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TERTIARY LARGER FORAMINIFERA OF VENEZUELA

(With Six Plates)

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INTRODUCTION

This paper presents the results of a study of larger Tertiary foraminifera of Venezuela, collected in 1925-26 by Dr. H. G. Kugler and Dr. L. Vonderschmitt; in 1927 by Drs. P. Leuzinger, P. A. Messmann, and A. Senn; and in 1928 by Mr. M. N. Bramlette. These were sent to Dr. T. Wayland Vaughan, Director of Scripps Institution of Oceanography, University of California, La Jolla, California, who permitted me to study the material.

The great portion of the material in these collections is indurated, and therefore the specimens had to be studied mostly in thin sections, of which I prepared nearly 300. For these reasons specific determinations of many specimens have not been made. It is possible that additional material from other localities may yield specimens which may be separated from the matrix, and the study of them in thin sections may make possible the determination of part of the specimens in this collection. Among the genera recognized were *Acervulina, Archaias, Carpenteria, Camerina, Heterostegina, Operculina,* and certain species of *Discocyclina* and *Lepidocyclina.* Some specimens of the last two genera were free from the matrix.

While at Scripps Institution of Oceanography, I was able to compare this Venezuelan collection with the valuable collection belonging to that Institution, and also with a part of the United States National Museum collection which Dr. Vaughan was using at the time. These collections contain authentically identified specimens of most of the described American species of larger foraminifera.

Types of the new species and a complete set of the other material will be deposited in the United States National Museum; and paratypes together with other material will be divided between the Naturhistorisches Museum in Basel, Switzerland, and the Scripps Institution of Oceanography.

The work on this paper was done under the supervision of Dr. T. Wayland Vaughan, to whom I am greatly indebted for many helpful

suggestions and criticisms. I also wish to express appreciation to Mr. M. N. Bramlette for the collection made by him, and to Drs. H. G. Kugler, P. Leuzinger, P. A. Messmann, A. Senn, and L. Vonderschmitt of the North Venezuelan Petroleum Company, Ltd., for other collections, and to Dr. Ruthven Pike for collections made by him.

Special thanks are due Dr. H. G. Kugler, who furnished maps and geologic information regarding the collections; and to Dr. K. C. Heald, staff geologist of the Gulf Companies, for permission to publish accounts of the material collected by Mr. Bramlette.

After the manuscript of this paper was completed and ready to go to press, a paper including many of the same localities was published by Nettie E. Gorter and I. M. van der Vlerk (25, pp. 94-122).[1] As my paper contains material from additional localities and also several new species, it is not a complete duplication and therefore appears to warrant publication.

REVIEW OF LITERATURE

In 1922 Tobler (44, pp. 380-84) described a new genus and species of *Helicolepidina spiralis,* which he referred to as a subgenus of *Lepidocyclina* from the upper Eocene of Trinidad and Venezuela. *Helicolepidina* has since been raised to the rank of genus.

Wiedenmayer in 1924 (68, pp. 508-12) reported the occurrence of abundant *Lepidocyclina* in the Cerro Campaña limestone of East Falcón.

In 1924 H. Douvillé (22, pp. 35-42) referred to the occurrence of *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé and specimens which appeared to be *L.* (*Lepidocyclina*) *pustulosa* H. Douvillé on the margin of Lake Maracaibo.

In 1926 Mrs. Hodson (27, pp. 1-46) reported the occurrence of the following species of larger Tertiary foraminifera in Venezuela:

Helicolepidina spiralis Tobler
tenuis H. K. Hodson
Discocyclina mirandana H. K. Hodson

A number of names were applied to specimens from Trinidad and Venezuela. Only those occurring in Venezuela are listed below. *Cisseis* was erroneously used as a generic name. Vaughan (62, p. 3) states " It is probable that most or all of them are variants of *Asterocyclina asterisca* (Guppy)."

[1] Numbers in parentheses refer to list of literature cited, printed at the end of this article.

D. (*Asterocyclina*) *asterisca* (Guppy)
venezuelana (H. K. Hodson)
zuliana (H. K. Hodson)
pariana (H. K. Hodson)
trinidadensis (H. K. Hodson)
weeksi (H. K. Hodson)
maracaibensis (H. K. Hodson)
parva (H. K. Hodson)
aurarensis (H. K. Hodson)

Unfortunately, the localities from which the above were obtained were referred to only by numbers, no description being given of them other than the states in which they occur.

As the material from Venezuela that I have studied consists almost entirely of indurated rock, I have not been able to recognize Mrs. Hodson's variants.

The following species of *Lepidocyclina* are reported by Mrs. Hodson from the Eocene of Venezuela:

L. (*Lepidocyclina*) *trinitatis* H. Douvillé
carribbeanensis H. K. Hodson
venezuelana H. K. Hodson
hubbardi H. K. Hodson
bolivarensis H. K. Hodson
aurarensis H. K. Hodson
weeksi H. K. Hodson

In regard to the above reputed species and subspecies, although I have not been able to study the types of them, it appears that they are all variants of *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé. A large suite of material from locality 163 contained abundant specimens of *L. trinitatis.* These specimens were free from the matrix. All of the above reputed species and subspecies of Mrs. Hodson were represented by specimens in this collection. However, these forms intergrade so gradually that it is impossible to draw any distinct lines between the various forms. For this reason I believe that the reputed species and subspecies listed above are all variants of *L. trinitatis* H. Douvillé.

The following species are also described in the same paper:

L. (*Lepidocyclina*) *maracaibensis* H. K. Hodson
(*Nephrolepidina*) *kochi* H. K. Hodson
(*Polylepidina*) *zuliana* H. K. Hodson
mirandana H. K. Hodson
(*Polylepidina?*) *churuguaritana* H. K. Hodson
sp. H. K. Hodson

Also two new species of *Miogypsina* from Oligocene-Miocene:

Miogypsina hawkinsi H. K. Hodson
venezuelana H. K. Hodson

In 1928 Liddle (31, pp. 1-552) made a few references to certain larger foraminifera occurring in Venezuela, namely *Amphistegina* sp. (p. 295) in the Damsite formation, middle Miocene; *Lepidocyclina* sp. associated with *Orthaulax* (p. 265) in the Agua Clara shale, upper Oligocene; ". . . . bluish gray limestone, which contains two predominant species of *Lepidocyclina,* one a large species which is common in the San Luis formation elsewhere." It is possible that the large species referred to by Liddle is *Lepidocyclina undosa* Cushman, which is abundant in parts of the San Luis formation.

Liddle also reports (p. 258) the occurrence of *Lepidocyclina duplicata* Cushman, *L.* cf. *panamensis* Cushman, *L.* cf. *antillea* Cushman, and specimens called *Orthophragmina hayesi* (Cushman). The latter form is not a *Discocyclina* (*Orthophragmina*), but a *Lepidocyclina.* On the basis of the above reported fauna Liddle erroneously called the material Oligocene, although he stated that it suggested upper Eocene. If the foraminifera were correctly identified, the formation is upper Eocene rather than Oligocene.

In 1927 Woodring (71, pp. 992-996) described an Eocene fauna from material collected by Dr. N. H. Darton from the Eastern slope of the Venezuelan Andes. "The material was collected half a mile southeast of the village of Masparito, or about 12 miles east of Calderas, in the State of Zamora (U.S. Geol. Survey locality 1/1189)." The fauna contains a *"Nummulites",* a stellate (*"Orthophragmina"*), and a *Lepidocyclina.* "The megalospheric form of the *Lepidocyclina* belongs to the subgenus *Pliolepidina* and represents *L. panamensis* Cushman or a very similar species." Woodring (71, pp. 995-996) considers this fauna to be upper Eocene in age.

The most recent publication on the larger foraminifera of Venezuela is by Gorter and Van der Vlerk (25, pp. 94-122). They report the occurrence of the following species in Central Falcón, Venezuela:

L. (*Lepidocyclina*) *r. douvillei* Lisson
falconensis Gorter and Van der Vlerk
kugleri Gorter and Van der Vlerk
pustulosa Gorter and Van der Vlerk
trinitatis H. Douvillé
sp. indet.
L. (*Polylepidina*) *adkinsi* Vaughan
L. (*Nephrolepidina*) *marginata* Michelotti
L. (*Eulepidina*) *senni* Gorter and Van der Vlerk
undosa Cushman
L. (*Helicolepidina*) *spiralis* Tobler
D. (*Discocyclina*) *blumenthali* Gorter and Van der Vlerk
flintensis Cushman

D. (*Asterocyclina*) *georgiana* Cushman
maracaibensis Gorter and Van der Vlerk
vaughani Cushman
Discocyclina sp.
? *Pellatispira* sp.
Heterostegina sp.
Operculinella sp.
Operculina sp.
Camerina sp.
Amphistegina sp.
Carpenteria sp.
Gypsina sp.

It is most unfortunate that the localities from which the types of the above new species were obtained were not specified.

As parts of the above paper and of the present paper are based upon the same collection, a brief discussion of the major differences in the results is given.

Figures of surface views and thin sections and the description published by Gorter and Van der Vlerk (25, p. 105, pl. 11, fig. 3) are not *L.* (*Lepidocyclina*) *r. douvillei* Lisson, as these specimens have an embryonic apparatus at least twice the size of topotypes of *L.* (*Lepidocyclina*) *r. douvillei* Lisson that are in the collection of the Scripps Institution of Oceanography. The figures appear to be *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé.

The name *L.* (*Lepidocyclina*) *kugleri* Gorter and Van der Vlerk appears to have been applied to specimens of *L. trinitatis* that have a well-developed flange. A study of a large number of specimens of *L. trinitatis* from locality 163 Venezuela, Soldado Rock, and Bella Vista, San Fernando, Trinidad, shows the presence of a complete series of forms of *L. trinitatis* ranging from flat, lenticular forms with a narrow flange to highly inflated umbonate types with a wide flange. There appear to be no structural characteristics upon which this series may be divided into two or more recognizable species. *L.* (*Lepidocyclina*) *kugleri* Gorter and Van der Vlerk, like *L. trinitatis* Douvillé var. *carribbeanensis* Hodson, *L. trinitatis* var. *venezuelana* Hodson, *L.* (*Lepidocyclina*) *hubbardi* Hodson, *L. hubbardi* var. *bolivarensis* Hodson, *L. hubbardi* var. *aurarensis* Hodson, and *L.* (*Lepidocyclina*) *weeksi* Hodson, seem to be based upon individual variations of *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé.

Gorter and Van der Vlerk (25, p. 99) report the presence of *L.* (*Polylepidina*) *adkinsi* Vaughan in material from localities 1149 and 1152. Thin sections of our material from these localities contain no sections which are *L.* (*Polylepidina*) *adkinsi* Vaughan.

Gorter and Van der Vlerk (25, p. 104) identify specimens of *Lepidocyclina* occurring in material 1116 and 1120 as *L.* (*Nephrolepidina*) *marginata* Michelotti. These specimens are not *L.* (*Nephrolepidina*) *marginata* but are *L.* (*Lepidocyclina*) *sanluisensis,* n. sp. As is stated in the discussion of *L. sanluisensis,* n. sp., this species closely resembles *L.* (*Nephrolepidina*) *marginata* in form and surface ornamentation, but differs in the character of the embryonic apparatus, belonging to *Lepidocyclina* s.s., whereas *L. marginata* is distinctly a *Nephrolepidina.* It is very probable that Gorter and Van der Vlerk may have based their determination upon a specimen with a deformed embryonic apparatus, because one of our specimens from locality 1120 showed an embryonic apparatus which was so deformed as to have a nephrolepidine form. The other sectioned specimens have the true *Lepidocyclina* s.s. type of embryonic apparatus and are identical with the cotypes of *L.* (*Lepidocyclina*) *sanluisensis,* n. sp.

Helicolepidina spiralis Tobler is reported by Gorter and Van der Vlerk (25, p. 97) as occurring at locality 163. This species may be present, but it was not recognized in our material.

L. (*Lepidocyclina*) *pustulosa* H. Douvillé was reported by Gorter and Van der Vlerk (25, pp. 96-97) as occurring at localities 163 and 165. Their illustrations seem to be closer to *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé than to *L. pustulosa,* especially plate 12, figure 8.

Lepidocyclina occurring at localities 469 and 476, reported by Gorter and Van der Vlerk (25, p. 101) as "*Lepidocyclina* sp. (small specimens)", are *L.* (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé.

The several species of *Asterocyclina* specifically identified by Gorter and Van der Vlerk are from localities not represented in our collections.

STRATIGRAPHY OF THE TERTIARY FORMATIONS OF VENEZUELA

The following is the stratigraphic column of the Tertiary formations occurring in the State of Falcón, Venezuela, according to Drs. H. G. Kugler and V. A. Senn:

Pliocene
  Cadore series
Upper Miocene
  La Vela series
Middle Miocene
  Damsite series
Lower Miocene
  Socorro series
  Querales series

Aquitanian[3]
Cerro Pelado series
Upper Oligocene
Agua Clara series
Middle Oligocene
San Luis series
Lower Oligocene
Churuguara series
Upper Eocene
Guayaval series (Cerro Campaña limestone)
? Pauji shales? (occurrence not definitely proved)
? Middle Eocene ?
Paraíso series (probably also upper Eocene)

STRATIGRAPHIC DISTRIBUTION OF THE LARGER FORAMINIFERA

The following is a list of the species according to their apparent stratigraphic positions:

PLIOCENE

Cadore series
Amphistegina lessonii d'Orbigny

UPPER MIOCENE

La Vela series
No material from this series.

MIDDLE MIOCENE

Damsite series
Amphistegina lessonii d'Orbigny

LOWER MIOCENE

Socorro-Querales series
Amphistegina lessonii d'Orbigny

AQUITANIAN

Cerro Pelado series
No material from this series.

UPPER OLIGOCENE

Agua Clara series
Amphistegina lessonii d'Orbigny
Amphisorus? sp.
L. (*Lepidocyclina*) sp. indet. *a* (possibly from the San Luis series)

[3] The Cerro Pelado series, which is considered by Kugler to be Aquitanian, is placed by Liddle (31, composite geologic column for Venezuela) in the lower Miocene. Vaughan (48, p. 704) states: ". . . . and there has been difference of opinion as to whether the Aquitanian should be classified as Oligocene or Miocene."

MIDDLE OLIGOCENE

San Luis series
Amphistegina lessonii d'Orbigny
Archaias sp.
Camerina sp. indet.
Carpenteria sp.
Heterostegina panamensis Gravell, n. sp.
L. (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé
L. (*Lepidocyclina*) *forresti* Vaughan
L. (*Lepidocyclina*) *sanluisensis* Gravell, n. sp.
Lepidocyclina gigas Cushman
Lepidocyclina sp. indet. *b*
L. (*Nephrolepidina*) *undosa* Cushman
L. (*Nephrolepidina*) sp.
L. (*Eulepidina*) *favosa* Cushman
Miogypsina bramlettei Gravell, n. sp.
Miogypsina hawkinsi Hodson

LOWER OLIGOCENE

Churuguara series
Amphistegina lessonii d'Orbigny
Camerina sp. *a*
Heterostegina sp. cf. *H. antillea* Cushman

UPPER EOCENE

Guayaval series (Cerro Campaña limestone)
Camerina sp. cf. *C. parvula* (Cushman)
Carpenteria sp.
D. (*Asterocyclina*) *asterisca* (Guppy)
D. (*Asterocyclina*) *kugleri* Gravell, n. sp.
Gypsina vesicularis (Parker and Jones)
Operculina sp. cf. *O. cookei* Cushman
L. (*Lepidocyclina*) *trinitatis* H. Douvillé
L. (*Lepidocyclina*) *macdonaldi* Cushman

? MIDDLE EOCENE ?

Paraíso series
Discocyclina sp. indet. (probably *Discocyclina flintensis* (Cushman))

DISCUSSION

No larger foraminifera were observed in the Pliocene and Miocene sediments, with the exception of *Amphistegina lessonii,* which has no value for interregional correlation.

The upper Oligocene Agua Clara series is represented by material from only four localities, and of these, three contain large foraminifera. Sections of material from locality 204 contain specimens of *Amphistegina lessonii* d'Orbigny, and a few fragments of a small

Lepidocyclina which may be *L.* (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé. Sections of indurated yellowish limestone from locality 443 consist largely of shell fragments and contain a few sections of a small indeterminate *Lepidocyclina* (*Lepidocyclina*) sp. indet. *a.* Kugler considers it possible that material from locality 443 may be from the San Luis series. The few specimens of indeterminate *Lepidocyclina* do not present sufficient paleontologic evidence to determine definitely the stratigraphic age of the material.

The material from locality 468 is dense algal limestone. Sections of this limestone contain a few poor specimens of an indeterminate species of large foraminifera, which Dr. H. G. Kugler by personal communication informed Dr. T. Wayland Vaughan had been identified by G. D. Hawkins as *Orbitolites sanluisensis* Hodson. A survey of the literature has thus far failed to reveal any description or mention of any such species. The large foraminifera occurring in this material do not belong to the genus *Orbitolites,* but appear to be *Amphisorus.*

The San Luis series is represented by material from numerous localities. This formation contains *Amphistegina lessonii* d'Orbigny, *Archaias* sp., *Camerina* sp. indet., *Carpenteria* sp., *Heterostegina panamensis* Gravell, n. sp.

Gypsina globulus (Reuss), *L.* (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé, *L.* (*Lepidocyclina*) *forresti* Vaughan, *L.* (*Lepidocyclina*) *sanluisensis* Gravell, n. sp., *L.* (*Nephrolepidina*) *undosa* Cushman, *L.* (*Nephrolepidina*) sp., *Lepidocyclina gigas* Cushman, *L.* (*Eulepidina*) *favosa* Cushman, *Lepidocyclina* sp. indet. *b, Miogypsina hawkinsi* Hodson, and *Miogypsina bramlettei* Gravell, n. sp. The stratigraphic occurrence of the latter is somewhat uncertain, although the specimens are probably from the San Luis series.

The San Luis series is most probably susceptible of division into zones on the basis of the larger foraminiferal fauna. This would require the collection of material at frequent intervals across as many sections of the formation as possible, in order that geologic succession, range, and the lateral distribution and persistence of the faunal units could be accurately determined.

It appears that the San Luis series may safely be correlated with at least the lower part of the Antigua formation of the Island of Antigua, West Indies, which contains a similar fauna. The following species are reported by Cushman (14, p. 24) from Antigua: *L.* (*Eulepidina*) *favosa* Cushman, *L.* (*Nephrolepidina*) *undosa* Cushman, *Lepidocyclina gigas* Cushman, *Lepidocyclina undulata* Cushman. In addition to the above species of Cushman, Vaughan (55, pp. 1, 2) described *L.* (*Lepidocyclina*) *forresti* from the Oligocene of Antigua.

The Antiguan Oligocene and the San Luis series contain the following species in common: *L.* (*Nephrolepidina*) *undosa* Cushman, *L.* (*Eulepidina*) *favosa* Cushman, *Lepidocyclina gigas* Cushman, and *L.* (*Lepidocyclina*) *forresti* Vaughan.

The San Luis series may also be correlated with the Oligocene of Panama.

The following species have been reported from the Oligocene of Panama by Cushman (12, pp. 94-97): *L.* (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé, specimens which Cushman referred to as *Lepidocyclina chaperi* Lemoine and R. Douvillé (Vaughan, 47, p. 798, states that the *Lepidocyclina chaperi* of Cushman from the Panama Canal zone is not *L. chaperi* Lemoine and R. Douvillé); *L.* (*Nephrolepidina*) *vaughani* Cushman; and *Miogypsina panamensis* (Cushman). In the same paper Cushman also described *L.* (*Lepidocyclina*) *macdonaldi* Cushman, and *L.* (*Pliolepidina*) *duplicata* Cushman from strata in Panama which were at that time considered Oligocene, and tentatively placed *L.* (*Pliolepidina*) *panamensis* Cushman in the Oligocene. Vaughan (47, pp. 796-797) places *L. macdonaldi* and *L. duplicata* in the Eocene. He also tentatively placed *L. panamensis* in the Oligocene. Vaughan has reported and described the following species from Panama (47, p. 813, pl. 36, figs. 4-6): *Miogypsina cushmani* Vaughan from the upper part of the Culebra formation, an undescribed species of *Heterostegina* (47, p. 789) from the Culebra formation at Bohio Ridge Switch, and *L.* (*Lepidocyclina*) *miraflorensis* Vaughan (55, p. 4, figs. 3-5), "The horizon is supposed to be the lower Miocene, Emperador limestone, but the stratigraphic position is not definitely known."

The following species are common to the San Luis series of Venezuela and the Oligocene of Panama: *L. canellei* and the undescribed species of *Heterostegina* reported from Panama by Vaughan, which is described in this paper as *Heterostegina panamensis* Gravell, n. sp.

As the stratigraphic relations of the lower Tertiary formations of Panama are still somewhat uncertain, only the general relationships of the San Luis series of Venezuela to the Oligocene of Panama are indicated.

The San Luis series may also be correlated with the Oligocene of Jamaica, which is represented by the Moneague formation and at least part of the Montpelier white limestone. Vaughan (57, p. 280) lists their faunas as follows:

Moneague formation: *L.* (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé, *L.* (*Lepidocyclina*) *yurnagunensis* Cushman, *L.* (*Lepidocyclina*) *miraflorensis* Vaughan, *L.* (*Lepidocyclina*) *forresti*

Vaughan, *L.* (*Lepidocyclina*) *parvula* Cushman, *L.* (*Lepidocyclina*) *matleyi* Vaughan, *L.* (*Nephrolepidina*) *undosa* Cushman, *Lepidocyclina gigas* Cushman var., *L.* (*Nephrolepidina*) *crassata* Cushman.

Montpelier white limestone: *Miogypsina bracuensis* Vaughan, *L.* (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé, *L.* (*Nephrolepidina*) *undosa* Cushman, *L.* (*Nephrolepidina*) *crassata* Cushman.

Vaughan (57, p. 279) quotes Dr. C. A. Matley as follows: "The flint-bearing, chalky, and globigerinal 'Montpelier formation' of Hill lies below the *Lepidocyclina undosa* zone, but its type of sedimentation is missing from the succession in many parts of the island and it seems to be a deep-water facies of the White Limestone that passes laterally into shallower-water mollusca-bearing beds. Hill's 'Moneague formation' certainly includes the *L. undosa* zone but its upper limit was not defined by the writer."

Vaughan (57, p. 280), in summarizing the stratigraphic distribution of the larger foraminifera of Montpelier white limestone and the Moneague formation shows that the larger foraminiferal fauna supports Dr. Matley's conclusions regarding the relations of these formations.

The Oligocene of Jamaica and the San Luis series contain the following species in common: *Lepidocyclina canellei, L. forresti, L. undosa, L. gigas.* They also contain species of the genus *Miogypsina.*

Rocks of Oligocene age, which for the present may be considered equivalent to the San Luis series of Venezuela, occur on the island of Trinidad, although a description of their Oligocene fauna has not, to my knowledge, yet been published. Oligocene material from Trinidad, containing *L.* (*Nephrolepidina*) *undosa* Cushman, *L.* (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé, *L.* (*Lepidocyclina*) *yurnagunensis* Cushman, *L.* (*Eulepidina*) *favosa* Cushman, and other Oligocene forms, is in the collection of the Scripps Institution of Oceanography.

The San Luis series of Venezuela may be correlated with the Meson, from which Vaughan (48, p. 732) reports the occurrence of abundant *Lepidocyclina gigas* var. *mexicana* Cushman and *L.* (*Nephrolepidina*) *undosa* Cushman, and states: "The formation is approximately the equivalent of the Glendon formation of Alabama, Florida, and Georgia, and of at least the lower part of the Antigua formation of Antigua."

Collections from Mexico, at the Scripps Institution of Oceanography, also contain other middle Oligocene large foraminifera. Some of these species are *L.* (*Eulepidina*) *favosa* Cushman, *L.* (*Nephrolepidina*) *crassata* Cushman, *L.* (*Nephrolepidina*) *tournoueri* Lemoine and R. Douvillé, and *L.* (*Nephrolepidina*) *chattahoocheensis* Cushman.

Cole (8a, pp. 3-5, pl. 1) lists the following species from the Meson formation of Mexico: *L.* (*Lepidocyclina*) *parvula* Cushman, *L.* (*Nephrolepidina*) *undosa* Cushman, *L. undosa* var. *tumida* Vaughan, *Lepidocyclina gigas* Cushman, *Lepidocyclina gigas* var. *mexicana* Cushman, *L.* (*Nephrolepidina*) *crassata* Cushman, *Lepidocyclina* sp., and *Heterostegina antillea* Cushman.

The San Luis series and the middle Oligocene of Mexico are known to contain the following large foraminifera in common: *L. undosa, L. gigas, L.* (*Eulepidina*) *favosa,* and possibly *Heterostegina antillea.*

A section through the anticline of Buena Vista at the town of Buena Vista, State of Lara (personal communication of Dr. H. G. Kugler to Dr. T. Wayland Vaughan), shows a thick series of variegated shales referred to as the lower part of the lower Oligocene, resting with apparent conformity upon a series of upper Eocene conglomerates and orbitoidal limestones.

The collection that I have studied contained material from only one locality in the variegated shale series. No larger foraminifera were observed in this material.

Along the section through the Buena Vista anticline, a thick series of nummulitic limestone occurs directly above the variegated glauconitic shales. This nummulitic limestone series is placed by Kugler as upper to lower Oligocene. The larger foraminiferal fauna of this series consists of abundant specimens of *Amphistegina lessonii* d'Orbigny, *Camerina* sp. *a,* and *Heterostegina* cf. *H. antillea* Cushman. The above fauna sheds but little light upon the stratigraphic position of this nummulitic limestone.

Material from sediments of upper Eocene age were collected from Guacharaca out of the Guayaval series (Cerro Campaña limestone), District of Acosta, East Falcón, and also from the Buena Vista anticline at Buena Vista, State of Lara. The fauna contains *D.* (*Asterocyclina*) *asterisca* (Guppy), *D.* (*Asterocyclina*) *kugleri* Gravell, n. sp., *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé, *L.* (*Lepidocyclina*) *macdonaldi* Cushman, *Camerina* sp. cf. *C. parvula* (Cushman), *Operculina* sp. cf. *O. cookei* Cushman, and *Gypsina vesicularis* (Parker and Jones). The fauna is distinctly of an upper Eocene type.

The Guayaval series (Cerro Campaña limestone) is evidently of the same age as the formation from Panama from which Cushman (12, pp. 90-91) described the following species: *L.* (*Lepidocyclina*) *macdonaldi* Cushman, *L. duplicata* Cushman, *L.* (*Pliolepidina*) *panamensis* Cushman, and *Discocyclina minima* (Cushman). Cushman questionably referred these species to the Oligocene. Vaughan (47,

pp. 796-797) places all of the above in the Eocene. *Lepidocyclina macdonaldi* is common to both the Guayaval series (Cerro Campaña limestone) and the upper Eocene of Panama.

The upper Eocene of Jamaica, Vaughan (57, p. 279), contains *Dictyoconus codon* Woodring, *D. fontabellensis* (Vaughan), *Discocyclina crassa* (Cushman), *Discocyclina* sp. aff., *Discocyclina pustulata* (Cushman), *Discocyclina perkinsi* Vaughan, *D.* (*Asterocyclina*) *georgiana* (Cushman), *D.* (*Asterocyclina*) sp. indet., *L.* (*Pliolepidina*) *kinlossensis* Vaughan, *L.* (*Lepidocyclina*) *macdonaldi* Cushman, *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé, *L.* (*Lepidocyclina*) *sherwoodensis* Vaughan, *L.* (*Nephrolepidina*) *haddingtonensis* Vaughan, *L.* sp. cf. (*Nephrolepidina*) *perundosa* Cushman.

L. (*Lepidocyclina*) *trinitatis* H. Douvillé, *L.* (*Lepidocyclina*) *macdonaldi* Cushman, and species of the genus *Asterocyclina* are common to both the upper Eocene of Jamaica and the Guayaval (Cerro Campaña limestone) of Venezuela.

The upper Eocene of Trinidad contains several species which also occur in the upper Eocene deposits of Venezuela. These species are *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé, and *D.* (*Asterocyclina*) *asterisca* (Guppy).

It appears that the Guayaval series (Cerro Campaña limestone) may be safely considered approximately the equivalent of the Ocala limestone of Florida, Georgia, and Alabama; with at least part of the Lobitos shales of northwestern Peru; and with a formation exposed on sea cliffs near Ancón, province of Guayas, Ecuador.

Several papers have been published on the larger foraminifera of the upper Eocene Ceroe di Cueba limestone of the island of Curaçao by Koch (28, 1926), L. Rutten (39, 1928), and Rutten and Vermunt (41, 1932). Koch considered the limestone to be lower Oligocene in age. L. Rutten recognized the fauna to be Eocene. M. G. Rutten and Vermunt (41, p. 7) regard the Ceroe di Cueba limestone as upper Eocene.

The Guayaval series (Cerro Campaña limestone) of Venezuela may be approximately equivalent in age to the Ceroe di Cueba, since both formations contain *L. trinitatis* H. Douvillé and *L. macdonaldi* Cushman, also specimens of *Operculina* and *Camerina* ("*Nummulites*"). The chief difference in faunas is that in Ceroe di Cueba *Discocyclina* and *Asterocyclina* are absent, these subgenera not having yet been reported in the literature on Curaçao.

The Pauji shale is represented by a collection from only one locality. The material contains no large foraminifera.

The Paraíso series is placed by Kugler in the middle Eocene. Only two localities in Venezuela are represented by the material that I have studied. Of these only one contains larger foraminifera, an indeterminate species of *Discocyclina* which closely resembles *D. flintensis* (Cushman), in material from locality 1142. On the basis of this species of *Discocyclina* it is concluded that the geologic age is Eocene. Gorter and Van der Vlerk (25, p. 111) identify this species as *Discocyclina flintensis* (Cushman), which would suggest that at least part of the Paraíso series of Venezuela and the Brito formation of Nicaragua are of the same age.

DESCRIPTION OF SPECIES

Family CAMERINIDAE

Genus CAMERINA Brugière

CAMERINA sp. cf. C. PARVULA (Cushman)

Plate 1, fig. 6

Nummulites parvula Cushman (14, p. 51, pl. 4, figs. 3-6).

Poorly preserved specimens which appear to belong to this species occur in Orbitoidal limestone from several upper Eocene localities in Venezuela.

Test small, robustly lenticular: umbo composed of light-colored shell material, surface rather poorly preserved, shows only traces of slightly raised gently curved septal markings.

Both the microspheric and megalospheric forms were found. They have the same exterior form, but differ in size and number of whorls. The microspheric form has a diameter of about 3.5 mm and a thickness of about 2.0 mm, composed of about four closely coiled whorls, having about 32 chambers in the last whorl.

The megalospheric form is only about half as large, diameter about 2.0 mm; thickness about 1.2 mm. Test composed of about three whorls, there being about 24 chambers in the last whorl; septal walls gently curved. The marginal chord of both forms is thick.

The poor preservation and occurrence in hard limestone, which made the extraction of specimens from the matrix impractical, renders the identification of these specimens as *Camerina parvula* (Cushman) a little uncertain.

These specimens also resemble *C. matleyi* Vaughan (63, p. 376, pl. 39, figs. 2-7) from the middle Eocene "Yellow limestone" of Jamaica.

Localities and geologic horizon.—Fairly abundant in material from locality 163. Rock sections of material from localities 148, 149, 165, 1149, 1152, and 1162 contain a few poor sections of this species. That the above localities are upper Eocene is shown by the association of *D.* (*Asterocyclina*) *asterisca* (Guppy), *D.* (*Asterocyclina*) *kugleri* Gravell, n. sp., *L.* (*Lepidocyclina*) *macdonaldi* Cushman, *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé, and other species.

CAMERINA sp. *a*

Plate 1, figs. 1-5

Test small, compressed, lenticular; outer surface without surface ornamentation except the slightly raised narrow septal markings. Diameter about 1.5 to 2.5 mm; thickness about 0.5 to 0.75 mm. The thickness is about one third the diameter.

Test composed of four to five whorls, the fourth having about 26 chambers and the fifth about 32.

The specimens sectioned are all of the megalospheric form. The initial chamber has a diameter of about 70 μ.

Localities and geologic horizon.—This species occurs in the Oligocene at localities 480, 481, 482, 496, 497, 1147, 1166, 1186, 1222, and possibly 514. Associated with *Heterostegina* sp. cf. *H. antillea* Cushman.

Camerina sp. *a* is probably closely related to *C. panamensis* (Cushman) (12, p. 98, pl. 43, figs. 9-10), from the Culebra formation of Panama, as that species has approximately the same size, shape, and number of whorls, but it differs in the width of its whorls, which are not so wide as those of *C. panamensis*.

This species and *Heterostegina* sp. cf. *antillea* compose the bulk of the limestone from several localities. Unfortunately, good specimens cannot be separated from the matrix, owing to poor preservation of the specimens or to hardness of the matrix. Although this is probably a new species, it is not named because the material is too poor for adequate specific characterization.

CAMERINA sp. indet.

Sections of hard middle Oligocene San Luis limestone from localities 498, 959, 1121,, 1123, 1209, and 1221 contain a few random sections of a small indeterminate species of *Camerina*.

Test small, lenticular, thickest in center, gradually sloping to the periphery, which is broadly rounded; diameter about 2.0 mm; thickness about 0.8 mm. Test composed of four to five whorls.

These specimens are less compressed and have thicker chamber roofs than those of *Camerina* sp. *a* and *C. panamensis* (Cushman) (12, p. 98, pl. 43, figs. 9, 10).

Genus OPERCULINA d'Orbigny

OPERCULINA sp. cf. O. COOKEI Cushman

Plate 1, figs. 7-9

Operculina cookei Cushman (16, pp. 127, 128, pl. 18, figs. 1, 2).

These specimens differ somewhat from the typical *Operculina cookei.*

Test small, with a large excentrically placed thick swelling occupying about one half the test, surrounded by a thin flange. The diameter of the test measured from the periphery of the apertural face across the center is about 2.75 mm; thickness through center about 0.8 mm; outside the central area about 0.2 mm. Test composed of three and one half whorls, which widen rapidly; septa gently curved to near the periphery, where they turn backward abruptly. Chambers numerous, 30 to 34 in last whorl.

The center of the thickened part of the test is composed of an umbo of light-colored shell material and is about 0.5 mm in diameter. The sutures are but slightly raised; surface slightly depressed between the sutures.

These specimens differ from *O. cookei* as described by Cushman from the Ocala Limestone (upper Eocene), United States Geological Survey Station 7116, near Oakfield, Ga., in that they are only about half as large, and the width of the whorls does not increase quite so rapidly as does that of the whorls of typical *O. cookei.*

Localities and geologic horizon.—Fairly abundant at locality 163. Thin sections of material from localities 148, 1149, and 1162 contain a few poor sections of an *Operculina* which appear to be *Operculina* sp. cf. *O. cookei.*

That the above localities are upper Eocene is shown by the association of *Discocyclina* (*Asterocyclina*) *asterisca* (Guppy), *D.* (*Asterocyclina*) *kugleri* Gravell n. sp., *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé, and *L.* (*Lepidocyclina*) *macdonaldi* Cushman.

Genus HETEROSTEGINA d'Orbigny

HETEROSTEGINA sp. cf. H. ANTILLEA Cushman

Plate 1, fig. 12

Heterostegina antillea Cushman (14, p. 49, pl. 2, fig. 1; pl. 5, figs. 1-2).
Heterostegina antillea Cushman (16, p. 131, pl. 20, figs. 13, 14).

Test medium-sized, thin; diameter up to about 8.0 mm; thickness through umbo up to about 0.7 mm, generally about 0.5 mm. The umbonate area low and gently curved; excentrically located, about 1.5 mm from the margin of the test, surrounded by a wide, thin flange; thickness of flange at junction of umbonate area about 0.35 mm, decreasing gradually to about 0.17 mm at the periphery of the test. The test is composed of about two and one half whorls, which rapidly increase in width.

Localities and geologic horizons.—*Heterostegina* sp. cf. *H. antillea* and *Camerina* sp. *a* compose a large part of the material from localities 482, 497, 1147, 1157, 1166, and 1222. A few sections of *Heterostegina* which may be *H.* sp. cf. *H. antillea* occur in thin sections of material from localities 496, 1210, 1221. All of the above listed localities are in the Nummulitic Limestone series, upper to lower Oligocene.

In thin sections *Heterostegina* sp. cf. *H. antillea* closely resembles *Heterostegina antillea* Cushman. No positive identification could be made, because the surface ornamentation could not be studied, owing to the impracticability of separating the fragile specimens from their indurated matrix.

HETEROSTEGINA PANAMENSIS Gravell, n. sp.

Plate 1, figs. 10, 11

Heterostegina sp. Vaughan (47, p. 789).

Test of the megalospheric form small; diameter up to about 3.0 mm; thickness up to about 0.75 mm; test composed of a rounded thickened area occupying about one half of the diameter, surrounded by a thin flange, which increases in breadth, giving the thickened area an excentric position. In the center of this thickened area is a small umbo of light-colored shell material. Periphery of the test broadly rounded; central portion ornamented by irregular, radial, slightly raised costae, which meet the chamberlets near the base of the thickened area. Test composed of about three and one half whorls, which gradually increase in breadth.

The embryonic apparatus of the megalospheric form (pl. 1, fig. 10) consists of a globular chamber about 140 μ in diameter, followed by a crescent-shaped chamber about 70 to 140 μ in diameter. The division of the chambers into chamberlets begins in the fourth chamber.

The microspheric form resembles very closely the megalospheric form, having the same number of whorls and the same surface ornamentation; however, its thickness through the center is as much as 1.25 mm. A horizontal section (pl. 1, fig. 11) shows the embryonic apparatus to be of the same type as the megalospheric form, though only about half as large. The first chamber has a diameter of about 75 μ; the second about 40 by 90 μ, followed by four unsubdivided chambers; the chambers following are subdivided.

Localities and geologic horizon.—Locality 4. This species is associated with *L.* (*Lepidocyclina*) *canellei* Douvillé, *L.* (*Nephrolepidina*) *undosa* Cushman, *Miogypsina hawkinsi* Hodson, and *Amphistegina lessonii* d'Orbigny in the San Luis limestone, middle Oligocene.

These specimens differ in no significant characteristics from specimens of *Heterostegina* collected by Vaughan and McDonald from the "Culebra" formation, U.S.G.S. station 6025, south end of Bohio Ridge switch, Panama Railroad, Panama, and mentioned by Vaughan (46, p. 789).

Family PENEROPLIDAE

Genus ARCHAIAS Montfort

ARCHAIAS sp.

Plate 2, fig. 1

A few specimens of this genus were found in thin sections of limestone from localities 1123, and 1206, middle Oligocene, collected by H. G. Kugler. They appear to be very close to, if not identical with, the recent specimens of *Archaias aduncus* (Fichtel and Moll). Plate 2, figure 1, is a horizontal section of a specimen having a diameter of about 1.4 mm.

These specimens are associated with *Gypsina globulus* Reuss, *Camerina* sp. indet., and *Miogypsina hawkinsi* Hodson.

Genus AMPHISORUS Ehrenberg

Amphisorus? sp.

Test thin, disklike; diameter up to about 8 mm. Horizontal sections show the median chambers to be almost circular, about 40 μ in

diameter, arranged in annular rings. The annular and radial walls are about 20 μ thick. The specimens were too poorly preserved to permit determination of the type of communication between the median chambers.

The specimens occur in limestone. As it was impossible to remove them from the matrix, the margins of the test could not be examined. Several thin sections were made, but these did not yield sections from which the species or even the genus might safely be determined. However, these specimens appear to be much closer to *Amphisorus* than to *Orbitolites*.

Locality and geologic horizon.—From locality 468 in limestone lenses in the Agua Clara shales, which are believed to be upper Oligocene.

Dr. H. G. Kugler has informed Dr. T. Wayland Vaughan that these specimens have been identified as *Orbitolites sanluisensis* Hodson. I have thus far been unable to find any description or mention of this species in the literature.

Family AMPHISTEGINIDAE

Genus AMPHISTEGINA d'Orbigny

AMPHISTEGINA LESSONII d'Orbigny

Plate 2, fig. 2

Amphistegina lessonii d'Orbigny (35, p. 304, pl. 17, figs. 1-4).
Amphistegina lessonii Brady (6, p. 740, pl. 111, figs. 1-7).
Amphistegina lessonii Cushman (10, p. 35, pl. 19, fig. 2. 12, p. 77. 13, p. 20, pl. 4, fig. 3; p. 70, pl. 26, fig. 5; pl. 27, fig. 3; pl. 28, fig. 1. 14, p. 50, pl. 7).

This species occurs in material from localities 204, 228, 322, 404, 468, 476, 477, 478, 494, 496, 510, 556, 843, 957, 960, 962, 1042, 1043, 1119, 1121, 1127, 1208, 1223, and Cerro Gauche.

In this collection the geologic range of this species is from middle Oligocene to Recent. This species also occurs at numerous places in Trinidad, Dominican Republic, Panama, Mexico, southern United States, Europe, and the West Indies.

Family PLANORBULINIDAE

Genus GYPSINA Carter

GYPSINA GLOBULUS (Reuss) Carter

Plate 2, fig. 3

Ceriopora globulus Reuss (37, p. 33, pl. 5, fig. 7).
Gypsina globulus Brady (6, p. 717, pl. 101, fig. 8).
Gypsina globulus Cushman (14, p. 44, pl. 4, fig. 7).

Test small, globular; diameter up to about 1.4 mm; surface marked by an irregular network of raised chamber walls.

A horizontal section through the medium plane of a specimen having a diameter of 1.4 mm (pl. 2, fig. 3) shows that the chambers in the test are irregularly polygonal in shape, having a diameter of from 40 to 60 μ. At a point about 240 μ from the center, the chambers become regular in shape and are arranged in definite radial rows, the chambers being short rectangular, the tangential diameter exceeding the radial diameter. The dimensions of the chambers increase toward the periphery of the test; at a point about 240 μ from the center, radial diameter about 40 μ; tangential diameter about 50 μ; at a point 700 μ from the center, radial diameter about 45 μ; tangential diameter about 60 μ. Chamber walls are about 18 μ thick; roofs and floors of chambers perforated by cribriform perforations having a diameter of about 4 μ.

Localities and geologic horizon.—Thin sections of material from localities 4, 469, 960, 1117, 1123, 1208, and 1209 contain a few specimens that resemble this species too closely to be referred to any other.

All the localities listed are in the San Luis series, which is considered middle Oligocene.

GYPSINA VESICULARIS (Parker and Jones)

Plate 2, figs. 4, 5

Orbitolina vesicularis Parker and Jones (36, p. 31, no. 5).
Tinoporus vesicularis Brady (6, p. 718, pl. 101, figs. 9-12).
Gypsina vesicularis Cushman (14, p. 43).

A few specimens apparently belonging to this species were found in material from localities 149 and 163.

Diameter of test 1 to 3 mm; thickness from about 0.3 to 0.7 mm; smaller specimens disk-shaped; larger ones curved and wavy, attached side concave. Surface entirely covered by areolae, which have a fairly constant size, about 39 to 50 μ, but are very irregular in form. Vertical section of a specimen from locality 149 (pl. 2, fig. 4) has a diameter of about 2 mm, thickness about 0.5 mm.

This species is associated with *D.* (*Asterocyclina*) *asterisca* (Guppy), *D.* (*Asterocyclina*) *kugleri* Gravell, n. sp., *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé, and *L.* (*Lepidocyclina*) *macdonaldi* Cushman.

Although this species has no stratigraphic value, the associated species indicate that the horizon is upper Eocene.

Family RUPERTIIDAE

Genus CARPENTERIA Gray

CARPENTERIA sp.

Plate 2, figs. 6, 7

Thin sections of both Eocene and Oligocene limestone contain a few sections of *Carpenteria*. Owing to the impracticability of removing them from the indurated matrix, it was not possible to study their surface or to obtain complete information regarding their form.

In view of the reasons stated above it would be very hazardous to attempt specific determination of these specimens. It is possible that they represent two or more species.

A horizontal section from locality 12 is shown on plate 2, figure 7. A vertical section of a specimen from locality 1206 is figured on plate 2, figure 6.

Localities and geologic horizon.—Localities 12, 148, 163, 469, 957, 960, 970, 1043, 1206, and 1223. Localities 12, 148, and 163 are from the upper Eocene. The remaining localities are from the middle Oligocene.

Family ORBITOIDIDAE

Genus DISCOCYCLINA Gümbel

DISCOCYCLINA sp. indet.

Plate 2, figs. 8, 9

Test flat to slightly undulate, very thin, only slightly increasing in thickness toward the center; no distinct umbo. All the specimens examined were broken, the thinness of the test making preservation of unbroken specimens difficult. Diameter at least 5.5 mm, possibly as much as 8 mm; thickness through center about 0.4 mm, decreasing very gradually to the periphery, which is about 30 μ thick; surface of test apparently covered by very small concentrically arranged papillae, about 30 μ in diameter.

The embryonic apparatus is composed of two chambers, the initial chamber being spherical, about 90 μ in diameter, and the second being crescent-shaped, half surrounding the initial chamber. The dimensions of the second chamber are about 80 by 110 μ.

Equatorial chambers rectangular, elongated radially, and in definite annuli; near center chambers have a radial length of 40 μ; width about 25 μ; toward periphery radial length from 40 to 100 μ, average length being about 80 μ; average width about 30 μ.

The equatorial layer is very thin, nearly uniform in thickness, about 30 to 40 μ; chamber cavities are elliptical, about 24 μ high and about 26 μ long; thickness of roofs and floors about 8 to 10 μ.

Lateral chambers in vertical section are small and have arched roofs. There are about seven to eight layers of lateral chambers on each side of the equatorial layer over the center, and these are not arranged in definite tiers. The number of tiers decreases toward the periphery, which is not covered by lateral chambers. This uncovered portion of the equatorial layer has a width of about 1.5 mm, and a thickness of about 30 μ. Height of chamber cavities varies from 8 to 10 μ; length varies from 20 to 30 μ; roofs and floors about 6 μ thick.

Locality and geologic horizon.—Locality 1142, Paraíso series, middle Eocene. This species is fairly abundant and is associated with a few poorly preserved specimens of an indeterminable species of *Camerina.*

These specimens resemble *Discocyclina flintensis* (15, p. 44, pl. 9, figs. 3-6) from the Brito formation of Nicaragua (U.S.G.S. station 6408). Their poor preservation makes specific determination impossible. Better material may show this to be a new species.

Gorter and Van der Vlerk (25, p. 111, pl. 16, figs. 5-6) identify what are probably better-preserved specimens from locality 1142 as *Discocyclina flintensis* Cushman.

Subgenus ASTEROCYCLINA Gümbel

DISCOCYCLINA (ASTEROCYCLINA) ASTERISCA (Guppy) Vaughan

Cisseis asteriscus Guppy (26, p. 584, pl. 25, figs. 19a-b).
Cisseis asteriscus Guppy, Hodson (27, pp. 11-13, pl. 2, figs. 1, 2, 10).
Discocyclina (*Asterocyclina*) *asterisca* (Guppy) Vaughan (62, p. 3).

Material collected by H. G. Kugler and L. Vonderschmitt from locality 163, Venezuela, contained four broken specimens of this species. Rock sections of material from localities 12, 148, 163, 1149, and 1162 contain sections of this species. Fragments of *Asterocyclina* occur at locality 1152. These may possibly be *D.* (*Asterocyclina*) *asterisca* (Guppy).

This species is associated with *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé, *Camerina* sp. cf. *C. parvula* (Cushman), *D.* (*Asterocyclina*) *kugleri,* Gravell, n. sp., *Operculina* sp. cf. *O. cookei* Cushman, *Gypsina vesicularis* (Parker and Jones), and *Carpenteria* sp.

DISCOCYCLINA (ASTEROCYCLINA) KUGLERI Gravell, n. sp.

Plate 3, figs. 1, 2, 3, 4, 5

Test small, swollen, lenticular, with five to six short arms that start near the periphery of the test; surface densely papillate. Only megalospheric individuals were found. Diameter of test 2.0 to 4.0 mm; thickness, 1.0 to 1.7 mm, being about one half the diameter. The central portion of the test is thick, double-domed, its sides sloping gradually to a distance of about three fourths the radial distance from the center and from there less steeply to the periphery. There is a narrow, slightly undulating rim around the periphery, and it is extended into five or six short rounded arms which are usually broken off. Surface ornamented by small hexagonal papillae. The diameter of those near the center is about 80 μ. They decrease in size toward the edge, until the diameter is about 30 μ at the periphery. The distance between papillae is approximately equal to their diameters.

The embryonic apparatus is composed of two chambers. The initial chamber is subglobular about 114 by 134 μ, partly embraced by a crescent-shaped chamber whose dimensions are about 110 by 220 μ; the walls are about 30 μ thick.

Equatorial chambers are rectangular, arranged in annuli of varying width. This irregularity of the width of the annuli makes the raylike *Asterocyclina*-pattern of the equatorial chambers a little indefinite. The equatorial chambers of the rays are radially elongate, radial diameter about 50 to 60 μ; transverse diameter, 25 to 35 μ. The chambers between the rays vary in length, ranging from square, about 30 μ on a side, to radially elongate forms about 30 by 60 μ. The radial walls of adjacent annuli alternate in alignment and have a thickness of about 6 μ. The equatorial layer is about 20 μ high near center and 80 μ high at a point 1.5 mm from the center; the length of equatorial chambers is about 20 μ near the center and about 100 μ at a point 1.5 mm from the center.

The lateral chambers are very numerous, regular in size and form, arranged in tiers. The number of layers in the thick umbonate region is as many as 40 on each side of the equatorial layer, decreasing gradually to one or two at the periphery. The length of the lateral chambers varies from 60 to 80 μ; roofs and floors are about 6 μ thick. There are no real pillars, although the overlapping ends of the lateral chambers, which are arranged in very regular tiers, give the appearance of pillars.

Localities and geologic horizons.—Cotypes from locality 163. This species also occurs at locality 149, associated with *L. macdonaldi*

Cushman, *L. trinitatis* Douvillé, *D.* (*Asterocyclina*) *asterisca* (Guppy). It is evidently upper Eocene.

Wiedenmayer (68) stated that the genus *Discocyclina* did not occur in the Cerro Campaña limestone and placed the latter in the Oligocene.

This species appears to be rather closely related to a form which was obtained near Calita Sal, Department of Piura, Peru, and was described by Berry (2, pp. 405-407, pl. 1), as *D.* (*Asterodiscocyclina*) *stewardi*, new genus and new species, but it differs from the latter species in important respects. It has distinct *Asterocyclina* arms, although they are small and often broken off, and its test is thicker than that of *D.* (*Asterodiscocyclina*) *stewardi* Berry.

Genus LEPIDOCYCLINA Gümbel

LEPIDOCYCLINA (LEPIDOCYCLINA) CANELLEI Lemoine and R. Douvillé

Plate 5, figs. 4, 5, 6, 7, 8

Lepidocyclina canellei Lemoine and R. Douvillé (30, p. 20, pl. 1, fig. 1; pl. 3, fig. 5).

Lepidocyclina canellei Cushman (15, p. 75, pl. 32, figs. 1-5).

Lepidocyclina (*Lepidocyclina*) *canellei* Vaughan (47, p. 797, pl. 33, fig. 4. 57, pp. 290-291, pl. 49, figs. 1-5, 7-9).

Test small, discoid; diameter about 2.8 mm; thickness about 0.75 mm, or approximately one fourth the diameter. Test composed of a large, low, evenly curved swelling, surrounded by a thin, narrow collar, increasing in thickness toward the periphery; surface of test evenly covered by very small papillae. Only the megalospheric form was observed.

Embryonic apparatus composed of two small equal chambers, divided by a straight wall; diameter of embryonic apparatus in a horizontal plane about 220 by 260 μ; peripheral wall about 14 μ thick. Embryonic apparatus in vertical section about 240 μ high and about 260 μ long.

Equatorial chambers in horizontal section are distinctly hexagonal, slightly increasing in size from center toward the periphery; near the center radial diameter about 55 μ; tangential diameter about 40 μ; near the periphery radial diameter about 80 μ; tangential diameter about 60 μ. The chamber walls are relatively thin, measuring about 5 μ. Roofs and floors perforated by cribriform perforations about 1.0 μ in diameter. Equatorial chambers in vertical section are rectangular; height of chambers near center about 50 μ; radial diameter about 35 μ; height at periphery about 100 μ; radial diameter about 75 μ.

Lateral chambers regular in size and distribution, in center of test about 10 layers in a tier on each side of the equatorial layer; length of tier about 400 μ, therefore about one chamber to 40 μ; length of chambers about 50 to 80 μ. Some of the specimens have small pillars in the central part of the test.

Localities and geologic horizon.—*L.* (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé occurs in material from localities 4, 469, 476, 957, 960, 1042, 1043, 1206, Cerro Gauche, and possibly 204, San Luis series, middle Oligocene. (See check list for associated foraminifera.)

L. (*Lepidocyclina*) *canellei* also occurs at many places in Panama, Jamaica, and Mexico.

LEPIDOCYCLINA (LEPIDOCYCLINA) FORRESTI Vaughan

Plate 3, fig. 6

Lepidocyclina (*Lepidocyclina*) *forresti* Vaughan (55, p. 3, pl. 1, figs. 1-4; pl. 2, figs. 1-6).
Lepidocyclina (*Lepidocyclina*) *forresti* Vaughan (57, p. 291).

Specimens which differ in no significant characteristics from the cotypes of *Lepidocyclina* (*Lepidocyclina*) *forresti* Vaughan (from east of Lynch Point, Willoughby Bay, Antigua, West Indies) were collected by H. G. Kugler from the San Luis series, middle Oligocene, at locality 1206 near Agua Clara, District of Democracia, Falcón, Venezuela.

They are associated with *L.* (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé.

LEPIDOCYCLINA (LEPIDOCYCLINA) MACDONALDI Cushman

Plate 5, figs. 1, 2, 3

Lepidocyclina macdonaldi Cushman (12, pp. 94, pl. 40, figs. 1-6).
Lepidocyclina macdonaldi Cushman (15, p. 77, pl. 34, figs. 1-3).
Lepidocyclina (*Lepidocyclina*) *macdonaldi* Vaughan (47, p. 797).
Lepidocyclina (*Lepidocyclina*) *macdonaldi* Vaughan (57, p. 288).
Lepidocyclina (*Lepidocyclina*) *macdonaldi* M. Rutten and Vermunt (41, p. 9, pl. 1, fig. 13).

H. G. Kugler and L. Vonderschmitt collected limestone containing this species from the following localities in the upper Eocene of the State of Falcón, Venezuela: 12, 16, 148, and 149, from Guacharaca, Guayaval series; 163 and 165, from Cerro Campaña, Cerro Campaña limestone, also out of the Guayaval series.

This species is abundant. It is associated with *D.* (*Asterocyclina*) *kugleri* n.sp., *D.* (*Asterocyclina*) *asterisca* (Guppy), *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé, and *Carpenteria* sp.

The indicated horizon is upper Eocene. *L.* (*Lepidocyclina*) *macdonaldi* also occurs in Panama and Jamaica.

LEPIDOCYCLINA (LEPIDOCYCLINA) TRINITATIS H. Douvillé

Plate 3, figs. 7, 8

Isolepidina pustulosa H. Douvillé (21, p. 844, fig. 3, *not* fig. 4).
Isolepidina trinitatis H. Douvillé (22, p. 34, pl. 1, text figs. 7-9).
Lepidocyclina (*Lepidocyclina*) *trinitatis* Hodson (27, p. 19, pl. 4, fig. 10).
Lepidocyclina (*Lepidocyclina*) *trinitatis* Vaughan (47, p. 797. 57, p. 289, pl. 49, figs. 10-13).
Lepidocyclina (*Lepidocyclina*) *trinitatis* Gorter and Van der Vlerk (25, pp. 107-108).

Test small; shape variable, globular to umbonate. In the umbonate forms the flange ranges in development from a mere vestige to a rim occupying over one half the diameter of the test. The central thickened area is covered with pustules which decrease in size toward the flange, absent on the outer margin of flange. Diameter of test about 1 to 5 mm; thickness about 1 to 2 mm.

Embryonic apparatus composed of two equal to subequal chambers, whose greater diameter is about 480 to 540 μ and lesser diameter about 350 to 420 μ. On each side of the junction of the embryonic chambers there is in many specimens a crescent-shaped chamber which is larger than the succeeding equatorial chambers. Vertical section shows the embryonic apparatus to be about 480 to 540 μ long and about 320 μ high; walls about 20 μ thick.

Equatorial chambers have rounded outer walls and pointed inner ends, largest at the center, with a radial diameter of about 100 μ; tangential diameter about 80 μ. Equatorial chambers decrease in size toward the periphery, where the radial diameter is about 64 μ and the tangential 50 μ; walls about 20 μ thick; roofs and floors perforated by evenly distributed pores with a diameter of about 2 μ. Height of equatorial layer near center about 120 μ; height at a point 1.5 mm from the center about 240 μ; thickness of the roofs and floors about 25 μ.

Lateral chambers arranged in tiers of 5 to 12 layers over the center on each side of the equatorial layer, decreasing in number toward the periphery where the equatorial layer is not covered by lateral chambers. The length of the lateral chambers ranges from 80 to 200 μ, longest over embryonic apparatus near the surface of test;

height fairly constant, about 60 μ; roofs about 16 μ thick. Pillars cone-shaped in vertical section, regularly distributed in central part of the test. They are largest over the center, where they have a diameter of about 180 μ, decreasing in size toward the flange.

Localities and geologic horizon.—Fairly abundant at localities 12, 16, 148, 149, 163, 165, and 1149. The material from localities 1152 and 1162 contains abundant fragments of *Lepidocyclina* and *Asterocyclina.* Some of the specimens of *Lepidocyclina* appear to be *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé.

Associated with *D.* (*Asterocyclina*) *asterisca* (Guppy), *D.* (*Asterocyclina*) *kugleri* Gravell, n. sp., and *L.* (*Lepidocyclina*) *macdonaldi* Cushman.

The indicated geologic horizon is upper Eocene. *L.* (*Lepidocyclina*) *trinitatis* also occurs in the upper Eocene of Trinidad and Jamaica.

A single section (pl. 3, fig. 8) of a specimen of *Lepidocyclina* which in many features resembles *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé was observed in rock sections of material from locality 165. This specimen differs from *L. trinitatis* in that its embryonic apparatus is double, composed of two pairs of subequal embryonic chambers. This specimen has the type of embryonic apparatus exhibited by *L.* (*Polylepidina*) *vanslobbeni* M. G. Rutten and Vermunt (41, p. 13, pl. 1, fig. 11; pl. 2, fig. 9; pl. 3, figs. 3, 4). *Lepidocyclina vanslobbeni* does not belong to the subgenus *Polylepidina,* as its embryonic apparatus is not polylepidine, but is a double or twinned *Lepidocyclina* s.s. type of embryonic chambers.

This twinning of the embryonic apparatus also occurs in the genus *Discocyclina.* Vaughan (62, pp. 14-16, pl. 5, figs. 1-6) described *Discocyclina cloptoni* Vaughan, some specimens of which species contain the normal type of embryonic apparatus, and others two, three. and even four sets of embryonic chambers.

LEPIDOCYCLINA (LEPIDOCYCLINA) SANLUISENSIS Gravell n. sp.

Plate 4, figs. 1, 2, 3, 4

Only the megalospheric form of this species was observed.

Test medium size, lenticular, rather thick, with a narrow, stout projecting rim; diameter ranges from about 3 to 8 mm; thickness from about 2 to 2.7 mm; rim varies from a well-developed conspicuous collar about 200 μ wide to a mere vestige. The margin of the largest specimen is broken; diameter of this specimen about 8 mm; rim projects about 2 mm on each side; thickness about 2.75 mm. Large polygonal papillae about 250 μ in diameter cover the central part of

the test, decreasing to about 90 μ near the rim. The papillae are separated by a distance approximately equal to their diameter.

The embryonic apparatus is composed of two subequal chambers, initial chamber subspherical, about 210 by 280 μ in diameter; second chamber nearly hemispherical, 170 by 320 μ; the wall between chambers slightly curved toward the second chamber. On each side of the junction of embryonic chambers is a chamber about 100 μ long and 50 μ wide.

The equatorial chambers in horizontal section have curved outer walls and pointed inner ends, the radial diameter only slightly greater than the transverse diameter; dimensions near the embryonic apparatus about 50 μ; near periphery about 60 μ. In vertical section equatorial chambers are about 30 μ wide and 60 μ high near the embryonic apparatus; at the periphery about 40 μ wide and 140 μ high; roofs and floors about 10 to 16 μ thick, perforated by pores from 2 to 3 μ in diameter.

The lateral chambers in vertical section 20 to 40 μ high; 40 to 200 μ long. The smaller chambers are next to the equatorial layer and increase in size toward the surface of the test; as many as 16 layers over the center of the test in a tier 0.9 mm high, decreasing in number toward the periphery. Large, cone-shaped pillars, irregular in width interrupt the development of the lateral chambers. The pillars are largest over the center of the test, where they attain a thickness of more than 300 μ.

Localities and geologic horizon.—Cotypes from locality 168 of M. N. Bramlette's collection. Other localities at which this species occurs are 960, 970, 1042, 1116, and 1120, San Luis limestone, middle Oligocene. This species appears to be restricted to the San Luis limestone.

L. (*Lepidocyclina*) *sanluisensis* resembles *L.* (*Nephrolepidina*) *marginata* (Michelotti) in form and surface ornamentation, but differs in the character of the embryonic apparatus. The species is named after the San Luis limestone of Venezuela.

Gorter and Van der Vlerk (25, p. 104) identified specimens of *L.* (*Lepidocyclina*) *sanluisensis*, n. sp., from localities 1116 and 1120, as *L.* (*Nephrolepidina*) *marginata*. The embryonic apparatus, however, is not that of a *Nephrolepidina*, but is that of *Lepidocyclina* s.s.

LEPIDOCYCLINA (LEPIDOCYCLINA) sp. indet. (a)

Thin sections of a limestone largely composed of mollusk fragments contain a few rather unsatisfactory sections of a small *Lepidocyclina*.

Test small, lenticular; diameter 1.60 to 2.5 mm; thickness through center 0.6 to 0.7 mm, decreasing gradually to the periphery. Two subequal embryonic chambers; initial chamber globular, about 100 μ in diameter and about 100 μ high, followed by a subglobular chamber, length about 100 μ; width about 50 μ; walls of embryonic chambers about 15 μ thick.

Equatorial chambers open arcuate in form, increasing in size toward the periphery; tangential diameter 70 to 100 μ; radial diameter 40 to 60 μ; roofs and floors perforated by cribriform pores having a diameter of about 2 μ. Equatorial layer about 50 μ high near embryonic apparatus, increasing to about 160 μ high at a point approximately 0.6 mm from the center; roofs and floors about 15 μ thick.

Lateral chambers rather uniform in size; length about 80 to 100 μ; height about 20 to 30 μ; roofs and floors about 15 μ thick, perforated by minute pores. There are about six to seven tiers of lateral chambers on each side of the equatorial layer over the center of the test, the number decreasing toward the periphery, where the equatorial layer is covered by only one layer of chambers.

Pillars small, formed by the overlapping of ends of the lateral chambers. These pillars obtain a maximum diameter of about 30 μ at their distal ends over the center of the test.

Locality and geologic horizon.—From locality 443, lower part of producing zone, British Controlled Oil Fields Ltd., Buchivacoa, Falcón. This locality is believed to be in the Agua Clara or even the San Luis series.

LEPIDOCYCLINA sp. indet. (*b*)

Test small, with a large, thick central area, surrounded in some specimens by a narrow collar. Diameter up to 3 mm; thickness up to about 1.24 mm.

As specimens were rare and in a rock matrix, it was impossible to obtain sections that showed the character of the embryonic apparatus; therefore no specific determination has been attempted.

Although no good horizontal sections were obtained, the equatorial chambers appear to be spatulate to hexagonal. Several good vertical sections were obtained, showing the equatorial chambers to be square to rectangular, in vertical section; at center about 30 μ high; radial diameter about 60 μ; roofs and floors about 20 μ thick.

Lateral chambers in vertical section resemble flat convex lenses and are in regular tiers, as many as 11 chambers over the center in a tier 450 μ high, or about one chamber to every 40 μ. They decrease in number toward the periphery, ending at the collar, which is not

covered by lateral chambers. The chambers increase slightly in size toward the surface of the test. Near the equatorial layer, height about 18 μ; length about 130 μ; roofs and floors about 18 μ thick. A few large cone-shaped pillars over center of test originate at point a little above the equatorial layer and rapidly increase in thickness, attaining a diameter of as much as 240 μ at the surface. A section parallel to the equatorial layer shows 11 large polygonal pillars in center of test, one occupying a central position; they are surrounded by a polygonal mesh formed by the walls of the lateral chambers.

Locality and geologic horizon.—Locality 1043, San Luis series, middle Oligocene. Associated with *Lepidocyclina canellei* Lemoine and R. Douvillé and *Amphistegina lessonii* d'Orbigny.

LEPIDOCYCLINA GIGAS Cushman

Lepidocyclina gigas Cushman (15, p. 63, pl. 19, figs. 1, 2, 3, *not* fig. 4).
Lepidocyclina gigas Vaughan (47, p. 799. 51, p. 295).

This species is associated with *L.* (*Nephrolepidina*) *undosa* Cushman at localities 477, 478, and in transported blocks at locality 1223 from the San Luis series, which is considered to be middle Oligocene.

Lepidocyclina (*Lepidocyclina*) *gigas*, according to Vaughan (42, p. 799), appears to be the microspheric form of *L.* (*Nephrolepidina*) *undosa* Cushman, as it invariably occurs with *L.* (*Lepidocyclina*) *undosa* and also has the same type of equatorial chambers.

Lepidocyclina gigas is a very common and widely distributed middle Oligocene species. Besides occurring in Venezuela, it has been found at numerous localities in Antigua, Mexico, Jamaica, and Trinidad.

Subgenus NEPHROLEPIDINA H. Douvillé

LEPIDOCYCLINA (NEPHROLEPIDINA) UNDOSA Cushman

Plate 6, fig. 4

Lepidocyclina undosa Cushman (15, p. 68, pl. 25, fig. 3).
Lepidocyclina (*Nephrolepidina*) *undosa* Vaughan (57, p. 294, pl. 48, fig. 3).
Lepidocyclina (*Eulepidina*) *undosa* Gorter and Van der Vlerk (25, p. 110, pl. 15, figs. 1-4).

This species is very abundant in parts of the San Luis limestone of Venezuela. It occurs in material from localities 4, 477, 478, 959, 960, 968, Cerro Gauche, and in transported blocks at localities 1219, 1221, and 1223, and possibly as fragments in a limestone at locality 236, which is composed of unweathered fragments of *Heterostegina* sp., *L.* (*Lepidocyclina*) sp., and *Amphistegina lessonii* d'Orbigny, cemented with calcite. The foraminifera appear to be primary, as they are unweathered.

Lepidocyclina (*Nephrolepidina*) *undosa* is a very common and widely distributed middle Oligocene species. Besides Venezuela, it occurs at numerous localities in Mexico, Antigua, Jamaica, and Trinidad. Gorter and Van der Vlerk (25, p. 110) place *L. undosa* in the subgenus *Nephrolepidina*. A large number of sections of this species show the embryonic apparatus varying from the nephrolepidine to eulepidine type, making the assignment of this species to either subgenus virtually optional.

LEPIDOCYCLINA (NEPHROLEPIDINA) sp.

Plate 5, figs. 9, 10; plate 6, fig. 1

Thin sections of hard San Luis limestone from locality 1209 contain a few rather poorly preserved specimens of *Nephrolepidina,* associated with a few specimens of *Gypsina globulus* (Reuss), a few specimens of a small indeterminate species of *Camerina,* several genera of small foraminifera, and calcareous algae.

Test variable in shape; some specimens have a large centrally thickened area, well demarked from a surrounding rim, in others the thickness of the test decreases gradually from the center to the periphery. Some of the specimens are strongly curved, whereas others show little or no curvature.

A megalospheric specimen, which has its edges broken, is 12 mm in diameter. It is possible that the megalospheric form attains a diameter of 20 mm; thickness through center up to about 2 mm.

Embryonic apparatus of *Nephrolepidina* type, composed of an initial ovate chamber about 360 μ long and about 260 μ wide, half surrounded by a crescent-shaped chamber about 200 by 530 μ. Both chambers are enveloped in a common wall about 50 μ thick; height about 500 μ.

Equatorial chambers hexagonal in horizontal section; radial and tangential diameters about 70 μ. The equatorial layer increases but slowly in height toward the periphery; height about 80 μ near the embryonic apparatus; about 120 μ high at a distance of 1.6 mm from the embryonic apparatus; roofs about 15 μ thick.

Lateral chambers low and flat, about 15 layers over the center of the test in a tier 660 μ high, or about one chamber to 44 μ; chamber spaces about 30 μ high; roofs about 15 μ thick; length increases from about 60 μ at the equatorial layer to about 200 μ at the surface of the test. The number of layers of lateral chambers decreases from 15 over the center to one or two layers at the periphery. The pillars are small, regular in distribution, originating at the equatorial layer

and attaining a maximum thickness of about 70 μ at their outer ends, about 45 μ being more common.

The hardness of the matrix made it impractical to separate the specimens from the matrix. Although the specimens appear to belong to a single species, better material may show the arched and unarched forms to constitute two distinct species.

Subgenus EULEPIDINA H. Douvillé

LEPIDOCYCLINA (EULEPIDINA) FAVOSA Cushman

Plate 5, fig. 11; plate 6, fig. 2

Lepidocyclina favosa Cushman (14, p. 66, pl. 3, figs. 1, 2b; pl. 15, fig. 4. 15, p. 66, pl. 15, fig. 5(B)).
Lepidocyclina (*Eulepidina*) *favosa* Vaughan (47, p. 799, pl. 34, fig. 8).
Lepidocyclina sp. Gorter and Van der Vlerk (25, p. 103).

Specimens of *L.* (*Eulepidina*) *favosa* were found in limestone from localities 498 and 967.

The indicated geologic horizon is middle Oligocene. *Lepidocyclina* (*Eulepidina*) *favosa* was described by Cushman from the Antigua formation, middle Oligocene. The type locality is U.S.G.S. station 6881, Antigua, Leeward Islands, bluffs on north side of Willoughby Bay.

Subfamily MIOGYPSININAE

Genus MIOGYPSINA Sacco

MIOGYPSINA BRAMLETTEI Gravell, n. sp.

Plate 6, figs. 5-10

Both megalospheric and microspheric forms of this species were found. The microspheric form (pl. 6, fig. 5) is flat disk-shaped; diameter as much as 4 mm; thickness about 0.75 mm; entirely covered by glassy pustules from 50 to 80 μ in diameter, separated by a distance of about twice their diameter. The surface of the test is marked by a mesh work formed by the lateral chamber walls.

Test of the megalospheric form is smaller and wedge-shaped (pl. 6, figs. 8, 10). The dimensions of one specimen are 2.6 mm long, 2.4 mm wide, and about 0.4 mm thick in the thickest portion, which is near the apex of the test. The thickness decreases gradually toward the periphery, which is rounded. The surface is covered with pustules as in the microspheric form, though they are somewhat smaller, having a diameter of about 39 to 70 μ, being largest over the thickest portion of the test.

The embryonic apparatus of a specimen 2.1 mm in length and 1.8 mm wide (pl. 6, fig. 9) peripherally located at the apex of the test, consists of an initial globular chamber about 140 μ in diameter, followed by two globular chambers about 120 μ in diameter. The initial chambers are followed by four or five slightly smaller chambers which are intermediate in character between the first two embryonic chambers and the equatorial chambers and are cyclically arranged around the inner side of the first three initial chambers; walls of embryonic chambers about 30 μ thick.

The equatorial chambers are diamond-shaped and vary in size, the radial diameter almost always being the greater. The average size is about 140 by 160 μ, though chambers half this size are found. The walls are about 20 μ thick; roofs and floors of the equatorial chambers are pierced by numerous cribriform perforations, having a diameter of about 3 μ.

The equatorial chambers of the microspheric form near the embryonic chambers are arcuate in form; diameter about 40 μ; at a distance of about 0.8 mm from the apex they become diamond-shaped; radial diameter about 160 μ; tangential diameter about 140 μ; at a distance of about 2 mm from the apex, radial diameter about 200 μ; transverse diameter about 130 μ; chamber walls about 20 μ thick; roofs and floors perforated by numerous cribriform perforations about 3 μ in diameter.

In a vertical section of a broken specimen having a diameter of 1.52 mm and a thickness of 0.48 mm, the equatorial layer is 120 to 160 μ high; chamber spaces elliptical, from 60 to 100 μ high; length near embryonic apparatus about 40 μ; at a point about 1.5 mm from the embryonic apparatus, length about 180 μ. The roofs and floors of the equatorial layer are about 20 μ thick.

There are about four layers of lateral chambers on each side of the equatorial layer, irregular in arrangement and size, not arranged in tiers. Dimensions of chamber spaces: Height, about 30 to 40 μ; length, about 40 to 200 μ; roofs and floors slightly arched, thickness about 20 μ, perforated by numerous cribriform perforations. This species has no pillars.

Locality and geologic horizon.—These specimens were obtained by M. N. Bramlette from well Rodriguez No. 23 from a depth of 2,482 feet, Ambrosia Field, District of Bolivar, Venezuela.

The geologic horizon from which these specimens were obtained is not definitely known, though it is probably middle or upper Oligocene.

This species differs from other described species of American *Miogypsina* in its lack of definite pillars. It is also thinner. Mature megalospheric specimens have a thickness of only 0.4 mm. This species has the peripherally located type of embryonic apparatus which is possessed by *M. cushmani* Vaughan, *M. hawkinsi* Hodson, *M. bracuensis* Vaughan, and *M. venezuelana* Hodson. It differs from the first three in being only about half as thick, and from the latter by its much smaller size.

This species is named in honor of Mr. M. N. Bramlette.

MIOGYPSINA HAWKINSI Hodson

Plate 6, figs. 11, 12, 13, 14

Miogypsina hawkinsi Hodson (27, pp. 28-29, pl. 7, fig. 9; pl. 8, figs. 1-2).

Specimens of this species occur in material from the San Luis series, middle Oligocene, at the following localities: 4, 8, 168, 960, 1042, 1123, 1127, and possibly at localities 500, 843, 1119, and 1120. Some of the associated species are *L.* (*Lepidocyclina*) *canellei* Lemoine and R. Douvillé, *L.* (*Lepidocyclina*) *sanluisensis*, n. sp., *L.* (*Nephrolepidina*) *undosa* Cushman, *Camerina* sp. indet., and *Heterostegina* sp.

DESCRIPTION OF LOCALITIES

All the following localities are in the States of Falcón, East Falcón, or Lara, Venezuela.

Cerro Gauche. Three kilometers south of San Luis, District of Bolivar, Falcón. Collected by M. N. Bramlette.

Rodriguez No. 23. From well Rodriguez No. 23, 2,482 feet, Ambrosia Field, District of Bolivar, Falcón. Collected by M. N. Bramlette.

4. About 1 kilometer northeast of Pecaya, District of Democracia. Collected by M. N. Bramlette.

8. District of Buchivacoa, Falcón. Collected by M. N. Bramlette.

12. From Guacharaca, out of Guayaval series, District of Acosta, East Falcón. Collected by H. G. Kugler and L. Vonderschmitt.

16. From Guacharaca, out of Guayaval series, District of Acosta, East Falcón. Collected by H. G. Kugler and L. Vonderschmitt.

148. From Guacharaca, out of Guayaval series, District of Acosta, East Falcón. Collected by H. G. Kugler and L. Vonderschmitt.

149. Same locality as 148.

163. From Cerro Campaña, out of Guayaval series (Cerro Campaña limestone), District of Acosta, East Falcón. Collected by H. G. Kugler and L. Vonderschmitt.

165. From Cerro Campaña, out of Guayaval series (Cerro Campaña limestone), District of Acosta, East Falcón. Collected by H. G. Kugler and L. Vonderschmitt.

TABLE 1.—*Species Listed According to Localities*

Species	Localities: Cerro Colorado; Quiriquire; Quiriquire 23; 4; 8; 12; 118; 119; 163; 165; 168; 204; 226; 236; 253; 263; 443; 468; 469; 476; 477; 478; 480; 481; 484; 494; 496; 497; 498; 500; 510; 514; 536; 543; 957; 959; 960; 962; 963; 968; 970; 1042; 1043; 1116; 1119; 1120; 1123; 1127; 1142; 1147; 1149; 1152; 1162; 1166; 1206; 1208; 1209; 1210; 1219; 1232; 1235
Camerina sp. cf. C. parvula (Cushman)	
Camerina sp. a	
Camerina sp. indet.	
Operculina sp. cf. O. cookei Cushman	
Heterostegina sp. cf. H. antillea Cushman	
Heterostegina panamensis Gravell, n. sp.	
Archaias sp.	
Amphisorus ? sp.	
Amphistegina lessonii d'Orbigny	
Gypsina globulus (Reuss)	
Gypsina vesicularis (Parker and Jones)	
Carpenteria sp.	
Discocyclina sp. indet. (probably Discocyclina Flintensis (Cushman)	
D. (Asterocyclina) asterisca (Guppy)	
D. (Asterocyclina) kugleri Gravell, n. sp.	
L. (Lepidocyclina) canellei P. Lemoine and R. Douville	
L. (Lepidocyclina) forresti Vaughan	
L. (Lepidocyclina) macdonaldi Cushman	
L. (Lepidocyclina) trinitatis H. Douville	
L. (Lepidocyclina) sanluisensis Gravell, n. sp.	
L. (Lepidocyclina) sp. indet. a	
Lepidocyclina sp. indet. b	
Lepidocyclina gigas Cushman	
L. (Nephrolepidina) undosa Cushman	
L. (Nephrolepidina) sp.	
L. (Eulepidina) favosa Cushman	
Miogypsina bramlettei Gravell, n. sp	
Miogypsina hawkinsi Hodson	

168. District of Democracia, Falcón. Collected by M. N. Bramlette.
204. El Mene del Salto from base of El Mene beds, Agua Clara series, District of Acosta, East Falcón. Collected by H. G. Kugler and L. Vonderschmitt.
228. Quebreda Juso near El Pozon, District of Acosta, East Falcón. Collected by L. Vonderschmitt.
233. From alluvial drift block on west side of Rio Ricoa nearly opposite town of Moturo, District of Zamora, East Falcón. Collected by H. G. Kugler and L. Vonderschmitt.
236. Outcrop on road from Carorita to Agua Linda, District of Acosta, East Falcón. Collected by H. G. Kugler and L. Vonderschmitt.
322. Caparare limestone between La Caridad and Mirimiri. Collected by H. G. Kugler and L. Vonderschmitt.
404. Near Curamichate. Loose blocks? Collected by L. Vonderschmitt.
443. From lower part of producing zone, British Controlled Oil Fields, Ltd., District of Buchivacoa, Falcón. Collected by H. G. Kugler.
468. From Guarabal, District of Mirandana, State of Falcón. Collected by H. G. Kugler.
469. San Luis limestone about 3 miles south of Cabure, on Cabure-Churuguara Road, District of Petit. Collected by H. G. Kugler.
476. Cabure-Churuguara Road, about 1 mile north of Juan Diaz, District of Federación, Falcón. Collected by H. G. Kugler.
477. Cabure-Churuguara Road, District of Federación, Falcón. Collected by H. G. Kugler.
478. San Luis limestone, between Parucia and Churuguara, District of Federación, Falcón. Collected by H. G. Kugler.
480. Churuguara beds just south of Churuguara, District of Federación, Falcón. Collected by H. G. Kugler.
481. Churuguara beds just south of Churuguara, District of Federación, Falcón. Collected by H. G. Kugler.
482. Churuguara beds just south of Churuguara, District of Federación, Falcón. Collected by H. G. Kugler.
494. Just north of town of Aguada Grande, State of Lara. Collected by H. G. Kugler.
496. Between El Tupi and Campo Alegre, District of Federación, State of Falcón. Collected by H. G. Kugler.
497. Between El Tupi and Campo Alegre, District of Federación, Falcón. Collected by H. G. Kugler.
498. On road between Guarabal and Pecaya between La Puerta and Porvenir, District of Bolivar, San Luis limestone. Collected by H. G. Kugler.
500. About 2 miles south of Agua Clara, District of Miranda, Falcón. Collected by H. G. Kugler.
510. About 2 miles east of Sabanas Altas, District of Zamora, East Falcón. Collected by H. G. Kugler.
514. About 2 miles south of Guarabal, District of Miranda, Falcón. Collected by H. G. Kugler.
556. Ojo de Agua beds at Repelón, near El Mene, District of Acosta, East Falcón. Collected by L. Vonderschmitt.
843. La Penita, Guayaval. Collected by L. Vonderschmitt.

957. Facies of San Luis limestone, Macoruca, District of Colina, Falcón. Collected by L. Vonderschmitt.

959. Marly limestone underlying the main San Luis limestone layer, El Cumbre, District of Colina, Falcón. Collected by H. G. Kugler and L. Vonderschmitt.

960. Main San Luis limestone. El Cumbre, District of Colina. Collected by H. G. Kugler and L. Vonderschmitt.

962. Marly limestone overlying the San Luis beds separated from them by a thick shale formation. At El Solito, District of Colina, Falcón. Collected by H. G. Kugler.

967. Bluish limestone. At La Guyia, District of Colina, Falcón. Collected by L. Vonderschmitt.

968. Orbitoidal marl at La Guyia, just south of locality 967, District of Colina, Falcón. Collected by L. Vonderschmitt.

970. Acurigua, District of Colina, Falcón. San Luis limestone. Collected by L. Vonderschmitt.

1042. Acurigua, District of Colina, Falcón. San Luis limestone. Collected by L. Vonderschmitt.

1043. El Cumbre (Orbitoidal marl underlying locality 959), District of Colina, Falcón. Collected by H. G. Kugler and L. Vonderschmitt.

Material from the following localities were collected by Drs. P. Leuzinger, P. A. Messmann, and A. Senn, and sent to Scripps Institution of Oceanography by Dr. H. G. Kugler.

1116. Pedregosa, District of Democracia, Falcón. Fine conglomerate cemented with lime.

1117. La Caca, District of Bolivar, Falcón. Stratigraphically about 150 feet above 1209.

1119. Guasiqui, District of Bolívar, Falcón.

1120. Pedregosa, District of Democracia, Falcón. Stratigraphically about 300 feet above locality 1116.

1121. Along the "Carretera de Falcón" on the summit of the Cordillera de Agua Negra, South of Tupi, District of Federación, Falcón.

1123. Pedregosa, District of Democracia, Falcón. About 130 feet above locality 1116.

1127. Pedregosa, District of Democracia, Falcón. Stratigraphically about 170 feet above 1116.

1142. Buena Vista, State of Lara.

1147. About half way between El Paujicito and El Vadillal, and stratigraphically about 2,300 feet above 1149.

1149. Between El Vadillal and El Oso, about 700 feet north of El Vadillal, State of Lara.

1152. Between El Oso and El Vadillal, State of Lara. About 80 feet north and stratigraphically about 60 feet below locality 1149.

1157. Paso Grande, District of Democracia, Falcón.

1162. Between El Oso and El Vadillal, about 1,000 feet north of El Vadillal, and stratigraphically about 200 feet below locality 1149.

1166. Paso Grande, District of Democracia, Falcón.

1186. About half way between El Vadillal and El Paujicito, State of Lara, stratigraphically about 200 feet above locality 1149.
1194. A short distance north of El Oso, State of Lara.
1206. East side of Baño Gorge, Los Baños, District of Democracía, Falcón.
1208. West side of Baño Gorge. Stratigraphically about 750 feet above locality 1210, District of Democracía, Falcón.
1209. La Caca, District of Bolivar, Falcón.
1210. Los Baños, west side of Baño Gorge, District of Democracía, Falcón.
1219. Transported blocks from El Yavito, District of Democracía, Falcón.
1221. Transported blocks from La Idea, State of Lara.
1222. El Vadillal, State of Lara.
1223. Transported blocks from El Mamonsito, State of Lara.

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EXPLANATION OF PLATES

The locality numbers are explained under "Description of Localities."

Plate 1

Figs. 1-5. *Camerina* sp. *a*. Figs. 1, 2, exterior views of three specimens, × 13, from locality 497; fig. 3, horizontal section, × 20, from locality 482; fig. 4, vertical section, × 20, from locality 497; fig. 5, horizontal section, × 20, from locality 496.

Fig. 6. *Camerina* sp. cf. *C. parvula* Cushman, vertical section, × 20, from locality 163.

Figs. 7-9. *Operculina* sp. cf. *O. cookei* Cushman. Fig. 7, exterior view a specimen, × 13; fig. 8, vertical section, × 42; fig. 9, horizontal section, × 20. All specimens are from locality 163.

Figs. 10, 11. *Heterostegina panamensis* Gravell, n. sp. Fig. 10, horizontal section of a megalospheric specimen, × 20; fig. 11, horizontal section of a microspheric specimen, × 19. Both specimens are from locality 4.

Fig. 12. *Heterostegina* sp. cf. *H. antillea* Cushman, vertical section, × 20, from locality 482.

Plate 2

Fig. 1. *Archaias* sp., horizontal section, × 20, from locality 1123.

Fig. 2. *Amphistegina lessonii* d'Orbigny, vertical section, × 50, from locality 228.

Fig. 3. *Gypsina globulus* (Reuss), horizontal section, × 36, from locality 1208.

FIGS. 4, 5. *Gypsina vesicularis* (Parker and Jones.) Fig. 4, vertical section, × 20, from locality 149; fig. 5, vertical section, × 34, from locality 163. (*Lepidocyclina trinitatis* H. Douvillé at the right margin of the fig. 4.)

FIGS. 6, 7. *Carpenteria* sp. Fig. 6, vertical section, × 21, from locality 1206; fig. 7, horizontal section, × 21, from locality 12.

FIGS. 8, 9. *Discocyclina* sp. indet. Fig. 8, portion of horizontal section, × 86, from locality 1142; fig. 9, portion of vertical section, × 86, from locality 1142.

PLATE 3

FIGS. 1–5. *Discocyclina* (*Asterocyclina*) *kugleri* Gravell, n. sp. Figs. 1, 2, surface views of cotypes, × 12; fig. 3, surface view of a cotype, × 5; fig. 4, vertical section of a cotype (fig. 4, × 21); fig. 5, horizontal section of a cotype, × 20. All specimens are from locality 163.

FIG. 6. *L.* (*Lepidocyclina*) *forresti* Vaughan, portion of horizontal section, × 25, from locality 1206.

FIG. 7. *L.* (*Lepidocyclina*) *trinitatis* H. Douvillé, vertical section, × 21, from locality 149.

FIG. 8. *L.* (*Lepidocyclina*) *trinitatis*, vertical section of a specimen that has a twin embryonic apparatus, × 20, from locality 165.

PLATE 4

FIGS. 1–4. *Lepidocyclina* (*Lepidocyclina*) *sanluisensis* Gravell, n. sp. Fig. 1, surface view of a cotype, × 13; fig. 2, horizontal section of a cotype, × 18; fig. 3, vertical section of a cotype, × 16; fig. 4, portion of horizontal section of a cotype, × 40. All specimens are from locality 168.

PLATE 5

FIGS. 1–3. *Lepidocyclina* (*Lepidocyclina*) *macdonaldi* Cushman. Fig. 1, vertical section, × 46, from locality 149; fig. 2, horizontal section, × 13, from locality 163; fig. 3, horizontal section, × 20, from locality 12.

FIGS. 4–8. *Lepidocyclina* (*Lepidocyclina*) *cauellei* Lemoine and R. Douvillé. Fig. 4, surface view, × 10, from locality 4; fig. 5, vertical section, × 20, from locality 469; fig. 6, horizontal section, × 20, from locality 469; fig. 7, vertical section of two specimens, × 20, from locality 469; fig. 8, portion of horizontal section, × 40, from locality 4.

FIGS. 9, 10. *Lepidocyclina* (*Nephrolepidina*) sp. Fig. 9, vertical section, × 12; fig. 10, vertical section, × 20. Both specimens are from locality 1209. (See pl. 6, fig. 1.)

FIG. 11. *Lepidocyclina* (*Eulepidina*) *favosa* Cushman, vertical section, × 19, from locality 498.

Plate 6

Fig. 1. *Lepidocyclina* (*Nephrolepidina*) sp., horizontal section, × 11, from locality 1209. (See pl. 5, figs. 9, 10.)

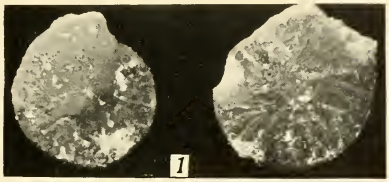
Fig. 2. *Lepidocyclina* (*Eulepidina*) *favosa* Cushman, vertical section, × 21, from locality 967.

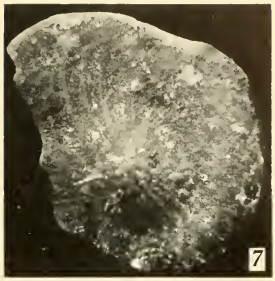
Fig. 3. *Lepidocyclina* sp. indet. (*b*), vertical section, × 20, from locality 1043.

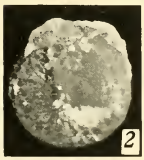
Fig. 4. *Lepidocyclina* (*Nephrolepidina*) *undosa* Cushman, vertical section, × 20, from locality 1223.

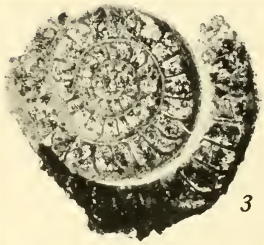
Figs. 5–10. *Miogypsina bramlettei* Gravell, n. sp. Figs. 5-7, surface views; fig. 5, microspheric specimen, × 18; figs. 6, 7, megalospheric specimens (fig. 6 × 23, fig. 7, × 13); fig. 8, horizontal section, × 20; fig. 9, horizontal section of another specimen, × 20; fig. 10, vertical section of microspheric specimen, × 36. The above specimens are all from well Rodriguez 23.

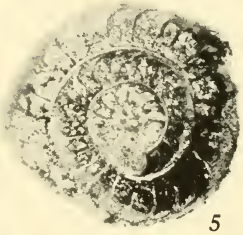
Figs. 11, 12, 13, 14. *Miogypsina hawkinsi* Hodson. Fig. 11, horizontal section, × 20, locality 9; figs. 12-14, surface view of three specimens, × 13, from locality 8.

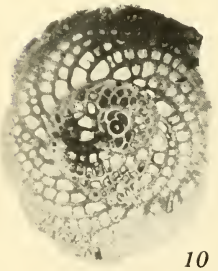












TERTIARY FORAMINIFERA OF VENEZUELA

(For explanation, see page 42.)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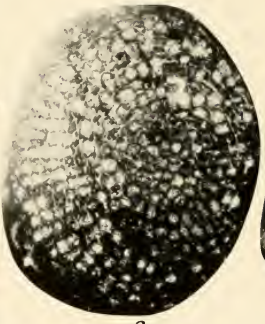
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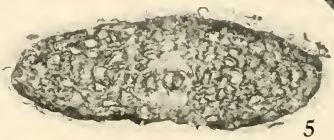
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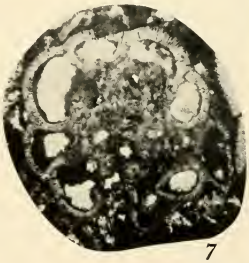
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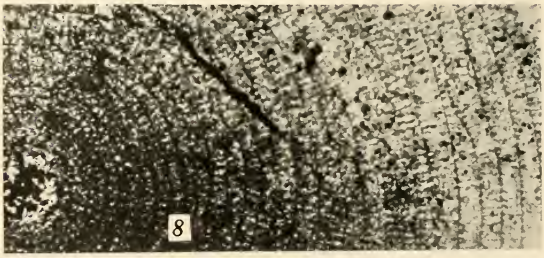
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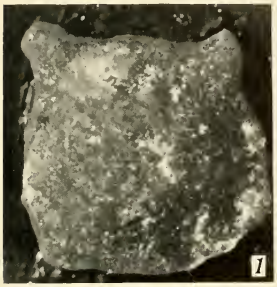
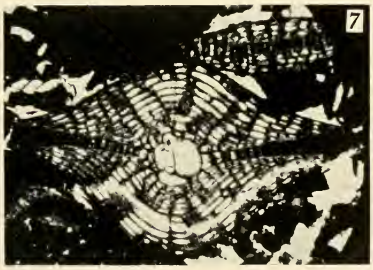
TERTIARY FORAMINIFERA OF VENEZUELA

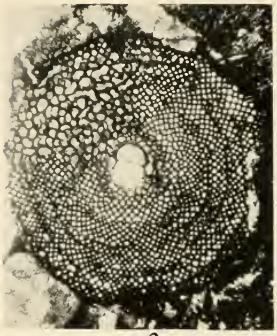
(For explanation, see page 42.)





TERTIARY FORAMINIFERA OF VENEZUELA

(For explanation, see page 43.)



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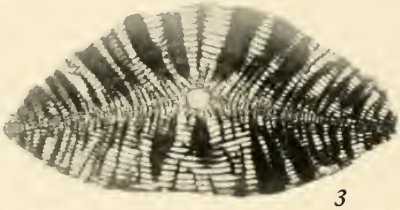

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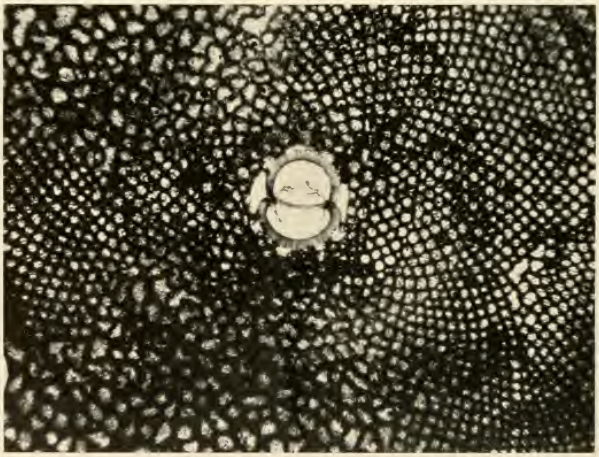
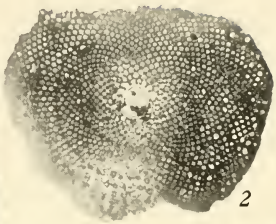
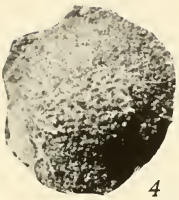


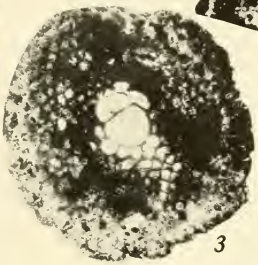
4

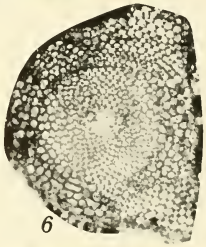
TERTIARY FORAMINIFERA OF VENEZUELA

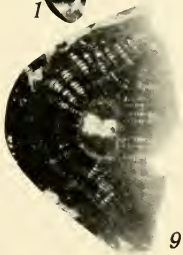
(For explanation, see page 43.)

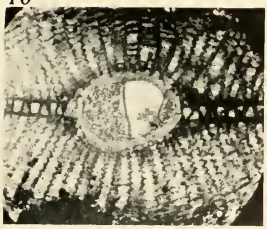


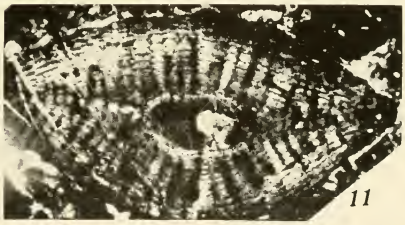






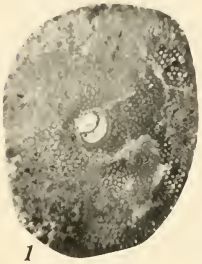


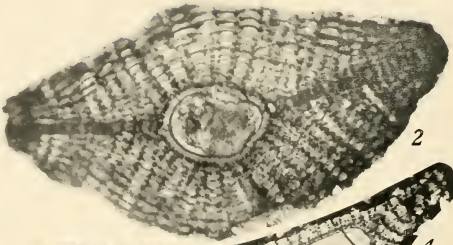


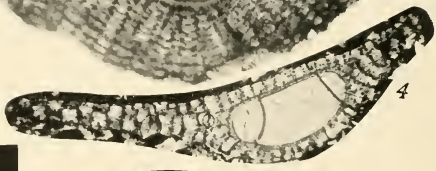


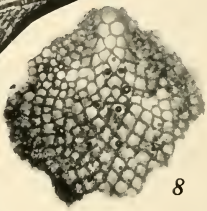
TERTIARY FORAMINIFERA OF VENEZUELA

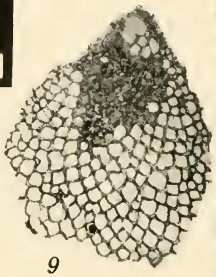
(For explanation, see page 43.)

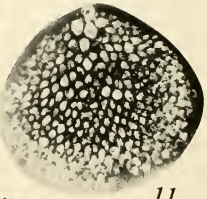


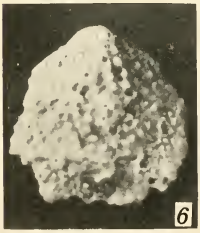


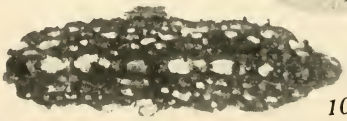


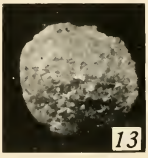












TERTIARY FORAMINIFERA OF VENEZUELA

(For explanation, see page 44.)