

g) *Radiolaria.* It should be recalled that Müllerried (1942, p. 131) mentioned the presence of radiolarians in limestones of Upper Jurassic age.

h) *Porifera.* Müllerried, Miller and Furnish (1941, p. 400) mentioned the occurrence of sponges (*Stromatidium* cf. *S. typicale* Girty) in deposits of Permian age in Chiapas, and Müllerried (1942, p. 131) again claimed that more sponge remains existed in Upper Jurassic strata in southern Mexico.

i) *Coelenterata.* Corals are abundant in geologic deposits in Chiapas, and references to forms studied by Sapper (1896), Aguilera (1896, 1907), Böse and other workers may be found in the papers of Müllerried (1936, 1942).

j) *Echinodermata.* Crinoid fragments have also been found in Upper Jurassic strata, according to Müllerried (1942, p, 131). Spines of echinoids are abundant in superficial and well samples from Chiapas and Tabasco.

k) *Bryozoa.* These forms have been reported from Upper Jurassic beds in Chiapas by Müllerried (1942, p. 131).

l) *Ostracoda.* Salas and López-Ramos (1951, p. 12) mentioned that ostracoda are present in the upper portion of the Guayal limestone, above the zone of miliolids, in the Macuspana region, and that they could probably be used to differentiate Albian from Cenomanian strata, as well as for correlation purposes. In the José Colomo wells, Mrs. C. Téllez-Girón, of the Paleontological Laboratory, has found several forms, of Miocene age, already known from Louisiana, Florida, Cuba, British Honduras and Guatemala, along with others which seem to be new.

m) *Mollusca.* The smaller forms are being checked in the José Colomo wells, in Tabasco, by Miss G. Alencáster-Ybarra, to establish their range in the geologic column.

n) *Annelidae.* Worms were mentioned by Müllerried, Miller and Furnish (1941, p. 400) in deposits of the Chicomuselo area, in Chiapas. This probably indicates that conodonts and scolecodonts, if present, might help in the solution of stratigraphic problems in the pre-Upper Paleozoic deposits.

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89. MIOCENE AND PLEISTOCENE FORAMINIFERA FROM ORANJESTAD, ARUBA (NETHERLANDS ANTILLES)

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ABSTRACT—One hundred and seventy-seven species, subspecies and varieties of Foraminifera from Miocene and Pleistocene sediments in a fresh water well near Oranjestad, Aruba, are listed, of which 5 species and 11 varieties are described as new.

INTRODUCTION

During 1942 a boring for fresh water was drilled within the limits of Oranjestad. After piercing the Holocene and Pleistocene reef limestones a thick series of alternating sands and clays was encountered so far unknown on the surface of the islands Aruba, Curacao, and Bonaire (Lit. 4, 5). For more detailed information regarding the geological and hydrological features of the drink-water boring near Oranjestad reference is made to the paper by J. H. Westermann (Lit. 6).

The bailer samples of the boring yielded, besides a few ostracods and indeterminable fragments of other invertebrates, a rather rich association of smaller Foraminifera. W. A. van den Bold (Lit. 2) described from the same material *Cytheromorpha minuta,* an ostracod species also known so far from the Cuban Miocene.

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STRATIGRAPHY

The lithological data in the stratigraphical Table 1 were taken over from Westermann's paper (Lit. 6). The upper part of the section drilled through can safely be assumed to be of Pleistocene age, although Westermann (personal communication) regards some of the reef limestones as possibly Holocene in age.

The Miocene age of the sands and clays underlying the Pleistocene reef limestones is based upon a comparison of the foraminiferal assemblages with hitherto described faunas from the tropical American or Caribbean region, especially with those from the Agua Salada group of formations described by H. H. Renz (Lit. 3), and from the Dominican Republic by P. J. Bermudez (Lit. 1). This comparison makes it probable to conclude that either the entire Miocene, or then at least a large part of it, is present in Aruba. Based on slight differences in faunal composition the Miocene of Oranjestad is subdivided into an upper and a lower zone. Since the basal sands in the well are without any Foraminifera no age could be established for the stratigraphic section below the depth of 830 feet.

PLEISTOCENE

The upper calcareous part (probably partly Holocene) contains a large number of usually badly preserved specimens of *Amphistegina* (partly determinable as *A. lessonii* Orbigny) and some immature specimens of *Globigerina* and *Globigerinoides,* while the middle marly member yielded a rather rich foraminiferal fauna.

In the lower calcareous gravel only few species were

TABLE 1

	Depth in Feet	Lithological Remarks	Faunal Remarks	Sample Numbers	
QUARTERNARY	0-20	Weathered debris of diorite		1	
QUARTERNARY	20-320	White limestones	Very few Foraminifera, *Amphistegina*	2-16	? 21
QUARTERNARY	320-330	Grey marl	Many Foraminifera, mainly *Planulina ariminensis*	17	
QUARTERNARY	330-390 Unconformity	Calcareous gravel	Few Foraminifera	18-20	
MIOCENE, Upper zone	390-430	Fine sand	Many Foraminifera, *Bolivina subaenariensis* var. *mexicana*	21-22	Miocene
MIOCENE, Upper zone	430-666	Marly clays		23-34	
MIOCENE	666	Pyritised micaceous sandstone	Wood remains	35	P. obliq.
MIOCENE, Lower zone	666-720	Fine sand	Many Foraminifera *Bolivina subaenariensis* var. *westermanni*	36-38	
MIOCENE, Lower zone	720-830	Marly clays		39-44	
	830-930	Fine sand	No Foraminifera or other fossils	45-49	

encountered, one of which, *Eponides parantillarum* Galloway and Heminway, was not found in the marl.

In the lower two parts of the Oranjestad Pleistocene, a total of 38 species and varieties was identified, of which the following 10 are restricted to this zone:

Ammodiscus incertus (Orbigny)
Textularia wiesneri Earland
Robulus orbicularis (Cushman) (non Orbigny)
Nodosaria intercellularis Brady
Reussella sp. cf. *R. glabrata* (Cushman)
Siphonina pulchra Cushman
Cancris sagra (Orbigny)
Cymbaloporetta squammosa (Orbigny)
Cassidulinoides bradyi (Norman)
Globigerinoides ruber (Cushman) (non Orbigny)

31 of the species (82% of the fauna) have been reported from recent seas.

The fauna offers little evidence for an exact age determination, because of scant knowledge about Pleistocene foraminiferal assemblages in the Caribbean-Gulf of Mexico region.

So far only 3 species have been recorded from strata older than Pleistocene, namely:

Reussella sp. cf. *R. glabrata* (Cushman)
Eponides parantillarum Galloway and Heminway
Virgulina pontoni Cushman

The Pleistocene fauna of Oranjestad is characterized by the relative abundance of *Planulina ariminensis* Orbigny (over 25% of all individuals). Most of its specimens show irregular growth of the later chambers. Another feature is the occurrence of:

Cibicides mckannai Galloway and Wissler var. *westermanni* n. var.
Cibicides mckannai Galloway and Wissler var. *arubana* n. var.
Cibicides mckannai Galloway and Wissler var. *oranjestadensis* n. var.

These varieties also occur in the lower zone of the Miocene of Oranjestad.

The occurrence of several irregularly growing species of the Family *Anomalinidae* is probably due to special ecological conditions.

MIOCENE

A total of 172 species and varieties were determined from the Oranjested Miocene, of which 96 (56%) have been recorded from recent seas.

The Oranjestad fauna shows particularly close affinities with those from the Oligocene-Miocene of the Agua Salada group of Venezuela, but relations are also indicated with Middle Tertiary faunas of the Antilles and Florida.

The most reliable age determination of a certain fauna of smaller Foraminifera is obtained by the use of the stratigraphical ranges of all species, as established from the previously known occurrences elsewhere, and evaluating at the same time the importance of each of them. Forms with limited geographical distribution are as a rule most important, since they often prove to be of restricted stratigraphical occurrence. It should, however, be kept in mind that if faunas are poor in species, the age determination might still be uncertain.

In order to arrive at the conclusion as to a Miocene age of the sand and clay section in the Oranjestad well, several methods were tried out, namely, 1) age determination based on the comparison of percentages of recent species in the faunal assemblages (which was found to be unreliable on account of insufficient knowledge of recent faunas, different personal opinions as to correct specific identification, and the interplay of ecological factors, facies etc.); 2) age determination of a fauna by means of the number of species in common with other comparable faunas, expressed in percentages of the latter (proportional species correlation), which again showed to a large extent the facies-susceptibility of the Foraminifera; and 3) age determination based on the known stratigraphical ranges of the species. This last method has, so far, given the most reliable results. Of all the more than 170 species and varieties listed below from the Oranjestad fauna, apparently only three, namely:

Ammodiscus dominicensis Bermudez var. *deformis* Bermudez
Bermudezina halconi (Hedberg)
and *Frondicularia* sp cf. *F. alazanensis* Nuttall

are up to now unknown in deposits younger than Oligocene. On the other hand, the following 5 species have been so far only been reported from sediments younger than Miocene:

Siphonodosaria antillea (Cushman)
Nonionella opima Cushman
Elphidium simplex Cushman
Bolivina subaenariensis Cushman
and *Cibicides mckannai* Galloway and Wissler

Some other species, occurring in the Oranjestad material so far are apparently restricted to the Caribbean Miocene: *Marginulina basispinosa* Cushman and Renz, *Bolivina pozonensis* Cushman and Renz, *Cibicides isidroensis* Cushman and Renz (all Lower Miocene, Venezuela, species); *Ehrenbergina spinea* Cushman var. *amina Bermudez* (Middle Miocene, Santo Domingo); *Planulina ariminensis* Orbigny var. *crassa* Galloway and Heminway (Lower and Middle Miocene, Porto Rico and Dominican Republic).

Furthermore, there are three species present in our material, which are well-known zone or index fossils in H. H. Renz' biostratigraphic subdivision of the Agua Salada Group, Falcon region, Venezuela:

Marginulina basispinosa Cushman and Renz
Lenticulina senni (Cushman and Renz)
and *Vaginulina superba* (Cushman and Renz)

After comparing and tabulating all known younger Tertiary foraminiferal assemblages, so far published from the Central American-Caribbean province, the conclusion is reached that the sands and clays in the Oranjestad boring most probably belong to Lower and Middle Miocene. As to the presence of Upper Miocene in the boring no conclusions are drawn on account of the rather poor present knowledge of foraminiferal assemblages of this age in the Caribbean region.

ECOLOGY

Although most of the samples from the Oranjestad Miocene contain a fairly large number of species, most of them occur in small quantities. Only about 15 percent of the total fauna can be classified as either common, abundant or very abundant in one or more samples. The ecological picture is somewhat marred by the unkown extent of possible contamination, since the bailer samples cover stratigraphic trajects of up to 20 feet. The assemblages observed, therefore, indicate widely diverging bathymetric environments, and it is not impossible that at least some of the Foraminifera might have lived elsewhere and had been transported by wave actions and sea currents from different habitats. Ever present *Amphistegina* specimens throughout the whole section drilled indicate near-ness of coral reefs during Miocene time. The dominant families in the whole assemblages are the Buliminidae, Lagenidae, Anomalinidae, Rotaliidae, Nonionidae and Cassidulinidae, both what regards number of species and quantity of specimens. Pelagic forms are well represented in most samples.

In general, it can be concluded that the Oranjestad Miocene is made up of sediments which had been deposited in an open sea, at moderate depth varying between 100 and 1000 meters, in a region of tropical to subtropical temperatures.

SYSTEMATIC DESCRIPTION

Of the following 177 species, subspecies and varieties encountered in the Oranjestad boring some are described in detail. For each form mentioned the vertical distribution in the section is given by means of the sample-number in which it was found (see also Distribution Chart). The quantitative results were gained by counting the number of specimens of each species on a surface (tray) of 12 square centimeters and by spreading about one quarter of this surface with particles of the wash-residue. The frequency of the species in a single counting for each sample is expressed, as follows:

Rare (R) : 1-3 specimens
Few (F) : 4-6 specimens
Common (C) : 7-20 specimens
Abundant (A) : 21-60 specimens
Very abundant (V) : 61 and more specimens.

DEPOSITORY

All slides and preparations of the species cited below are deposited in the collections of the Mineralogical-Geological Institute of the State University of Utrecht, Holland, under Collection numbers D-33039 to D-33288 inclusive.

FAUNAL LIST AND SYSTEMATIC DESCRIPTIONS

Family AMMODISCIDAE

Genus **Ammodiscus** Reuss, 1861

Ammodiscus dominicensis Bermudez var. **deformis** Bermudez

Plate 19, figure 1

Ammodiscus dominicensis BERMUDEZ var. *deformis* BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 48, pl. 1, figs. 51, 52.

Occurrence.—40-44 (see Distribution Chart No. 89), restricted to the lower zone of the Oranjestad Miocene.

Coll. No.—D-33039

Ammodiscus incertus (Orbigny)

Operculina incerta ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 49, pl. 6, figs 16, 17.

Ammodiscus incertus CUSHMAN, 1918, U. S. Nat. Mus., Bull. 104, pt. 1, p. 95, pl. 39.

Occurrence.—17 (R), 19 (R), restricted to the Oranjestad Pleistocene.

Coll. No.—D-33040

Family TEXTULARIIDAE

Genus **Textularia** Defrance, 1824

Textularia alazanensis Nuttall

Plate 19, figures 2a, b

Textularia mississippiensis CUSHMAN var. *alazanensis* NUTTALL, 1932, Journ. of Pal., vol. 6, p. 5, pl. 1, fig. 5; CUSHMAN, 1929, Contrib. Cushman Lab. Foram. Res., vol. 5, p. 79, pl. 12, fig. 5; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 170, pl. 12, fig. 1.

Occurrence.—36-43 (see Distribution Chart No. 76), restricted to the lower zone of the Oranjestad Miocene.

Coll. No.—D-33041, D-33042

Textularia alazanensis Nuttall var. **arubana** Drooger n. var.

Plate 19, figures 3a-5

Description.—Variety differing from the typical in having the lateral edges of most of the chambers broken off, especially in the later portion of the test.

Remarks.—Similar characters in the peripheral part of the chambers are also shown in some other species, as in the recent *T. sagittula* Defrance var. *fistulosa* Brady (1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 362, pl. 42, fig. 19-22) and in *Vulvulina dominicana* Bermudez (1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 55, pl. 1, figs. 54-57) from the Middle Miocene of the Dominican Republic. The specimens in the Oranjestad column are distinctly related to the accompanying *T. alazanensis.* Possibly these forms should be regarded as aberrant individuals, appearing in some species under special, but unknown, environmental conditions. In our material this variety was encountered in but two samples within the range of *T. alazanensis.* These samples also contain peculiarly-shaped varieties in some other species (see for instance *Cibicides pseudoungerianus* and *C. mckannai*).

Occurrence.—42 (R), 43 (R)

Holotype from the Miocene, sample 43 (790 feet below the surface-level) of the Oranjestad boring, Aruba.

Coll No.—D-33043, 33044

Textularia bermudezi Cushman and Todd

Plate 19, figures 6a-7

Textularia bermudezi CUSHMAN and TODD, 1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 3, pl. 1, fig. 7; BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 58, pl. 2, figs. 51-56.

Remarks.—The Oranjestad specimens show definitely raised ridges along the upper borders of the chambers, which characteristic gives a truncate appearance to the periphery. They are strongly variable in size as well as in the relative length of the test.

Occurrence.—24-34 (see Distribution Chart No. 37), restricted to the upper zone of the Oranjestad Miocene.

Coll. No.—D-33045

Textularia conica Orbigny

Textularia conica ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 143, pl. 1, figs. 19, 20; CUSHMAN, 1922, U. S. Nat. Mus., Bull. 104, pt. 3, p. 22, pl. 5, figs. 5-7.

Remarks.—The specimens from Aruba, considered to belong to this species, show a rather wide variation. Most of them closely resemble those, pictured in the references, cited above, but others grade into *T. lateralis Lalicker* (1935, Smiths. Misc. Coll., vol. 91, no. 22, p. 2, pl. 1, figs. 3-5).

Occurrence.—17-43 (see Distribution Chart No. 91).

Coll. No.—D-33046, 33047

Textularia gramen Orbigny

Textularia gramen ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 248, pl. 15, figs. 9, 10.

Occurrence.—21 (R), 23 (R)

Coll. No.—D-33048

Textularia wiesneri Earland

Plate 19, figure 8

Textularia wiesneri EARLAND, 1933, Discovery Reports, vol. 7, p. 95, pl. 3, figs. 18-20.

Remarks.—Some of the Oranjestad specimens are distinctly twisted by having the plane of the last-formed chambers about perpendicular to that of the early chambers.

Occurrence.—17 (R), restricted to the Pleistocene marl of Oranjestad.

Coll. No.—D-33049, 33050

Family VERNEUILINIDAE

Genus **Gaudryina** Orbigny, 1839

Gaudryina (Pseudogaudryina) atlantica (Bailey)

Textularia atlantica BAILEY, 1851, Contrib. Smiths. Inst., Wash., vol. 2, p. 12, figs. 34-43.

Gaudryina atlantica CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 7, p. 95, pl. 14, figs. 4, 5.

Remarks.—Some of our specimens show a development of heavier keels than is shown by the typical ones resembling *G. bullbrooki* Cushman (1936, Cushman Lab. Foram. Res., Spec. Publ. 6, p. 16, pl. 2, fig. 16). The latter is probably merely a varietal form of *G. atlantica.*

Occurrence.—31 (R), 38 (R)

Coll. No.—D-33051

Genus **Bermudezina** Cushman, 1937

Bermudezina halconi (Hedberg)

Plate 19, figures 9a, b

Heterostomella (?) *halconi* HEDBERG, 1937, Journ. of Pal., vol. 11, p. 667, pl. 90, fig. 9.

Remarks.—Only two specimens have been found, the larger one (pl. 19, fig. 9) resembling Hedberg's type fairly well, only having somewhat higher chambers in the biserial part of the test. The smaller one is very close to the specimen of *B. pariana* (Guppy), as figured by Palmer from the Upper Oligocene of Cuba (1940, Mem. Soc. Cub. Hist. Nat., vol. 14, p. 119, pl. 17, fig. 10). Possible relations between both species cannot be concluded from our insufficient material.

Occurrence.—23 (R)

Coll. No.—D-33052

Genus **Pseudoclavulina** Cushman, 1936

Pseudoclavulina mexicana (Cushman)

Clavulina humilis BRADY var. *mexicana* CUSHMAN, 1922, U. S. Nat. Mus., Bull. 104, pt. 3, p. 83, pl. 16, figs. 1-3.

Pseudoclavulina mexicana CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 7, p. 117, pl. 16, figs. 5-11; CORYELL and RIVERO, 1940, Journ. of Pal., vol. 14, p. 325, pl. 43, fig. 4.

(?) *Clavulina carinata* CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 8, pl. 1, fig. 18.

Remarks.—The Oranjestad specimens are usually more smoothly finished than the recent types. They show a considerable amount of variation in the number of uniserial chambers. Several specimens have a definite ring around the aperture; smaller ones among them are identical with the specimen, pictured as *Clavulina carinata* by Cushman and Renz from Venezuela. In the Aruba samples the latter specimens can be considered as juvenile forms of *P. mexicana.* Other specimens with only few uniserial chambers, but lacking the terminal ring, resemble the figure given by Coryell and Rivero of an obviously young individual of *P. mexicana* from Haiti.

Occurrence.—24-44 (see Distribution Chart No. 38).

Coll. No.—D-33053

Family VALVULINIDAE

Genus **Martinottiella** Cushman, 1933

Martinottiella nodulosa (Cushman)

Clavulina communis ORBIGNY var. *nodulosa* CUSHMAN, 1922, U. S. Nat. Mus., Bull. 104, pt. 3, p. 85, pl. 18, figs. 1-3.

Listerella nodulosa CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 8, p. 150, pl. 17, figs. 13-19.

Remarks.—Our specimens usually show a somewhat longer multiserial-biserial stage than the typical ones.

Occurrence.—22-44 (see Distribution Chart No. 20).

Coll. No.—D-33054

Family MILIOLIDAE

Genus **Quinqueloculina** Orbigny, 1826

Quinqueloculina laevigata Cushman (non Orbigny)

Quinqueloculina laevigata, CUSHMAN (non Orbigny), 1929, U. S. Nat. Mus., Bull. 104, pt. 6, p. 30, pl. 4, fig. 3.

Remarks.—Very few specimens, smooth to finely striate, resembling fairly well Cushman's figures. They are probably different from d'Orbigny's species.

Occurrence.—17-37 (see Distribution Chart No. 77).

Coll. No.—D-33055

Quinqueloculina lamarckiana Orbigny

Quinqueloculina lamarckiana ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 189, pl. 11, figs. 14,15; CUSHMAN, 1929, U. S. Nat. Mus., Bull. 104, pt. 6, p. 26, pl. 2, fig. 6.

Occurrence.—24-44 (see Distribution Chart No. 39).

Coll. No.—D-33056

Quinqueloculina seminulum (Linné)

Serpula seminulum LINNÉ, 1767, Syst. Nat., ed. 12, p. 1264.

Quinqueloculina seminulum CUSHMAN, 1930, Flor. State Geol. Survey, Bull. 4, p. 19, pl. 2, figs. 1, 2.

Remarks.—Few specimens, closest to this species.

Occurrence.—23-42 (see Distribution Chart No. 23).

Coll. No.—D-33066

Quinqueloculina spp.

D'ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères.

D'ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne.

Remarks.—In the lower zone of the Oranjestad Miocene (samples 36-44) a number of single specimens were found, belonging to different species of *Quinqueloculina.* They resemble the following six species which have all been reported from recent seas:

Q. akneriana Orbigny (1846, p. 290, pl. 18, figs. 16, 17),

Q. agglutinans Orbigny (1839, p. 195, pl. 12, figs. 11-13),

Q. candeina Orbigny (1839, p. 170, pl. 12, figs.24-26),

Q. contorta Orbigny (1846, p. 298, pl. 20, figs. 4-6),

Q. poeyana Orbigny (1839, p. 191, pl. 11, figs. 25-27),

Q. polygona Orbigny (1839, p. 198, pl. 12, figs. 21-23).

Coll. No.—D-33057-33062

Genus **Sigmoilina** Schlumberger, 1887

Sigmoilina schlumbergeri Silvestri

Plate 19, figure 10

Planispirina celata BRADY (non Costa), 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 197, pl. 8, figs. 1-4.

Sigmoilina schlumbergeri SILVESTRI, 1904, Mem. Pont. Nuovi Lincei, vol. 22, p. 267; CUSHMAN, 1929, U. S. Nat. Mus., Bull. 104, pt. 6, p. 49, pl. 11, figs. 1-3.

Occurrence.—21-44 (see Distribution Chart No. 1).

Coll. No.—D-33063

Sigmoilina tenuis (Czjzek)

Quinqueloculina tenuis CZJZEK, 1848, Haid. Nat. Abh., Wien, vol. 2, pt. 1, p. 149, pl. 13, figs. 31-34.

Sigmoilina tenuis CUSHMAN, 1946, Contrib. Cushman Lab. Foram. Res., vol. 22, p. 32, pl. 35, figs. 13-15.

Occurrence.—42 (R), 43 (R). In addition, a single specimen, resembling *S. miocenica* Cushman (1946, Contrib. Cushman Lab. Foram. Res., vol. 22, p. 33, pl. 35, figs. 13-15) was found in sample 37.

Coll. No.—D-33064, 33065

Genus **Triloculina** Orbigny, 1826

Triloculina trigonula (Lamarck)

Miliolites trigonula LAMARCK, 1804, Ann. Mus. Nat. Hist. Nat., tome 5, p. 351, tome 9 (1807), pl. 17, fig. 4.

Triloculina trigonula CUSHMAN, 1929, U. S. Nat. Mus., Bull. 104, pt. 6, p. 56, pl. 12, figs. 10, 11, pl. 13, figs. 1, 2.

Occurrence.—17 (R), 39 (R)

Coll. No.—D-33289

Genus **Pyrgo** Defrance, 1824

Pyrgo depressa (Orbigny)

(Plate 19, figures 11a, b

Biloculina depressa ORBIGNY, 1826, Ann. Sci. Nat., Sér. 1, tome 7, p. 298, mod. 91.

Pyrgo depressa CUSHMAN, 1929, U. S. Nat. Mus., Bull. 104, pt. 6, p. 71, pl. 19, figs. 4, 5.

Remarks.—Most specimens from Oranjestad show a broad aboral tail, but individuals without this characteristic are equally present.

Occurrence.—34-43 (see Distribution Chart No. 68).

Coll. No.—D-33067, 33068

Pyrgo subsphaerica (Orbigny)

Biloculina subsphaerica ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 162, pl. 8, figs. 25-27.

Pyrgo subsphaerica CUSHMAN, 1929, U. S. Nat. Mus., Bull. 104, pt. 6, p. 68, pl. 18, figs. 1, 2.

Occurrence.—17-37 (see Distribution Chart No. 69).

Coll. No.—D-33069

Family LAGENIDAE

Genus **Robulus Montfort,** 1808

Robulus americanus (Cushman)

Cristellaria americana CUSHMAN, 1918, U. S. Geol. Survey, Bull. 676, p. 50, pl. 10, figs. 5, 6.

Robulus americanus RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 157, pl. 12, fig. 3.

Remarks.—Most specimens, considered to belong to this species, are immature individuals, and, therefore, referred only tentatively to this form. Among the larger specimens some resemble Cushman's figures fairly well, whereas others are identical with the specimens pictured by Renz. The variety *R. americanus* (Cushman) var. *grandis* (Cushman) (1920, U. S. Geol. Survey, Prof. Paper 128-B, p. 68, pl. 11, fig. 2) is also present in the Oranjestad samples. A few specimens closely resemble *R. melvilli* Cushman and Renz (1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 12, pl. 2, fig. 12), but it is impossible to separate them specifically from *R. americanus* in our material.

Occurrence.—28-44 (see Distribution Chart No. 56).

Coll. No.—D-33070.

Robulus calcar (Linné)

Nautilus calcar LINNÉ, 1767, Syst. Nat. 12th ed., p. 1162, no. 272.

Robulus calcar RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 158, pl. 3, fig. 6.

Occurrence.—24-44 (see Distribution Chart No. 40).

Coll. No.—D-33071

Robulus clericii (Fornasini)

Cristellaria clericii FORNASINI, 1901, R. Accad. Sci. Ist., Mem. Sci. Nat., Bologna, ser. 5, tomo 9, p. 65, text-fig. 17.

Robulus clericii RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 158, pl. 3, fig. 8.

Occurrence.—32 (R), 34 (R)

Coll. No.—D-33072

Robulus iota (Cushman)

Cristellaria iota CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 111, pl. 29, fig. 2, pl. 30, fig. 1.

Occurrence.—29-44 (see Distribution Chart No. 57).
Coll. No.—D-33073

Robulus orbicularis (Cushman) (non Orbigny)
Plate 19, figure 12

Cristellaria orbicularis CUSHMAN (non Orbigny), 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 101, pl. 21, fig. 7.

Remarks.—The specimens from the Pleistocene of Oranjestad show little variation. They are identical with the one pictured by Cushman. They are probably different from d'Orbigny's species.

Occurrence.—17 (R), restricted to the Pleistocene marl.
Coll. No.—D-33074

Robulus spp. Cushman and Todd

CUSHMAN and TODD, 1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 16, 17, pl. 2, figs. 13-17.

Remarks.—Throughout the Miocene part of the Oranjestad column a rather large number of specimens were found, possibly belonging to more than one species of *Robulus*. Among them several types can be recognized, which are strikingly identical with a number of specimens, figured by Cushman and Todd from the Miocene of Buff Bay, Jamaica under the following names:

R. falcifer (p. 16, pl. 2, fig. 13),
R. cf. *cultratus* (p. 16, pl. 2, fig. 14),
R. occidentalis var. *glabratus* (p. 16, pl. 2, fig. 15),
R. sp. *A* (p. 17, pl. 2, fig. 16),
R. sp. *B* (p. 17, pl. 2, fig. 17).

These types are distinctly different, but in our material many other specimens represent intermediate forms. Specific determination is impossible.

Since species as well as individuals of the genus *Robulus* are often highly variable both in space and time, such a similarity in the faunas of Buff Bay and Oranjestad strongly suggests a close relationship.

Occurrence.—21-44 (see Distribution Chart No. 2).
Coll. No.—D-33075

Robulus suteri Cushman and Renz
Plate 19, figure 13

Robulus suteri CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 10, pl. 2, figs. 5-8; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 161, pl. 3, fig. 18, pl. 4, figs. 1, 2.

Occurrence.—27-30 (see Distribution Chart No. 54), present in fairly high numbers of a short range in the upper zone of the Oranjestad Miocene.
Coll. No.—D-33076

Genus **Lenticulina** Lamarck, 1804
Lenticulina senni (Cushman and Renz)
Plate 19, figures 17-19

Robulus senni CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 12, pl. 2, fig. 14, 15; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 160, pl. 3, figs. 15, 16.

Lenticulina senni BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 134, pl. 8, figs. 31, 32.

Occurrence.—42 (R)
Coll. No.—D-33077

Lenticulina subaculeata (Cushman)
var. **glabrata** (Cushman)
Plate 19, figures 20-23

Cristellaria subaculeata Cushman var. *glabrata* CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 124, pl. 32, fig. 4, pl. 33, figs. 2, 3, pl. 34, fig. 3.

Robulus subaculeatus Cushman var. *glabratus* RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 160, pl. 3, figs. 20, 21.

Remarks.—In most samples of the Oranjestad Miocene specimens were found which can be regarded as immature *Cristellaria*-forms. They show a few loosely coiled, rapidly expanding chambers, with a differently developed external keel. Various forms of ornamentation exist, consisting of all intermediates between an unornamented wall with smooth raised sutures and forms which sometimes show the wall covered with knobs and short costae. The external keel shows transitions between a narrow irregular flange and an ornamentation of two and sometimes more spines. Some of these juvenile forms have been figured (pl. 19, figs. 20-23). Full-grown individuals are very scarce but can without difficulty be referred to different species and even genera. To *L. subaculeata* var. *glabrata* can be referred some specimens with a more or less uncoiling later portion, which is distinctly curved and more or less rounded. Some specimens of similar form, but with slight or no ornamentation of wall and sutures strongly resemble *L. limbata* (Flint) (1897, Ann. U. S. Nat. Mus., pt. 1, p. 318, pl. 67, fig. 1). Few others resemble *L. senni* (Cushman and Renz), others again are identical with *Marginulina basispinosa* Cushman and Renz. Two specimens were found that are very close to *Vaginulina superba* (Cushman and Renz), being slightly less compressed and having somewhat more expanding later chambers than the typical. The early stages of the above mentioned species fall within the range of variation of our immature specimens, suggesting a close relation between these species, at least in the Oranjestad samples.

Probably during Oligocene-Miocene time several mutants and geographical races have developed in tropical America from a single stock. Though being closely related, they show different morphological later developments, which place them in many cases in different genera. Apart from those mentioned above from the Oranjestad Miocene, several other species can be considered as probably belonging to this *L. subaculeata* group. These closely allied forms may prove to be locally very good time stratigraphic markers.

Occurrence.—21-44 (see Distribution Chart No. 3). All immature specimens are included here.

Coll. No.—D-33078-33080.

Lenticulina peregrina (Schwager)

Plate 19, figure 16

Cristellaria peregrina SCHWAGER, 1866, Novarra Exped., Geol. Theil, vol. 2, pt. 2, p. 245, pl. 7, fig. 89.

Lenticulina peregrina CORYELL and RIVERO, 1940, Journ. of Pal., vol. 14, p. 328, pl. 43, figs. 13, 14.

Occurrence.—33-42 (see Distribution Chart No. 64).

Coll. No.—D-33081

Genus **Marginulina** Orbigny, 1826

Marginulina basispinosa Cushman and Renz

Plate 19, figures 24, 25

Marginulina basispinosa CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 13, pl. 2, figs. 16-18.

Marginulinopsis basispinosus RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 145, pl. 4, figs. 8-10.

Occurrence.—37-44 (see Distribution Chart No. 83), restricted to the lower zone of the Oranjestad Miocene.

Coll. No.—D-33082, 33083

Marginulina striatula Cushman

Plate 19, figure 26

Marginulina striatula CUSHMAN, 1913, U. S. Nat. Mus., Bull. 71, p. 79, pl. 23, fig. 4.

Marginulina cf. *striatula* RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 145, pl. 4, figs. 15, 16.

Occurrence.—42 (R)

Coll. No.—D-33084

Marginulina subbullata Renz (non Hantken)

Plate 24, figures 1a, b

Marginulina subbullata RENZ (non Hantken), 1948, Geol. Soc. of Amer., Mem. 32, p. 145, pl. 4, figs. 13, 14.

Remarks.—The type of Hantken's *M. subbullata* [1875 (1876), Mag. kir. földt. int. evkön., vol. 4, p. 39, pl. 4, figs. 9, 10, pl. 5, fig. 9] shows strongly inflated chambers, which characteristic is only slightly if at all present in the specimens of the Aruba Miocene and probably also in those of Venezuela.

Occurrence.—41 (R), 43 (R)

Coll. No.—D-33085

Genus **Dentalina** Orbigny, 1826

Dentalina sp. cf. **D. consobrina** Orbigny

Plate 19, figure 27

Dentalina consobrina ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 46, pl. 2, figs. 1-3.

Remarks.—Few broken specimens of doubtful specific determination. As far as could be ascertained, they are close to Brady's figure of *Nodosaria filiformis* (1884 Rep. Voy. Challenger, Zoology, vol. 9, p. 500, pl. 63, fig. 3).

Occurrence.—25 (R), 39 (R)

Coll. No.—D-33086

Dentalina flintii (Cushman)

Plate 19, figure 28

Nodosaria flintii CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 85, pl. 14, fig. 1.

Remarks.—*D. isidroensis* Cushman and Renz (1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 15, pl. 3, figs. 2, 3) from the Upper Oligocene and Lower Miocene of the State of Falcón, Venezuela, is probably very close to, if not identical with *D. flintii.* The exact relations between both species could not be ascertained from our insufficient and fragmentary material.

Occurrence.—37 (R), 39 (R)

Coll. No.—D-33087

Dentalina pauperata Orbigny

Dentalina pauperata ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 46, pl. 1, figs. 57, 58.

Occurrence.—43 (R), a single specimen.

Coll. No.—D-33088

Genus **Nodosaria** Lamarck, 1812

Nodosaria intercellularis Brady

Plate 19, figure 30

Nodosaria intercellularis BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 515, pl. 65, figs. 1-4; CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 89, pl. 14, figs. 2-4, pl. 17, fig. 3.

Remarks.—In part of our specimens the costae are oblique, especially on the early chambers.

Occurrence.—17 (R), restricted to the Pleistocene marl.

Coll. No.—D-33091

Nodosaria vertebralis (Batsch)

Nautilus (Orthoceras) vertebralis BATSCH, 1791, Conchylien des Seesands, pt. 3, no. 6, pl. 2, fig. 6.

Dentalina vertebralis CUSHMAN, 1931, Contrib. Cushman Lab. Foram. Res., vol. 7, p. 66, pl. 8, figs. 20, 21.

Nodosaria vertebralis RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 147, pl. 5, figs. 8-11.

Remarks.—The Oranjestad specimens can partly be assigned to *Nodosaria,* partly to *Dentalina.* Besides the typical form the variety *N. vertebralis* (Batsch) var. *albatrossi* Cushman (1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 87, pl. 15, fig. 1) was also observed.

Occurrence.—29-39 (see Distribution Chart No. 58).

Coll. No.—D-33094

Genus **Saracenaria** Defrance, 1824

Saracenaria arcuata (Orbigny) var. **ampla** Cushman and Todd

Plate 20, figure 1

Saracenaria arcuata (ORBIGNY) var. *ampla* CUSHMAN and TODD, 1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 31, pl. 5, figs. 5, 6.

Remarks.—Larger specimens from Oranjestad fairly well resemble fig. 6 of the paper on the Jamaican fauna. Few small individuals, possibly belonging to this species, strongly resemble *S.* sp. cf. *S. schencki,* as figured by Renz (1948, Geol. Soc. of Amer., Mem. 32, p. 163, pl. 5, fig. 20).

Occurrence.—36-41 (see Distribution Chart No. 78).

Coll. No.—D-33095, 33096

Genus **Vaginulina** Orbigny, 1826

Vaginulina advena Cushman

Plate 20, figure 2

Vaginulina advena CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 134, pl. 39, figs. 1-4; BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 155, pl. 9, fig. 39.

Occurrence.—36-43 (see Distribution Chart No. 79), restricted to the lower zone of the Oranjestad Miocene.

Coll. No.—D-33097

Vaginulina crepidula (Brady) (non Fichtel and Moll)

Plate 19, figures 14, 15

Cristellaria crepidula BRADY (non Fichtel and Moll), 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 542, pl. 67, figs. 19, 20; CUSHMAN (non Fichtel and Moll), 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 117, pl. 35, figs. 3, 4.

Remarks.—Nearly all Oranjestad specimens fairly well resemble those pictured by Brady (fig. 19) and Cushman (fig. 4) by showing a definite uncoiling of the later portion of the test. The generic position of our forms is somewhat doubtful, caused by the individual development. In the early stages they might be assigned to the genera *Lenticulina* and *Astacolus.*

Occurrence.—17-43 (see Distribution Chart No. 70), being most frequent in the Pleistocene marl.

Coll. No.—D-33098-33100

Vaginulina superba (Cushman and Renz)

Plate 20, figure 3

Marginulina superba CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 14, pl. 2, figs. 19, 20.

Vaginulinopsis superbus RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 177, pl. 4, figs. 17, 18.

Remarks.—Only two adult specimens were found, slightly differing from the typical in having a somewhat thicker test.

Occurrence.—24 (R), 29 (R)

Coll. No.—D-33101

Genus **Frondicularia** Defrance, 1826

Frondicularia sp. cf. **F. alazanensis** Nuttall

Plate 20, figure 4

Frondicularia alazanensis NUTTALL, 1932, Journ. of Pal., vol. 6, p. 17, pl. 3, fig. 15, pl. 4, fig. 1; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 134, pl. 5, fig. 26.

Occurrence.—33 (R), a single, slightly damaged specimen, not allowing correct determination.

Coll. No.—D-33102

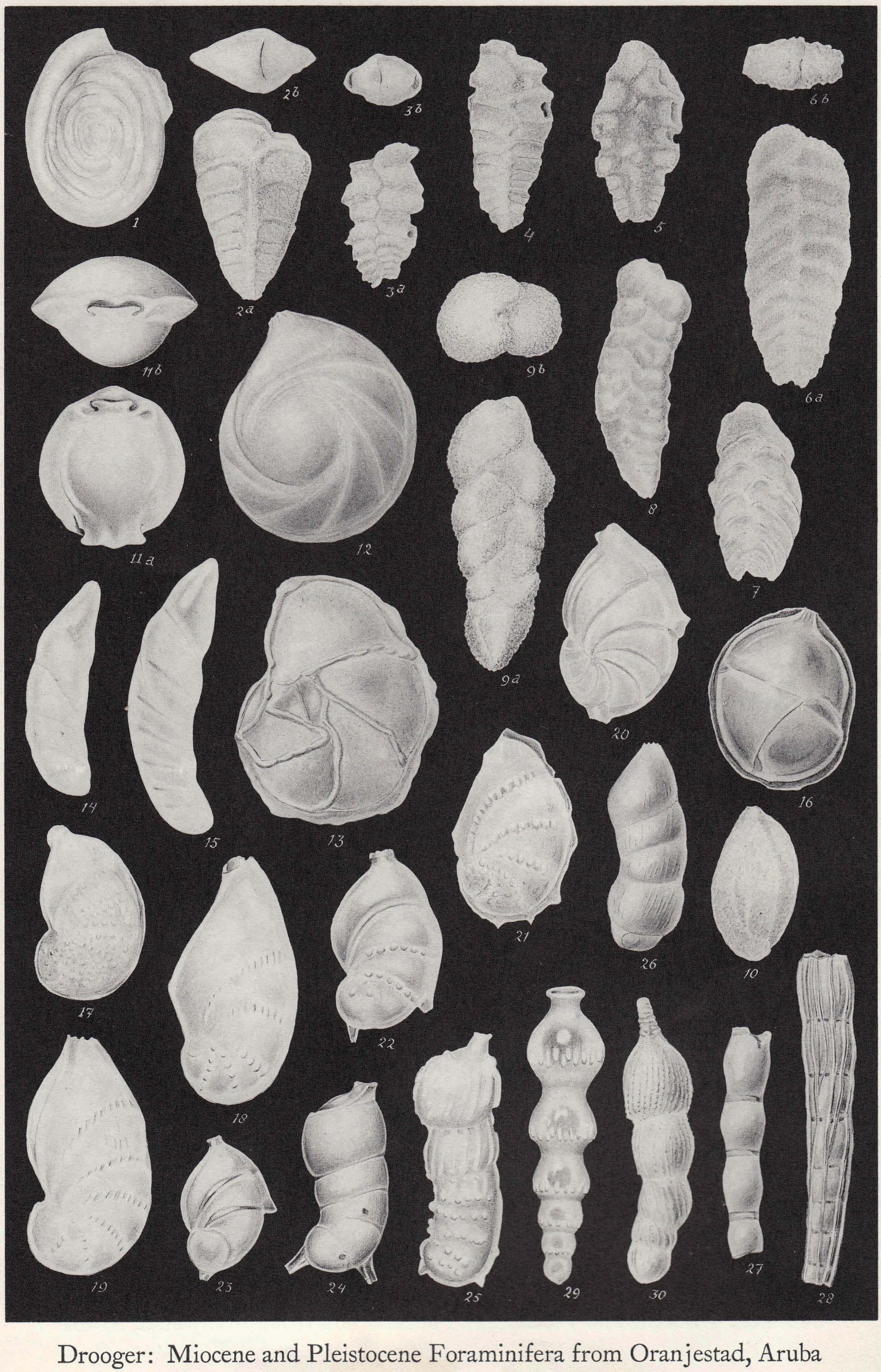
Frondicularia compta Brady

Plate 20, figures 5, 6

Frondicularia compta BRADY, 1884, Rep. Voy. Challen-

EXPLANATION OF PLATE 19

FIGS.		PAGE
1.	*Ammodiscus dominicensis* Bermudez var. *deformis* Bermudez. Miocene (41). × 95.	119
2a, b.	*Textularia alazanensis* Nuttall. 2a, side view; 2b, apertural view. Miocene (37). × 45.	119
3a-5.	*Textularia alazanensis* Nuttall var. *arubana* Drooger n. var. 3, Holotype; 4, 5, paratypes. 3a, side view; 3b, apertural view. Miocene (43). × 33.	119
6a-7.	*Textularia bermudezi* Cushman and Todd. 6a, 7, side views; 6b, apertural view. Miocene (34). × 45.	119
8.	*Textularia wiesneri* Earland. Pleistocene (17). × 95.	119
9a, b.	*Bermudezina halconi* (Hedberg). 9a, side view; 9b, apertural view. Miocene (23). × 45.	120
10.	*Sigmoilina schlumbergeri* Silvestri. Miocene (34). × 33.	121
11a, b.	*Pyrgo depressa* (Orbigny). 11a, front view; 11b, apertural view. Miocene (42). × 33.	121
12.	*Robulus orbicularis* (Cushman) (non Orbigny). Pleistocene (17). × 65.	122
13.	*Robulus suteri* Cushman and Renz. Miocene (27). × 33.	122
14, 15.	*Vaginulina crepidula* (Brady) (non Fichtel and Moll). Pleistocene (17). × 33.	124
16.	*Lenticulina peregrina* (Schwager). Miocene (33). × 65.	123
17-19.	*Lenticulina senni* (Cushman and Renz). Miocene (42). Fig. 17, × 45; figs. 18, 19, × 33.	122
20-23.	*Lenticulina subaculeata* (Cushman) var. *glabrata* (Cushman). Miocene (30-42). × 65.	122
24, 25.	*Marginulina basispinosa* Cushman and Renz. Miocene (37 and 42). × 45.	123
26.	*Marginulina striatula* Cushman. Miocene (42). × 23.	123
27.	*Dentalina* sp. cf. *D. consobrina* Orbigny. Miocene (25). × 45.	123
28.	*Dentalina flintii* (Cushman). Miocene (37). × 23.	123
29.	*Siphonodosaria antillea* (Cushman). Miocene (39). × 45.	137
30.	*Nodosaria (Siphonodosaria) intercellularis* Brady. Pleistocene (17). × 65.	123



Drooger: Miocene and Pleistocene Foraminifera from Oranjestad, Aruba

Drooger: Miocene and Pleistocene Foraminifera from Oranjestad, Aruba

ger, Zoology, vol. 9, p. 520, pl. 65, fig. 19; HERON-ALLEN and EARLAND, 1924, Journ. Roy. Micr. Soc., London, p. 156, pl. 10, figs. 51-53.
Occurrence.—42 (R), 43 (R)
Coll. No.—D-33103

Frondicularia sagittula van den Broeck var. **cojimarensis** Palmer

Frondicularia sagittula VAN DEN BROECK var. *cojimarensis* PALMER, 1940, Mem. Soc. Cub. Hist. Nat., vol. 14, p. 285, pl. 53, figs. 7, 8.
Frondicularia cojimarensis BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 158, pl. 10, figs. 21, 22.
Occurrence.—49 (R), a single megalospheric specimen. This is one of the rare specimens of Foraminifera from the lowermost barren sands. It may have been derived from a higher level in the Oranjestad column.
Coll. No.—D-33104

Genus **Lagena** Walker and Boys, 1784

All monothalamous forms, which are extremely rare in numbers of individuals, have been tentatively placed here under the genus *Lagena*.

Lagena acuticosta Reuss

Lagena acuticosta REUSS, 1861, Sitzungsber. Akad. Wiss., Wien, vol. 44, pt. 1, p. 305, pl. 1, fig. 4; BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 464, pl. 57, figs. 31, 32; CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 5, pl. 1, figs. 1, 2.
Occurrence.—43 (R)
Coll. No.—D-33105

Lagena hispida Reuss

Lagena hispida REUSS, 1863, Sitzungsber. Akad. Wiss., Wien, vol. 46, pt. 1, p. 335, pl. 6, figs. 77-79.
Occurrence.—40 (R), 42 (R)
Coll. No.—D-33106

Lagena (Entosolenia) marginata (Walker and Boys)

Lagena marginata BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 476, pl. 59, figs. 21-23.
Occurrence.—42 (R)
Coll. No.—D-33107

Lagena (Entosolenia) orbignyana (Seguenza)

Fissurina orbignyana SEGUENZA, 1862, Foram. Monot. Mioc. Messina, p. 66, pl. 2, figs. 25, 26.
Lagena orbignyana BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 484, pl. 59, figs. 25, 26.
Occurrence.—17 (R), 33 (R)
Coll. No.—D-33108

Lagena (Entosolenia) orbignyana (Seguenza) var. **clathrata** Brady

Lagena orbignyana (Seguenza) var. *clathrata* BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 485, pl. 60, fig. 4.
Remarks.—In the specimens of Oranjestad the costae are slightly irregular.
Occurrence.—42 (R)
Coll. No.—D-33109

Lagena (Entosolenia) orbignyana (Seguenza) var. **lacunata** Burrows and Holland

Lagena castrensis BRADY (non Schwager), 1884, Rep. Voy. Challenger, p. 485, pl. 60, figs. 1-3.
Lagena lacunata BURROWS and HOLLAND, 1895, in Jones, Paleont. Soc., p. 205, pl. 7, fig. 12.
Occurrence.—17 (R), 34 (R), most frequent in the Pleistocene marl.
Coll. No.—D-33110

Lagena squamosa (Montagu)

Vermiculum squamosum MONTAGU, 1803, Test. Brit., p. 526, pl. 14, fig. 2.
Lagena squamosa BRADY, Rep. Voy. Challenger, Zoology, vol. 9, p. 471, pl. 58, figs. 28, 29.
Remarks.—Much confusion exists in literature about

EXPLANATION OF PLATE 20

FIGS.		PAGE
1.	*Saracenaria arcuata* (Orbigny) var. *ampla* Cushman and Todd. Miocene (36). × 33.	124
2.	*Vaginulina advena* Cushman. Miocene (37). × 26.	124
3a, b.	*Vaginulina superba* (Cushman and Renz). 3a, side view; 3b, front view. Miocene (29). × 33.	124
4.	*Frondicularia* sp. cf. *F. alazanensis* Nuttall. Miocene (33). × 9.	124
5, 6.	*Frondicularia compta* Brady. Miocene (42 and 43). × 65.	124
7.	*Guttulina irregularis* (Orbigny). Miocene (36). × 45.	126
8a, b.	*Guttulina kishinouyi* Cushman and Ozawa. 8a, 8b, opposite views. Miocene (37). × 45.	126
9a, b.	*Nonion triangulare* Drooger n. sp. Holotype. 9a, side view; 9b, apertural view. Miocene (44). × 65.	127
10a-c.	*Nonionella auris* (Orbigny). 10a, 10b, side views; 10c, apertural view. Miocene (33). × 95.	128
11a-c.	*Nonionella opima* Cushman. 11a, 11b, side views; 11c, oblique apertural view. Miocene (33). × 95.	128
12a, b.	*Elphidium discoidale* (Orbigny). 12a, side view; 12b, apertural view. Miocene (41). × 65.	128
13-17.	*Buliminella elegans* (Orbigny). Miocene (42-44). × 95.	128
18, 19.	*Bulimina inflata* Seguenza. Miocene (42). × 65.	129
20.	*Bulimina inflata* Seguenza var. *renzi* Drooger n. var. Holotype. Miocene (42). × 65.	129
21-24.	*Bulimina marginata* Orbigny. Miocene (29-42). × 65.	129

the classification of reticulate species of the genus *Lagena*. In the Oranjestad samples such forms are relatively scarce. In addition to the typical ones some forms occur, which can be assigned to the following varieties:

L. squamosa (Montagu) var. *scalariformis* Williamson (1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 20, pl. 2, figs. 21, 22),

L. squamosa (Montagu) var. *hexagona* Williamson (ibid., p. 20, pl. 2, fig. 23),

L. squamosa (Montagu) var. *melo* (Orbigny) (1839, Voy. dans l'Am. Mérid., Foraminifères, tome 5, pt. 5, p. 20, pl. 5, fig. 9).

Intermediate specimens between these types were also observed in our material.

Occurrence.—17-47 (see Distribution Chart No. 71).
Coll. No.—D-33111-33115

Lagena sulcata (Walker and Jacob)

Serpula (Lagena) sulcata WALKER and JACOB, 1798, Adams' Essays, Kanmacher's ed., p. 634, pl. 14, fig. 5.
Lagena sulcata BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 462, pl. 57, figs. 23, 26, 33, 34.

Remarks.—The occurrence of the variety *L. sulcata* (Walker and Jacob) var. *apiculata Cushman* (1913, U. S. Nat. Mus., Bull. 71, pt. 3, p. 23, pl. 9, figs. 3, 4) was also noted.

Occurrence.—31-43 (see Distribution Chart No. 60).
Coll. No.—D-33116, 33117

Lagena vulgaris Williamson

Lagena vulgaris WILLIAMSON, 1858, Roy. Soc., London, p. 3, pl. 1, figs. 5, 5a; REUSS, 1862, Sitzungsber. Akad. Wiss., Wien, vol. 46, pt. 1, p. 321, pl. 1, fig. 15, pl. 2, figs. 16, 17.

Remarks.—A single specimen of the variety *L. vulgaris* Williamson var. *semistriata* Williamson (1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 14, pl. 1, figs. 9, 10) has been found.

Occurrence.—41 (R), 42 (R)
Coll. No.—D-33118, 33119

Family POLYMORPHINIDAE
Genus **Guttulina** Orbigny, 1839
Guttulina irregularis (Orbigny)
Plate 20, figure 7

Globulina irregularis ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 226, pl. 13, figs. 9, 10.
Guttulina irregularis CUSHMAN, 1929, Contrib. Cushman Lab. Foram. Res., vol. 5, p. 89, pl. 13, figs. 15, 16; CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 25, pl. 3, figs. 4, 5, pl. 7, figs. 1, 2; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 138, pl. 6, fig. 1.

Occurrence.—36 (R), 41 (R)
Coll. No.—D-33120

Guttulina kishinouyi Cushman and Ozawa
Plate 20, figure 8

Guttulina kishinouyi CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 40, pl. 8, figs. 5, 6.

Remarks.—Our few specimens are slightly shorter than the typical. They are probably closely related to *G. basalis* Galloway and Heminway (1941, New York Ac. Sci., Sci. Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 354, pl. 13, fig. 4) from the Lower Miocene of Porto Rico, their closest affinity, however, is with the Japanese species.

Occurrence.—36 (R), 37 (R)
Coll. No.—D-33121

Genus **Globulina** Orbigny, 1839
Globulina inaequalis Reuss

Globulina inaequalis REUSS, 1850, Denkschr. K. Akad. Wiss., Wien, vol. 1, p. 377, pl. 48, fig. 9; CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 73, pl. 18, figs. 2-4.

Occurrence.—36 (R), one single specimen.
Coll. No.—D-33122

Globulina inaequalis Reuss var. **caribaea** (Orbigny)

Guttulina (Globulina) caribaea ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 135, pl. 2, figs. 7, 8.
Globulina inaequalis Reuss var. *caribaea* CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 75, pl. 18, figs. 5, 6.

Occurrence.—38 (R), a single specimen.
Coll. No.—D-33123

Genus **Glandulina** Orbigny, 1839
Glandulina laevigata Orbigny

Glandulina laevigata ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 29, pl. 1, figs. 4, 5; CUSHMAN and TODD, 1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 34, pl. 5, fig. 19.

Remarks.—The Oranjestad material yielded only few specimens belonging to this world-wide distributed species. They are irregularly biserial in the microspheric forms and uniserial with slightly oblique sutures in the megalospheric individuals.

Occurrence.—34-44 (see Distribution Chart No. 72).
Coll. No.—D-33124

Glandulina striata Drooger n. sp.
Plate 24, figures 3-5

Description.—Test oval to fusiform, usually bluntly pointed at both ends, about circular in transverse section; chambers irregularly biserial to uniserial, the last-formed one strongly overlapping, in most cases making up more than half of the entire test; sutures more or less oblique and irregular, often rather indistinct; wall thick, finely granular and ornamented by numerous fine longitudinal striae on the lower part of the test; aperture terminal, radiate.

Length up to 1.0 mm..

Remarks.—Externally *G. striata* resembles *Pseudoglandulina trochoformis* Coryell and Rivero (1940, Journ. of Pal., vol. 14, p. 331, pl. 42, figs. 13, 14). Regarding its generic position, the species from the Miocene of Haiti should be uniserial, though little evidence is given for this, neither in the description nor in the figures. The striae in *G. striata,* however, do not cover the entire surface.

Occurrence.—42 (R), 43 (R)

Holotype from the Miocene, sample 43 (790 feet below the surface-level) of the Oranjestad boring, Aruba.

Coll. No.—D-33125, 33126

Family NONIONIDAE

Genus **Nonion** Montfort, 1808

Nonion affine (Reuss)

Nonionina affinis REUSS, 1851, Zeitschr. d. d. geol. Ges., vol. 3, p. 72, pl. 5, fig. 32.

Nonion affine CUSHMAN, 1929, Contrib. Cushman Lab. Foram. Res., vol. 5, p. 89, pl. 13, fig. 24; CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper 191, p. 9, pl. 2, fig. 13; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 148, pl. 6, fig. 3.

Remarks.—The majority of the Oranjestad specimens resemble best those pictured from the Tertiary of Venezuela.

Occurrence.—21-44 (see Distribution Chart No. 4).

Coll. No.—D-33127

Nonion grateloupi (Orbigny)

Nonionina grateloupi ORBIGNY, 1839, in Ramon le la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 46, pl. 6, figs. 6, 7.

Nonion grateloupi CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper 191, p. 21, pl. 6, figs. 1-7.

Occurrence.—17-44 (see Distribution Chart No. 24).

Coll. No.—D-33128

Nonion labradoricum (Dawson)

Nonionina labradorica DAWSON, 1860, Canadian Naturalist, vol. 5, p. 191, fig. 4.

Nonion labradoricum CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper 191, p. 23, pl. 6, figs. 13-16.

Nonion sloanii (Orbigny) var. *nitida* CUSHMAN, 1947, Contrib. Cushman Lab. Foram. Res., vol. 23, p. 90, pl. 19, fig. 9.

Remarks.—Judged by its figure the recent *N. sloanii* var. *nitida* seems to fall entirely within the range of variation of *N. labradoricum.*

Occurrence.—23 (R), 42 (R)

Coll. No.—D-33129

Nonion pacificum (Cushman)

Nonionina umbilicatula (Montagu) var. *pacifica* CUSHMAN, 1924, Carn. Inst., Wash., Publ. 342, p. 48, pl. 16, fig. 3.

Nonion pacificum CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper 191, p. 25, pl. 6, fig. 25; CUSHMAN and TODD, 1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 36, pl. 5, fig. 26.

Remarks.—The Oranjestad specimens most closely resemble the one pictured from the Miocene of Jamaica.

Occurrence.—17-43 (see Distribution Chart No. 73).

Coll. No.—D-33130, 33131

Nonion sloanii (Orbigny)

Nonionina sloanii ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 68, pl. 6, fig. 18.

Nonion sloanii CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper 191, p. 22, pl. 6, figs. 9, 10.

Remarks.—Few of our specimens are identical with d'Orbigny's type, but most of them are closer to the specimen figured by Cushman from San Juan Harbor, Porto Rico. No intermediates between *N. sloanii* and *N. labradoricum* were observed in the Aruban samples.

Occurrence.—17-44 (see Distribution Chart No. 25).

Coll. No.—D-33132

Nonion triangulare Drooger n. sp.

Plate 20, figure 9

Nonion costiferum RENZ (non Cushman), 1948, Geol. Soc. of Amer., Mem. 32, p. 148, pl. 6, fig. 5, pl. 12, fig. 6.

Description.—Test somewhat longer than broad, involute, nearly symmetrical; periphery subacute; chambers distinct, 10-13 in the last-formed coil, rapidly increasing in size as added; sutures curved, limbate and raised in their inner parts, appearing more or less wedge-shaped; wall smooth, finely perforate; aperture median, small and low, at the base of the final chamber; apertural face broadly triangular to heart-shaped with a slight ridge along its borders.

Greatest diameter about 0.4 mm.

Remarks.—*N. triangulare* differs from *N. costiferum* (Cushman) (1926, Contrib. Cushman Lab. Foram. Res., vol. 1, p. 90, pl. 13, fig. 2) from the Miocene of California by the lower number of chambers, which are more rapidly increasing in size as added.

Occurrence.—39-44 (see Distribution Chart No. 86), restricted to the lower zone of the Oranjestad Miocene. Of common occurence in sample 44.

Holotype from the Miocene, sample 44 (800-830 feet below the surface-level) of the Oranjestad boring, Aruba. The species is recorded by Renz from Upper Oligocene to Middle Miocene in the Agua Salada group of formations, State of Falcón, Venezuela.

Coll. No.—D-33133, 33134

Genus **Nonionella** Cushman, 1926
Nonionella auris (Orbigny)
Plate 20, figure 10

Valvulina auris ORBIGNY, 1839, Voy. dans l'Am. Mérid., Foraminifères, vol. 5, pt. 5, p. 47, pl. 2, figs. 15-17.
Nonionella auris CUSHMAN, 1930, Flor. State Geol. Survey, Bull. 4, p. 38, pl. 7, fig. 1; CUSHMAN, 1939, U. S. Geol. Survey Prof. Paper 191, p. 33, pl. 9, fig. 4.

Remarks.—This species shows some variation in the number of chambers and their degree of inflation. The few specimens from Oranjestad have 9 slightly inflated chambers in the final whorl. They approach the type of *N. modesta* Galloway and Heminway (1941, New York Ac. Sci., Sci. Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 359, pl. 13, fig. 5) from the Middle Oligocene of Porto Rico.

Occurrence.—33 (R)
Coll. No.—D-33135

Nonionella opima Cushman
Plate 20, figure 11

Nonionella opima CUSHMAN, 1947, Contrib. Cushman Lab. Foram. Res., vol. 23, p. 90, pl. 20, figs. 1-3.

Remarks.—Some of our specimens are rather coarsely perforate and others show slightly inflated chambers. *N. opima* has possibly been derived from *N. crassipunctata* Cushman (1935, Contrib. Cushman Lab. Foram. Res., vol. 11, p. 31, pl. 4, fig. 11), with which it has many characteristics in common. The latter species is known from several Oligocene deposits in the United States and Cuba.

Occurrence.—32-34 (see Distribution Chart No. 62), confined to a short range in the upper zone of the Oranjestad Miocene.
Coll. No.—D-33136, 33137

Genus **Elphidium** Montfort, 1808
Elphidium advenum (Cushman)

Polystomella advena CUSHMAN, 1922, Carnegie Inst., Wash., Publ. 311, p. 56, pl. 9, figs. 11, 12.
Elphidium advenum CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper 191, p. 60, pl. 16, figs. 31-35.

Occurrence.—23 (F), 37 (R)
Coll. No.—D-33138

Elphidium discoidale (Orbigny)
Plate 20, figure 12

Polystomella discoidalis ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 56, pl. 6, figs. 23, 24.
Elphidium discoidale CUSHMAN, 1939, U. S. Geol. Survey Prof. Paper 191, p. 56, pl. 15, figs. 5-7; BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 168, pl. 11, fig. 36.

Remarks.—Our specimens differ slightly from the type of d'Orbigny in having the sutures not tangential to the umbo. Moreover, the umbo is usually less protruding. A rather compressed form of the Aruban fauna has been figured which distinctly shows an additional aperture in the terminal face. This feature was observed in some individuals, but in others, equally well-preserved, it is lacking.

Occurrence.—24-44 (see Distribution Chart No. 41).
Coll. No.—D-33139, 33140

Elphidium simplex Cushman
Plate 24, figure 6

Elphidium simplex CUSHMAN, 1933, U. S. Nat. Mus., Bull. 161, pt. 2, p. 52, pl. 12, figs. 8, 9.

Occurrence.—44 (R)
Coll. No.—D-33141

Family HETEROHELICIDAE
Genus **Plectofrondicularia** Liebus, 1903
Plectofrondicularia floridana Cushman

Plectofrondicularia floridana CUSHMAN, 1930, Flor. State Geol. Survey, Bull. 4, p. 41, pl. 8, fig. 1; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 152, pl. 6, fig. 19.

Remarks.—In their sutural characters some of the Oranjestad specimens approach the type of *P. californica* Cushman and Stewart (1926, Contrib. Cushman Lab. Foram. Res., vol. 2, p. 39, pl. 6, figs. 9-11).

Occurrence.—23-44 (see Distribution Chart No. 26).
Coll. No.—D-33142

Family BULIMINIDAE
Genus **Buliminella** Cushman, 1911
Buliminella elegans (Orbigny)
Plate 20, figures 13-17

Bulimina elegans ORBIGNY, 1826, Ann. Sci. Nat., sér. 1, tome 7, p. 270, mod. 9; BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 398, pl. 50, figs. 1-4; CUSHMAN and PARKER, 1937, Contrib. Cushman Lab. Foram. Res., vol. 14, p. 93, pl. 16, fig. 13.

Remarks.—The specimens from Oranjestad, referred to this species, show a wide variation as to the relative proportions of the test, the apertural characters and the number of chambers in a whorl. The length of the test varies from 1½ to 4 times the breadth. The aperture is either a wide opening at the inner margin of the final chamber, extending upwards; or this opening is more or less contracted at its base, resulting in a comma-shaped aperture, usually reaching the inner margin of the last-formed chamber, in extreme cases even well separated from it. The number of chambers in a whorl varies between 3 and 4, thus giving different aspects to the tests, so that some specimens might be assigned to *Bulimina,* others to *Buliminella.*

In addition to specimens, which are identical with the type of d'Orbigny, others resemble various species, described from several parts of the world. Some of these are: the recent *Bulimina elegans* Orbigny var. *exilis* Brady (1884, Rep. Voy. Challenger, Zoology, vol.

9, p. 399, pl. 50, figs. 5, 6), *Buliminella inconstans* Coryell and Mossman (1942, Journ. of Pal., vol. 16, p. 243, pl. 36, fig. 45) from the Pliocene of Panama, *Buliminella basistriata* Cushman and Jarvis var. *nuda* Howe and Wallace (1932, Louis. Dept. Cons., Geol. Bull. 2, p. 60, pl. 11, fig. 4) from the Upper Eocene of the United States, *Buliminella* sp. cf. *B. basistriata* var. *nuda* Renz (1948, Geol. Soc. of Amer., Mem. 32, p. 123, pl. 6, fig. 10) from the Middle Oligocene to Middle Miocene of Venezuela. Specimens identical to the figure of the latter reference are common in the Aruban samples. The specimens of sample 23 all show the triserial type.

Notwithstanding the very different appearances of the specimens it proved to be impossible to distinguish more than one species in our material.

Occurrence.—23-44 (see Distribution Chart No. 27).
Coll. No.—D-33143-33145

Buliminella subteres (Brady)

Bulimina subteres BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 403, pl. 50, figs. 17, 18.
Buliminella subteres CUSHMAN, 1922, U. S. Nat. Mus., Bull. 104, pt. 3, p. 110, pl. 22, figs. 3-5.
Occurrence.—36 (R)
Coll. No.—D-33146

Genus **Bulimina** Orbigny, 1826
Bulimina falconensis Renz
Plate 24, figure 7

Bulimina falconensis RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 121, pl. 6, fig. 15.

Remarks.—In sample 44 a considerable number of specimens were found, differing from the typical in being slightly less elongate.

Occurrence.—44 (R)
Coll. No.—D-33147

Bulimina inflata Seguenza
Plate 20, figures 18, 19

Bulimina inflata SEGUENZA, 1862, Atti. Accad. Gioenia Sci. Nat., ser. 2, vol. 18, p. 109, pl. 1, fig. 10; CUSHMAN, 1929, Contrib. Cushman Lab. Foram. Res., vol. 5, p. 94, pl. 13, fig. 31; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 121.
Occurrence.—24-44 (see Distribution Chart No. 42).
Coll. No.—D-33148, 33149

Bulimina inflata Seguenza var. **renzi** Drooger n. var.
Plate 20, figure 20

Bulimina inflata CUSHMAN and JARVIS, 1930, Journ. of Pal., vol. 4, p. 362, pl. 33, fig. 5.
Bulimina cf. *inflata* RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 122, pl. 12, fig. 14.

Description.—Variety differing from the typical in having a less elongate test of about equal height and breadth, whereas all whorls except the prominent last-formed one are only visible in a sharply pointed low spire as very narrow strips, or are indistinct.

Length 0.25-0.40 mm.

Remarks.—In the Oranjestad Miocene the species and the variety are always found together, but the variety is proportionately better represented in the lower zone. Though the extreme forms are intergrading in our material with many intermediates (for instance pl. 20, fig. 19) a varietal name is proposed on account of the stratigraphic value of this variety. According to Renz the latter is possibly restricted to Upper Oligocene and Lowermost Miocene in tropical America.

Occurrence.—See *B. inflata* Seguenza.
Holotype from the Miocene sample 42 (780-800 feet below the surface-level) of the Oranjestad boring, Aruba.
Coll. No.—D-33149, 33150

Bulimina marginata Orbigny
Plate 20, figures 21-24

Bulimina marginata ORBIGNY, 1826, Ann. Sci. Nat., sér. 1, tome 7, p. 269, pl. 12, figs. 10-12; CUSHMAN and PARKER, 1937, Contrib. Cushman Lab. Foram. Res., vol. 14, p. 91, pl. 16, figs. 5, 6.

Remarks.—Several samples of Oranjestad yielded a number of specimens of *B. marginata,* which show considerable variation. They are usually shorter than the typical ones resembling the variety *B. marginata* d'Orbigny var. *tessellata* Cushman and Todd (1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 39, pl. 6, fig. 9) from the Miocene of Buff Bay, Jamaica, but lacking the peculiar perforations of the latter. Our specimens also show different degrees of prominence of the lower angles of the chambers, in the extreme case resembling *B. pagoda* Cushman var. *deformata* Cushman and Parker (1937, Contrib. Cushman Lab. Foram. Res., vol. 14, p. 58, pl. 10, fig. 3). The development of spines is variable from being nearly absent to abundantly present, especially in the lower part of the test, in this case approaching *B. aculeata* Orbigny (1826, Ann. Sci. Nat., sér. 1, tome 7, p. 269, fig. 4).

Occurrence.—25-42 (see Distribution Chart No. 48).
Coll. No.—D-33151, 33152

Bulimina pupoides Orbigny var.
Plate 21, figures 1-3

Bulimina pupoides ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 185, pl. 11, figs. 11, 12; CUSHMAN and PARKER, 1937, Contrib. Cushman Lab. Foram. Res., vol. 13, p. 47, pl. 6, fig. 3; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 122, pl. 6, fig. 11.

Remarks.—Larger specimens from Oranjestad closely resemble Renz' figure; smaller ones show slightly more overlapping chambers. The type of d'Orbigny's species is distinctly more elongate than our specimens. A short form of the species is also pictured by Cushman and Parker. Probably we are dealing with a rather short, possibly characteristical Caribbean, variety of *B. pu-*

poides, which may be identical with *B. ovata* Orbigny from the Miocene of the Vienna Basin. Moreover, in our material some affinity seems to be present with the recent West Indian species *B. ovula* and *B. affinis* as pictured by Cushman (1940, Contrib. Cushman Lab. Foram. Res., vol. 16, p. 7, pl. 2, figs. 3, 4).

Occurrence.—33-42 (see Distribution Chart No. 65).

Coll. No.—D-33153, 33154

Genus **Virgulina** Orbigny, 1826
Virgulina pontoni Cushman
Plate 21, figure 4

Virgulina pontoni CUSHMAN, 1932, Contrib. Cushman Lab. Foram. Res., vol. 8, p. 17, pl. 8, fig. 7; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 19, pl. 2, figs. 26-28; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 178, pl. 6, fig. 18.

Remarks.—Some of our specimens approach the type of *V. punctata* Orbigny (1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, p. 139, pl. 1, figs. 35, 36). Similar features were observed by Renz in the Oligocene-Miocene representatives of *V. pontoni* in the Agua Salada group.

Occurrence.—17-44 (see Distribution Chart No. 28).

Coll. No.—D-33155, 33156

Genus **Bolivina** Orbigny, 1839
Bolivina acerosa Cushman
Plate 21, figure 5

Bolivina acerosa CUSHMAN, 1936, Cushman Lab. Foram. Res., Spec. Publ. 6, p. 54, pl. 8, fig. 1; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 94, pl. 12, figs. 11-13.

Occurrence.—37-43 (see Distribution Chart No. 84), restricted to the lower zone of the Oranjestad Miocene.

Coll. No.—D-33157

Bolivina alazanensis Cushman var. **hadleyi** Palmer
Plate 21, figure 6

Bolivina alazanensis Cushman var. *hadleyi* PALMER, 1940. Mem. Soc. Cub. Hist. Nat., vol. 14, p. 298, pl. 51, figs. 7, 8.

Remarks.—The Oranjestad specimens show but one distinct row of sutural processes to each side of the raised median line. From the figures can be concluded that *B. byramensis,* Coryell and Rivero (1940, Journ. of Pal., vol. 14, p. 341, pl. 44, fig. 17) and possibly also the same species recorded from the Agua Salada group of Venezuela (Renz, 1948, Geol. Soc. of Amer., Mem. 32, p. 117, pl. 6, fig. 22) are closely related to, if not identical with this variety from the Cuban Oligocene.

Occurrence.—34-43 (see Distribution Chart No. 74).

Coll. No.—D-33158, 33159

Bolivina floridana Cushman var. **imporcata** Cushman and Renz
Plate 21, figures 7, 8

Bolivina floridana Cushman var. *regularis* CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 17, pl. 3, fig. 7.

Bolivina floridana Cushman var. *imporcata* CUSHMAN and RENZ, 1944, Contrib. Cushman Lab. Foram. Res., vol. 20, p. 78.

Bolivina imporcata RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 118, pl. 7, fig. 3.

Remarks.—This variety is characterized by the lobular processes of the chambers, forming longitudinal ridges. In our material these features occur in typical as well as in more tapering forms. In some of them the ridges become irregular in the upper portion of the test as in *B. floridana* (1918, U. S. Geol. Survey, Bull. 676, p. 49, pl. 10, fig. 4).

Occurrence.—23-44 (see Distribution Chart No. 29).

Coll. No.—D-33160, 33161

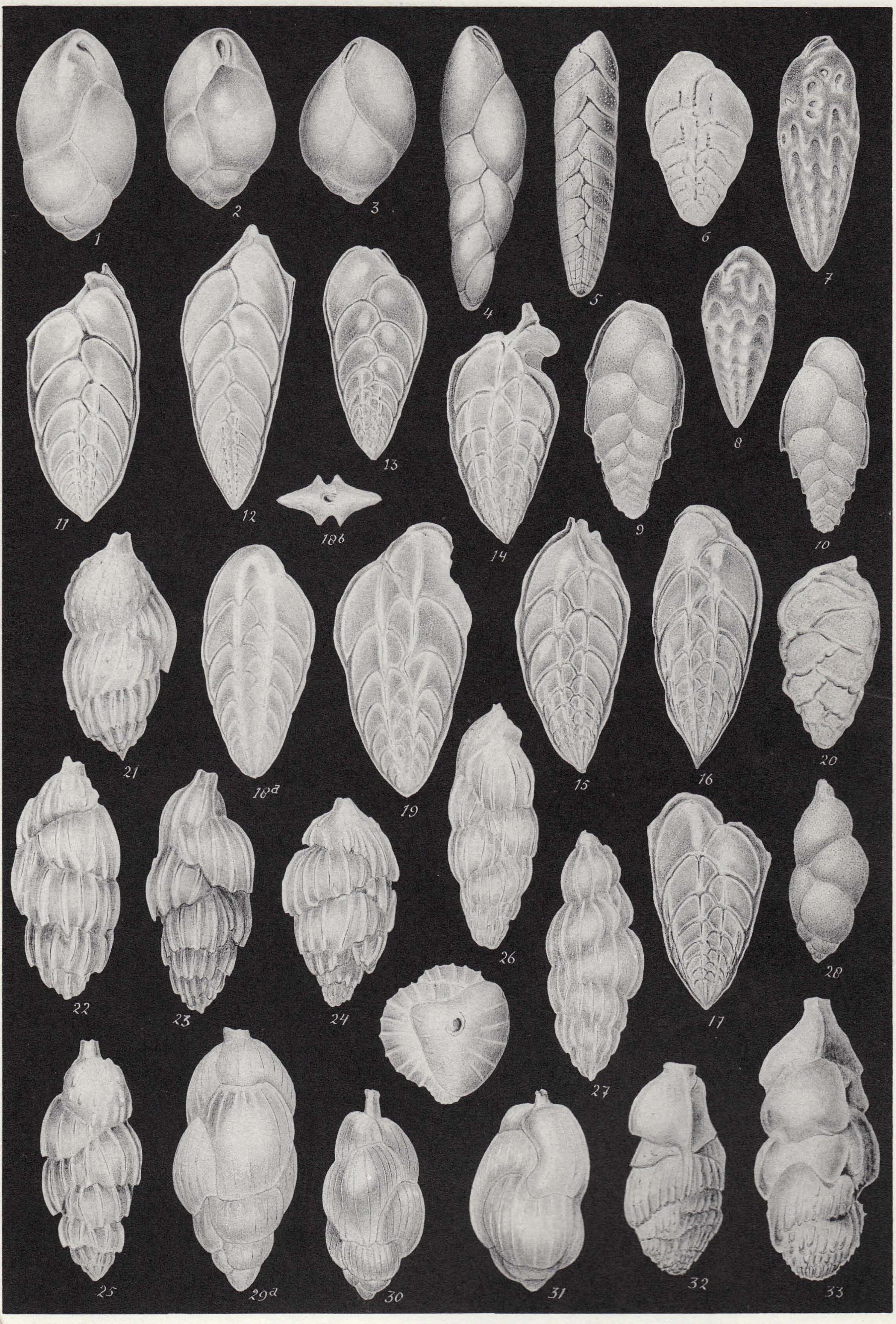
Bolivina isidroensis Cushman and Renz

Bolivina isidroensis CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 17, pl. 3, fig. 8; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 118, pl. 7, fig. 5.

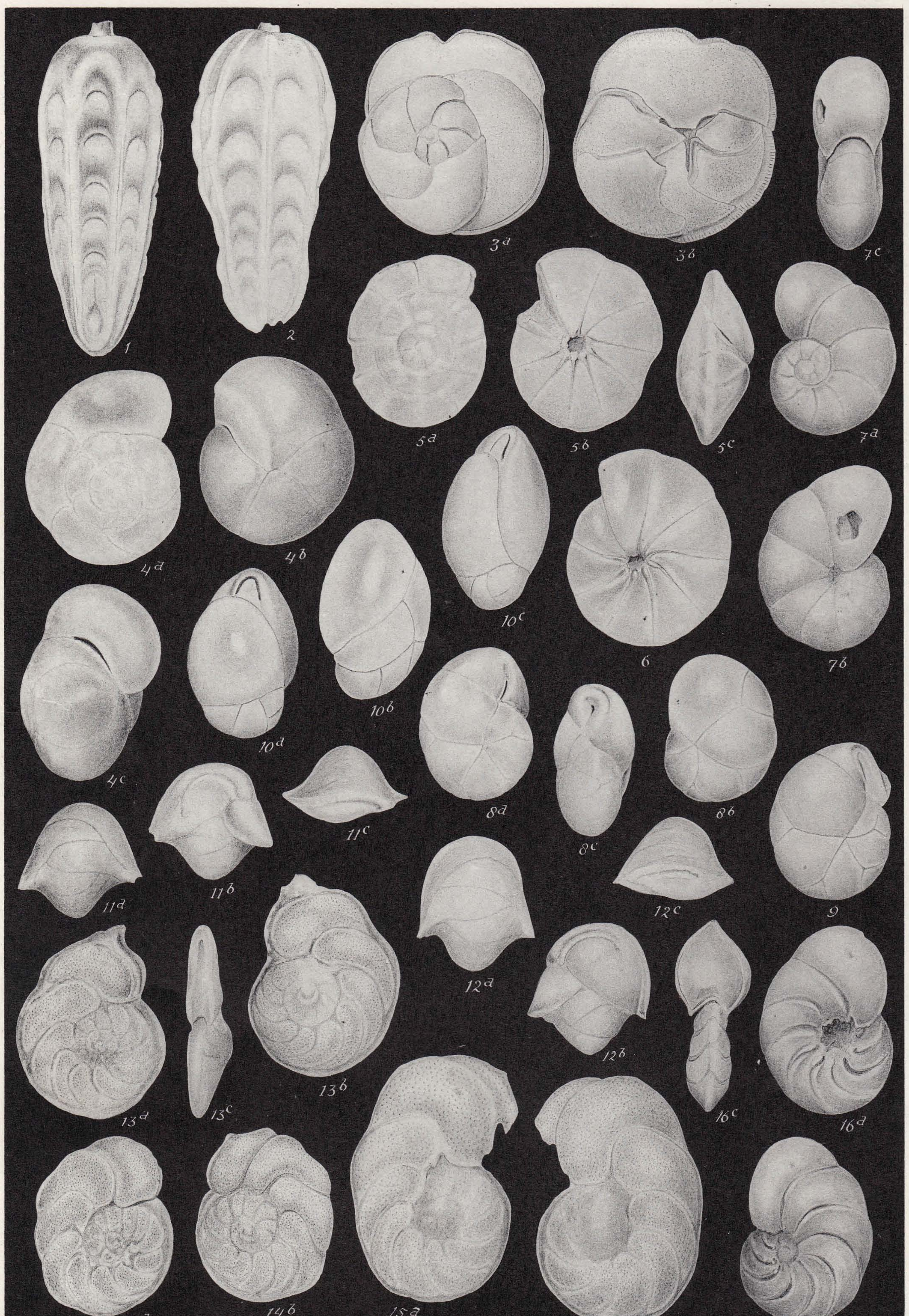
Remarks.—Few specimens of *B. isidroensis* were

EXPLANATION OF PLATE 21

FIGS.		PAGE
1-3.	*Bulimina pupoides* Orbigny var. Miocene (34). × 65.	129
4.	*Virgulina pontoni* Cushman. Miocene (44). × 65.	130
5.	*Bolivina acerosa* Cushman. Miocene (42). × 65.	130
6.	*Bolivina alazanensis* Cushman var. *hadleyi* Palmer. Miocene (34). × 65.	130
7, 8.	*Bolivina floridana* Cushman var. *imporcata* Cushman and Renz. Miocene (41). × 45.	130
9, 10.	*Bolivina pseudobeyrichi* Cushman. Miocene (43 and 23). × 65.	131
11-13.	*Bolivina subaenariensis* Cushman. Miocene (41, 42 and 29). × 65.	132
14-17.	*Bolivina subaenariensis* Cushman var. *mexicana* Cushman. Miocene (25-36). × 65.	132
18a-19.	*Bolivina subaenariensis* Cushman var. *westermanni* Drooger n. var., 18, Holotype; 19, paratype. 18a, 19, side views; 18b, apertural view. Miocene (42). × 65.	132
20.	*Reussella pulchra* Cushman. Side view. Miocene (37). × 65.	133
21-25.	*Uvigerina hispido-costata* Cushman and Todd. Miocene (41). × 65.	133
26, 27.	*Uvigerina hispido-costata* Cushman and Todd var. *pseudobradyana* Drooger n. var. 26, Holotype; 27, paratype. Miocene (41). × 65.	133
28.	*Uvigerina proboscidea* Schwager. Miocene (36). × 65.	136
29a-31.	*Uvigerina rutila* Cushman and Todd. 29a, 30, 31, side views; 29b, apertural view. Miocene (36, 37 and 39). × 65.	136
32, 33.	*Angulogerina occidentalis* (Cushman). Miocene (42). × 95.	136



Drooger: Miocene and Pleistocene Foraminifera from Oranjestad, Aruba



Drooger: Miocene and Pleistocene Foraminifera from Oranjestad, Aruba

found in our material. They are more stoutly developed than those belonging to *B. acerosa*. No possible relations between both species could be ascertained from our scarce material.

Occurrence.—23-43 (see Distribution Chart No. 30).

Coll. No.—D-33162

Bolivina marginata Cushman var. **multicostata** Cushman

Bolivina marginata Cushman var. *multicostata* CUSHMAN, 1930, Flor. State Geol. Survey, Bull. 4, p. 46, pl. 8, figs. 13, 14; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 87, pl. 10, figs. 7-10; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 118, pl. 7, figs. 6-8.

Occurrence.—40-44 (see Distribution Chart No. 90), restricted to the lower zone of the Oranjestad Miocene.

Coll. No.—D-33163

Bolivina plicatella Cushman var. **mera** Cushman and Ponton

Bolivina plicatella Cushman var. *mera* CUSHMAN and PONTON, 1932, Flor. State Geol. Survey, Bull. 9, p. 82, pl. 12, fig. 4; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 90, pl. 11, figs. 5-8; BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 193, pl. 12, fig. 46.

Occurrence.—42 (R)

Coll. No.—D-33164

Bolivina pozonensis Cushman and Renz

Bolivina pozonensis CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 16, pl. 3, fig. 12; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 119, pl. 7, fig. 14.

Occurrence.—23 (R), very few specimens.

Coll. No.—D-33165

Bolivina pseudobeyrichi Cushman

Plate 21, figures 9, 10

Bolivina beyrichi var. *alata* CUSHMAN (non Seguenza), 1911, U. S. Nat. Mus., Bull. 71, pt. 2, p. 35, textfig. 57.

Bolivina pseudobeyrichi CUSHMAN, 1926, Contrib. Cushman Lab. Foram. Res., vol. 2, p. 45; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 139, pl. 19, figs. 4, 5.

Bolivina alata CUSHMAN (non Seguenza), 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 106, pl. 13, figs. 4-11; RENZ (non Seguenza), 1948, Geol. Soc. of Amer., Mem. 32, p. 116, pl. 6, fig. 26, pl. 12, fig. 12.

Bolivina alata var. *effusa* CUSHMAN and TODD, 1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 42, pl. 6, fig. 26.

Remarks.—The references listed above includes specimens of *Bolivina,* slightly if at all differing from one another. Such minor differences are all found in the specimens from the Aruba boring and are considered to be of individual character only. Most West Indian references of *B. alata* are distinctly different from Seguenza's type (1862, Atti. Accad. Gioenia Sci. Nat., ser. 2, vol. 18, p. 115, pl. 2, fig. 5) and obviously very close to or identical with that of Cushman's *B. pseudobeyrichi.*

Occurrence.—23-43 (see Distribution Chart No. 31).

Coll. No.—D-33166, 33167

Bolivina rhomboidalis (Millett)

Textularia rhomboidalis MILLETT, 1899, Roy. Micr. Soc., p. 599, pl. 7, fig. 4.

Bolivina rhomboidalis CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 138, pl. 18, fig. 7.

Occurrence.—34 (R), a single specimen.

Coll. No.—D-33168

EXPLANATION OF PLATE 22

FIGS.		PAGE
1, 2.	*Siphogenerina lamellata* Cushman. Miocene (42 and 43). × 65.	136
3a, b.	*Discorbis bertheloti* (Orbigny) var. *floridensis* Cushman. 3a, dorsal view; 3b, ventral view. Miocene (38). × 33.	137
4a-c.	*Gyroidina parva* Cushman and Renz var. *oranjestadensis* Drooger n. subsp. Holotype. 4a, dorsal view; 4b, ventral view; 4c, peripheral view. Miocene (42). × 95.	137
5a-6.	*Gyroidina venezuelana* (Renz) var. *arubana* Drooger n. subsp. 5, Holotype; 6, paratype. 5a, dorsal view; 5b, 6, ventral views; 5c, peripheral view. Miocene (41). × 95.	138
7a-c.	*Gyroidina vicksburgensis* (Cushman) var. *hannai* Garrett. 7a, dorsal view; 7b, ventral view; 7c, peripheral view. Miocene (42). × 65.	138
8a-9.	*Cassidulina subglobosa* Brady var. *subcalifornica* Drooger n. var. 8, Holotype; 9, paratype. 8a, 8b, 9, side views; 8c, apertural view. Miocene (42). × 65.	140
10a-c.	*Cassidulinoides marksi* Drooger n. sp. Holotype. 10a, 10b, side views; 10c, ventral view. Miocene (34). × 65.	140
11a-c.	*Ehrenbergina spinea* Cushman. 11a, dorsal view; 11b, ventral view; 11c, front view. Miocene (44). × 65.	141
12a-c.	*Ehrenbergina spinea* Cushman var. *amina* Bermudez. 12a, dorsal view; 12b, ventral view; 12c, front view. Miocene (44). × 65.	141
13a-15b.	*Planulina antillea* Drooger n. sp. 13, Holotype; 14, 15, paratypes. 13a, 14a, 15a, dorsal views; 13b, 14b, 15b, ventral views; 13c, peripheral view. Miocene (42). × 45.	143
16a-c.	*Cibicides isidroensis* Cushman and Renz. 16a, dorsal view; 16b, ventral view; 16c, peripheral view. Miocene (42). × 45.	145

Bolivina subaenariensis Cushman

Plate 21, figures 11-13

Bolivina subaenariensis CUSHMAN, 1922, U. S. Nat. Mus., Bull. 104, pt. 3, p. 46, pl. 7, fig. 6; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 155, pl. 18, figs. 26-28.

Remarks.—This species, which is present in large numbers in nearly all samples of the Oranjestad boring, shows a wide variation in the development of the costae. To the typical species can be assigned those specimens with rather faint costae, usually only two on the lower part of the test. They occur in all our material. Specimens with four, more strongly developed, costae are referred here to *B. subaenariensis* var. *mexicana* Cushman in which the two middle costae are usually somewhat more prominent than is shown by the type-specimen of Cushman's variety. The second variety from Oranjestad *B. subaenariensis* var. *westermanni* n. var. is characterized by an ornamentation, consisting of only two costae, which are, however, extremely high and present over the entire length of the test. In addition to these forms a few specimens were observed with opaque sutures, instead of dark, vitreous ones.

The two varieties, designated below by varietal names, differ in range in the section of Oranjestad. In its typical form *B. subaenariensis* var. *westermanni* only occurs in the lower zone of the Oranjestad Miocene, in which part of the column, however, the species itself is much more abundantly present. The samples of the sandy upper portion of this zone contained no representatives of this group. In the upper Miocene zone most individuals fall within the range of variation of *B. subaenariensis* var. *mexicana.*

Occurrence.—21-44 (see Distribution Chart No. 5 and 87).

Coll. No.—D-33169-33173

Bolivina subaenariensis Cushman
var. **mexicana** Cushman

Plate 21, figures 14-17

Bolivina subaenariensis Cushman var. *mexicana* CUSHMAN, 1922, U. S. Nat. Mus., Bull. 104, pt. 3, p. 47, pl. 8, fig. 1; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 157, pl. 18, fig. 20; BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 195, pl. 12, fig. 21.

Remarks.—In *B. subaenariensis* as well as in both varieties considerable variation exists in the relative length of the test. Short specimens of *B. subaenariensis* var. *mexicana* from Oranjestad fairly well resemble those figured as *B. interjuncta* Cushman var. *bicostata* Cushman (1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 116, pl. 22, fig. 23) from the Pliocene of California and *B. interjuncta* Cushman var. *simplex* Cushman and Renz (1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 20, pl. 3, fig. 15) from the Oligocene-Miocene of the State of Falcón, Venezuela. Judged from their figures it is asumed that the latter two forms also belong to the group of *B. subaenariensis.*

Occurrence.—See *B. subaenariensis* Cushman (Distribution Chart No. 5). Relatively abundant in the upper zone of the Oranjestad Miocene. The rare specimens of this variety, present in the lower Miocene zone, have not been listed in the distribution chart.

Coll. No.—D-33169-33171, 33174, 33175

Bolivina subaenariensis Cushman
var. **westermanni** Drooger n. var.

Plate 21, figures 18, 19

Bolivina interjuncta Cushman var. *bicostata* BERMUDEZ (non Cushman), 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 191. pl. 12, fig. 24.

Description.—Variety differing from the typical one in having an ornamentation, consisting of two high, sharp and plate-like costae near the median line of the test, running over its entire length.

Remarks.—The specimen, pictured by Bermudez as *B. interjuncta* var. *bicostata,* is morphologically identical with *B. subaenariensis* var. *westermanni* from the Aruban Miocene. It is highly probable that *B. interjuncta* var. *bicostata,* as figured from the Pliocene of California, should be placed in synonymy with *B. subaenariensis* var. *mexicana* (see above), whereas the relation of Bermudez' form with *B. interjuncta* is much less evident than with *B. subaenariensis,* as could be concluded from the distinct connections of the various forms in the Oranjestad fauna.

Occurrence.—See *B. subaenariensis* (Distribution Chart No. 87), restricted to the lower zone of the Oranjestad Miocene. Holotype from the Miocene, sample 42 (780-800 feet below the surface-level) of the Oranjestad boring, Aruba. Reported from the Middle Miocene of the Dominican Republic.

Coll. No.—D-33169, 33170, 33176, 33177

Bolivina suteri Cushman and Renz

Bolivina suteri CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 18, pl. 3, fig. 9; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 119, pl. 7, fig. 15.

Occurrence.—40 (R), a single specimen.

Coll. No.—D-33178

Bolivina tortuosa Brady

Bolivina tortuosa BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 420, pl. 52, figs. 31, 32; CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 133, pl. 17, figs. 11-19.

Occurrence.—34 (R), a single specimen.

Coll. No.—D-33179

Genus **Loxostomum** Ehrenberg, 1854

Loxostomum instabile Cushman and McCulloch

Plate 24, figure 10

Loxostoma instabile CUSHMAN and McCULLOCH, 1942, Allan Hancock Pacific Exped., vol. 6, no. 4, p. 221, pl. 27, figs. 15-17, pl. 28, figs. 1-7.

Loxostomum instabile CUSHMAN and GRAY, 1946, Cushman Lab. Foram. Res., Spec. Publ. 19, p. 36, pl. 6, figs. 7-9.

Occurrence.—42 (R), a single specimen.

Coll. No.—D-33180

Loxostomum limbatum (Brady)
var. **costulatum** (Cushman)

Bolivina limbata Brady var. *costulata* CUSHMAN, 1922, Carn. Inst., Wash., Publ. 311, p. 26, pl. 3, fig. 8.

Loxostoma limbatum (Brady) var. *costulatum* CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 187, pl. 21, figs. 30, 31.

Occurrence.—23 (R), a single specimen.

Coll. No.—D-33181

Genus **Geminaricta** Cushman, 1936
Geminaricta sp. cf. **G. virgata** (Cushman)
Plate 24, figure 8

Bolivinella virgata CUSHMAN, 1929, Contrib. Cushman Lab. Foram. Res., vol. 5, p. 33, pl. 5, fig. 9.

Geminaricta virgata CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 208, pl. 28, figs. 30-32.

Remarks.—Our two specimens differ from the typical one in having the early portion somewhat twisted, whereas the sutures are depressed throughout. The wall is covered with minute granules of various sizes. The peculiar apertural character could only be ascertained in one of the Aruban specimens.

Occurrence.—37 (R), 42 (R), one specimen from each sample.

Coll. No.—D-33182

Genus **Reussella** Galloway, 1933
Reussella pulchra Cushman
Plate 21, figure 20

Verneuilina spinulosa MACFADYEN (non Reuss), 1930 (1931), Geol. Survey Egypt, p. 50, pl. 1, fig. 8.

Reussella pulchra CUSHMAN, 1945, Contrib. Cushman Lab. Foram. Res., vol. 21, p. 34, pl. 6, figs. 11, 12; CUSHMAN and TODD, 1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 49, pl. 7, fig. 21.

Occurrence.—17-42 (see Distribution Chart No. 32).

Coll. No.—D-33183, 33184

Reussella sp. cf. **R. glabrata** (Cushman)

Verneuilina glabrata CUSHMAN, 1918, U. S. Geol. Survey, Bull. 676, p. 9, pl. 1, fig. 2.

Reussella glabrata CUSHMAN, 1945, Contrib. Cushman Lab. Foram. Res., vol. 21, p. 37, pl. 6, fig. 23.

Remarks.—In addition to specimens in sample 17, which can be assigned to *R. pulchra,* others were found with flush sutures and relatively high chambers, possibly belonging to *R. glabrata.* Their poor state of preservation does not allow a correct determination.

Occurrence.—17 (R), only observed in the Pleistocene marl.

Coll. No.—D-33185

Genus **Uvigerina** Orbigny, 1826
Uvigerina hispido-costata Cushman and Todd
Plate 21, figures 21-25

Uvigerina hispido-costata CUSHMAN and TODD, 1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 51, pl. 7, figs. 27, 31.

Remarks.—The representatives of this species in the Oranjestad samples show a considerable amount of individual variation. The proportion of the length of the test to its breadth varies between 1½ and 2, the broadest part usually being in the upper portion, often about the middle and occasionally in the lower half of the test. The costae become serrate to spinose in different stages of individual development, but are often unbroken over the entire surface of the test, thus resembling *U. subperegrina* Cushman and Kleinpell (1934, Contrib. Cushman Lab. Foram. Res., vol. 10, p. 12, pl. 2, figs. 9-11). The height of the costae is also slightly variable. Some variation can also be observed in the degree of depression of the sutures. From the paratypes of *U. isidroensis* Cushman and Renz (1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 20, pl. 3, fig. 16), given by Cushman (1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 47, pl. 14, figs. 1-6) it looks probable that the holotype of this species is a rather extreme specimen as to the typical overhanging chambers. Several of our specimens are completely identical with the paratypes of *U. isidroensis.*

Many occurrences of *Uvigerinae* with high costae, interrupted at the sutures, are known from tropical America, often given different specific names. An extensive study of large numbers of specimens from these localities is needed to obtain a better idea of the individual variation in each fauna. Possibly it may be found out that most of these groups of individuals are only morphologically slightly differing evolutionary stages and geographical races of a single species. *U. peregrina* Cushman (1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 166, pl. 42, figs. 7-10) may be the recent form of this group. The latter species is, according to Cushman's type-description, different from others on account of its granular surface of the test.

Occurrence.—23-44 (see Distribution Chart No. 33).

Coll. No.—D-33186, 33187

Uvigerina hispido-costata Cushman and Todd
var. **pseudobradyana** Drooger n. var.
Plate 21, figures 26, 27

Description.—Variety differing from the typical form in its relatively longer test, 2½ and more times as long as broad, and in having usually distinctly lower costae. The later chambers tend to become irregularly biserial and sometimes even uniserial.

Length up to 0.60 mm.

DISTRIBUTION-CHART

OF ALL SPECIES, SUBSPECIES AND VARIETIES OCCURRING IN THREE OR MORE SAMPLES OF THE ORANJESTAD-COLUMN

SAMPLE NUMBERS	17	18	19	20	21	22	23	24	25	27	28	29	30	31	32	33	34	36	37	38	39	40	41	42	43	44
1 Sigmoilina schlumbergeri					R	R	R	F	R	R	R	R	R	R	R	R	R	R	R	R	R				R	R
2 Robulus spp Cushman and Todd. 1945					R		F			R		R		R		R		C					R	R	R	R
3 Lenticulina subaculeata glabrata					R	R			R				R	R		R	R	R		R				R	R	R
4 Nonion affine					R			R					R				R			R				R	R	R
5 Bolivina subaenariensis (pp) + var. mexicana					R	R	F	R	R	R	R	F	F	R	R	C	C									
6 Uvigerina cf. peregrina					F		A	R	R	F																
7 Siphogenerina lamellata					R		R												R		R		R	R	R	R
8 Eponides parantillarum		R			R				R								R	C	F	R	R	R			R	R
9 Siphonina pozonensis					R	R		R	R	R	R		R	R	R	R		R	R					R	R	
10. Amphistegina lessonii	C	C			C	A	C	F	R	R	R		R	R	R	R	F	R	A	C	R	F	R	R	R	F
11 Asterigerina carinata	R				R										R		F			R						R
12 Cassidulina subglobosa + var. subcalifornica					R	R	C	R	R	R	R	R	A	F	R	C	C	R	F	R	R	R	V	R	R	A
13 Globorotalia canariensis				R	R		F	R		R	R				R	R	R	R	R	R	R			R	R	R
14 Globorotalia menardii				R	C	C	A	R	C	C	R	R	F	C	C	C	C	C	C	F	R	R	R	C	F	R
15 Planulina ariminensis + var. canimarensis + var. crassa	V	R	R	R	R		R	R	R			R					R	R	R	R	R		R	R		R
16 Cibicides americanus					R	R	C	R	R	R	R	R	R		R	R	R	C	C	R		R	R	R	R	R
17 Cibicides mckannai + var. westermanni	C				R	R	F	F	R	R	R	R	R	F	R	F	R	F	R	R	R	R	R	C	C	R
18 Cibicides pseudoungerianus + var compressus					R	R	C	R	R	R	R		R	R	R	R	F	R	R	R	R		R		R	R
19 Cibicides pseudoungerianus umbonatus					R	R												R						R	R	
20 Martinottiella nodulosa						R						R									R		R	R	R	R
21 Orbulina universa	R	R				R	R			R	R		R		R	F	R	R	C	R	R		R	R	R	F
22 Cibicides floridanus						R			R		R							R	R							
23 Quinqueloculina seminula							R			R														R		
24 Nonion grateloupi	R						R																			R
25 Nonion sloanii	R						R			R			R	R			R		R			R	R	R	R	R
26. Plectofrondicularia floridana							R	R	R				F	R	R	R	R		R		R		R	R	R	R
27 Buliminella elegans							R															R	R	R	R	R
28 Virgulina pontoni	R						R	R					R				R				R		R	R	R	R
29 Bolivina floridana imporcata							F	R	R	R	R	R		R	R	R	R		R		A	R	V	C	R	R
30 Bolivina isidroensis							R														R				R	
31 Bolivina pseudobeyrichi							R								R									R	R	
32 Reussella pulchra	R						R											R	R		R			R		
33 Uvigerina hispido-costata + var. pseudobradyana							F	F	F	C	R	C	A	C	C	C	C	C	F	R	A	C	V	C	C	A
34 Angulogerina occidentalis							R														R		R	F	F	
35 Rotalia beccarii							R								R		R		R			R	F			A
36 Cassidulina carapitana							R	R	R				R	R		R	R	F	R		R			C	F	R
37 Textularia bermudezi								R								R	R									
38 Pseudoclavulina mexicana								R						R		R				R	R		R		R	R
39 Quinqueloculina lamarckiana								R	R		R		F	R	R	F	C	C	F	R	R		R	R	R	A
40 Robulus calcar								F	R	R	R	R	F	F	F	F	F	F	R	R		R	R	R		R
41 Elphidium discoidale								R			R		R		R	R	R	R			R	R	C	R	R	R
42 Bulimina inflata + var. renzi								R		R		R	R	R	R	R	R		R		A	R	C	C	C	C
43 Gyroidina parva oranjestadensis								R							R	R					R		R	R	R	R
44 Epistomina elegans	C							R	R				R	R		R	R	F	R		R					
45 Sphaeroidinella rutschi								R	R	R	R	R	R	R	R	R	F	R	R	R	F		R	R	R	F

	17	18	19	20	21	22	23	24	25	27	28	29	30	31	32	33	34	36	37	38	39	40	41	42	43	44
46 Globorotalia crassula								R		R			R	R	R		R									
47 Cibicides isidroensis								F	R	R	R	R	R	R	C	R	F	R	R	R	R	R	C	R	R	R
48 Bulimina marginata									R			R	R			F	R	R			R			F		
49 Uvigerina rutila									R		R		R		R	R	R	C	C	R	R		R	R	R	R
50 Eponides praecinctus									R										R	R				R	R	R
51 Pulleniatina obliquiloculata									R							R				R	R					
52 Globorotalia menardii miocenia									R							R	R									
53 Planulina wuellerstorfi									R					R		R	R	R	R		R			R	R	R
54 Robulus suteri										F	R		R													
55 Cibicides lobatus										R		R					R	R	R	R	R			R	R	R
56 Robulus americanus + var grandis											R	R			R		R		R	R	R		R			R
57 Robulus iotus												R			R					R	F		F	R	R	R
58 Nodosaria vertebralis												R				R	R			R	R					
59 Siphonodosaria antillea													R			R			R		R				R	
60 Lagena sulcata														R							R		R		R	
61 Cassidulinoides marksi														R	R	R	R				R				R	
62 Nonionella opima															R	R	R									
63 Gyroidina venezuelana arubana															R						R	R	C		R	R
64 Lenticulina peregrina																R	R				R		R	R		
65 Bulimina pupoides var.																R	F				R			R		
66 Eponides umbonatus ecuadorensis																R			R		R		R	R		
67 Pullenia bulloides																R					R		R	R	R	R
68 Pyrgo depressa																	R							R	R	
69 Pyrgo subsphaerica	R																R	R	R							
70 Vaginulina crepidula (Brady) (non Fichtel a. Moll)	F			R													R								R	
71 Lagena squamosa + var	R																R					R		R	R	R
72 Glandulina laevigata																	R				R				R	R
73 Nonion pacificum	R		R														R		R					R	R	
74 Bolivina alazanensis hadleyi																	R							R	R	
75 Planulina antillea																	R	R	R	R				R	R	R
76 Textularia alazanensis																		R	R					R	R	
77 Quinqueloculina laevigata Cushman (non d'Orb)	F																	R	R							
78 Saracenaria arcuata ampla																		R			R		R			
79 Vaginulina advena																		R	R	R			R		R	
80 Discorbis berthelotí floridensis	R																	R	R	R					R	R
81 Gyroidina vicksburgensis hannai																		R	R					R	R	
82 Ehrenbergina spinea + var. amina																		R	R	R	R		R	C	R	
83 Marginulina basispinosa																			R					R	R	R
84 Bolivina acerosa																			R				R	R	R	
85 Siphonodosaria paucistriata var.																					R				R	R
86 Nonion triangulare																					R		R			C
87 Bolivina subaenariensis (pp) + var. westermanni																					C	F	V	C	R	R
88 Discorbis orbicularis	R																				R				R	
89 Ammodiscus dominicensis deformis																						R	R			R
90 Bolivina marginata multicostata																						R		R		F
91 Textularia conica	R																							R	R	
92 Globigerinella aequilateralis	R			R																				R	R	
93 Cibicides mckannai oranjestadensis + Cibicides mckannai arubana	R																							R	R	

Remarks.—The new variety includes a large number of specimens in which the costae are unbroken on all the chambers, while others have the spinose to serrate costae on the later chambers. Between the species and the variety exist the same morphological relations as between *U. peregrina* Cushman and its variety *U. peregrina* Cushman var. *bradyana* Cushman (1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 168, pl. 42, fig. 12). Although both types from the Aruban Miocene intergrade, intermediates are relatively scarce.

Occurrence.—The same as for *U. hispido-costata* Cushman and Todd. Holotype from the Miocene, sample 41 (760-780 feet below the surface-level) of the Oranjestad boring, Aruba.

Coll. No.—D-33188, 33189

Uvigerina sp. cf. **U. peregrina** Cushman

Plate 24, figure 9

Uvigerina peregrina CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 166, pl. 42, figs. 7-10.

Remarks.—In the upper part of the Aruban Miocene a number of specimens were found which can only be tentatively referred to this species. They differ from Cushman's type in having rather low costae, whereas the greatest breadth is usually found in the higher portion of the test. In some cases the apertural neck is nearly entirely absent. These granular *Uvigerinae* have been observed in the higher samples of the section, partly overlapping the range of *U. hispido-costata.* The number of individuals from this part of the boring, where both species occur together, is too scarce to allow the determination of relations between them in our material. Only few more or less intermediate specimens were found.

Occurrence.—21-27 (see Distribution Chart No. 6) confined to the upper part of the upper zone of the Oranjestad Miocene.

Coll. No.—D-33190, 33191

Uvigerina proboscidea Schwager

Plate 21, figure 28

Uvigerina proboscidea SCHWAGER, 1866, Novara Exped., Geol. Theil, vol. 2, pt. 2, p. 250, pl. 7, fig. 96; CUSHMAN and TODD, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 73, pl. 17, fig. 9, pl. 19, figs. 3-9.

Remarks.—The Oranjestad specimens belonging to this species fall completely within the range of variation, given by Cushman and Todd. No doubt some forms determined as *U. auberiana* Orbigny (1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 106, pl. 2, figs. 23, 24) from the West Indian area belong to *U. proboscidea,* as d'Orbigny's species is represented by a nearly entirely biserial specimen.

Occurrence.—36 (R), 39 (R)

Coll. No.—D-33192, 33193

Uvigerina rutila Cushman and Todd

Plate 21, figures 29, 30

Uvigerina rutila CUSHMAN and TODD, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 78, pl. 20, figs. 16-22.

Remarks.—The figures of Cushman and Todd show a larger amount of variation in the number of costae on each chamber, than is indicated in their description. Our specimens lack the initial spines, a character, however, not shown in the holotype figure. It is probable that *U. charltonae* Palmer (1945, Bull. Amer. Paleont., vol. 29, no. 115, p. 49, pl. 1, fig. 3) may be identical with *U. rutila.*

Occurrence.—25-44 (see Distribution Chart No. 49), most common in the sandy samples 36-38.

Coll. No.—D-33194, 33195

Genus **Siphogenerina** Schlumberger, 1883

Siphogenerina lamellata Cushman

Plate 22, figures 1, 2

Siphogenerina lamellata CUSHMAN, 1918, U. S. Geol. Survey, Bull. 676, p. 55, pl. 12, fig. 3; CUSHMAN, 1930, Flor. State Geol. Survey, Bull. 4, p. 49, pl. 9, fig. 10; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 165. pl. 7, fig. 25.

Remarks.—The figure of Cushman's holotype is rather indistinct. From his later figures and from those of Renz the range of variation within the species can be estimated. The Aruban specimens never show a phialine lip on the aperture and they have usually less lamellate costae than is shown in the holotype.

Occurrence.—21-44 (see Distribution Chart No. 7).

Coll. No.—D-33196, 33197

Genus **Angulogerina** Cushman, 1927

Angulogerina illingi Cushman and Renz

Angulogerina illingi CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 21, pl. 3, figs. 19, 20; CUSHMAN and TODD, 1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 52, pl. 8, fig. 2; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 114, pl. 7, figs. 31, 32.

Occurrence.—30 (R)

Coll. No.—D-33198

Angulogerina occidentalis (Cushman)

Plate 21, figures 32, 33

Uvigerina angulosa CUSHMAN (non Williamson), 1922, Carnegie Inst., Wash., Publ. 311, p. 34, pl. 5, figs. 3, 4.

Uvigerina occidentalis CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 169.

Angulogerina occidentalis CUSHMAN, 1930, Flor. State Geol. Survey, Bull. 4, p. 50, pl. 9, figs. 8, 9; BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 218, pl. 13, fig. 57.

Remarks.—Most of the Oranjestad specimens are only partly costate, being nearest to those figured by Cushman from the Miocene of Florida.

Occurrence.—23-43 (see Distribution Chart No. 34).

Coll. No.—D-33199

Genus **Siphonodosaria** Silvestri, 1924

In the course of time several genera have been erected for straight, uniserial, perforate Foraminifera, mainly based on the apertural characteristics. The few specimens occurring in the Oranjestad samples are often broken, whereas in cases in which these characteristics were visible, they proved to be variable. In this paper all species are tentatively placed in the genus *Siphonodosaria.*

Siphonodosaria antillea (Cushman)

Plate 19, figure 29

Nodosaria antillea Cushman, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 91, pl. 14, fig. 9.

Occurrence.—30-43 (see Distribution Chart No. 59).

Coll. No.—D-33089, 33090

Siphonodosaria paucistriata (Galloway and Morrey) var.

Plate 24, figure 2

Nodosarella paucistriata Galloway and Morrey, 1929, Bull. Am. Paleont., vol. 15, no. 55, p. 42, pl. 6, fig. 12; Coryell and Rivero, 1940, Journ. of Pal., vol. 14, p. 343, pl. 42, figs. 21-23.

Ellipsonodosaria verneuili (Orbigny) var. *paucistriata,* Cushman, 1929, Contrib. Cushman Lab. Foram. Res., vol. 5, p. 97, pl. 14, figs. 4, 5; Renz, 1948, Geol. Soc. of Amer., Mem. 32, p. 131, pl. 8, figs. 6, 7.

Remarks.—Among earlier authors some confusion exists about the apertural characteristics of this species. In well-preserved specimens from Oranjestad the aperture is definitely rounded with a striate neck and a thick, somewhat flaring lip. Some of them, however, show a tooth-like extension at the inner border of the aperture, which in others is distinctly absent. In addition to the sutural striae most of our specimens develop a row of slight knobs on the lower part of the chambers, which is not shown in any of the previously pictured specimens.

Occurrence.—39-44 (see Distribution Chart No. 85), confined to the lower zone of the Oranjestad Miocene.

Coll. No.—D-33092, 33093

Family ELLIPSOIDINIDAE

Genus **Gonatosphaera** Guppy, 1894

Gonatosphaera prolata Guppy

Gonatosphaera prolata Guppy, 1894, Zool. Soc. London, Proc., p. 651, pl. 41, figs. 14-19; Cushman, 1929, Contrib. Cushman Lab. Foram. Res., vol. 5, p. 97, pl. 13, fig. 41.

Lingulina prolata Renz, 1948, Geol. Soc. of Amer., Mem. 32, p. 144, pl. 5, fig. 24.

Remarks.—The few specimens found closely resemble Cushman's figure from Aguide, Venezuela.

Occurrence.—42 (R), 43 (R)

Coll. No.—D-33200

Family ROTALIIDAE

Genus **Discorbis** Lamarck, 1804

Discorbis bertheloti (Orbigny) var. **floridensis Cushman**

Plate 24, figure 3

Discorbis bertheloti (Orbigny) var. *floridensis* Cushman, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 17, pl. 3, figs. 3-5; Cushman and Jarvis, 1930, Journ. of Pal., vol. 4, p. 364, pl. 33, fig. 12.

Remarks.—Among the specimens, considered to belong to this species, some smaller ones were noticed more or less resembling the type of *D. bertheloti* (Orbigny) (1839, in Barker, Webb and Berthelot, Hist. nat. des Iles Canaries, vol. 2, pt. 2, p. 135, pl. 1, figs. 28-30).

Occurrence.—17-44 (see Distribution Chart No. 80).

Coll. No.—D-33201

Discorbis mira Cushman

Discorbis mira Cushman, 1922, Carn. Inst., Wash., Publ. 311, p. 39, pl. 6, figs. 10, 11.

Occurrence.—43 (R)

Coll. No.—D-33402

Discorbis orbicularis (Terquem)

Rosalina orbicularis Terquem, 1876, Mém. Soc. Dunkerquoise (1877), vol. 20, p. 166, pl. 9, fig. 4.

Discorbis orbicularis Cushman, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 27, pl. 6, fig. 3.

Occurrence.—17-43 (see Distribution Chart No. 88).

Coll. No.—D-33203

Discorbis orbicularis (Terquem) var. **selseyensis** (Heron-Allen and Earland)

Discorbina rosacea (Orbigny) var. *selseyensis* Heron-Allen and Earland, 1911, Journ. Roy. Micr. Soc., London, p. 330, pl. 10, figs. 20, 21.

Discorbis orbicularis (Terquem) var. *selseyensis* Cushman, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 29, pl. 7, fig. 1.

Occurrence.—43 (R), a single specimen.

Coll. No.—D-33204

Genus **Gyroidina** Orbigny, 1826

Gyroidina parva Cushman and Renz var. **oranjestadensis** Drooger n. var.

Plate 22, figure 4

Description.—Variety differing from the typical species in having only 5 chambers in the final whorl and the last-formed coil not depressed below the previous one.

Diameter: 0.18-0.30 mm.

Remarks.—This is probably a local Aruban variety of *G. parva* from the Oligocene-Miocene of Venezuela (1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 23, pl. 4, fig. 2). The variety shows small, but constant, differences with respect to the species. Only few specimens have the final whorl slightly depressed below the previous one.

Occurrence.—24-44 (see Distribution Chart No. 43). Holotype from Miocene, sample 42 (780-800 feet below the surface-level) of the Oranjestad boring, Aruba.

Coll. No.—D-33205, 33206

Gyroidina venezuelana (Renz) var. **arubana** Drooger n. var.

Plate 22, figures 5, 6

Description.—Test small, biconvex, dorsally less convex than ventrally, at the latter side forming a low cone; the ventral side with a narrow, rather deep umbilicus; periphery subacute, slightly if at all lobulate; chambers distinct, dorsally three or four whorls visible, 9-10 chambers in the last-formed coil; sutures dorsally radial, straight, limbate, usually slightly raised, ventrally nearly radial, tangential to the small umbo, straight, limbate and raised, especially near the umbo; wall thin, smooth, finely perforate; aperture ventral, a narrow elongate slit along the inner margin of the last-formed chamber, extending from near the umbilicus to near the periphery. Usually the aperture is indistinct due to the final chamber being partly broken off.

Diameter: 0.18-0.30 mm.

Remarks.—This variety differs from the typical species, *Gyroidinoides venezuelana* Renz (1948, Geol. Soc. of Amer., Mem. 32, p. 141, pl. 12, fig. 21) in its more convex dorsal side, slightly lower number of chambers, and raised sutures which are straight and dorsally radial.

This new variety might be considered as a local Aruban mutant of a species from Venezuela. The latter is known from the Upper Oligocene and Lower Miocene of the Agua Salada group of formations in the State of Falcón.

Occurrence.—32-44 (see Distribution Chart No. 63), nearly entirely confined to the lower zone of the Oranjestad Miocene. Holotype from Miocene, sample 41 (760-780 feet below the surface-level) of the Oranjestad boring, Aruba.

Coll. No.—D-33207, 33208

Gyroidina vicksburgensis (Cushman) var. **hannai Garrett**

Plate 22, figure 7

Gyroidina vicksburgensis (Cushman) var. *hannai* GARRETT, 1939, Journ. Pal., vol. 13, p. 578, pl. 66, fig. 5.

Remarks.—Part of our specimens show an open umbilicus, which in others is filled with shell-substance.

Occurrence.—36-43 (see Distribution Chart No. 81), restricted to the lower zone of the Oranjestad Miocene.

Coll. No.—D-33209, 33210

Genus **Eponides** Montfort, 1808

Eponides parantillarum Galloway and Heminway

Eponides parantillarum GALLOWAY and HEMINWAY, 1941, New York Ac. Sci., Sci. Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 374, pl. 18, fig. 1; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 133.

Remarks.—The individual variation of the Oranjestad specimens is fairly large. As in the type from Porto Rico they are dorsally usually more strongly convex than ventrally, but reverse and all intermediate conditions occur also. Some of our specimens sometimes have their dorsal sutures slightly raised.

Occurrence.—18-44 (see Distribution Chart No. 8).

Coll. No.—D-33211

Eponides praecinctus (Karrer)

Rotalia praecincta KARRER, 1868, Sitzungsber. Akad. Wiss., Wien, vol. 58, pt. 1, p. 189, pl. 5, fig. 7.

Truncatulina praecincta BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 667, pl. 95, figs. 1-3.

Eponides praecinctus PALMER, 1940, Mem. Soc. Cub. Hist. Nat., vol. 14, pt. 1, p. 181, pl. 15, figs. 12, 13.

Occurrence.—25-44 (see Distribution Chart No. 50).

Coll. No.—D-33212

Eponides umbonatus (Reuss) var. **ecuadorensis** (Galloway and Morrey)

Rotalia ecuadorensis GALLOWAY and MORREY, 1929, Bull. Amer. Paleont., vol. 15, no. 55, p. 26, pl. 3, fig. 13.

Eponides umbonatus (Reuss) var. *ecuadorensis* BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 249, pl. 17, figs. 25-27.

Remarks.—Among our specimens intermediates are present between this variety and *E. umbonatus* (Reuss) (1851, Zeitschr. d. d. geol. Ges., vol. 3, p. 75, pl. 5, fig 35).

Occurrence.—33-42 (see Distribution Chart No. 66).

Coll. No.—D-33213

Genus **Rotalia** Lamarck, 1804

Rotalia beccarii (Linné)

Nautilus beccarii LINNÉ, 1767, Syst. Nat., ed. 12, p. 1162.

Rotalia beccarii CUSHMAN, 1928, Contrib. Cushman Lab. Foram. Res., vol. 4, p. 103, pl. 15; CUSHMAN, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 61, pl. 12, figs. 1-7, pl. 13, figs. 1, 2.

Streblus beccarii RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 167, pl. 9, fig. 2.

Remarks.—A large number of specimens, belonging to this species, have been found in the Oranjestad samples, all being of about equal size (diameter 0.25-0.35 mm.). They resemble the figures 3-5 in Cushman (1931), which represent, however, different stages of development of the species. A sutural development as given in Cushman's figures 6 and 7 (1931) is not seen in our material. The ornamentation of the umbo is highly variable, an umbilicus hardly filled to one completely filled and with one or more bosses of shell-substance. The number of chambers in the final coil is variable between 6 and 13. Specimens referable to *R. beccarii* (Linné) var. *tepida* Cushman (1926, Carn. Inst., Wash., Publ. 344, p. 79, pl. 1, fig. 3) were also found in the Oranjestad samples.

Occurrence.—23-44 (see Distribution Chart No. 35), abundant in sample 44. When this species plays a dominant part in a fauna it indicates shallow water environment. In sample 44 the relative abundance of *R. beccarii* may have been caused by redeposition.

Coll. No.—D-33214

Rotalia rosea Orbigny

Rotalia rosea ORBIGNY, 1826, Ann. Sci. Nat., sér. 1, tome 7, p. 272, mod. 36; CUSHMAN, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 62, pl. 13, fig. 5.

Occurrence.—36 (R)

Coll. No.—D-33215

Genus **Epistomina** Terquem, 1883

Epistomina elegans (Orbigny)

Rotalia elegans ORBIGNY, 1826, Ann. Sci. Nat., sér. 1, tome 7, p. 276.

Epistomina elegans CUSHMAN, 1927, Contrib. Cushman Lab. Foram. Res., vol. 3, p. 182, pl. 31, 32.

Occurrence.—17-39 (see Distribution Chart No. 44).

Coll. No.—D-33216

Genus **Siphonina** Reuss, 1850

Siphonina pozonensis Cushman and Renz

Plate 24, figure 11

Siphonina pozonensis CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 24, pl. 4, fig. 3; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 166, pl. 8, fig. 16.

Remarks.—The Oranjestad specimens show only slightly curved ventral sutures, and a test which is usually less thick than that of the type-specimen. They are considered to belong here and not to *S. tenuicarinata* Cushman (1927, Journ. of Pal., vol. 1, p. 166, pl. 26, figs. 11, 12), though both species are obviously closely related. The Aruban representatives of *S. pozonensis* lack the wide peripheral keel with the distinct dorsal fimbriations of *S. tenuicarinata*. The latter feature is only faintly present on the keel of some of our specimens.

Occurrence.—21-43 (see Distribution Chart No. 9).

Coll. No.—D-33217

Siphonina pulchra Cushman

Siphonina pulchra CUSHMAN, 1919, Carn. Inst., Wash., Publ. 291, p. 42, pl. 14, fig. 7; CUSHMAN, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 69, pl. 14, figs. 2, 3.

Remarks.—Our specimens are rather small (diameter 0.3-0.4 mm.) resembling the figure given in Cushman (1931, fig. 3) which shows a young stage of the species from Montego Bay, Jamaica. The larger specimens possess a more rounded periphery.

Occurrence.—17 (F), restricted to the Pleistocene marl.

Coll. No.—D-33218

Genus **Cancris** Montfort, 1808

Cancris sagra (Orbigny)

Rotalina sagra ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 77, pl. 5, figs. 13-15.

Cancris sagra BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 256, pl. 18, figs. 28-30.

Occurrence.—17 (R), restricted to the Pleistocene marl.

Coll. No.—D-33220

Family AMPHISTEGINIDAE

Genus **Asterigerina** Orbigny, 1839

Asterigerina carinata Orbigny

Asterigerina carinata ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 118, pl. 5, fig. 25; pl. 6, figs. 1, 2; CUSHMAN, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 77, pl. 15, figs. 4, 5.

Occurrence.—17-44 (see Distribution Chart No. 11).

Coll. No.—D-33219

Genus **Amphistegina** Orbigny, 1826

Amphistegina lessonii Orbigny

Amphistegina lessonii ORBIGNY, 1826, Ann. Sci. Nat., sér. 1, tome 7, p. 304, pl. 17, figs. 1-4; CUSHMAN, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 79, pl. 16, figs. 1-3.

Amphistegina gibbosa ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 120, pl. 8, figs. 1-3.

Remarks.—Our specimens are highly variable as to the relative thickness of the test and the size of the umbilical knob.

Occurrence.—17-44 (see Distribution Chart No. 10). *A. lessonii* is nearly the only recognizable species in the Holocene-Pleistocene limestones above sample 17.

Coll. No.—D-33221

Family CYMBALOPORIDAE

Genus **Cymbaloporetta** Cushman, 1927

Cymbaloporetta squammosa (Orbigny)

Rosalina squammosa ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 91, pl. 3, figs. 12-14.

Cymbaloporetta squammosa BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 266, pl. 19, figs. 40-42.

Occurrence.—17 (R), in the Pleistocene marl only.

Coll. No.—D-33222

Family CASSIDULINIDAE

Genus **Cassidulina** Orbigny, 1826

Cassidulina carapitana Hedberg

Plate 24, figure 12

Cassidulina carapitana HEDBERG, 1937, Journ. of Pal., vol. 11, p. 680, pl. 92, fig. 6; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 124, pl. 9, fig. 8.

Remarks.—Some of the Oranjestad specimens develop a distinct thin peripheral keel.

Occurrence.—23-44 (see Distribution Chart No. 36).

Coll. No.—D-33223

Cassidulina subglobosa Brady

Plate 24, figure 13

Cassidulina subglobosa BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 430, pl. 54, fig. 17; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 125, pl. 9, figs. 11, 12.

Occurrence.—21-44 (see Distribution Chart No. 12).

Coll. No.—D-33224-33226

Cassidulina subglobosa Brady
var. **subcalifornica** Drooger n. var.

Plate 22, figures 8, 9

Description.—Variety differing from the typical species in having a moderately compressed test.

Diameter up to 0.45 mm.

Remarks.—This new variety is very close to *C. californica* Cushman and Hughes (1925, Contrib. Cushman Lab. Foram. Res., vol. 1, p. 12, pl. 2, fig. 1) from the Pliocene and Pleistocene of California. It differs from this species in the shape of the aperture. Both, however, are distinctly related to *C. subglobosa* Brady. The varietal characters can only be observed in larger specimens, thus suggesting that smaller specimens are inseparable from the juvenile forms of *C. subglobosa*. *C. subglobosa* var. *subcalifornica* possibly represents the ancestral form of *C. californica*. Our specimens are about half the size of typical representatives of the species.

Occurrence.—The same as for *C. subglobosa* Brady. Typical specimens of this variety are rare, but intermediate forms between the species and the variety are abundant, especially in the lower part of the section. In the upper zone of the Oranjestad Miocene specimens are considerably smaller than in the lower zone. Holotype from the Miocene, sample 42 (780-800 feet below the surface-level) of the Oranjestad boring, Aruba.

Coll. No.—D-33225-33227

Genus **Cassidulinoides** Cushman, 1927

Cassidulinoides bifrons Drooger n. sp.

Plate 24, figures 14, 15

Description.—Test fusiform, narrowly rounded at both ends, about twice as long as broad, nearly circular in transverse section; chambers biserially arranged in about a half coil, from one side nearly all chambers, except the first ones, visible, from the other side only the last-formed two, which extend to the base of the test; sutures nearly straight, slightly if at all depressed; wall smooth, finely perforate, aperture an elongate opening in a depression of the apertural face, extending from the inner margin of the final chamber to the top of the test.

Length up to 0.45 mm.

Remarks.—Although only very few specimens could be obtained from the samples, their features are strikingly different from those in all other known species of the genus. A new species is, therefore, proposed. The morphological characters of *C. bifrons* are more or less intermediate between those of the genera *Cassidulina* and *Cassidulinoides*. *C. simplex* Cushman and Todd (1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 63, pl. 10, fig. 15) from the Miocene of Jamaica and *C. nipeensis* Keyzer (1945, Outline of the Geology of the Eastern part of the Province of Oriente, Cuba; Acad. Thesis Utrecht, p. 204, pl. 4, fig. 53) from the Oligocene-Miocene of Cuba show intermediate features in the arrangement of the chambers between *C. bifrons* and the other regularly uncoiling representatives of the genus *Cassidulinoides*. As far as could be ascertained, the chambers in *C. bifrons* are entirely biserial, the earliest portion being somewhat indistinct.

Occurrence.—39 (R), 43 (R)

Holotype from Miocene, sample 39 (720-740 feet below the surface-level) of the Oranjestad boring, Aruba.

Coll. No.—D-33228

Cassidulinoides bradyi (Norman)

Cassidulinoides bradyi BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 431, pl. 54, figs. 6-10.

Occurrence.—17 (R), only observed in the Pleistocene marl.

Coll. No.—D-33229

Cassidulinoides marksi Drooger n. sp.

Plate 22, figure 10

Description.—Test close-coiled in the early portion, somewhat uncoiling in the adult, very slightly compressed; chambers distinct, somewhat inflated, strongly overlapping in the adult, the last-formed two making up about two thirds of the entire test; sutures somewhat depressed; wall smooth, finely perforate; aperture large, at the inner margin of the last-formed chamber, extending upwards, nearly entirely filled with a thin plate-like tooth.

Length up to 0.45 mm.

Remarks.—*C. marksi* differs from *C. braziliensis* (Cushman) (1922, U. S. Nat. Mus., Bull. 104, pt. 3, p. 130, pl. 25, figs. 4, 5) and *C. compacta* Cushman and Ellisor (1945, Journ of Pal., vol. 19, p. 570, pl. 78, fig. 3) by its typical aperture and the strongly overlapping later chambers. Young individuals of *C. marksi* resemble *C. compacta* in their chamber-arrangement, but they are considerably thicker. *C. bradyi* (Norman) is a rather strongly compressed species. Bermudez records this species (1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 270, pl. 20, figs. 29-31) from the Oligocene and Miocene of the Dominican Republic. It may be closely related to, if not identical with *C. marksi.*

Occurrence.—31-43 (see Distribution Chart No. 61). Holotype from Miocene, sample 34 (630-666 feet below the surface-level) of the Oranjestad boring, Aruba.

Coll. No.—D-33230, 33231

Cassidulinoides sp.

Plate 24, figure 16

Remarks.—Very few specimens of an elongate, nearly cylindrical *Cassidulinoides* were found, which can not be placed under any known species. They differ from *C. mexicana* (Cushman) (1922, U. S. Nat. Mus., Bull. 104, pt. 3, p. 131, pl. 24, fig. 5) in not having a protruding early portion and by the presence of faint longitudinal striae with the perforations in between.

Occurrence.—42 (R)

Coll. No.—D-33232

Genus **Ehrenbergina** Reuss, 1850

Ehrenbergina spinea Cushman

Plate 22, figure 11

Ehrenbergina spinea CUSHMAN, 1935, Smiths. Misc. Coll., Wash., vol. 91, no. 21, p. 8, pl. 3, figs. 10, 11; CUSHMAN and TODD, 1945, Cushman Lab. Foram. Res., Spec. Publ. 15, p. 63, pl. 11, fig. 2.

Occurrence.—36-44 (see Distribution Chart No. 82), restricted to the lower zone of the Oranjestad Miocene.

Coll. No.—D-33233, 33234

Ehrenbergina spinea Cushman var. **amina** Bermudez

Plate 22, figure 12

Ehrenbergina amina BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 270, pl. 20, figs. 44-46.

Remarks.—In addition to typical *E. spinea* other specimens occur with a higher apertural face and relatively shorter lateral spines. They are identical with Bermudez' *E. amina.* In the Oranjestad samples both forms are intergrading and always found together. Thus Bermudez' species is here considered to be merely a varietal form in our material noted separately, howver, for its possibly restricted Miocene value.

Occurrence.—36-44 (see Distribution Chart No. 82).

Coll. No.—D-33234, 33235

Family CHILOSTOMELLIDAE

Genus **Pullenia** Parker and Jones, 1862

Pullenia bulloides (Orbigny)

Nonionina bulloides ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 107, pl. 5, figs. 9, 10.

Pullenia bulloides CUSHMAN and TODD, 1943, Contrib. Cushman Lab. Foram. Res., vol. 19, p. 13, pl. 2, figs. 15-18.

Occurrence.—33-44 (see Distribution Chart No. 67).

Coll. No.—D-33236

Pullenia quinqueloba (Reuss)

Nonionina quinqueloba REUSS, 1851, Zeitschr. d. d. geol. Ges., vol. 3, p. 71, pl. 5, fig. 31.

Occurrence.—42 (R)

Coll. No.—D-33237

Family GLOBIGERINIDAE

Genus **Globigerina** Orbigny, 1826

Globigerina altispira Cushman and Jarvis

Plate 24, figure 19

Globigerina altispira CUSHMAN and JARVIS, 1936, Contrib. Cushman Lab. Foram. Res., vol. 12, p. 5, pl. 1, figs. 13, 14.

Remarks.—The Oranjestad specimens show four or five chambers in the final whorl.

Occurrence.—Common to abundant in most samples 21-44.

Coll. No.—D-33238, 33239

Globigerina apertura Cushman

Globigerina apertura CUSHMAN, 1918, U. S. Geol. Survey, Bull. 676, p. 57, pl. 12, fig. 8; GALLOWAY and WISSLER, 1927, Journ. of Pal., vol. 1, p. 40, pl. 7, fig. 5.

Occurrence.—Present in most samples of the Oranjestad Miocene.

Coll. No.—D-33240

Globigerina sp. cf. **G. bulloides** Orbigny

Globigerina bulloides ORBIGNY, 1826, Ann. Sci. Nat., sér. 1, tome 7, p. 277, mod. 17, 76; CUSHMAN, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 38, pl. 10, figs. 1-13.

Remarks.—Specimens in the Oranjestad samples, resembling d'Orbigny's species, are characterized by their very small size. They possibly represent juvenile forms of other species.

Occurrence.—Throughout the column.

Coll. No.—D-33243

Globigerina sp. cf. **G. conglomerata** Schwager

Globigerina conglomerata SCHWAGER, 1866, Novara Exped., Geol. Theil, vol. 2, pt. 2, p. 255, pl. 7, fig. 113.

Remarks.—The type of this species is insufficiently figured by Schwager. Specimens from Oranjestad are tentatively referred to this species, although they might represent indistinct forms of *G. altispira* Cushman and Jarvis, in which the apertural characters are obscured by later filling of the umbilicus with sedimentary material.

Occurrence.—Observed in most samples 21-44.

Coll. No.—D-33244

Globigerina dutertrei Orbigny

Globigerina dutertrei ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 95, pl. 4, figs. 19-21.

Occurrence.—Ubiquitous.

Coll. No.—D-33245

Globigerina subcretacea Chapman

Globigerina cretacea BRADY (non Orbigny), 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 596, pl. 82, fig. 10.

Globigerina subcretacea CHAPMAN, 1902, Journ. Linn. Soc., Zoology, vol. 28, p. 410, pl. 36, fig. 16.

Occurrence.—In large numbers throughout the whole section.

Coll. No.—D-33246, 33247

Globigerina (Globigerinita) naparimaensis (Brönnimann)

Plate 24, figures 20 a-c

Globigerinatella aff. *insueta* BRÖNNIMANN, 1950, Contrib. Cushman Found. Foram. Res., vol. 1, p. 82, pl. 14. fig. 11.

Globigerinita naparimaensis BRÖNNIMANN, 1951, Contrib. Cushman Found. Foram. Res., vol. 2, p. 18, textfigs. 1-14.

Remarks.—Specimens in which the thin wall of the final chamber is partly broken off, distinctly show the characters of *G. apertura* Cushman in the earlier portion of the test. It should be remarked that all observed specimens are much smaller than the adult representatives of *G. apertura* which occur in the same samples. *G. naparimaensis* was only found in small numbers in two samples of the boring. Possibly we are dealing with aberrant immature individuals of *G. apertura,* originated under some unknown environmental influence. This opinion may be strengthened by the fact that in the same samples some individuals of the *G. altispira*-group were found with a relatively small final chamber. Another fact for our point of view is that in some samples of recent material of the Snellius Expedition (East Indies) we also found *G. naparimaensis* in small numbers and as very small individuals.

Morphologically the subgeneric nature of this species seems to be fully justified, but from our data we consider the specimens to be aberrant individuals of one or more normal *Globigerina* species. Similar features in *Globigerina* are also shown in the Upper Eocene *G. dissimilis* Cushman and Bermudez, 1937, and *G. bulloides* Orbigny var. *cryptomphala* Glaessner, 1937.

Until the biologic relations of these peculiar forms are fully understood they are best left as own species in the subgenus *Globigerinita.*

Occurrence.—32 (R), 33 (R)

Genus **Globigerinoides** Cushman, 1927

Globigerinoides conglobatus (Brady)

Globigerina conglobata BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 603, pl. 80, figs. 1-5.

Remarks.—Some specimens show intermediate characters between *C. conglobatus* and *G. trilobus* (Reuss).

Occurrence.—Abundantly present in all samples. Some specimens have also been observed in the Holocene-Pleistocene limestones.

Coll. No.—D-33248, 33249

Globigerinoides ruber (Cushman)

Globigerina rubra CUSHMAN (non Orbigny), 1924, U. S. Nat. Mus., Bull. 104, pt. 5, p. 15, pl. 3, figs. 4-7.

Remarks.—The original figures of d'Orbigny do not show the rather high, many-chambered *Globigerinoides* pictured by most later authors, but a form close to *G. trilobus.* In sample 17 few indistinct specimens have been found, resembling those figured by Cushman.

Occurrence.—17 (R)

Coll. No.—D-33250

Globigerinoides trilobus (Reuss)

Globigerina triloba REUSS, 1850, Denkschr. Akad. Wiss., Wien, vol. 1, p. 374, pl. 47, fig. 11.

Occurrence.—Ubiquitous.

Coll. No.—D-33251, 33252

Genus **Globigerinella** Cushman, 1927

Globigerinella aequilateralis (Brady)

Globigerina aequilateralis BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 605, pl. 80, figs. 18-21.

Occurrence.—17-43 (see Distribution Chart No. 92).

Coll. No.—D-33253

Genus **Orbulina** Orbigny, 1839

Orbulina universa Orbigny

Orbulina universa ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 2, pl. 1, fig. 1.

Occurrence.—17-44 (see Distribution Chart No. 21).

Coll. No.—D-33254

Genus **Pulleniatina** Cushman, 1927

Pulleniatina obliquiloculata (Parker and Jones)

Pullenia obliquiloculata PARKER and JONES, 1865, Roy. Soc., London, Philos. Trans., vol. 155, p. 368, pl. 19, fig. 4.

Pulleniatina obliquiloculata BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 283, pl. 22, figs. 5-7.

Occurrence.—25-39 (see Distribution Chart No. 51), only very few specimens.

Coll. No.—D-33255

Genus **Sphaeroidinella** Cushman, 1927

Sphaeroidinella rutschi Cushman and Renz

Plate 24, figure 21

Sphaeroidinella rutschi CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 25, pl. 4, fig. 5; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 167, pl. 10, fig. 1.

Occurrence.—24-44 (see Distribution Chart No. 45).

Coll. No.—D-33256

Genus **Candeina** Orbigny, 1839

Candeina nitida Orbigny

Candeina nitida ORBIGNY, 1839, in Ramon de la Sagra, Hist. phys. et nat. de l'Ile de Cuba, Foraminifères, p. 108, pl. 2, figs. 27, 28; BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 622, pl. 82, figs. 13-20.

Occurrence.—43 (R), a single specimen.

Coll. No.—D-33257

Family GLOBOROTALIIDAE

Genus **Globorotalia** Cushman, 1927

Globorotalia canariensis (Orbigny)

Plate 24, figure 18

Rotalina canariensis ORBIGNY, 1839, in Barker, Webb and Berthelot, Hist. Nat. des Iles Canaries, vol. 2, pt. 2, p. 130, pl. 1, figs. 34-36.

Pulvinulina canariensis BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 692, pl. 103, figs. 8-11.

Globorotalia canariensis CUSHMAN, 1929, Contrib. Cushman Lab. Foram. Res., vol. 5, p. 101, pl. 14, fig. 14; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 136, pl. 11, fig. 3.

Remarks.—Most specimens closely resemble the ones figured by Cushman and Renz from the Oligocene and Miocene of Venezuela. Few of them seem to be intermediate between *G. canariensis* and *G. hirsuta* (Orbigny) (1839, in Barker, Webb and Berthelot, Hist. Nat. des Iles Canaries, vol. 2, pt. 2, p. 131, pl. 1, figs. 37-39).

Occurrence.—20-44 (see Distribution Chart No. 13).

Coll. No.—D-33258

Globorotalia crassula Cushman and R. E. Stewart

Plate 24, figure 17

Pulvinulina crassa BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 692, pl. 103, figs. 11-12.

Globorotalia crassula CUSHMAN and STEWART, Trans. San Diego Soc. of Nat. Hist., vol. 6, p. 77, pl. 7, fig. 1.

Occurrence.—24-34 (see Distribution Chart No. 46), restricted to the upper zone of the Oranjestad Miocene.

Coll. No.—D-33259

Globorotalia menardii (Orbigny)

Rotalia menardii ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 273, mod. 10.

Globorotalia menardii CUSHMAN, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 91, pl. 17, fig. 1.

Remarks.—The specimens from Oranjestad show a wide variation as to the development of the peripheral keel and to the number of chambers in the final whorl, which amounts to 5 to 9. Some have a thick keel as is shown in *G. menardii* (Orbigny) var. *multicamerata* Cushman and Jarvis (1930, Journ. of Pal., vol. 4, p. 367, pl. 34, fig. 8) from the Miocene of Jamaica, but in none of these specimens does this character coincide with a high number of chambers. Only few specimens show a tendency in their morphological characters towards *G. menardii* (Orbigny) var. *tumida* (Brady) (1884, Rey. Voy. Challenger, Zoology, vol. 9, p. 692, pl. 103, figs. 4-6). The relation with *G. menardii* (Orbigny) var. *miocenica* Palmer of our species is not clear on account of the lack of a sufficient number of specimens.

Occurrence.—20-44 (see Distribution Chart No. 14).

Coll. No.—D-33260

Globorotalia menardii (Orbigny) var. **miocenica** Palmer

Globorotalia menardii (Orbigny) var. *miocenica* PALMER, 1945, Bull. Amer. Paleont., vol. 29, no. 115, p. 70, pl. 1, fig. 10; BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 287, pl. 22, figs. 12-14.

Occurrence.—25-34(see Distribution Chart No. 52), in small numbers in the upper zone of the Oranjestad Miocene.

Coll. No.—D-33261

Family ANOMALINIDAE

Genus **Planulina** Orbigny, 1826

Planulina antillea Drooger n. sp.

Plate 22, figures 13-15

(?) *Planulina* cf. *mexicana* RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 151, pl. 11, fig. 5.

Description.—Test complanate, strongly compressed, about two whorls visible on either side, dorsally flat, ventrally slightly convex with a raised umbilical knob of clear shell-substance, covering a variable part of the earlier chambers; periphery subacute; chambers distinct, curved, 9-10 in the last-formed whorl, the later chambers slightly inflated; sutures distinct, limbate, strongly to moderately curved, in the later portion with the strongest curvature near the middle of the chambers, slightly raised in the early part of the test, depressed in its later part; wall smooth to slightly granular, coarsely perforate; aperture peripheral, extending on the dorsal side along the inner margin of the last-formed two to five chambers.

Larger diameter 0.40-0.75 mm.

Remarks.—Some specimens have their later chambers more rapidly increasing in size than the previous ones. In this development the later sutures are less limbate and more depressed than in the holotype, but they keep the typical curvature. The size of the umbilical knob in *P. antillea* is variable from entirely covering the earlier whorls to being hardly present.

P. antillea differs from *P. mexicana* Cushman (1927, Contrib. Cushman Lab. Foram. Res., vol. 3, p. 113, pl. 23, fig. 5), mainly in the development of an umbilical knob and in the typical curvature of the sutures. The sutures of *P. subtenuissima* (Nuttall) (1928, Quart. Journ. Geol. Soc., London, vol. 84, p. 100, pl. 7, figs. 13, 15, textfig. 6) are more strongly curved, and those of *P. alazanensis* Nuttall (1932, Journ. of Pal., vol. 6, p. 31, pl. 8, figs. 4, 8, 9) less so. *P.* cf. *mexicana,* Renz may be identical with *P. antillea,* but Renz' figure of the ventral side does not allow to draw definite conclusions. Superficially representatives of *P. antillea* with more rapidly enlarging chambers somewhat resemble *Cibicides pseudoungerianus* var. *antilleana* nov. var. (see below), which are, however, immediately recognized by the much greater thickness of the test.

Occurrence.—34-44 (see Distribution Chart No. 75), nearly entirely confined to the lower zone of the Oranjestad Miocene. Holotype from the Miocene, sample 42 (780-800 feet below the surface-level) of the Oranjestad boring, Aruba.

Coll. No.—D-33262, 33263

Planulina ariminensis Orbigny

Plate 24, figure 22

Planulina ariminensis Orbigny, 1826, Ann. Sci. Nat., sér. 1, tome 7, p. 280, pl. 14, figs. 1-3; Cushman, 1929, Contrib. Cushman Lab. Foram. Res., vol. 5, p. 102, pl. 15, figs. 3, 4.

Remarks.—Only very few specimens from Oranjestad completely resemble the figures given by d'Orbigny and Cushman for this species. Most of them are intermediate in their characters between *P. ariminensis* and *P. crassa* Galloway and Heminway, and only a few are identical with the latter. In several specimens, moreover, only one keel is kept at different stages of the individual development, thus resembling *P. edwardsiana* Orbigny var. *canimarensis* Palmer and Bermúdez. In this case we are probably dealing with another varietal form of *P. ariminensis* Orbigny.

Typical specimens of *P. edwardsiana* var. *canimarensis* and *P. ariminensis* var. *crassa* occur especially in the Miocene part of the boring. The characters of the Pleistocene specimens in these respects are rather indistinct bcause in the Pleistocene marl most individuals of *P. ariminensis* show more or less irregular-growing later chambers, possibly due to a lack of sufficiently large, flat planes of attachment. A specimen, commencing such irregular growth, has been pictured.

Occurrence.—17-44 (see Distribution Chart No. 15).

Coll. No.—D-33264-33266

Planulina ariminensis Orbigny var. **canimarensis** Palmer and Bermudez

Planulina edwardsiana Orbigny var. *canimarensis* Palmer and Bermudez, 1936, Mem. Soc. Cub. Hist. Nat., vol. 9, no. 4, p. 256, pl. 21, figs. 4-6; Palmer, 1945, Bull. Amer. Paleont., vol. 29, no. 115, p. 71, pl. 1, fig. 9.

Occurrence.—See *P. ariminensis* Orbigny.

Coll. No.—D-33266

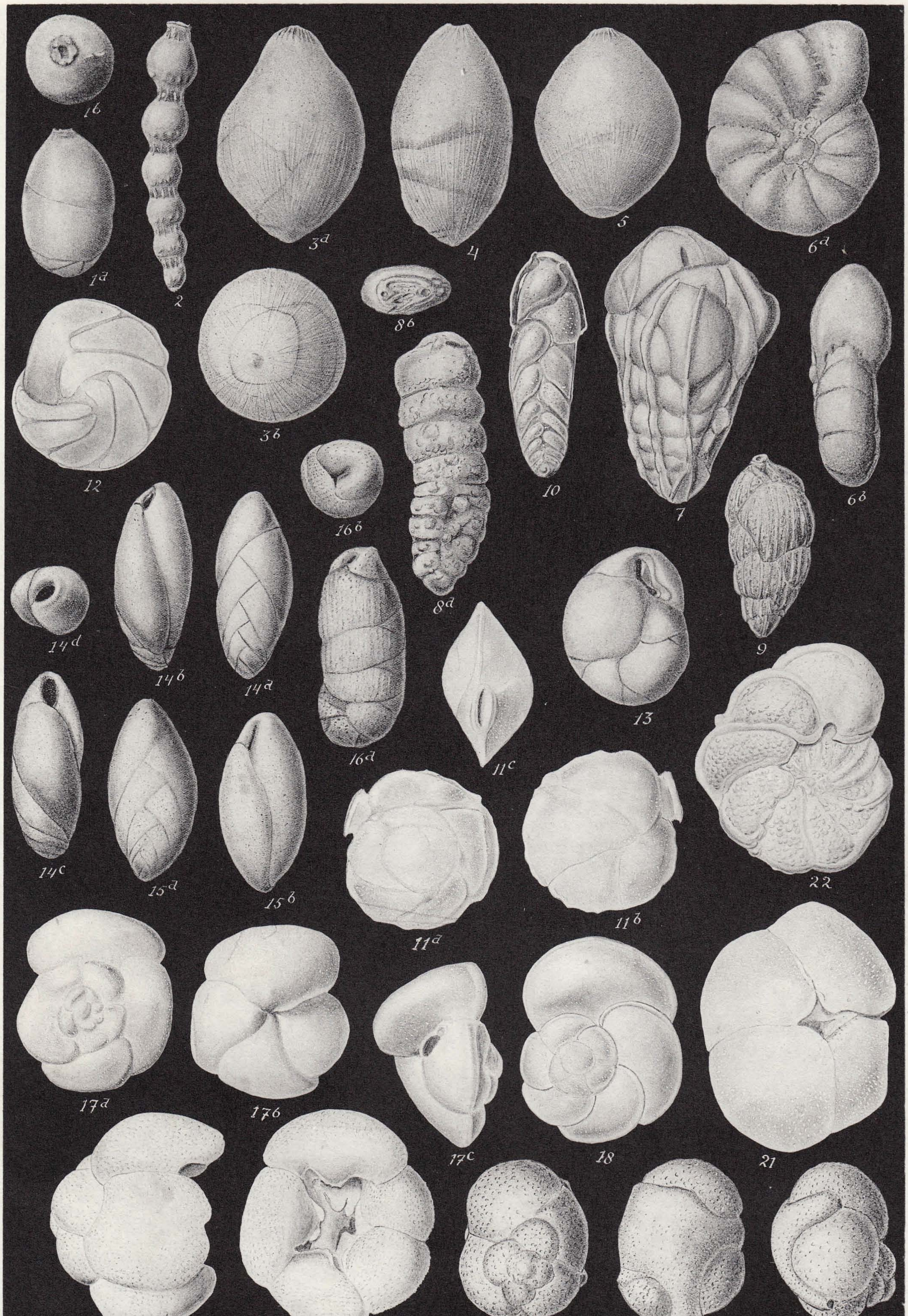
Planulina ariminensis Orbigny var. **crassa** Galloway and Heminway

Planulina crassa Galloway and Heminway, 1941, New York Ac. Sci., Sci. Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 4, p. 398, pl. 25, fig. 2;

EXPLANATION OF PLATE 23

Figs.		Page
1.	*Cibicides isidroensis* Cushman and Renz. Dorsal view. Miocene (42). × 45.	145
2a-c.	*Cibicides pseudoungerianus* (Cushman). 2a, dorsal view; 2b, ventral view; 2c, peripheral view. Miocene (21). × 45.	145
3a-c.	*Cibicides pseudoungerianus* (Cushman) var. *compressus* (Cushman and Renz). 3a, dorsal view; 3b, ventral view; 3c, peripheral view. Miocene (41). × 45.	146
4a-5b.	*Cibicides pseudoungerianus* (Cushman) var. *antilleana* Drooger n. var. 4, Holotype, 5, paratype. 4a, 5a, dorsal views; 4b, 5b, ventral views; 4c, peripheral view. Miocene (42 and 43). × 45.	146
6a-c.	*Cibicides mckannai* Galloway and Wissler. 6a, dorsal view; 6b, ventral view; 6c, peripheral view. Miocene (31). × 95.	146
7a-c.	*Cibicides mckannai* Galloway and Wissler var. *westermanni* Drooger n. var. Holotype. 7a, dorsal view; 7b, ventral view; 7c, peripheral view. Miocene (42). × 65.	146
8a-11b.	*Cibicides mckannai* Galloway and Wissler var. *arubana* Drooger n. var. 8, Holotype; 9-11, paratypes. 8a, 9a, 10a, 11a, dorsal views; 8b, 9b, 10b, 11b, ventral views. Miocene (42). × 65.	146
12a-14b.	*Cibicides mckannai* Galloway and Wissler var. *oranjestadensis* Drooger n. var. 12, Holotype; 13, 14, paratypes. 12a, 13a, 14a, dorsal views; 12b, 13b, 14b, ventral views. Miocene (42). Fig. 12, × 45; figs. 13, 14, × 65.	147

Drooger: Miocene and Pleistocene Foraminifera from Oranjestad, Aruba



Drooger: Miocene and Pleistocene Foraminifera from Oranjestad, Aruba

BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 290, pl. 23, figs. 25-27.
Occurrence.—See *P. ariminensis.*
Coll. No.—D-33266

Planulina wuellerstorffi (Schwager)

Anomalina wuellerstorffi SCHWAGER, 1866, Novara Exped., Geol. Theil, vol. 2, pt. 2, p. 258, pl. 7, figs. 105, 107.
Planulina wuellerstorffi CORYELL and RIVERO, 1940, Journ. of Pal., vol. 14, p. 337, pl. 44, fig. 3.
Occurrence.—25-44 (see Distribution Chart No. 53).
Coll. No.—D-33267

Genus **Cibicides** Montfort, 1808

Cibicides americanus (Cushman)

Truncatulina americana CUSHMAN, 1918, U. S. Nat. Mus., Bull. 103, p. 68, pl. 23, fig. 2.
Cibicides americanus RENZ, 1948, Geol. Sco. of Amer., Mem. 32, p. 126, pl. 11, fig. 10.
Occurrence.—21-44 (see Distribution Chart No. 16).
Coll. No.—D-33268, 33269

Cibicides floridanus (Cushman)

Truncatulina floridana CUSHMAN, 1918, U. S. Geol. Survey, Bull. 676, p. 62. pl. 19, fig. 2.
Cibicides floridanus CUSHMAN, 1930, Flor. State Geol. Survey, Bull. 4, p. 61, pl. 12, fig. 3.
Occurrence.—22-37 (see Distribution Chart No. 22).
Coll. No.—D-33270

Cibicides isidroensis Cushman and Renz

Plate 22, figure 16, Plate 23, figure 1

Cibicides isidroensis CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 26, pl. 4, fig. 10; RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 128, pl. 10, fig. 10.
Remarks.—Some specimens develop slightly thicker chambers in the adult than shown in the type specimen from Venezuela and the majority of the Aruban specimens. Usually the final chamber is broken off.
Occurrence.—24-44 (see Distribution Chart No. 47).
Coll. No.—D-33271, 33272

Cibicides lobatus (Orbigny)

Truncatulina lobata ORBIGNY, 1839, in Barker, Webb and Berthelot, Hist. Nat. des Isles Canaries, Foraminifères, vol. 2, pt. 2, p. 134, pl. 2, figs. 22-24.
Cibicides lobatus BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 301, pl. 25, figs. 46-48.
Occurrence.—27-44 (see Distribution Chart No. 55).
Coll. No.—D-33273

Cibicides pseudoungerianus (Cushman)

Plate 23, figure 2

Truncatulina ungeriana BRADY (non Orbigny), 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 664, pl. 94, fig. 9.
Truncatulina pseudoungeriana CUSHMAN, 1922, U. S. Geol. Survey, Prof. Paper 129, p. 97, pl. 20, fig. 9.
Cibicides pseudoungerianus CUSHMAN and TODD, 1945,

EXPLANATION OF PLATE 24

FIGS.		PAGE
1a, b.	*Marginulina subbullata* Renz (non Hantken). 1a, side view; 1b, apertural view. Miocene (43). × 65.	123
2.	*Siphonodosaria paucistriata* (Galloway and Morrey) var. Miocene (39). × 65.	137
3a-5.	*Glandulina striata* Drooger n. sp. 3, Holotype; 4, 5, paratypes. 3a, 4, 5, side views; 3b, basal view. Miocene (43). × 33.	126
6a, b.	*Elphidium simplex* Cushman. 6a, side view; 6b, apertural view. Miocene (44). × 95.	128
7.	*Bulimina falconensis* Renz. Miocene (44). × 95.	129
8a, b.	*Geminaricta* sp. cf. *G. virgata* (Cushman). 8a, side view; 8b, apertural view. Miocene (37). × 95.	133
9.	*Uvigerina* sp. cf. *U. peregrina* Cushman. Miocene (21). × 65.	136
10.	*Loxostomum instabile* Cushman and McCulloch. Miocene (42). × 65.	132
11a-c.	*Siphonina pozonensis* Cushman and Renz. 11a, dorsal view; 11b, ventral view; 11c, peripheral view. Miocene (33). × 65.	139
12.	*Cassidulina carapitana* Hedberg. Miocene (37). × 95.	140
13.	*Cassidulina subglobosa* Brady. Miocene (44). × 65.	140
14a-15b.	*Cassidulinoides bifrons* Drooger n. sp. 14, Holotype; 15, paratype. 14a, 15a, dorsal views; 14b, oblique ventral view; 15b, ventral view; 14c, side view; 14d, apertural view. Miocene (39 and 43). × 65.	140
16a, b.	*Cassidulinoides* sp. 16a, side view. 16b, apertural view. Miocene (42). × 95.	141
17a-c.	*Globorotalia crassula* Cushman and R. E. Stewart. 17a, dorsal view; 17b, ventral view; 17c, peripheral view. Miocene (34). × 95.	143
18.	*Globorotalia canariensis* (Orbigny). Dorsal view. Miocene (32). × 95.	143
19a, b.	*Globigerina altispira* Cushman and Jarvis. 19a, ventral view; 19b, side view. Miocene (23). × 65.	141
20a-c.	*Globigerina (Globigerinita) naparimaensis* (Brönnimann). 20a, dorsal view; 20b, ventral view; 20c, side view. Miocene (33). × 95.	142
21.	*Sphaeroidinella rutschi* Cushman and Renz. Miocene (34). × 65.	143
22.	*Planulina ariminensis* Orbigny. Pleistocene (17). × 65.	144

Cushman Lab. Foram. Res., Spec. Publ. 15, p. 70, pl. 12, fig. 7.

Remarks.—Throughout the Oranjestad section specimens of *Cibicides* occur which are considered to belong to this species. In the higher part of the Miocene of the boring typical specimens are most abundant, but downwards the characters gradually change to a form identical with *Cibicides floridanus* (Cushman) var. *compressus* (Cushman and Renz), recorded from the Oligocene-Miocene of Venezuela.

Occurrence.—21-44 (see Distribution Chart No. 18).

Coll. No.—D-33274, 33275

Cibicides pseudoungerianus (Cushman) var. **compressus** (Cushman and Renz)

Plate 23, figure 3

Cibicides floridanus (Cushman) var. *compressa* CUSHMAN and RENZ, 1941, Contrib. Cushman Lab. Foram. Res., vol. 17, p. 26, pl. 4, fig. 9.

Cibicides americanus RENZ, 1948, Geol. Soc. of Amer., Mem. 32, p. 127, pl. 10, fig. 9.

Description.—Variety differing from the typical species by the less prominent or usually absent umbilical filling of shell-material, the very strongly curved sutures and the more sinuous character of the ventral side between umbo and periphery.

Occurrence.—See *C. pseudoungerianus* (Cushman).

Coll. No.—D-33275, 33276

Cibicides pseudoungerianus (Cushman) var. **antilleana** Drooger n. var.

Plate 23, figures 4, 5

Description.—Variety differing from the typical species by the flat dorsal side, the more spreading and often somewhat irregular later chambers and the possession of a large ventral umbilical knob of clear shell-substance.

Larger diameter 0.6-1.0 mm.

Remarks.—Most specimens, observed in samples 42 and 43, in which this variety is best represented, show the sutural characteristics of *C. pseudoungerianus* (Cushman) var. *compressus* (Cushman and Renz).

Occurrence.—21-43 (see Distribution Chart No. 19). Holotype from Miocene, sample 42 (780-800 feet below the surface-level), Oranjestad boring, Aruba.

Coll. No.—D-33277, 33278

Cibicides mckannai Galloway and Wissler

Plate 23, figure 6

Cibicides mckannai GALLOWAY and WISSLER, 1927, Journ. of Pal., vol. 1, p. 65, pl. 10, figs. 5, 6.

Remarks.—This species seems to be closely related to *C. pseudoungerianus* (Cushman) according to our material. Specimens from the Oranjestad samples, referred to *C. mckannai,* differ from *C. pseudoungerianus* in their smaller size and greater relative thickness, and by having a more promient umbilical knob of clear shell-material. It is often extremely difficult, if not impossible, to separate specimens, belonging to *C. mckannai* from small specimens of *C. pseudoungerianus.* The sutures in the Oranjestad representatives range from very slightly depressed to very slightly raised, thus apparently placing *C. falconensis* Renz (1948, Geol. Soc. of Amer., Mem. 32, p. 128, pl. 11, fig. 7) from the Upper Oligocene-Lower Miocene of Venezuela in synonymy with *C. mckannai* Galloway and Wissler or as one of its varietal forms. Some specimens are very close to *C. sinistralis* Coryell and Rivero (1940, Journ. of Pal., vol. 14, p. 335, pl. 44, fig. 12) from the Middle Miocene of Haiti.

Occurrence.—17-44 (see Distribution Chart No. 17). Present in small numbers throughout the section of the boring.

Coll. No.—D-33279, 33280

Cibicides mckannai Galloway and Wissler var. **westermanni** Drooger n. var.

Plate 23, figure 7

Description.—Variety differing from the typical species in being dorsally flat and ventrally rather strongly convex, with usually more evenly curved sutures.

Larger diameter up to 0.5 mm.

Remarks.—Apart from the occurrence in the Miocene samples, a number of rather badly preserved specimens were observed in the Pleistocene marl, very probably belong to this variety. *C. mckannai* and this new variety are always found together. The variety strongly outnumbers the species in the lower zone of the Oranjestad Miocene, but in the upper zone conditions are reversed in a much smaller total number of individuals. A rapid change in the relative abundance occurs at samples 34 and 36. The new variety, however, becomes dominant again in the Pleistocene marl.

Occurrence.—See *C. mckannai* Galloway and Wissler. Holotype from Miocene, sample 42 (780-800 feet below the surface-level), Oranjestad boring, Aruba.

Coll. No.—D-33280-33282

Cibicides mckannai Galloway and Wissler var. **arubana** Drooger n. var.

Plate 23, figures 8-11

Description.—Variety differing from *C. mckannai* var. *westermanni* nov. var. in the irregular spreading arrangement of the later chambers, having apertures at the periphery of the irregular chambers. The later chambers are more distinctly perforate ventrally than the earlier ones.

Larger diameter up to 0.5 mm.

Remarks.—See *C. mckannai* var. *oranjestadensis* nov. var.

Occurrence.—17-43 (see Distribution Chart No. 93). Holotype from Miocene, sample 42 (780-800 feet below the surface-level), Oranjestad boring, Aruba.

Coll. No.—D-33283-33286

Cibicides mckannai Galloway and Wissler var. **oranjestadensis** Drooger n. var.

Plate 23, figures 12-14

Description.—Variety differing from *C. mckannai* Galloway and Wissler var. *arubana* nov. var. in having the later irregular chambers more or less biserially arranged.

Larger diameter up to 0.85 mm.

Remarks.—This variety is merely a special morphological case of the preceding one.

In samples 17, 42 and 43 a fairly large number of specimens of *Cibicides* occur with irregularly arranged later chambers. Similar forms are well-known in literature and have usually been assigned to the genera *Cibicidella* Cushman, and *Dyocibicides* Cushman and Valentine. Most specimens from Oranjestad, however, clearly show all characters of *C. mckannai* var. *westermanni* in the regularly formed early *Cibicides*-portion of the test. It seems, therefore, a case of interspecific variation rather than of generic differentiation. The irregular arrangement of the later chambers begins at different stages of the individual development. Sometimes the regular portion is very small or nearly entirely covered on the ventral side by the irregular later chambers. Some specimens may be related to *C. lobatus* (Orbigny) and should in such a case be referred to this species.

The aberrant forms probably originate under the influence of some special yet unknown, environmental condition because *C. mckannai* var. *westermanni* commonly occurs in many other samples of the boring, in which not a single irregular specimen was found. The ability to react on these environmental factors, however, is obviously a property inherent to the species since not all species of *Cibicides* evidently possess this ability. Possibly *C. lobatus,* which is rather scarce in the samples, reacts in about the same way. Furthermore only *C. pseudoungerianus* (Cushman) distinctly shows similar features. In samples 42 and 43 this species develops a large number of specimens with spreading chambers, described in this paper as *C. pseudoungerianus* var. *antilleana* nov. var. This latter variety is also represented by single specimens in a few samples higher up in the boring. On the other hand numerous specimens of *C. americanus* (Cushman) and *C. isidroensis* Cushman and Renz were obtained from samples 42 and 43, but no aberrant forms observed.

Whether other records of *Cibicidella* and *Dyocibicides* are also connected with regular *Cibicides* species in the same localities cannot be stated without an intensive study of the faunas containing them. From the peculiar relations, observed in the Oranjestad section, however, some doubt may be expressed as to the validity of the genera *Cibicidella* and *Dyocibicides.* A closer study of the numerous described species of *Cibicides,* taking into account the variability of larger groups in space and time, is needed to establish proper relationships between *Cibicidella, Dyocibicides* and *Cibicides.*

Occurrence.—17-43 (see Distribution Chart No. 93). In addition to the occurrence of both irregular varieties in two samples of the lower Miocene zone, both reappear in the Pleistocene marl. Holotype from Miocene, sample 42 (780-800 feet below the surface-level), Oranjestad boring, Aruba.

Coll. No.—D-33285-33287

Family PLANORBULINIDAE

Genus **Planorbulinella** Cushman, 1927

Planorbulinella larvata (Parker and Jones)

Planorbulina larvata PARKER and JONES, 1865, Philos. Trans., p. 380, pl. 19, fig. 3; BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 684, pl. 92, figs. 5, 6.

Occurrence.—37 (R)

Coll. No.—D-33288

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90. *HEMICYCLAMMINA SIGALI* N. GEN N. SP. FROM THE CENOMANIAN OF ALGERIA

WOLF MAYNC
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In January 1952, the writer received some North African material on Mesozoic lituolid foraminifera from J. Sigal, Paris, with a request for an examination and identification. One of the slides contained a few specimens of an arenaceous foraminifer tentatively labeled by J. Sigal as "?*Pseudocyclammina*."

The study of thin-sections revealed that this particular form from the middle Cenomanian of Algeria, cannot be referred to either *Pseudocyclammina* nor to any known genus of the *Lituloidae*, as will be seen in the following note.

In recognition of the kindness of J. Sigal who put the interesting material at the writer's disposal and gave him permission to publish the present study, the type species of the new genus *Hemicyclammina* is named after this eminent worker on Mediterranean foraminifera.

Family LITUOLIDAE Brady
Subfamily SPIROCYCLININAE Maync
Genus **Hemicyclammina** Maync, n. gen.

Genotype: *Hemicyclammina sigali* Maync, n. sp.

Diagnosis.—Test free, discoid, biumbilical symmetric, axially somewhat compressed; spiral involute; periphery slightly rounded to subacute; surface as a rule roughly arenaceous; composed of a proloculus and one planispirally coiled large chamber which is incompletely subdivided by discontinuous, straight or slightly curved, pointed septa projecting from the periphery inward one half or four fifths into the chamber cavity; the interrupted septa (called semi-septa here) are irregularly spaced and are sometimes reflected at the surface of the test by faint constrictions; there are nine to eleven of such semi-septa in the last whorl; the wall of the test is clearly labyrinthic, with ramifying passages and alveoles; the delicate non-continuous septal projections, on the other hand, are not labyrinthic; aperture obscure, apparently some pores on the septal face.

Type level.—Middle Cenomanian (early Upper Cretaceous).

Type locality.—Near Morsott, E-Constantinois, Algeria, North Africa.

Type specimen.—Deposited in the U. S. National Museum, Cushman Foundation for Foraminiferal Research, Washington 25, D. C.

REMARKS AND AFFINITIES

Externally this new foraminifer shows great resemblance with the genus *Haplophragmoides* Cushman from which it differs, however, in its apparently different apertural features and, foremost, in its truly labyrinthic wall structure.

With respect to its interior structure, *Hemicyclammina* reveals affinities with *Discammina* and with some lituolid genera.

Discammina Lacroix, 1932, is a strongly compressed arenaceous, *Ammodiscus*-like form showing an irregularly contoured interior of the long second chamber. This second chamber is not subdivided by either septa or semi-septa[1]. This irregular outline of the chamber lumen is due to a maze of protuberances projecting from the homogenous (non-labyrinthic) wall into the chamber cavity. It is, in our opinion, not correct to designate the wall structure of *Discammina* Lacroix as labyrinthic because this term generally implies a spongy character of the wall itself (passages extending from the hypodermal layer into the chamber) which is not the case in *Discammina* (Maync, 1952 a). The wall of the new genus *Hemicyclammina* is, however, genuinely labyrinthic (see Text Fig. 1, No. 4).

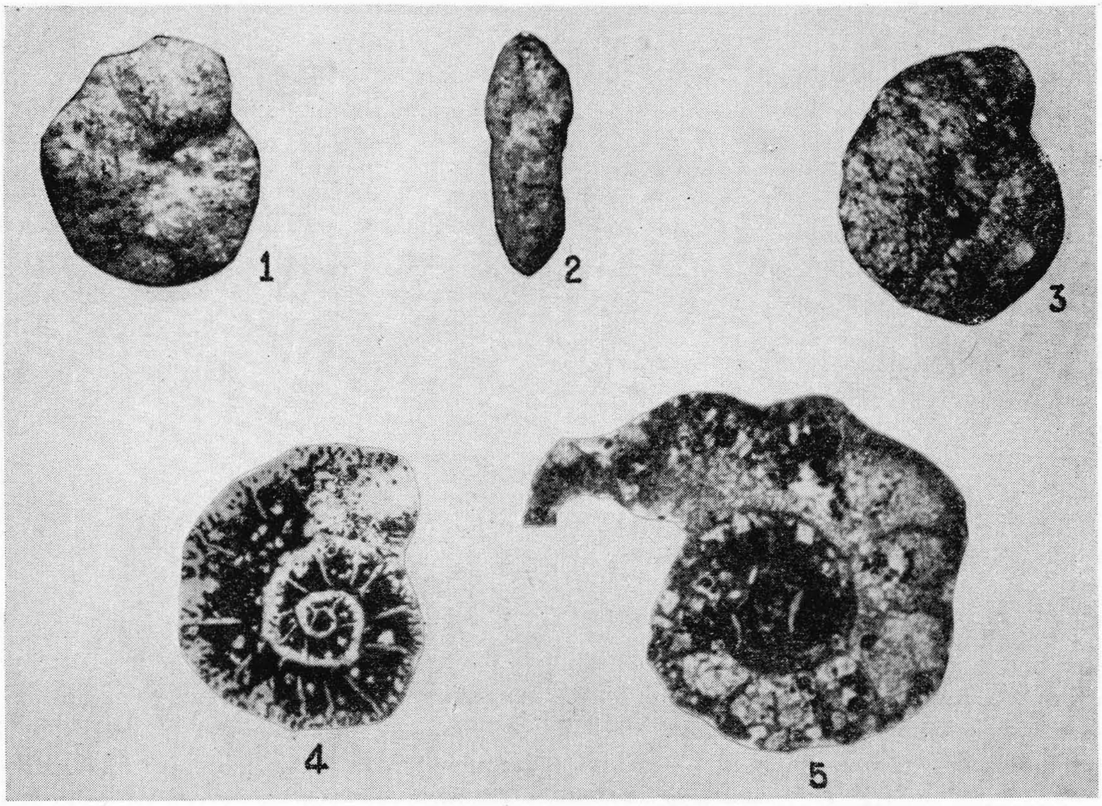
The genus *Discamminoides* Brönnimann, 1951, differs from *Hemicyclammina* in having non-labyrinthic arenaceous walls; its interior is, moreover, subdivided into different chambers by normal continuous simple septa (Brönnimann, 1951). The partial filling of the lumina by heterogenous spongy material is sometimes observed. The aperture of *Discamminoides* is reported to be simple in juvenile stages, possibly cribrate in adult specimens. Contrary to *Hemicyclammina* and *Discammina, Discamminoides* uncoils in the adult.

With regard to its true labyrinthic wall structure, *Hemicyclammina* agrees completely with the genus *Cyclammina* Brady. The latter is, however, composed of numerous sharply defined chambers with thick labyrinthic septal divisions in between, — features which clearly differentiate it from the new genus *Hemicyclammina*.

The apertural characters of *Hemicyclammina* cannot be definitely stated without having more material at hand. They appear to consist of several pores on the septal face but no apertural slit is discernible. Also in this respect *Hemicyclammina* seems to differ from *Cyclammina*.

Pseudocyclammina Yabe and Hanzawa and *Hemicyclammina* seem to have similar cribrate apertures

[1] The figures given by E. Lacroix (1932, textfigs. c, d) do not show any true subdivisions of the second chamber by septal elements as is indicated by P. Brönnimann (1951, p. 103).



TEXT FIGURE 1

but the former genus shows a true subdivision of the interior (septa) into several well-defined chambers, has regularly pierced septa (similar to *Choffatella*), and uncoils in the adult.

Alveolophragmium Stschedrina shows a typically labyrinthic wall structure like *Hemicyclammina*. This labyrinthic growth is often found to fill the entire lumina (Maync, 1952 b). As a rule, *Alveolophragmium* has normal continuous septa which may, however, become obliterated by the labyrinthic interior structure. When this is the case, both *Alveolophragmium* and *Hemicyclammina* become closely linked with each other; *Alveolophragmium* is certainly a close ally of *Hemicyclammina*.

The characteristic feature of the new genus *Hemicyclammina* is seen in the discontinuous pointed semi-septa projecting inwards from the labyrinthic wall. The only other genus with semi-septa is *Phenacophragma* Applin, Loeblich and Tappan, 1950. In this Lower Cretaceous genus, however, normal continuous septa alternate with the very short rudimentary partitions, and the interior structure of walls and septa is definitely simple, i. e. non-labyrinthic (Applin, Loeblich and Tappan, 1950).

TAXONOMY

Taxonomically, *Hemicyclammina* takes an intermediate position between *Discammina and Alveolophragmium-Cyclammina*. It may be considered as a link between the two foraminiferal families *Ammodiscidae* and *Lituolidae*. With its genuine labyrinthic wall structure (*Cyclammina* type) and its conspicuous though discontinuous septa which subdivide the inner cavity to some extent, *Hemicyclammina* appears to be a more advanced genus here allocated to the *Lituolidae*.

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EXPLANATION OF TEXT FIGURE

FIGS.

1-5. *Hemicyclammina sigali* Maync, *n. gen. n. sp.* Middle Cenomanian (early Upper Cretaceous), near Morsott, E-Constantinois, Algeria, North Africa.

1. External view of holotype specimen. × 27.
2. Side view (apertural face) of same specimen. × 27.
3. External view of another specimen. × 36.
4. Median section showing labyrinthic wall structure and discontinuous simple semi-septa which subdivide the chamber lumen partially. × 27.
5. Median section displaying irregularly spaced projections (semi-septa). × 36.

raminifera from the Miocene of Trinidad, B.W.I. Contrib. Cushman Found. for Foram. Research, vol. II, pt. 3, October, 1951, pp. 97-105, Pl. 11, figs. 5-7, textfigs. 1-12.

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91. OBSERVATIONS ON SOME PLANKTONIC HETEROHELICIDAE FROM THE UPPER CRETACEOUS OF CUBA

P. BRÖNNIMANN and N. K. BROWN, JR.

The so-called striate Gümbelinas are a group of planktonic Heterohelicids, which are structurally similar to the glabrous or smooth species of *Gümbelina* s. str. Examination of well-preserved specimens from the Upper Cretaceous of Cuba has disclosed the presence of accessory apertures in certain species of the striate group. The genus *Pseudogümbelina* n. gen. is herein established for these forms. Perhaps accessory apertures are present in all striate forms, but this lacks confirmation. *Textularia globulosa* Ehrenberg, a smooth species, is the genoholotype of *Gümbelina.* It does not exhibit accessory apertures. However, later investigations may demonstrate that accessory apertures are present in other smooth forms.

Accessory apertures have been observed in five striate species, viz., *Gümbelina excolata* Cushman, *G. costulata* Cushman, *G. punctulata* Cushman, *Textularia striata* Ehrenberg, and *Pseudogümbelina palpebra* n. sp.

Two other planktonic Heterohelicids encountered in Upper Cretaceous strata of Cuba belong to the genus *Gublerina.* They are herein described as *Gublerina hedbergi* n. sp. and *G. glaessneri* n. sp. *Gublerina* was originally described from the Maestrichtian of southern France as monotypic by Kikoine (1948, p. 26, pl. 2, fig. 10a-c). This genus has not heretofore been recognized in the Western Hemisphere.

All figured specimens were obtained from light brown silty marl, collected from the construction pit of the Gran Templo Nacional Masonico at the northwest corner of Paseo Carlos III and Calzada de Belascoain (Padre Varela), Habana, Cuba.

Some of the foraminifers found in this material are: *Vaughanina cubensis* Palmer, *Torreina torrei* Palmer, *Lepidorbitoides* spp., *Sulcoperculina dickersoni* (Palmer), *S. vermunti* (Thiadens), *Colomia cretacea* Cushman and Bermúdez, *Rugoglobigerina (R.)* ex. gr. *rugosa* (Plummer), *Globotruncana havanensis* Voorwijk, *G. stuarti* (de Lapparent), *G. contusa* (Cushman), *G. mayaroensis* Bolli, *Gümbelina globulosa* (Ehrenberg), and *Pseudotextularia varians* Rzehak. The age of this faunule is Maestrichtian, Upper Cretaceous.

All holotypes and hypotypes will be deposited in the collections of the U. S. National Museum,Washington, D. C., U.S.A. A duplicate set of specimens will be sent to the Museum of Natural History, Basel, Switzerland.

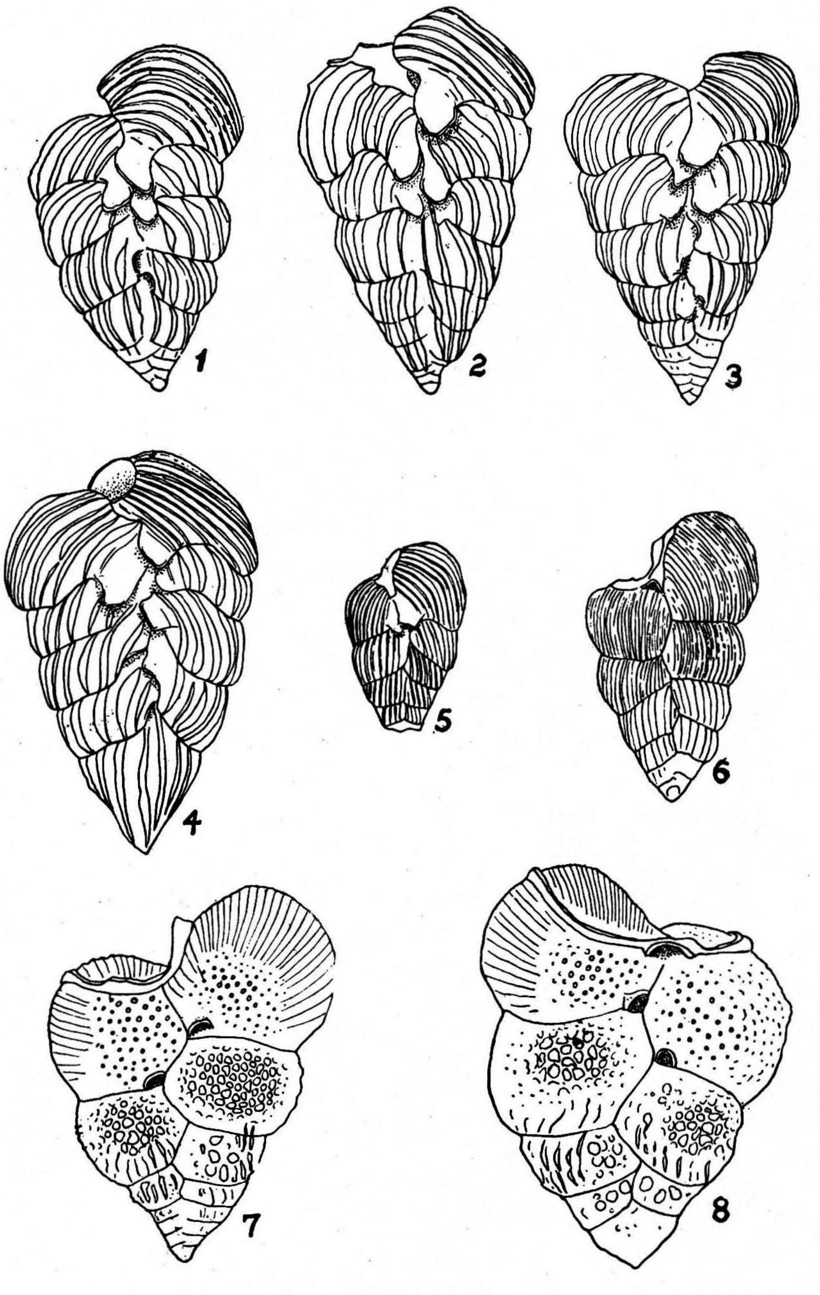
SYSTEMATIC PALEONTOLOGY

Family HETEROHELICIDAE
Genus **Pseudogümbelina** n. gen.

Genoholotype.—*Gümbelina excolata* Cushman

Definition.—The tapering calcareous test is composed of biserially staggered, globular to subglobular chambers as in the genus *Gümbelina.* A pointed unlobulated initial end consists of minute chambers, followed by a lobated stage with considerably larger and more-inflated chambers. The chambers may become laterally compressed in the last stage. The principal aperture is an arched opening at the base of the inner margin of the ultimate chamber. In the lobated stage a minute accessory aperture is developed at the base near the median line on each side of each chamber. These apertures are covered by tiny valves or flaps. They are commonly damaged or filled with adherent matrix, and thus are not readily detected. Striations or costations (if present) are arranged longitudinally, following the contour of the chambers.

Diagnosis.—*Gümbelina* s. str. resembles *Pseudogümbelina* n. gen., but it does not exhibit accessory apertures. *Textularia globulosa* Ehrenberg, a smooth species, is the genoholotype of *Gümbelina.* Ehrenberg (1840, p. 135) did not designate a type locality for this species, but among the localities mentioned are the Chalk of Gravesend, England, and Meudon in the Paris Basin. Cushman (1927, pp. 213-217) examined Ehrenberg's types in Berlin, and later figured (1938,



EXPLANATION OF TEXT-FIGURES 1-8

FIGS. (All magnifications approximately 77×)

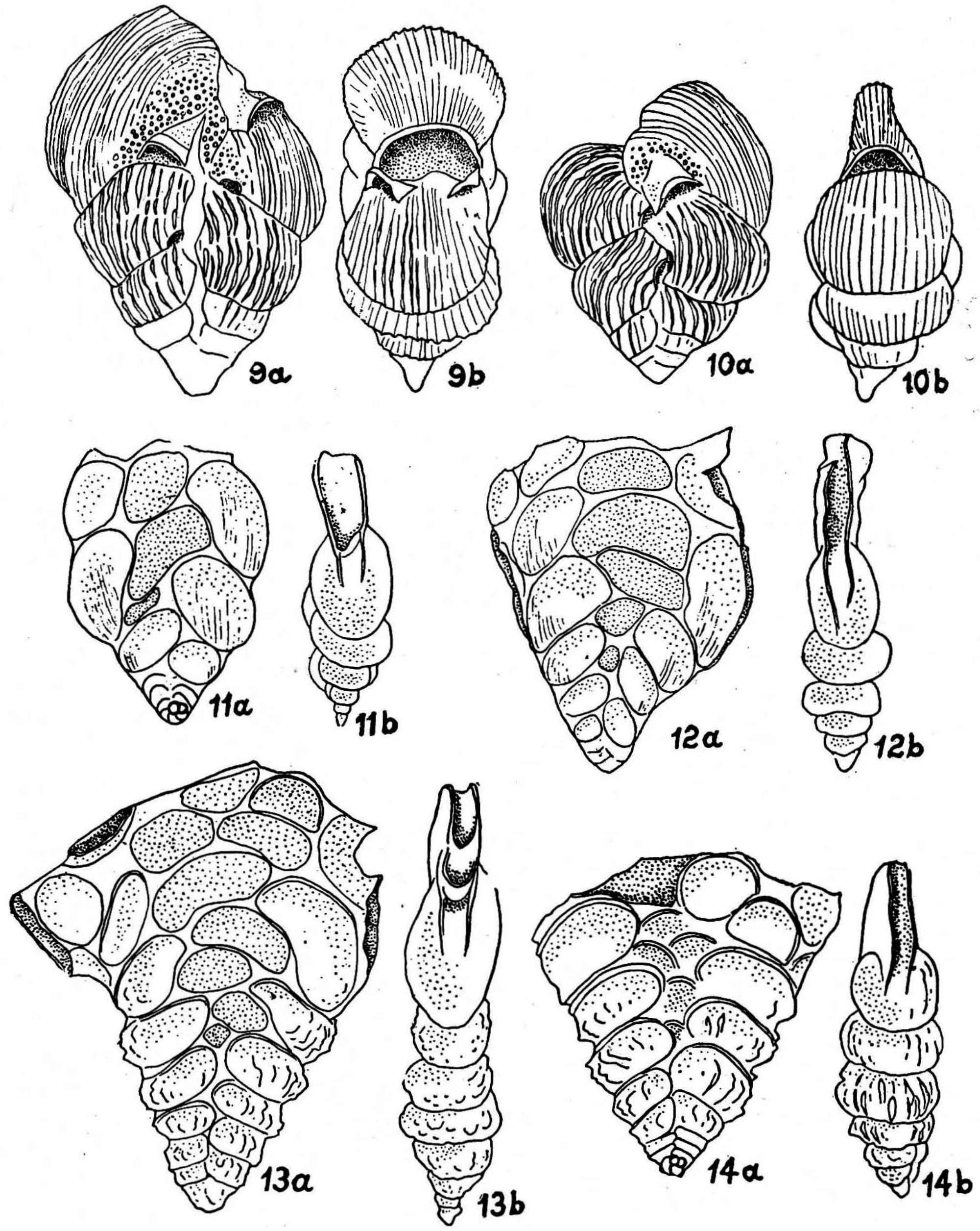
1-4. *Pseudogümbelina excolata* (Cushman).
  1. Lateral view of hypotype showing the principal aperture opening over the crest of the penultimate chamber.
  2. Lateral view of hypotype showing costae crossing the sutures.
  3. Lateral view of hypotype devoid of costae in early chambers.
  4. Lateral view of hypotype exhibiting costae in early chambers.

5. *Pseudogümbelina costulata* (Cushman). Lateral view of damaged hypotype lacking initial end. Two of the flaps are broken.

6. *Pseudogümbelina striata* (Ehrenberg). Lateral view of hypotype showing accessory aperture at the base of the broken ultimate chamber.

7, 8. *Pseudogümbelina punctulata* (Cushman). Lateral view of hypotypes showing accessory apertures at the base of the later chambers at the junction of the preceding chambers.

pl. 1, figs. 30, 31) specimens from the Gravesend locality. No accessory apertures were mentioned, nor do the figures indicate that they may be present. Glaessner (1936, p. 108, pl. 2, fig. 2) figured a specimen from the Paris Basin, but no accessory apertures were shown. Loeblich's figures (1951, p. 108, pl. 12, figs. 4, 5) of hypotypes from the Kemp clay, Navarro group (Maestrichtian) of Texas (U.S.G.S. Sta. 7638) are magnified 158 diameters, yet they do not reveal any features suggestive of accessory apertures. Specimens from the Upper Cretaceous of Cuba and from the Corsicana marl, Navarro group (Maestrichtian) of Texas (U.S.G.S. Sta. 13832, same as Plummer Sta. 1048) have been identified by the writers as *Gümbelina globulosa* (Eh-



EXPLANATION OF TEXT-FIGURES 9-14

FIGS. (All magnifications approximately 77×)

9. *Pseudogümbelina palpebra* n. sp.
   a. Lateral view of holotype showing conspicuous accessory apertures. The ultimate chamber is broken off.
   b. Oblique apertural view of holotype showing the principal aperture and an accessory aperture at each side of the broken ultimate chamber.
10. *Pseudogümbelina palpebra* n. sp.
   a. Lateral view of paratype showing conspicuous accessory apertures.
   b. Oblique apertural view of paratype illustrating the principal aperture and the laterally compressed ultimate chamber.
11. *Gublerina hedbergi* n. sp.
   a. Lateral view of holotype showing the initial coil and faint longitudinal striae in later chambers.
   b. Peripheral view of holotype showing flattened later chambers.
12. *Gublerina hedbergi* n. sp.
   a. Lateral view of paratype.
   b. Peripheral view of paratype.
13. *Gublerina glaessneri* n. sp.
   a. Lateral view of paratype showing the somewhat serrated outline of the early portion of the test.
   b. Peripheral view of paratype.
14. *Gublerina glaessneri* n. sp.
   a. Lateral view of holotype showing the initial coil and limbate sutures in later development.
   b. Peripheral view of holotype showing the rather rough irregular costae in early chambers.

renberg). No accessory apertures have been observed in these specimens.

Striate species in which the presence of accessory apertures has not yet been verified are: *Gümbelina ultimatumida* White, *G. planata* Cushman, *G. semicostata* Cushman, *G. carinata* Cushman, *G. globicarinata* Cushman, and others. The striate forms *G. plummerae* Loetterle and *G. nuttalli* Voorwijk differ from *Gümbelina* s. str. not only in ornamentation but also in the development of the later stages. They should probably be allocated to another genus.

Cushman (1938, pp. 11, 12) noted small depressed triangular areas between chambers of the smooth *Gümbelina reussi* Cushman and the striate *G. planata* Cushman. These features may be interpreted as the flaps covering accessory apertures. However, an examination of type specimens should be made before further comments on this interpretation can be warranted.

Coiling is known in the initial stage in the microspheric form of several species of *Gümbelina,* including the genoholotype *Textularia globulosa* Ehrenberg. *Textularia striata* Ehrenberg is the only species of *Pseudogümbelina* n. gen. in which coiling has been observed.

Pseudogümbelina excolata (Cushman)

Text-figs.

Guembelina excolata Cushman, 1926, Cushman Lab. Foram. Res. Contr., vol. 2, p. 20, pl. 2, fig. 9.—Cushman, 1927, Jour. Paleont., vol. 1, p. 157, pl. 28, fig. 13.

Gümbelina excolata Cushman, White, 1929, idem, vol. 3, p. 34, pl. 4, fig. 7a, b.—Cushman, 1938, Cushman Lab. Foram. Res. Contr., vol. 14, p. 17, pl. 3, figs. 11a, b.—Cushman and Hedberg, 1941, idem, vol. 17, p. 92, pl. 22, fig. 14.—Cushman, 1946, U. S. Geol. Surv. Prof. Pap. 206, p. 108, pl. 46, figs. 16a, b.—Le Roy, 1953, Geol. Soc. Amer., Mem. 54, p. 34, pl. 7, figs. 24, 25.—Hamilton, 1953, Jour. Paleont., vol. 27, p. 234, pl. 30, fig. 11.

Textularia costata Carsey, 1926, Univ. Texas Bull. 2612, p. 26, pl. 1, fig. 4.

This tapering biserial test is composed of eight to ten rather closely appressed pairs of chambers. The early stage consists of as many as five pairs of small chambers which increase considerably in size in the direction of growth. The larger chambers of later development are laterally compressed and increase less rapidly in size. The ultimate pair of chambers displays the maximum breadth, which is about two-thirds the length of the test. In lateral view the outline of the early stage is entire or unlobated, that of the later stage is lobated. The sutures in the early stage are slightly limbate, but become impressed in later development. Ten to twenty relatively strong costae arise from the margin of the principal aperture and extend outward and then downward toward the initial end. In the ultimate pair of chambers they are somewhat weaker but more numerous. The costae do not cross sutures in later development, but they may do so in the early stage (see text-fig. 4). However, many specimens are devoid of costae in the early stage (see text-fig. 3). The principal aperture lies at the base of the inner margin of the ultimate chamber. It is semilunar and is bordered by a delicate liplike rim. In many mature specimens it opens above the crest of the penultimate chamber (see text-fig. 1). Accessory apertures are not exhibited in the initial unlobated stage; they first appear as slight pinholes in the early portion of the lobated stage, and gradually become larger with the addition of each chamber. In each chamber in the lobated stage there are two accessory apertures, one at the base on each side near the median line. Small fragile pendent flaps shield these apertures, and like them increase in size with the addition of each chamber. In the later stage these flaps may slightly overlap the two preceding chambers. Each flap has a faint margin around the edge. Heautotypes figured by Cushman (1938, pl. 3, fig. 11a; 1946, pl. 46, fig. 16a) and by Cushman and Hedberg (1941, pl. 22, fig. 14) from the Corsicana marl, Navarro group of Texas (U.S.G.S. Sta. 13832, same as Plummer Sta. 1048) and the Colón shale of Colombia respectively clearly show these flaps.

Cushman (see synonymy) originally described this species from the Méndez shale of Mexico. It occurs in the Navarro group of Texas and Arkansas, and the subsurface Selma chalk in Florida. Other records include the Colón shale of Colombia and the Lantern marl of Trinidad, B.W.I. It has also been recorded from the Upper Cretaceous of Israel and Egypt, and as a redeposited fossil in Upper Cretaceous to Recent sediments in the Mid-Pacific guyot area.

Pseudogümbelina costulata (Cushman)

Text-fig. 5

Gümbelina costulata Cushman, 1938, Cushman Lab. Foram. Res. Contr., vol. 14, p. 16, pl. 3, figs. 7-9.—Cushman, 1946. U. S. Geol. Surv. Prof. Pap. 206, p. 108, pl. 46, figs. 10-12.—Hamilton, 1953, Jour. Paleont., vol. 27, p. 234, pl. 30, fig. 12.

Gümbelina excolata (not Cushman), Voorwijk, 1937, Kon. Akad. van Wetensch. Amsterdam Proc., vol. 40, No. 2, p. 194, pl. 1, figs. 7, 8.

The small tapering test is composed of six to eight rather closely appressed pairs of chambers, gradually increasing in size as added. The ultimate pair of chambers forms the maximum breadth, which is about one-half to two-thirds the length of the test. A faint keel may be developed in the early portion of the test. In the later stage the test is laterally compressed. In lateral view the outline is only slightly lobated. Sutures are flush in the early stage; later they are slightly impressed. Fine longitudinal costae parallel the contour of the chambers. The principal aperture is a semilunar opening at the base of the inner margin of the ultimate chamber. Near the median line small accessory apertures, one on each side at the base of each chamber, are developed in the later stage. They are covered by small fragile flaps.

Pseudogümbelina costulata (Cushman) resembles *P. excolata* (Cushman), but it is smaller, more uniformly tapering, and less deeply lobated in lateral view. Its costae are weaker and more numerous than those of *P. excolata.*

P. costulata was originally described by Cushman (1938, p. 16, pl. 3, figs. 7-9) from the upper Taylor marl (Campanian) of Texas. It is common in the Taylor and Navarro groups and equivalent strata in the Gulf Coastal Plain. Other records include the Pendola shale of California; the Maestrichtian of Israel; the Campanian of Algeria; and the Upper Cretaceous of Buton and eastern Seran (Ceram), Indonesia; and the Mid-Pacific guyot area.

Pseudogümbelina striata (Ehrenberg)

Text-fig.

Textularia striata EHRENBERG, 1840, K. Akad. Wiss. Berlin, Physik. Abh., p. 135, pl. 4, figs. 1α, 1α¹, 2α, 3α, 9α.

Gümbelina striata (Ehrenberg), BROTZEN, 1936, Sveriges Geol. Undersökning, Ser. C, No. 396, p. 118, pl. 9, figs. 1a, b; text-figs. 1 (4, 5), 2, 39, 40.—CUSHMAN, 1938, Cushman Lab. Foram. Res. Contr., vol. 14, p. 8, pl. 1, figs. 34-40.—CUSHMAN, 1946, U. S. Geol. Survey. Prof. Pap. 206, p. 104, pl. 45, figs. 4, 5.—KIKOINE, 1948, Soc. géol. France, Bull. (5), vol. 18, p. 19, pl. 1, figs. 7a-c.—BANDY, 1951, Jour. Paleont., vol. 25, p. 510, pl. 75, figs. 8, 9.—HAMILTON, 1953, idem, vol. 27, p. 235, pl. 30, fig. 13.

Guembelina globulosa (not Ehrenberg), SANDIDGE, 1932, Amer. Midl. Nat., vol. 13, p. 361, pl. 32, figs. 10, 11.

This variable species exhibits four to eight pairs of biserially arranged globular to subglobular chambers. In microspheric forms there is a small initial planispiral coil. The test gradually expands from the initial end to the ultimate pair of chambers which form the maximum breadth. The length of the test is approximately twice the breadth. In lateral view the outline of the initial end is weakly lobated, that of the later stage is strongly lobated. The sutures are flush to slightly impressed in the early stage; in the later stage they are deeply impressed. Fine striae follow the contour of the chambers. They become more numerous but very faint in the last stage. The principal aperture is a relatively large semilunar opening with a peripheral liplike rim. It is situated at the base of the inner margin of the ultimate chamber. The accessory apertures are very small arched openings and appear rather late in the growth of the test. The flaps are weakly developed or absent. Accessory apertures have been observed only in the ultimate chamber, one on each side at the base near the median line.

P. striata (Ehrenberg) is similar to *P. costulata* (Cushman), but it is larger and its outline is more strongly lobated. Its chambers are less compressed and exhibit fine striations.

P. striata has been recorded from Upper Cretaceous strata in many parts of the world.

Pseudogümbelina punctulata (Cushman)

Text-figs.

Gümbelina punctulata CUSHMAN, 1938, Cushman Lab. Foram. Res. Contr., vol. 14, p. 13, pl. 2, figs. 15, 16a, b.—CUSHMAN, 1946, U. S. Geol. Surv. Prof. Pap. 206, p. 108, pl. 46, figs. 13, 14a, b.

This relatively large test is composed of seven to nine pairs of globular to subglobular chambers. The pointed unlobated initial end consists of as many as six pairs of small chambers which increase considerably in size in the direction of growth. The larger chambers of later development increase less rapidly in size. The ultimate pair of chambers forms the maximum breadth, which is about two-thirds the length of the test. In lateral view the early stage expands rapidly, the later stage less so. The early stage is unlobated and may possess a slight keel, the later development is lobated and devoid of a keel. The sutures are slightly limbate and flush in the early stage; later they become strongly impressed. The walls of the early chambers are marked by fine longitudinal striae, and later by intermittent costae. Still later, in the antipenultimate pair of chambers, the walls are covered by many small pits which produce a somewhat reticular pattern of irregular ridges. In the last stage the chambers are less strongly marked but exhibit very faint lines of meridionally arranged pores converging toward a slightly roughened area on each side of the chamber wall. The principal aperture is a semilunar opening at the base of the inner margin of the ultimate chamber. Accessory apertures are not known to be present in the antipenultimate pair of chambers or in preceding chambers. They first appear in the penultimate pair of chambers as small arched openings. In the later stage each chamber exhibits two accessory apertures, one on each side at the junction of the two preceding chambers. In our specimens the flaps, which shield the accessory apertures, are damaged or developed only as delicate arched rims.

Cushman (1938, p. 13) stated, "aperture, a low, broad arch with a slight lip, the sides continuing in a flange onto the preceding chamber." This "flange" probably represents a flap of an accessory aperture.

This species differs from *Pseudogümbelina striata* (Ehrenberg) by its larger size, more-irregular surface markings, and a less uniformly expanding test.

P. punctulata was originally described by Cushman (1938, p. 13, pl. 2, figs. 15, 16a, b) from the upper Taylor marl (Campanian) of Texas. It has not heretofore been recorded from Cuba.

Pseudogümbelina palpebra n. sp.

Text-figs. 9a, b; 10a, b

This medium-sized test is composed of five to eight pairs of chambers which rapidly increase in size in the direction of growth. The pointed initial end consists of as many as five pairs of small chambers. In later development the chambers are considerably larger and more inflated. However, in many specimens the ultimate pair of chambers displays strong lateral compression (see text-fig. 10b). The pointed initial stage is entire or unlobated in lateral view; the later development is distinctly lobated. The sutures are flush in the early stage, and impressed in the later stage. Surface markings are indistinct or absent in the early stage; later well-developed longitudinal striae parallel the contour of the chambers. In the ultimate pair of chambers these striae are more numerous but somewhat fainter. The principal aperture is a relatively large semilunar opening at the base of the inner margin of the ultimate chamber. It is bordered by a liplike rim. Relatively large accessory apertures are developed in the later stage. Each chamber in the later stage possesses two conspicuous accessory apertures, one on each side, directly over the crest of the subjacent chamber. The flaps of the accessory apertures resemble small eyelids. Small papillae form a granular area above the flaps and near the median line.

Dimensions of holotype. Length, 0.60 mm.; breadth, 0.41 mm.; thickness, 0.24 mm.

This species is easily distinguished from other congeners by its large accessory apertures with eyelidlike flaps.

Pseudogümbelina palpebra n. sp. has been observed only from its type locality.

Genus **Gublerina** Kikoine, 1948

Genoholotype.—*Gublerina cuvillieri* Kikoine

Gublerina hedbergi n. sp.

Text-figs. 11a, b; 12a, b

Ventilabrella sp. VOORWIJK, 1937, Kon. Akad. van Wetensch. Amsterdam Proc., vol. 40, No. 2, p. 195, pl. 1, fig. 20.

This flabellate test is composed of planispirally coiled chambers in the initial stage, followed by a biserial stage. Later the biserially arranged chambers become divergent and a second biserial stage is interposed between the two original series. In the last stage more chambers may be interposed. The initial stage and early part of the first biserial stage, i. e., the first nine or ten chambers, are entire or unlobated in lateral view, and the chamber walls are devoid of surface markings. The later part of the first biserial stage is composed of peripheral or outer chambers. They exhibit fine longitudinal striae. The outline of the test in the later stage is distinctly lobated. Strong lateral compression flattens the interposed chambers below the level of the outer chambers. In the early stage the chambers are not inflated. In later development they are inflated and tend to become reniform. The sutures are flush in early development; later they are impressed and limbated. The last chambers are damaged or missing in our specimens, and the apertures could not be observed.

Dimensions of the holotype. Length, 0.41 mm.; breadth, 0.31 mm.; thickness, 0.14 mm.

The writers have not had the opportunity to examine types of *Gublerina cuvillieri* Kikoine. However, judging from Kikoine's figures (1948, pl. 2, figs. 10a-c) it lacks surface markings, and its outer chambers are more or less equal in size. On the other hand, the outer chambers of *G. hedbergi* n. sp. show fine longitudinal striae and increase gradually in size as added.

Ventilabrella compressa van der Sluis (1950, p. 20, pl. 1, figs. 1a-c) from the Maestrichtian of eastern Seran (Ceram), Indonesia exhibits inner chambers which are compressed below the level of the outer chambers, and therefore should be allocated to the genus *Gublerina*. *G. hedbergi* n. sp. differs from it by the strong lateral compression of the outer chambers in the later stage. The two outer series of chambers are closer together in *G. compressa* than in *G. hedbergi* n. sp. Furthermore, the chambers of *G. compressa* do not show any surface markings.

In addition to its occurrence in Cuba, *G. hedbergi* n. sp. is known to the writers from the *Siphogenerinoides plummerae* zone in the upper part of the Kemp clay, Navarro group (Maestrichtian) of Texas.

This species is named for H. D. Hedberg in recognition of his contributions to the stratigraphy of Latin America.

Gublerina glaessneri n. sp.

Text-figs. 13a, b; 14a, b

This flabellate test is composed of an initial planispiral coil followed by an early biserial stage, which later diverges and a second biserial stage is interposed between the two original series. In the last stage more chambers may be interposed. In lateral view the outline of the early stage is entire or unlobated, later it is somewhat serrated, and finally it becomes lobated. This outline is produced by the closely appressed chambers of the early stage, followed by subangular chambers, and then by the broadly rounded reniform chambers of later development. The inner chambers are laterally compressed and flattened below the level of the peripheral or outer chambers. Chambers in all series overlap and tend to become reniform in later development. The sutures are flush in the early stage. They become impressed and limbated in later development. The outer chambers display rather rough irregular longitudinal striae late in the early stage; later they tend to disappear. The last chambers are damaged or missing in our specimens, and the apertures could not be observed.

Dimensions of the holotype. Length, 0.53 mm.; breadth, 0.41 mm.; thickness, 0.17 mm.

Gublerina glaessneri n. sp. differs from *G. cuvillieri* Kikoine and *G. hedbergi* n. sp. in exhibiting subangular chambers late in the early stage.

This species is known only from its type locality.

It is named for M. F. Glaessner in recognition of his contributions to micropaleontology.

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SLUIS, J. O. VAN DER (1950), *in* Rutten, L., and Hotz, W., Geological, petrographical and palaeontological results of explorations, carried out from September 1917 till June 1919 in the island of Ceram: Amsterdam, J. H. de Bussy, 3d ser. (Geol.), no. 3, 63 pp. 2 pls., 1 map, 2 tables, 1 text-fig.

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the Foraminifera that have come to hand.

ABRARD, RENÉ. Individus tératologiques de **Nummulites wemmelensis** de la Harpe et van den Broeck.—C.R.S. Soc. Géol. France, No. 12, June 15, 1953, pp. 214, 215, text figs. 1-4.

ASANO, KIYOSHI. Miocene Foraminifera from the Shintotsugawa area, Kabato-gun, Hokkaido.—Trans. Proc. Palaeont. Soc. Japan, n. ser., No. 10, July 31, 1953, pp. 45-54, 1 pl., 6 tables.—The faunas of five formations are recorded in tabular form, and their age and ecologic relationships are discussed. Eighteen species, four new, are illustrated.

BRÖNNIMANN, PAUL. Note on planktonic foraminifera from Danian localities of Jutland, Denmark.—Eclogae geol. Helvetiae, vol. 45, No. 2, March 30, 1953, pp. 339-341, text fig. 1.—One new species is described and six others recorded.

GIANOTTI, A. Microfauna del Pliocene Superiore di Olimpia (Grecia).—Riv. Ital. Pal. Stratig., vol. 59, No. 1, 1953, pp. 23-36, pls. 2, 3, text fig. 3, table 1.—Thirty-three species of Foraminifera are listed and most of them illustrated.

Nuove specie di Foraminiferi del Tortoniano Italiano.—Riv. Ital. Pal. Stratig., vol. 59, No. 1, 1953, pp. 37-48, pls. 4, 5.—Four new species and one new variety.

GLAESSNER, M. F. Three foraminiferal zones in the Tertiary of Australia.—Geol. Mag., vol. 88, July-August 1951, pp. 273-283, correlation chart.—Based on **Hantkenina, Victoriella,** and **Austrotrillina.**

HOFKER, J. Recent Peneroplidae. Part I.—Journ. Royal Micr. Soc., vol. 70, ser. III, 1950, pp. 388-396, text fig. 1.—Descriptions of eight genera, two new: **Protopeneroplis** (genotype **Peneroplis senoniensis** Hofker), and **Puteolus** (genotype **Peneroplis proteus** d'Orbigny). Emphasis placed on ornamentation of test and nature of aperture.

Taxonomische Untersuchung von **Planulina osnabrugensis** Roemer 1838 (For.).—Geol. Jahrb. für 1950, vol. 66, October 1952, pp. 383-388, text figs. 1-6.—Relationship to and possibly synonymity with several species in the genera **Almaena, Kelyphistoma, Planulinella,** and **Pseudoplanulinella.**

HOPPIN, RICHARD A. Oscillations in the Vicksburg Stage as shown by the Foraminifera from a well in George County, Mississippi.—Journ. Pal., vol. 27, No. 4, July 1953, pp. 577-584, text figs. 1, 2 (map and chart), tables 1, 2.—Use of method described by Israelsky to detect delicate changes in depth of water by quantitative study of foraminiferal assemblages, and thereby provide a basis for close-range correlation.

JEPPS, MARGARET W. Nuclei of **Cycoclypeus carpenteri** Brady.—Nature, vol. 171, June 20, 1953, pp. 1114, 1115, 3 figs.

KANE, JULIAN. Temperature correlations of planktonic Foraminifera from the North Atlantic Ocean.—The Micropaleontologist, vol. 7, No. 3, July 1953, pp. 25-50, pls. 1-3, distribution chart, map.—Fifteen of the 26 species studied were found to be indicators of mean annual surface-water temperature of over 20°C.

McLEAN, JAMES D., JR. New and interesting species of Foraminifera from the Vincentown formation. Part

II. Forms previously described.—Notulae Naturae, No. 247, June 5, 1953, pp. 1-16, figs. 1-96 (on 4 pls.).—Forty-eight species and varieties recorded and some of them illustrated.

MALAURIE, JEAN, and PIMIENTA-FRENEX, SUZANNE. Sur des Lamellibranches et des Foraminifères quaternaires récoltés en Terre d'Inglefield (Groenland, côte NW).—C.R.S. Soc. Géol. France, No. 10, May 18, 1953, pp. 159-162, map.

MARTINIS, B. Le Formazioni Quaternarie del Sottosuolo di Grado (Gorizia).—Riv. Ital. Pal. Stratig., vol. 59, No. 1, 1953, pp. 3-22, pl. 1, text figs. 1, 2.—Foraminifera are listed and some illustrated from wells drilled through partly brackish Pleistocene sediments on Grado Island.

NAKKADY, S. E. The foraminiferal fauna of the Esna shales of Egypt. Part II, Taxonomic study of the fauna.—Bull. Instit. Égypt, vol. 33, 1952, pp. 397-430, pls. 1-8.—Fifty-five species, none new, through the family Lagenidae, are recorded and illustrated by photographs.

PAPP, A, and KÜPPER, K. Über die Entwicklung der Heterosteginen im Torton des Wiener Beckens.—Anzeiger, Osterreich. Akad. Wissenschaften, Math.-nat. Kl., 89 Jahrg., 1952, No. 10, pp. 110-118, text figs. 1-4.—The group may be used for close stratigraphic determination.

RAT, PIERRE. Sur la découverte de calcaires pseudo-oolitiques à Nubéculaires dans le Bajocien de Bourgogne.—C.R.S. Soc. Géol. France, No. 12, June 15, 1953, pp. 228-230.

REICHEL, MANFRED. Remarques sur les Globigérines du Danien de Faxe (Danemark) et sur celles des couches de passage du Crétacé au Tertiaire dans la Scaglia de l'Apennin.—Eclogae geol. Helvetiae, vol. 45, No. 2, March 30, 1953, pp. 341-349, 1 pl.—Material studied in thin section.

REISS, Z. Two new species of Foraminifera from Israel. —Bull. Research Council Israel, vol. 2, No. 3, December 1952, p. 269, text figs. 1, 2.—**Gyroidinoides pseudosimiensis,** guide fossil for the upper part of the Santonian-Campanian, and **Pseudovalvulineria avnimelechi,** guide fossil for the Danian-Paleocene.

On the occurrence of **Globotruncana calcarata** Cushman 1927 in the Upper Cretaceous of Israel.—Bull. Research Council Israel, vol. 2, No. 3, December 1952, pp. 270, 271, text fig. 1.—Includes lists of Foraminifera.

SCHUH, FRIEDRICH. Beitrag zur Alttertiärstratigraphie Nordwestdeutschlands, ausgehend von der Untersuchung einer fast geschlossenen Bohrkernfolge von über 300 m aus dem nordwestlichen Mecklenburg.—Geol. Jahrb. für 1950, vol. 66, October 1952, pp. 313-375, pl. A, tables 1-7, text figs. 1-16.—Numerous Foraminifera are recorded, their occurrence plotted, and some are illustrated.

STRAUB, E. W. Mikropaläontologische Untersuchungen im Tertiär zwischen Ehingen und Ulm a. d. Donau.—Geol. Jahrb. für 1950, vol. 66, October 1952, pp. 433-523, pls. A-C, text figs. 1-24 (Order Foraminifera, pp. 473-479)—Twenty-five species are recorded from the Meeresmolasse.

TEWARI, B. S. The Tertiary beds of Vinjhanmiani area, southwestern Cutch, India.—Current Science, Aug. 1952, 21, pp. 217-218.—Discovery of **Halkyardia, Linderina,** and **Hantkenina** in India. Other Foraminifera are listed.

THOMPSON, M. L., C. W. PITRAT, and G. A. SANDERSON. Primitive Cache Creek fusulinids from central British Columbia.—Journ. Pal., vol. 27, No. 4, July 1953, pp. 545-552, pls. 57, 58.—Five genera are represented. Two new species are described, and one new name is proposed.

VAN VOORTHUYSEN, J. H. Some remarks about the Plio-Pleistocene microbiostratigraphy in northwestern Europe and in North America.—Journ. Pal., vol. 27, No. 4, July 1953, pp. 601-604, text figs. 1, 2.—Observations regarding distribution of species of **Elphidiella.**

WICHER, CARL ADAM. **Involutina, Trocholina,** und **Vidalina**—Fossilien des Riffbereichs.—Geol. Jahrb. für 1950, vol. 66, October 1952, pp. 257-284, text figs. 1-4.—The evolutionary development of these reef-dwellers from a **Cornuspira** ancestor during the period from upper Triassic to uppermost Cretaceous.

RUTH TODD

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