pamensis) and *Planorbulinella*, locally with *Sorites* and some *Archaias*. This fauna continues throughout the late Middle Miocene (Tamana Formation) and the first part of the Late Miocene (Manzanilla Formation). No larger foraminifera occur higher up in the section. Younger reefs carry only *Amphistegina*.

5. Taxonomy

Family Orbitolinidae
Genus *Orbitolina* D'ORBIGNY
Orbitolina cf. *texana* ROEMER
Pl. 10:18

1941   *Orbitolina* sp. cf *texana*, Vaughan & Cole, p. 3, 7, 24, 31, pl. 8:2–4.
1961   *Orbitolina oculata* Douglass, p. 143, 149, pl. 65:1–3.

This species has been found in rock-building quantity in two limestone boulders, one in Pointe-a-Pierre, the other in the river bed at Quinam. According to Vaughan & Cole it probably indicates an Early Cretaceous (Albian) age. Douglass (1961) places the specimens from Pointe-a-Pierre in *Orbitolina occulata*.

Family Nummulitidae
Although familiar with Cole's arguments for uniting all the genera of this group under one name because all their characteristics are only of a gradual nature, the present author prefers for practical and in part stratigraphic reasons, to distinguish *Ranikothalia, Operculina, Operculinoides* and *Nummulites* as separate genera. In Trinidad, *Ranikothalia* occurs in the Late Paleocene, an evolute *Operculina* was found in the late Middle Eocene and reworked in the Late Eocene. *Nummulites* is very sparingly present in the Late Eocene, whereas *Operculinoides* in all its different forms ranges from Middle Eocene to top Miocene.

   Heterostegina seems to be restricted to the later part of the Oligocene in this area, but has an incompletely developed precursor in the early Late Eocene. *Spiroclypeus* is probably the same species that is so spectacularely developed in western Venezuela (Falcón). In Trinidad it is not found in situ, but occurs occasionally in mud flow erratica near the South Coast.

Genus *Ranikothalia* CAUDRI

General remarks

Ever since the name *Ranikothalia* was proposed for the peculiar «nummulites cordelées» of the Paleocene in both the Old and the New World, it has been turned down by some paleontologists who, for purely morphologic and statistic reasons, refused to separate these forms from *Nummulites, Operculinoides, Operculina* or even *Miscellanea*, as the case may be, whereas it was accepted by others who saw in them in first place a genetically close-knit group, generally recognizable at sight and limited in geological time. The clearest discussion in defence of a separation was presented by Drooger (1960). In 1966, Arni introduced the genus *Chordoperculinoides* (genotype *Operculina bermudezi* Palmer), which is a synonym of *Ranikothalia* (see also Cole 1969b).

The type species of the genus is *Nummulites nuttalli* (Nuttall) Davies from the Upper Ranikot beds of Sind, Pakistan, which are solidly established as Late Paleocene (Nuttall 1926; Davies 1927, 1949; Gill 1953). For the description of this species reference is made to Nuttall 1926 (114, pl. 10:1–2, textfig. 1), Davies 1927 (266, pl. 18:3–4; pl. 19:1–9) and Caudri 1934 (57, pl. 1:9; horizontal section). Our Venezuelan material (1944), which consists of hard limestones in which *Ranikothalia* is well preserved and in situ, was entirely adequate to prove the presence of this type of fossils also in the Caribbean Paleocene (in the Caramate member of the Guárico Formation near San Juan de los Morros; see Peirson, Salvador & Stainforth 1966).

Between certain latitudes, the geographic distribution of *Ranikothalia* is practically worldwide. In the West, it has been reported from eastern and central Venezuela (Caudri 1944; de Cizancourt 1951), Trinidad and Soldado Rock (Cushman & Jarvis 1932; Vaughan & Cole 1941; Vaughan 1945; Caudri 1975), Surinam, French Guayana and off-shore Guyana Basin (Drooger 1960; Wong 1976; Blondeau 1977; van Voorthuyzen 1979), Barbados (Vaughan 1945; de Cizancourt 1948; Caudri 1972b), Puerto Rico, Loisy Quarry (det. Caudri), Hispaniola (Hanzawa 1937; Butterlin & Bonet 1960a, 1960b), Jamaica (Robinson 1968), Cuba (Palmer 1934; Bermudez 1950; Cole 1953; Sachs 1957; Brönnimann & Rigassi 1963; Seiglie 1965; Butterlin 1976), Florida and Alabama, Georgia (Cole & Herrick 1953), Mexico, general (Butterlin 1977), Veracruz (Barker 1939), and Yucatan (Butterlin & Bonet 1960a, 1960b).

In the Eastern Hemisphere *Ranikothalia* occurs in Senegal (de Cizancourt & Cuvillier 1954; Blondeau 1977; Butterlin 1977), the Ivory Coast, Nigeria and Cameroon (Blondeau 1977), Togo (Davies 1949), probably Spain (Alicante and Catalonia), the French Pyrenees and Upper Egypt (Hottinger 1962), Libya (Arni 1966), Somalia and Arabia (verbal information; see also Silvestri's *Miscellanea assilinoides* from Somalia), Iran, Horassan and N.W. Saitan (Rahaghi 1978), Pakistan (Nuttall 1926; Davies 1927, 1949; Caudri 1934, 1944), Tibet, Assam, Coastal India and further East into Southern Burma (Nagappa 1959) and possibly Indonesia and New Guinea in the Tertiary-a of van der Vlerk (1955).

According to Glaessner, the equivalents of the Ranikot and Laki stages of Pakistan (Paleocene and Early Eocene, respectively) are missing in the Far East, which would make this Tertiary-a Middle Eocene (Nagappa 1959). The presence of *Ranikothalia* in Indonesia and New Guinea that high in the section should be checked.

Into how many species the genus *Ranikothalia* can be divided is still an open question. The variability in habitus as well as in interior features is so great that one can split the population in any given locality into a dozen or more different species or lump it into one. This is best illustrated by the comparison of de Cizancourt's work on Barbados (1951), in which eight or ten different species are recognized, to that of Sachs (1957), who by statistical methods came to the conclusion that they all belonged to one and the same species which he placed in *Operculina bermudezi* Palmer. For morphological reasons, Cole had already come to the same conclusion (Cole 1953, 1958, 1959b), but named the species *Operculina catenula* Cushman & Jarvis, which according to the rules should have priority over *O. bermudezi*. The tendency of several authors to ignore *O. catenula* lies in the circumstances that its type material seemed rather inadequate. It consists of one single intact specimen from Lizard Springs (Trinidad), in which the internal characteristics, necessary for the specific diagnosis, are not revealed (Butterlin 1977). The present author does not doubt the identity of this obscure holotype and agrees to name the Caribbean species *O.*

catenula. As in Caudri (1975) we follow Vaughan & Cole's names for the three Trinidad varieties. These are *Ranikothalia antillea* for the closely wound robust lenticular A-form, *R. tobleri* for the more flaring form with elongated, slightly curved round-topped chambers (A and B) and *R. soldadensis* for the large compressed heavy-rimmed fullgrown B-form (see illustrations in Caudri 1975, which also include material from Lizard Springs).

Drooger (1960) distinguishes two separate species: the very flattened individuals that make up the entire populations in Guayana and Georgia (*Ranikothalia soldadensis*) and the robust lenticular form which is usually associated with elsewhere (*R. bermudezi*). These two extremes are, however, linked by so many transitional forms that they most probably can never be separated. The present writer feels, on the other hand, that if after all the genus should get split up into more than one species it would be the small flat thin walled form from Georgia (*Operculinoides georgianus* Cole & Herrick) that would jump out of line first. It might represent a juvenile stage of our robust *Ranikothalia soldadensis*, or be a peculiar geographic variety, but it certainly is not typical of the species.

Also the Old World *Ranikothalia* are often considered as specifically the same as the American ones. Drooger (1960), quoting Davies (1927), suggests that *Operculina sindensis* and *Nummulites nuttalli* from Pakistan may prove to be conspecific with *Ranikothalia soldadensis* and *R. bermudezi*, respectively. This is an oversimplified conclusion as there are in the Pakistan Paleocene still other species to be considered: *Nummulites kohaticus*, *N. thalicus* and *Operculina gwynae*. Rahaghi (1979) uses the West Indian nomenclature, like *Ranikothalia soldadensis* and *Operculina catenula*, for his material from Iran. This has also been done in the work of Davies (1949), de Cizancourt & Cuvillier (1954) and Blondeau (1977). The last-mentioned author determined specimens from the Caribbean and Senegal as *Ranikothalia bermudezi-nutalli* and those from French Guyana, the Ivory Coast, Nigeria and Cameroon as *R. sindensis-soldadensis*. Over a smaller distance, Cole (1960b) puts *Nummulites nuttalli* and its A-form (*thalicus*) in synonymy with the European pair *N. elegans-planulatus*. Continental drift is sometimes mentioned as the cause of this peculiar global distribution, but it is not easily explained why this movement should affect only *Ranikothalia* and not its associated fauna as well. Blondeau 1982) thinks in first place of both-ways migration, with perhaps Senegal as the point of origin. All this needs careful further study.

Generally speaking, *Ranikothalia* is typical for Late Paleocene worldwide. In the West it forms the most conspicuous element in Cole's *Operculina catenula* fauna which has been traced throughout the Caribbean and Gulf regions and which Cole (1959b) considers as indicative for Late Paleocene also here.

In Trinidad this assemblage is composed of: *Ranikothalia antillea, tobleri* and *solda-densis, Neodiscocyclina barkeri, caudriae, grimsdalei, aguerreverei, fonslacertensis* and *mestieri, Athecocyclina soldadensis, Hexagonocyclina inflata* and *meandrica,* and *Actinos-iphon barbadensis.* For other localities, *Discocyclina weaveri, Athecocyclina stephensoni, Hexagonocyclina cristensis* and *Actinocyclina semmesi* should be included. Hottinger (1973) correlates its range with zones P_3 to P_5 of Blow's 1969 planktic zonation. According to Peirson, Salvador & Stainforth (1966), de Cizancourt's zones of Paleocene a, b and c in the area of San Juan de los Morros carry *Ranikothalia,* whereas her zone d, which is Early Eocene, is devoid of them. In 1951, however, she intimates that in western Venezuela many of her species occur also in the lower part of the Early Eocene (chart on p. 62). Also in Jamaica the genus seems to be restricted to the Paleocene (Robinson 1965).

There are, however, also a few rather isolated indications that the genus may continue into the Early Eocene. Butterlin traced its occurrence from the Late Paleocene (Bolli's *Morozovella pseudomenardii* Zone) to high in the Early Eocene (zones of *Morozovella aragonensis* and *Acarinina pentacamerata*). Similar observations were made by de Cizancourt (1951), Bermudez (1950), Sachs (1957), Butterlin & Bonet (1960), Brönnimann & Rigassi (1963), Seiglie (1965) and Bolli (1966), especially in Cuba, Mexico and the Gulf States. Nagappa (1959) writes also that in the Old World the genus is in general restricted to the Late Paleocene, but that in rare cases it may perhaps extend into the Early Eocene in South Asia.

One has to be careful when evaluating these cases of a post-Paleocene occurrence of *Ranikothalia*, especially when mentioned in association with such Middle Eocene markers as *Helicostegina dimorpha* and *Discocyclina anconensis*. Both these forms have more than once been identified incorrectly, this and reworking of *Ranikothalia* are likely the causes for post-Paleocene identifications of the genus. A striking example for that is the assemblage in the Middle Eocene Murphy's beds of Barbados, where *Neodiscocyclina anconensis* is the predominant and diagnostic species and the *Operculina catenula* fauna, no matter how well preserved, is reworked (Vaughan 1945; de Cizancourt 1948; Caudri 1972b).

Occurrence in Trinidad

In Trinidad, *Ranikothalia* occurs in a semi-authochthonous state in only one place: at the type locality Maerky 102b III of the Lower Lizard Springs Formation (*Morozovella velascoensis* Zone), in the bank of a tributary of the Ravine Ampelu. A pit in the immediate neighbourhood of this exposure yielded the isolated type specimen of *Operculina catenula* (Cole 1953) re-deposited from a contemporaneous bioherm, the *Ranikothalia* limestone of the Soldado Formation (Kugler & Caudri 1975).

This *Ranikothalia* limestone is not found in situ in Trinidad, but remnant blocks are frequently scattered in the southern part of the Island, especially in the Lizard Springs area and along the South coast in the mud-volcano effusiva, and in conglomerates around San Fernando and Pointe-a-Pierre. Detached specimens of *Ranikothalia* are very common in the clastic Late Eocene San Fernando Formation and, to a lesser degree, in the Middle Eocene Charuma silt and the Navet marls at Dunmore Hill (Caudri 1975).

The best material is that from Maerky 102b III, where *Ranikothalia* of the *antillea* and *tobleri* type are abundant, together with various Discocyclinidae. *Ranikothalia soldadensis* was represented by only one juvenile specimen and a few fragments (Caudri 1975, pl. 1:1–7; pl. 2:1–8).

In 1975 the present author announced a more extensive description of the Trinidad *Ranikothalia* following the study of the Lizard Springs material. It is unfortunate that Vaughan & Cole did not have access to this material for their 1941 paper and thus were not able to study the typical Lizard Springs fauna as a whole.

They had to describe their new species *Miscellanea tobleri* and *Discocyclina fonslacertensis*, which belong to this assemblage, from a Late Eocene erratic block in the nearby Ravine Djalan and consequently assigned them to the Late Eocene instead to the Paleocene. For his intended closer study of these forms, Vaughan afterwards received from the Pointe-a-Pierre laboratory a number of choice specimens and thin sections from

Maerky 102b III. His observations on them are, however, not mentioned in his 1945 Barbados paper. Only a preliminary report on the Lizard Springs *Ranikothalia* is kept, along with the material, in the U.S. National Museum in Washington (Caudri 1975).

As it turns out, the vague diagnosis and the good illustrations given then seem already clear enough for our purpose without adding more than a few photographs (Pl. 5:1–4; Pl. 9:1–2,4–9). What is still lacking, both in the type descriptions by Vaughan & Cole (1941) and in Caudri (1975) is a detailled description of *Ranikothalia soldadensis*, a species originally based only on a couple of off-center vertical sections in hard rock. The following species description is based on the best material available from Soldado Rock (samples K. 2951B and Rz. 248), illustrated in Caudri (1975, pl. 1:1; pl. 2:1, 8; pl. 6:1, 3; pl. 7:1–5).

Ranikothalia soldadensis (VAUGHAN & COLE)
Pl. 5:4; Pl. 9:1

1941   *Miscellanea soldadensis*, Vaughan & Cole, Geol. Soc. Amer., Spec. Pap. 30, 36, pl. 4:8–9.
1975   *Ranikothalia soldadensis*, Caudri, pl. 1:1, 4; pl. 2:6, 9; pl. 6:1, 3; pl. 7:1–5; pl. 8:1–3.

Exterior: Diameter of weathered specimens at K. 2951B 4–8 mm, up to at least 13 mm in well-preserved specimens in hard rock (Rz. 248). Test flat, discoid, with a thick protruding marginal cord, visible on the surface as a complete spiral; lateral walls sunken-in between the coils of the spiral, especially in the later whorls. No large pillars, except perhaps in the juvenile stage, septal filaments running across the surface right up to the center (see also the vertical section), often irregularly granulated, surface between the filaments also very finely granulated.

The same feature of evolute chambers without alar prolongations of the lumen but with the lateral sheet extending as a thin film over the older coils has been illustrated by de Cizancourt (1951) for the Barbados form of *Ranikothalia bermudezi*. It was also observed in *Operculina bontourensis* Caudri n. sp. Marginal cord especially in the later whorls magnificently developed, characterized by a conspicuous fan of wide canals radiating from the top of the chambers; the whole marginal complex clearly separated from the chamber lumina by a solid wall (compare *Miscellanea* which lacks such a wall). Lateral wall of the chambers also pierced by wide canals, thick in the inner whorls but becoming very thin in the last ones, sunken into the extent of sometimes nearly suppressing the lumen.

The smaller specimens from K. 2951B fall within the measurements given by Vaughan & Cole (1941) for the microspheric form of *Ranikothalia tobleri*.

Typical *Ranikothalia soldadensis* are very rare in Trinidad. Apart from the above mentioned juvenile specimen and a few fragments at Lizard Springs it has been found fully developed only in the Paleocene blocks of the conglomerate in the Hermitage Quarry near Pointe-a-Pierre.

Genus *Operculina* D'ORBIGNY
Operculina bontourensis CAUDRI, n. sp.
Pl. 1:1–4; Pl. 9:3, 10

Exterior: Diameter up to 4.5 mm; thickness 0.3–0.5 mm. Test flat, smooth, evolute, with a rounded edge (no marginal cord developed); entire coil visible from the outside,

accentuated by a thickening of the wall along the spiral suture. Septa as a rule on-
ly faintly visible, flush or with at the most very fine granulations, but in exceptio-
nal cases heavily decorated (variety *ornata* n. var., Pl. 5:7).

Horizontal section: Nucleoconch small (70–115 μ), megalospheric in all observed speci-
   mens. Spiral high, but not very rapidly increasing in height; number of whorls 3.5
   to 4.5. Number of chambers in the last whorl 26–30 (in one large specimen 24 in
   the last half whorl). Septa in centered sections more or less radial near the center
   but strongly bent backwards in their distal part (in off-center sections often ap-
   pearing more evenly curved).

Vertical section: Test flat, no central boss, edge thin, without a trace of a marginal cord.
   Chamber lumina without alar prolongations, but sometimes each new whorl adds
   a thin film of shell material over the previous ones right up to the center.

Holotype: Pl. 1:1 (C 36023).

Type locality: Point Bontour, St. 63, Late Eocene; material reworked.

Type level: Uppermost Middle Eocene (Farallon limestone).

Occurrence: *Operculina* limestone Farallon Rock; Coora beach (Hg. 39aA, *Operculina*
   limestone block); Point Bontour (reworked in the Eocene: St. 61A, 63, 68a, 71, 85,
   77, 89, 90, Cd. 18: reworked in the Oligocene: Cd. 211).

This conspicuous evolute *Operculina* was first reported from the Late Middle Eocene of
Farallon Rock where it occurs in situ in rockbuilding quantities in a hard limestone. De-
tached specimens occur, however, in the Late Eocene marl from Point Bontour just op-
posite Farallon on the San Fernando coast. Although there they are most probably re-
worked, the types for the species have been selected from that locality, hence the pro-
posed name.

   True evolute Operculinas are uncommon in the Caribbean area, and limestones
formed by them are rare. In South America the only examples known in the literature
are the Caus and the Cuicas limestone, both in the Chejendé and Rio Carache areas of
Trujillo, western Venezuela. The former lies stratigraphically between the Escuque For-
mation and the Pauji shale (Stratigraphical Lexicon of Venezuela 1956) and is thought to
be of the same age as the Farallon limestone. It contains banks exclusively consisting of
Operculinas repeatedly mentioned as *Operculina cookei* but which have probably never
been described or figured. The Cuicas limestone is of an earlier date, it occurs below the
Polylepidina antillea Zone and was assigned to the early Middle Eocene (de Cizancourt
1951). The rockbuilding *Operculina* in this limestone has erroneously been determined as
Operculinoides oliveri.

   Thin sections of a sample of typical Cuicas limestone in the author's collection, from
the Puente Gomez area between La Cuchilla and La Concepcion, just S.E. of de
Cizancourt's type locality in the La Paz section (collected by J.W. Durham, location No.
19151) show many examples of the truly *complanata* nature of this *Operculina*.

   Operculina has also been mentioned by Tobler from the Rio San Pedro limestone of
Zulia, Venezuela. Because this limestone and that from Farallon and the Rio Caus are of
the same age, the Operculinas in all three localities may well be the same species. Speci-
mens of the Cuicas limestone seem to have a wider spiral.

Operculina bontourensis var. *ornata* CAUDRI, n. var.
Pl. 5:7

Exterior: Large flaring involute form, heavily decorated.
Holotype: Pl. 5:7 (C 36045).
Type locality: Point Bontour, San Fernando area, Trinidad, Sample St. 63, specimens re-
worked.
Type level: Uppermost Middle Eocene (Farallon limestone).
Occurrence: Predominant at Farallon locality F.Z. 37, occurs also at Point Bontour and in
a limestone boulder from Coora beach.

The new variety resembles *Operculinoides ocalanus* but is larger and may actually be
much closer to *Operculina bontourensis*, apart from being involute. They are large flaring
forms with the same rate of opening of the spiral and the same number and curvature of
the septa as in *O. bontourensis*.

Genus *Operculinoides* HANZAWA
The Eocene species
Operculinoides ocalanus (CUSHMAN)
Pl. 5:5; Pl. 9:11–13

1921   *Operculina ocalana*, Cushman, Prof. Pap. U.S. Geol. Surv., 128-E. p. 129, pl. 19:4, 5.
1928   *Operculina trinitatensis*, Nuttall, textfig. 8.
1941   *Operculinoides ocalanus*, Vaughan & Cole, p. 38, pl. 8:8–9; pl. 9:1–4; pl. 10:1.
1975   *Operculinoides ocalanus*, Kugler & Caudri, p. 398–402, 404, 408.
1975   *Operculinoides ocalanus*, Caudri, p. 537, 538, 540, pl. 1:12; pl. 8:4, 9.

The species is abundant in the Middle Eocene limestone of Farallon Rock and common
in the Late Eocene of the Navette area.

Operculinoides ocalanus var. *decoratus* CAUDRI, n. var.
Pl. 3:4

Exterior: Granulated.
Holotype: Pl. 3:4 (C 36030).
Type Locality: Point Bontour, San Fernando area, Trinidad, sample St. 68, specimen re-
worked.
Type level: Middle to Late Eocene.

The new variety differs from *Operculinoides ocalanus* in its granulated exterior appea-
rance. The new variety is based on a single specimen which was not sectioned.

Operculinoides soldadensis VAUGHAN & COLE
Pl. 5:6; Pl. 9:14–15

1928   *Operculina trinitatensis*, Nuttall, textfig. 9.
1941   *Operculinoides soldadensis*, Vaughan & Cole, p. 18, 27, 40, pl. 9:5–8; pl. 10:1–2.

1975   *Operculinoides soldadensis,* Kugler & Caudri, p. 398–400, 402, 404, 407–408, 417(cf.), 419(cf.) and chart.
1975   *Operculinoides soldadensis,* Caudri, p. 537–538, 540, pl. 1:11, 19; pl. 8:5–8, 10(cf.).

Originally described from Bed 10 of the Soldado Rock section (Late Eocene). *Operculinoides soldadensis* has the same range as *O. ocalanus.*

Occurrence: Farallon Rock (common), Dunmore Hill, top of Mount Moriah, Morne Roche, Charuma (abundant), Hospital Hill marl, Point Bontour, Vistabella Quarry, Calyx 59 (upper and lower part), Schlumberger office section (lower part), San Fernando Railway Station (Marabella marl), Soldado Rock.

Operculinoides trinitatensis (NUTTALL)
Pl. 5:11; Pl. 9:16–17

1928   *Operculina trinitatensis,* Nuttall, p. 102–103, pl. 8:10–11, textfig. 7 (not 8 and 9).
1941   *Operculinoides trinitatensis,* Vaughan & Cole, p. 47–50, 52–53, pl. 10:3?, 12; pl. 13:4–14.
1975   *Operculinoides trinitatensis,* Kugler & Caudri, p. 398, 400, 402, 408.
1975   *Operculinoides trinitatensis,* Caudri, p. 541, pl. 1:10, 16; pl. 8:14–15.

The type material of *Operculinoides trinitatensis* came from a depth of 570 feet in test-well-A on Tarouba Estate, Naparima area. Also present in this interval is *Lepidocyclina subglobosa,* an indicator for the uppermost Late Eocene (Marabella marl), which is the type level of *Operculinoides trinitatensis.*

Vaughan & Cole (1941) mentioned the close relationship between *O. trinitatensis* of the Eocene and *Operculinoides semmesi* which abounds in the Early Oligocene of the same area and suggested that Nuttall may have included the latter in his description. Though the horizontal sections of the two species are practically the same, *O. semmesi* distinguishes itself in vertical section by a flattening of the axial region, and its variety *ciperensis* is altogether a flatter form than *O. trinitatensis.* For its lack of prominent features *O. trinitatensis* is difficult to determine, which makes it unsuitable as a guide fossil.

Occurrence: San Fernando area, chiefly in the Late Eocene: Point Bontour, Hospital Hill marl, Vistabella Quarry, Calyx 57 and 59, Marabella marl only at the San Fernando Railway Station and at the type locality, Morne Roche Quarry, Navette area (abundant), ?Charuma (Late Eocene), Dunmore Hill marl, ?Farallon Rock, Soldado Rock.

Operculinoides kugleri VAUGHAN & COLE
Pl. 5:9; Pl. 10:1, 3

1941   *Operculinoides kugleri,* Vaughan & Cole, p. 18, 42, pl. 10:3?,4–5,7–8; pl. 13:1–2.
1952   *Operculinoides kugleri,* Cole, p. 9, pl. 3:1–7.
1975   *Operculinoides kugleri,* Kugler & Caudri, p. 398, 400, 402, 408.

For the external view of this common species reference is made to Vaughan & Cole (1941) and Cole (1952). It ranges from late Middle to uppermost Late Eocene (Marabella marl).

Occurrence: Soldado Rock (beds, 7, 9, 9a, 10), San Fernando area: Mount Moriah (common), Point Bontour (lower part), ?Hospital Hill marl, Vistabella Quarry, Calyx

57 (Marabella marl), Calyx 59 (Vistabella and ?Marabella marls), San Fernando Railway Station (Marabella marl), Morne Roche Quarry, Charuma (Late Eocene), Farallon Rock (late Middle Eocene).

Operculinoides spiralis CAUDRI
Pl. 5:8; Pl. 9:18

1975   *Operculinoides spiralis*, Caudri, p. 542, pl. 1:7; pl. 8:13.

The type level of *Operculinoides spiralis* is the uppermost bed of the Soldado Eocene (K. 2651), which presumably corresponds with the Marabella marl in Trinidad. On the main island, however, it was found only in the lower part of the Late Eocene (Mount Moriah sandstone and Vistabella marl).

Occurrence: Soldado Rock (K. 2651, K. 2854), top of Mount Moriah, North of Mount Moriah, Point Bontour, Vistabella Quarry, Vistabella Calyx well 59 (lower part), Schlumberger office section (lower part), Charuma (Late Eocene part of section).

Operculinoides suteri CAUDRI, n. sp.
Pl. 1:5–8; Pl. 10:19

Exterior: Diameter about 2.5 mm, maximal 2.8 mm; test thin, discoid, with flush irregular filamental lines which overlap each other at odd angles and do not properly converge on the axis.

Horizontal section: Rapidly widening *Operculina*-like spiral; septa numerous, up to 30 in the last whorl, evenly curved.

Vertical section: Spiral sheet relatively thick; successive whorls tightly packed so that there is hardly any room for any alar prolongations of the chambers, but definitely involute.

Holotype: Pl. 1:5 (C 35961).

Type locality: Vistabella Calyx well 59, 390–400 feet.

Type level: Late Eocene, Marabella marl.

Occurrence: Regularly present throughout the Late Eocene of San Fernando area (Vistabella Quarry, Calyx 57 and 59, Marabella 1, San Fernando Railway Station, scarce in Vistabella marl, locally common in Marabella marl of San Fernando Railway Station, Cd. 208).

Named after Dr. H.H. Suter, chief geologist with T.L.L. in Pointe-a-Pierre, at the time the material was collected.

This is a nearly always poorly preserved species but still easily recognizable for its particular filamental lines. Its test is thin discoid, with smooth irregular sutures, which tend to reach the central area but overlap each other at an angle and do not converge into a single axis. In horizontal section it looks like *Operculina* because of its rapidly widening spiral, in vertical section one notices that the successive whorls are so tightly packed that there is no room left for the lumina of the alar prolongations of the chambers. Because the spiral sheet is involute, the species is placed in the genus *Operculinoides*.

The Oligo-Miocene species

Over the years 1957 to 1966, Cole has devoted a great deal of detailed work trying to establish the natural relationship between the different species of *Operculinoides* in the American Oligocene and Miocene, especially in connection with the stratigraphic level at which they occur. But the variability of all their features and the abundance of transitional forms proved so confusing that in the end he came to the conclusion that there were only two valid all-embracing species: *Operculinoides (Camerina) panamensis* for the Oligocene (including *Operculinoides dia, bullbrooki, semmesi* and *semmesi ciperensis*, to mention only the species that are of interest for Trinidad), and *Operculinoides (Camerina) cojimarensis* (with as synonyms *tuxpamensis* and *tamanensis*) for the Miocene.

Unfortunately, the original descriptions and illustrations of the key species under discussion (*dia, panamensis* and *cojimarensis*) are all unsatisfactory. Cole, therefore, published new photographs of topotype material of the three. For *O. panamensis* we can turn to Vaughan & Cole (1941, pl. 10:12–13; pl. 11:1–4) and Cole (1964b, pl. 14:2, 6, 9–10, 14); topotypes of *O. dia* were figured in 1961 (1961b, pl. 8:4–5; pl. 17:4, 11) and in 1964 (1964b, pl. 14:1, 5, 11) and of *O. cojimarensis* in 1958 (1958b, pl. 29:5; 1958c, pl. 34:7). That way, Cole's trend of thought is easily followed.

However, it remains a fact that in a paleontologic study a certain degree of subjectivity cannot always be avoided and this leads to a difference of opinion. For instance Cole (1964) supports his lumping of *Operculinoides panamensis, O. dia* and *O. bullbrooki* with a series of illustrations of topotypes, claiming that there are no important differences between them, but the present writer, being less statistically minded and admittedly perhaps less objective, does not find it difficult to pick out *O. bullbrooki* from the lot for its visual aspect alone, and also the other two look to her different from each other.

Cole's subdivision between Oligocene and Miocene forms is thrown off balance by the more recent observations that the Morne Diablo limestone, which contains *O. bullbrooki* and *O. semmesi*, is not Oligocene but Early Miocene in age according to its planktic fauna. As far as *O. bullbrooki* is concerned, this is of no consequence as this form should anyway be placed in the group of *O. cojimarensis* instead of *O. panamensis*, but *O. semmesi* cannot be considered as typical of the Oligocene.

Taking all this into consideration, the present author prefers to fall back on the old names used by Vaughan & Cole (1941) for the Trinidad species *Operculinoides semmesi, semmesi ciperensis, bullbrooki, tuxpamensis*, and *tamanensis*, to which we should perhaps add *cojimarensis*. *O. bullbrooki, tuxpamensis* and *tamanensis*, each have in turn played a dominant role in the Trinidad Miocene. Maybe typical *O. cojimarensis* does not occur in Trinidad, but it is here included in the discussion for comparison.

Operculinoides semmesi VAUGHAN & COLE
Pl. 5:14; Pl. 10:5–6

1936   *Operculinoides semmesi*, Vaughan & Cole, p. 491, pl. 37:10–13, 14?; pl. 38:1–2, 5?, 6?.
1941   *Operculinoides semmesi*, Vaughan & Cole, p. 50, pl. 14:5–9; pl. 15:1–2, 9.

The species was first described by Vaughan & Cole from the Oligocene Meson Formation of Mexico which later was placed by Barker & Blow (1976) into the Early Miocene.

There seems to be no difference between the Oligocene and the Miocene specimens

of Trinidad, but judging from the figures given in Vaughan & Cole's table (1941), those from Morne Diablo (K. 2907) have a longer spiral than the Mexican types and are, accordingly, slightly larger and have more chambers in the last whorl.

It is sometimes difficult to distinguish the *Operculinoides semmesi* in the Morne Diablo material at first sight from small specimens of the more common *O. bullbrooki*, but in both horizontal and vertical section the two forms are clearly different. *O. semmesi* is more closely related to the Eocene *O. trinitatensis*, the only difference being that the test of *O. semmesi* is slightly flattened in the axial area, whereas *O. trinitatensis* has a central boss. Like in *O. trinitatensis* the characteristics of *O. semmesi* are difficult to define and the form can therefore not be used as a reliable index fossil.
Occurrence: Mejias Quarry, Erin Point, Taparo Point, Morne Diablo Quarry.

Operculinoides semmesi ciperensis VAUGHAN & COLE
Pl. 5:10; Pl. 10:7–9

1941   *Operculinoides semmesi* var. *ciperensis*, Vaughan & Cole, p. 51, 53, pl. 15:3–8

This form, which in horizontal section is practically indistinguishable from *Operculinoides semmesi* and *O. trinitatensis*, is somewhat flatter and has a more protracted margin than either of them. There is a wide range of variation in the external features within the same population, e.g. that from the Cipero coast, but as a whole, such a population is different from an Eocene assemblage.
Occurrence: Cipero coast (floods), Mejias Quarry (common), Kapur Quarry (few, chiefly in sample Lz. 3475).

Operculinoides bullbrooki VAUGHAN & COLE
Pl. 5:12,15; Pl. 10:13–14

1941   *Operculinoides bullbrooki*, Vaughan & Cole, p. 44, pl. 11:6–7; pl. 12:4–5.

This is the common species of *Operculinoides* in the Early Miocene Morne Diablo limestone Quarry, present in nearly all of the more calcareous beds, often in floods. Externally, it is not very different from *O. semmesi* from the Early Oligocene of the Cipero coast but it is flatter and the last whorl tends to flare out in a broad round-edged margin.

Operculinoides cojimarensis (PALMER)
Pl. 10:10–12

1934   *Operculinella cojimarensis*, Palmer, p. 259–260, pl. 15:1, 3–4, textfig. 18.

Amongst the common megalospheric specimens of *Operculinoides bullbrooki* in the Early Miocene Morne Diablo Quarry occur small B-forms that do not seem to belong to this species but rather to *O. cojimarensis*.

The specimens are only 1.5 to 2.1 mm in diameter. In part they are juvenile forms and for the rest fragments of larger pieces. They are very flat and smooth and the axis is marked by a small prominent tubercle. The smaller ones are so transparent that the inner coils are clearly visible through the walls, but they are completely involute as the hair-

lines of the septal filaments can be traced right to the center. The spiral is very high and opens rapidly; it consists of a great many chambers, the septa of which are strongly and evenly curved backwards. The vertical section is compact and distinctly diamond-shaped.
Occurrence: Morne Diablo Quarry.

Operculinoides tuxpamensis (THALMANN)
Pl. 6:1; Pl. 11:1,3–4

1935   *Operculina tuxpamensis*, Thalmann, p. 603, textfig. a–b.
1941   *Operculinoides tuxpamensis*, Vaughan & Cole, p. 45–46, pl. 14:1–4.

Operculinoides tuxpamensis, first described from the Early Miocene Tuxpan Formation of Mexico, is a medium large, smooth, very thin form with a rather high spiral and close-set evenly curved septa. Barker (1939) and Vaughan & Cole (1941) later determined the abundant *Operculinoides* specimens of the Biche Quarry in Trinidad as belonging to this species.

Thalmann stated that some of the largest individuals in his material were microspheric. In Biche, however, even the large ones are megalospheric, but with a very small nucleoconch. The protoconch measures 70–128 µ.
Occurrence: Biche Village Quarry (Middle Miocene, together with *Planorbulinella trinitatensis*).

Operculinoides tamanensis VAUGHAN & COLE
Pl. 6:2; Pl. 11:2,5–7

1941   *Operculinoides tamanensis*, Vaughan & Cole, p. 43, pl. 10:9–10; pl. 11:8–10; pl. 12:1–3.

Operculinoides tamanensis is a fairly large form (up to 6.3x5.6 mm) with a somewhat inflated test and a conspicuous central knob. In vertical section it proves to be thin-walled, with spacious well-developed alar prolongations of the chambers (compare *O. tuxpamensis* and *O. cojimarensis*).
Occurrence: Tamana-Carmichael Road, Guaico-Tamana Road at 13 1/2, 13 5/8, and 13 1/4 miles from Guaico (with *Planorbulinella trinitatensis*).

Genus *Nummulites* LAMARCK

Nummulites striatoreticulatus (L. RUTTEN)
Pl. 5:13; Pl. 10:2

1928   *Nummulites striatoreticulatus*, L. Rutten, p. 8–10, pl.:F–I (not J), textfig. 41–50.
1941   *Camerina striatoreticulata*, Vaughan & Cole, p. 31, pl. 8:5–7.

Amongst the Trinidad Nummulitidae, this robustly inflated form stands out for its notable size (up to 6 mm) and the larger number of whorls in its spiral.
Occurrence: Point Bontour (St. 63), Vistabella Quarry (rare), Morne Roche Quarry.

Genus *Heterostegina* D'ORBIGNY

Heterostegina indicata CAUDRI, n. sp.
Pl. 1:9–10

Exterior: Large flat *Operculina*-like form with a rapidly opening coil and a very thin
flange; maximal diameter exceeding 15 mm, thickness not over 1 mm; septal fila-
ments continuing right up to the center, beaded; no trace of secondary chamber-
lets visible on the surface.

Horizontal section: Rapidly increasing spiral of about 2.5 to 3 whorls; rather heavy keel;
primary septa numerous, evenly curved in the beginning, later becoming straigh-
ter and more or less radial but strongly bent backwards distally; nucleoconch mega-
lospheric, followed by about five operculine chambers, from there on a secondary
sub-division of the chambers is indicated along the primary septa. The secondary
septa are very incompletely developed or are absent.

Vertical section: Test very flat but central portion definitely involute though too compact
to leave room for alar prolongations of the chambers; flange with very low lumen;
intersections with the septa protruding (beaded).

Holotype: Pl. 1:10 (C 35965).

Type locality: Morne Roche Quarry, K.S. 167.

Type level: Basal Upper Eocene (Mount Moriah sandstone level).

Occurrence: Known only from incidental sections of hard rock. It is common in one of
the limestone samples from Morne Roche quarry, but as good as absent in all oth-
ers from the same locality.

This species is one of the transition forms between the morphological genera *Operculina*
and *Heterostegina* that have made their appearance from time to time during their long
history. It compares with *Heterostegina heterostegina* (Silvestri) from the Helvetian of
Turin, the Early Miocene of the Aquitanian Basin and from the Priabonian and the Early
Oligocene of Alicante, or with *Operculina canalifera gomezi* from the Biarritzian of Cata-
lonia (Hottinger 1972), and with the microspheric generation of *Heterostegina operculi-
noides*, a living form in the eastern part of Indonesia, of which the megalospheric genera-
tion has fully developed secondary chamberlets (Hofker 1927, 1933). Both authors refer
also to the group of *Heterostegina costata* of the Vienna Basin (Miocene) which shows a
similar transition between the two genera.

All these transitional forms developed independently along parallel lines. There is no
genetic or stratigraphic relation between them. True *Heterostegina* is reported from the
Paleocene up (*Planorotalites pseudomenardii* Zone) from Somalia (Eames & Clarke
1967) and from the Middle Eocene of Cuba (Beckmann 1959).

Genus *Spiroclypeus* H. DOUVILLÉ

Spiroclypeus bullbrooki VAUGHAN & COLE
Pl. 8:7

1917   *Spiroclypeus* sp. Douvillé, p. 845–847.
1941   *Spiroclypeus bullbrooki* Vaughan & Cole, p. 54, pl. 17.

In Trinidad *Spiroclypeus* occurs in considerable numbers in three erratic limestone blocks near the South coast (Douvillé 1917; Vaughan & Cole 1941), and was described as *Spiroclypeus bullbrooki*. It is associated with *Lepidocyclina parvula-giraudi, yurnagunensis* (or *vaughani*), *tempanii, sanluisensis* and *gigas*, *Miogypsina hawkinsi* and *Heterostegina antillea*, which points to an Oligocene age. As in Venezuela, the genus is absent in the Early Oligocene of the Cipero section and in the limestones of the Mejias Quarry and the Kapur Ridge, here placed in the Middle Oligocene. For this reason, and also for the presence of *Miogypsina hawkinsi* in the fauna, which shows the close relation to the Miocene reef of Morne Diablo, the *Spiroclypeus* horizon in Trinidad is here regarded as Late Oligocene.

Occurrence: Erin Point (common, z. 2), Marac River (K. 482, later re-numbered K. 911), Chagonary Point (J.A.B. 27).

Group Discocycliniformes

Classification

In the present study, Vaughan & Cole's (1941) subdivision of the Family Discocyclinidae is replaced by the new classification proposed by Caudri (1972a).

This revision was necessary because both Vaughan (1945) and Caudri observed that many of the American forms usually determined as *Discocyclina (Discocyclina)* sp. sp. possess in the microspheric generation a simple, sometimes clearly trochoid, initial spiral, fundamentally different from the complicated, more nummulitic or heterosteginoid development of true Discocyclinas of the Old World. To these forms Caudri has given the new generic name *Neodiscocyclina* removed from the Discocyclinidae to the new family Orbitoclypeidae, together with *Orbitoclypeus* and *Asterocyclina*. As far as known, all Discocyclinas of Trinidad may belong to this new genus. It is not impossible that all American species will eventually prove to be of the same type, and that the genus *Discocyclina* s. s. is absent in the Americas.

This does not mean that the entire family of the Discocyclinidae is lacking in the New World. Work on the microspheric forms of the other genera and subgenera of Vaughan & Cole's classification is only just beginning, but a complicated discocyclinid spiral has already been observed in the B-form of several species of *Proporocyclina* and *Athecocyclina* from the West Indies and Florida.

On the other hand, *Pseudophragmina* s. s., at least the species *P. bainbridgensis* (Vaughan), seems to have a simple spiral and is tentatively transferred to the Orbitoclypeidae.

As a new element, the Hexagonocyclinas are included in the group of the Discocycliniformes. Their characteristic megalospheric nepiont with its four periembryonic spirals may represent a primitive stage in the evolution of the Orbitoclypeidae, but it may also be that they belong to a third independent family. Nothing is as yet known about their microspheric form.

The following tentative classification is proposed for the American forms:

Group Discocycliniformes (term of no systematic value); Family Discocyclinidae, genus *Athecocyclina*, genus *Proporocyclina*; Family Orbitoclypeidae, ?genus *Hexagonocyclina*, genus *Neodiscocyclina*, ?genus *Stenocyclina*, genus *Pseudophragmina* s. s., genus *Asterocyclina*.

Geographic distribution

For the geographic distribution of the American Discocycliniformes reference is made to Vaughan's (1945) extensive review to which little is to be added.

The southern limits for these forms lie in N.W. Peru (*Neodiscocyclina, Proporocyclina*). Along the northern margin of their habitat the limit for *Discocyclina* s. s. (presumably *Neodiscocyclina*) is set in the Gulf States and California. Only four species have so far been found there: *Discocyclina waltonensis* Cole & Applin (1964) in the Wilcox Formation (Early Eocene) of Florida, *Discocyclina marginata* Cole & Gravell (1952) (?*Orthophragmina marginata* Cushman) in the Middle Eocene of Georgia (Cole & Applin 1964), *Discocyclina blanpiedi* Vaughan 1936 (*Proporocyclina*) in the upper part of the Paleocene Nanafalia Formation of Alabama and *Discocyclina californica* Schenck 1929 in the ? Late Eocene of California. The genus *Proporocyclina* with *Proporocyclina clarki* (Cushman) goes North as far as California, Oregon and Washington (Vaughan 1945, Cole & Appin 1964). Peru is mentioned as the southern limit of this species (Cole & Applin); this refers to *Proprocyclina peruviana* (Cushman), which Cole (1958d) had placed in synonymy of *Proporocyclina clarki.*

Stratigraphic range

In Trinidad, the genera *Athecocyclina, Hexagonocyclina* and *Neodiscocyclina* make their appearance in the Paleocene beds at Lizard Springs, in the southeastern corner of the Island and in equivalent deposits on Soldado Rock, the *Ranikothalia* limestone and its practically contemporaneous reefal counterpart, the *Athecocyclina* limestone (Kugler & Caudri 1975), of which only remnants are found in southern Trinidad. Their upper limit is more difficult to establish. Reworking has dispersed them throughout the Eocene section; often the specimens are enclosed in obviously erratic material, but just as often they are mixed with the autochthonous fauna of these younger beds without a hint at their unreliable nature. Trinidad does not offer a continuous section for the interval between the Paleocene and the Late Eocene transgression, as far as the reef facies is concerned. *Athecocyclina* and *Hexagonocyclina* are typical for the *Ranikothalia* Zone (Paleocene–early Early Eocene). In Trinidad, and generally in the southern Caribbean region, *Neodiscocyclina* does not go beyond the early Middle Eocene.

Athecocyclina

The only cases in which, to our knowledge, *Athecocyclina* is mentioned from beds younger than early Early Eocene are those of *Athecocyclina* cf. *soldadensis* in the upper part of the Early Eocene of Venezuela (beds of San Francisco de Cara, de Cizancourt 1951) and of *Athecocyclina jukes-browni* in the Middle Eocene Chalky Mount beds of Barbados (Vaughan 1945).

At present, the evidence is insufficient to prove that *Athecocyclina* exceeds the range of *Ranikothalia.*

Proporocyclina

The oldest *Proporocyclina* is found in the so-called *Proporocyclina tobleri* limestone (Bed No. 11 of the Soldado Rock section) which is basal Middle Eocene or highest Early Eocene. Various other species are known from the Middle as well as the Late Eocene.

Stenocyclina

This genus was introduced to unite those Proporocyclinas which distinguish themselves by having very narrow rings of equatorial chambers (*advena, cloptoni, palenquenensis, perkensis*, etc.). Most of them occur in the Middle Eocene, but they are also known from the Late Eocene. One single specimen was found in the type material of the Lizard Springs Formation (Paleocene).

Pseudophragmina s. s.

Pseudophragmina s. s. is typical of the Late Eocene (Vaughan 1945; Frost & Langenheim 1974). Also in Trinidad the single specimen came from a Late Eocene sample (Point Bontour, St. 46).

Hexagonocyclina

The genotype of *Hexagonocyclina, Discocyclina cristensis* (Vaughan), comes from the uppermost Paleocene at the base of the Early Eocene of Mexico, Veracruz, Chicontepec Formation (Vaughan 1945). The genus has further been found around the Caribbean in beds of comparable age: Cuba: Type locality of *Ranikothalia bermudezi*; Venezuela: Rio Carache section, San Juan de los Morros area; Trinidad: Lizard Springs, Soldado Rock; Barbados: Joes River blocks. It is regarded as a typical element of the *Ranikothalia* Zone. Its frequent occurrence in the Late Eocene of Trinidad is ascribed to reworking.

This restricted range of the Hexagonocyclinas is contradicted by de Cizancourt (1951) who, in her distribution chart, lists *Hexagonocyclina inflata* as an abundant fossil in the upper part of the Early Eocene of Venezuela (the beds of San Francisco de Cara and the La Paz limestone). Reworking seems to be out of question in this case but, nevertheless, this extension of the vertical range can not be readily accepted. It is already strange that the species does not figure in the column for the early Early Eocene (though it is reported from both Parapara de Ortiz and Paso Lalaha), and then suddenly re-appears in the late part. Checking back on the faunal lists of the various samples, the localities of the individual species and the summary of the fauna (from which *Hexagonocyclina inflata* is omitted) leaves the impression that the author continuously hesitated in her determinations between *Hexagonocyclina inflata* and a similar form called *Discocyclina cristensis*. This is understandable considering the kind of hard rock material she had to deal with. It seems highly probable that the common form in these younger beds is not *Hexagonocyclina inflata* but exclusively *Discocyclina cristensis*.

The question whether the genus *Hexagonocyclina* as such reaches up into the upper apart of the Early Eocene hinges on the systematic place of this Venezuelan *Discocyclina cristensis*. As stated above, the typical *Discocyclina cristensis* (Vaughan) (genotype of *Hexagonocyclina*) occurs, in limited numbers, in the Paleocene or at the very base of the Early Eocene, whereas the Venezuelan form is characteristic for the upper part of the Early Eocene, with a sprinkling of rare specimens as low down as the lower part, and is absent in the Paleocene. This difference in the stratigraphic distribution already sounds a warning against identifying the latter with *Discocyclina cristensis* (Vaughan). De Cizancourt's specific determination was based exclusively on the external appearance and the hexagonal shape of the equatorial chambers but no attention was paid to the crucial point whether or not the nepiont is of the quadriserial type. The illustration is equally inadequate. The present author rather suspects that the form is a species of *Neodiscocyclina*, the equatorial chambers are considerably less elongated than those up to now observed in the true Hexagonocyclinas.

There is no convincing evidence for the occurrence of the genus *Hexagonocyclina* beyond the *Ranikothalia* Zone. An extended study of the Venezuelan material is necessary.

Neodiscocyclina

The genus *Neodiscocyclina* is not restricted to the Paleocene–early Early Eocene. Its type species *Neodiscocyclina anconensis* (Barker) is characteristic of the early Middle Eocene in Ecuador and Barbados and also the other Discocyclinas s. s. from this same level. *Discocyclina harrisoni* Vaughan from Barbados and the identical form from Cuba which was determined by Cole & Gravell (1952) as *Discocyclina marginata* will probably turn out to belong to the same genus. Certain related forms may even go up into the Late Eocene (see below).

Confusing data on the occurrence of nearly all the species of *Neodiscocyclina* have led to the notion that some of them have a long vertical range, across all the hurdles of regression and transgression in the course of the Paleocene and Eocene. This problem is at length discussed in Caudri's paper on Barbados (1972b); the best explanation of such abnormal ranges is reworking. Most probably the individual species have a neatly restricted vertical range and are diagnostic for their type level.

In Trinidad, *Neodiscocyclina* makes its appearance in the Paleocene (Lizard Springs, Soldado Rock). Its highest autochthonous occurrence here is in the Charuma silt member of the Navet Formation (early Middle Eocene: *Neodiscocyclina anconensis*). In the higher part of the Middle Eocene (Dunmore Hill marl member) and in the Late Eocene, the genus is considered reworked.

Vaughan (1945) states that the greatest development of the Discocyclinidae in America is in the Late Eocene. This includes *Asterocyclina* and *Proporocyclina*. He also mentions six species of *Discocyclina (Discocyclina)* as typical of that part of the section: *D. bullbrooki* Vaughan & Cole (Trinidad, Soldado Rock), *D. californica* Schenck (California), *D. crassa* (Cushman) (Cuba, Haiti), *D. cubensis* (Cushman) (Cuba, Haiti; ?Trinidad, ?Soldado Rock), *D. minima* (Cushman) (Trinidad). Of these *D. bullbrooki* should be eleminated because it is reworked in the typical Late Eocene of Trinidad and Soldado Rock. As far as *D. minima* is concerned, Vaughan himself admits that it is an imperfectly

known species (Cole transferred it in 1952 to *Asterocyclina*). A presence of *D. cubensis* in the Late Eocene of Trinidad and Soldado Rock can not be confirmed.

This reduces the number of alleged Late Eocene species to two: *Discocyclina crassa* (Cushman) and *D. californica* Schenck, both considered by Vaughan as closely related to *Neodiscocyclina anconensis*. If this is correct, they, too, should be placed in *Neodiscocyclina*. In both, the protoconch is as a rule entirely surrounded by a circular deuteroconch, but a partially embracing second chamber has also been observed. The type description of *D. californica* leaves much to be desired and unfortunately Vaughan does not re-describe or figure this species which, from a stratigraphic viewpoint, is of such particular interest. *D. crassa*, as figured by him, seems to develop very narrow elongated equatorial chambers with a tendency towards alignment of the radial walls in the successive annuli, a feature which may be of specific significance. Careful additional study is necessary for the characteristics of both species, as also of the exact stratigraphic position of their type localities. Vaughan places *D. crassa* tentatively in the early Late Eocene.

There are, however, also arguments for a Middle Eocene age of these species. Cole & Gravell (1952) combine *Discocyclina crassa*, *Discocyclina californica* and *Proporocyclina marginata* (= *Orthophragmina marginata* Cushman from St. Bartholomew) (Vaughan 1945) with their *Discocyclina (Discocyclina) marginata* from the early Middle Eocene of Cuba (Peñon Seep), which undoubtedly is very similar in many respects, including the gradual change from alternating to aligned chambers towards the periphery. The same peculiarity was also observed in *Discocyclina harrisoni* Vaughan from the Middle Eocene of Barbados (Caudri 1972b). The localities of *Discocyclina crassa*, *D. californica* and *Orthophragmina marginata* may, after all, well prove to belong to the Middle Eocene (Cole & Applin 1964), but until the age has been firmly established there remains a possibility that *D. crassa* and *D. californica* (or their synonyms) really continue, as the final stage in the evolution of the Neodiscocyclinas, into the Late Eocene along the northern margin of their geographic province.

As to the southern part of their habitat (northern South America, southern Caribbean, and especially Trinidad), there is more and more evidence that the frequent occurrence of *Discocyclina (Neodiscocyclina)* sp. sp. in the Late Eocene is always due to reworking.

Asterocyclina

The stratigraphic range of the American Asterocyclinas still needs further study. The upper limit is clear, their extinction marks the end of the Late Eocene. About the base there is less agreement. Mostly, the lower limit is given as Middle Eocene (Vaughan 1945). According to Cole & Applin (1964) the firt species (*Asterocyclina monticellensis*) in the Middle Eocene of Florida and southern Georgia does not appear before their third zone, the Upper Lake City Formation, above the zone of *Lepidocyclina (Polylepidina) antillea*; but they admit that in Jamaica and St. Bartholomew the species occurs in association with *Lepidocyclina antillea*. Also, the locality where *A. monticellensis* was found in Cuba (the Peñon Seep) is Middle Eocene (*Hantkenina nuttalli* Zone), there the species is accompanied by *Amphistegina parvula*, *Eoconuloides wellsi* and *Helicostegina gyralis*. The same goes for Margarita Island, where the species occurs in combination with *Lepidocyclina antillea* and *Amphistegina parvula* (Caudri 1974).

In Coastal Ecuador, *Asterocyclina* occurs consistently in the remnants of the San Eduardo reef limestone, which lies unconformably on basemennt rocks and represents a very low level of the Middle Eocene (Stainforth 1948).

These data would lead to the conclusion that the origin of the American Asterocyclinas coincides with the beginning of the Middle Eocene. However, on the strength of observations in Jamaica, Robinson believes that they begin lower in the section. In 1968a he reports *Asterocyclina* sp. from the Wagwater Belt Group, from a level between the *Operculina catenula* fauna of Cole and the *Acarinina pentacamerata* Zone, a horizon which he places in the Early Eocene, in spite of the fact that it already carries *Amphistegina (Eoconuloides) lopeztrigoi* and *Yaberinella jamaicensis.*

For Cuba, the occurrence of *Asterocyclina* in the Early Eocene is firmly stated by Beckmann (1958), the possibility is even mentioned that it starts already in the Late Paleocene.

In Trinidad sporadic Asterocyclinas were encountered in the Middle Eocene Dunmore Hill marl, but their full development, often in floods, lies in the Late Eocene.

Description of species

Family Discocyclinidae

Genus *Athecocyclina* VAUGHAN & COLE

Athecocyclina soldadensis (VAUGHAN & COLE)

1941   *Pseudophragmina (Athecocyclina) soldadensis,* Vaughan & Cole, p. 62, pl. 19:4–8.
1975   *Athecocyclina soldadensis,* Caudri, p 545, pl. 11:1–5; pl. 12:1.

This thinnest of Athecocyclinas is very rare in Trinidad.
Occurrence: Soldado Rock (*Athecocyclina* limestone and Beds 3, 4), Lizard Springs type locality (Mky. 102b III), Hermitage Quarry (Paleocene blocks in Plaisance conglomerate).

Genus *Proporocyclina* VAUGHAN & COLE

Proporocyclina tobleri (VAUGHAN & COLE)

1941   *Pseudophragmina (Proporocyclina) tobleri,* Vaughan & Cole, p. 62, pl. 21:6; pl. 22:3–4.
1975   *Proporocyclina tobleri,* Caudri, p. 547, pl. 1:13–14; pl. 3:5–6; pl. 12:2–5; pl. 13:1–4, 7.

Proporocyclina tobleri is characterized by its narrow rings and square to very broad equatorial chambers with thin wavering, often incomplete radial walls; in vertical section the lateral chambers show up as narrow slits. The species is the predominant element in the fauna of the Boca de Serpiente Formation of Soldado Rock (Bed 11, *Proporocyclina tobleri* limestone). Its age is uppermost early or basal Middle Eocene, probably Middle Eocene (Caudri 1975).

Occurrence: Lizard Springs area (Mky. 99, block), Erin (G. 65B, Br. 67, blocks), Dunmore Hill (type locality, Ha. 215), Hindustan Village (Middle Eocene, reworked), Point Bontour and Vistabella area (Late Eocene, reworked), Soldado Rock (Bed 11, and reworked in the Late Eocene).

Proporocyclina mirandana (HODSON)

1926   *Discocyclina mirandana*, Hodson, p. 8, pl. 1:3, pl. 10:13.
1941   *Pseudophragmina (Proporocyclina) flintensis*, Vaughan & Cole, p. 10, 20, 27, 61, pl. 20:8–9.
1975   *Proporocyclina mirandana*, Caudri, p. 549, pl. 13:5–6.

Megalospheric specimens occur regularly in the Late Eocene, but never in great numbers. From Soldado Rock (Caudri 1972a, 1975) we had one microspheric specimen with the complicated initial pattern typical for the family Discocyclinidae.

Family Orbitoclypeidae

Genus *Hexagonocyclina* CAUDRI (tentatively placed in this family)

1944   *Hexagonocylina*, Caudri, p. 362.
1975   *Hexagonocyclina*, Caudri, p. 543.

The genus *Hexagonocyclina* was erected 1944 for a group of *Discocyclina*-like forms from the Paleocene of Trinidad and Venezuela, which are distinguished by a quadriserial nepionic development and a strong tendency towards a hexagonal rather than rectangular shape of the equatorial chambers.

The validity of the genus has been questioned ever since, chiefly for nomenclatural reasons but also because of the dubious diagnosis of its genotype *Orbitoclypeus? cristensis* Vaughan 1929b, pl. 2:1 (lectotype). The following discussion may help towards its final recognition.

The Venezuelan material of *Hexagonocyclina meandrica*, described 1944, was unsatisfactory as type material for a new genus. For that reason, a Mexican form, *Discocyclina cristensis* Vaughan, which showed the same characteristics was designated as the genotype. The choice of the name *Hexagonocyclina* was an unfortunate one. Not only is it nearly a homonym of *Exagonocyclina* Checchia-Rispoli, which stands for a similar, though different, form from the Eocene of Sicily, but *Exagonocyclina* is, in an oblique way, involved in the synonymy of *Discocyclina cristensis*. To make matters worse, several authors, amongst whom in first place Vaughan himself, stuck to the view that *D. cristensis* is a true *Discocyclina* s. s. and placed *Hexagonocyclina* into the synonymy with *Discocyclina*. In an effort to remedy this confusion, a new genus: *Bontourina* Caudri (genotype: *B. inflata* Caudri) was introduced in 1948 to cover the forms from Trinidad and Venezuela only, leaving out the controversial *Discocyclina cristensis*. This was, however, not a satisfactory solution. After due consideration, *Hexagonocyclina* proves to be valid after all, and *Bontourina* is to be repressed as a synonym. The nomenclatural complications can be summed up as follows:

Originally, Vaughan determined the holotype of *Discocyclina cristensis* as *Orbitoclypeus? cristensis* (1924b). *Orbitoclypeus* is a badly defined genus from the Late Eocene of

Palermo, Sicily, proposed by Silvestri in 1907. Its type species *Orbitoclypeus himerensis* is described as a *Discocyclina*-like organism with hexagonal equatorial chambers, but no illustrations were given. Later, Silvestri published a figure of another species of the same genus, *Orbitoclypeus tellini* (1924, pl. 1:14). It is because of the similarity in form of the median chambers of *Orbitoclypeus tellini* and *Discocyclina cristensis* that Vaughan originally referred the latter to the genus *Orbitoclypeus*.

Similar forms from the same area (Palermo) were better described by Checchia-Rispoli (1907–1909) as a subgenus of *Orbitoides*, under the name of *Exagonocyclina*. Silvestri (1910) placed this subgenus in synonymy with *Orbitoclypeus*. A thorough discussion of this subject, citing all the pertinent literature, is given in Brönnimann (1945a) on *Discocyclina* and *Asterocyclina*.

In the original diagnosis of *Exagonocyclina*, the thin-walled hexagonal chambers are mentioned as the characteristic feature, but nothing of value is said about the embryonic apparatus. However, for one of the species, *Orbitoides schopeni*, the nucleoconch is well illustrated and is described as consisting of a loose protoconch enclosed in a much larger circular deuteroconch, which in turn is surrounded by a complete ring of equal-sized equatorial chambers. This same feature was also reported from *Orbitoclypeus himerensis* (= *Orbitoides schopeni*) by Brönnimann (1945a).

From the above it becomes clear that the genus *Exagonocyclina (Orbitoclypeus)* is not identical with the Hexagonocyclinas of the Western Hemisphere with their quadriserial nepiont.

As to the question of its genotype: Vaughan (1945) admits that one species of *Hexagonocyclina (Hexagonocyclina meandrica* from Venezuela and Trinidad) may represent a different subgenus of *Discocyclina*, but he insists that the genotype, *Discocyclina cristensis*, is a true *Discocyclina* s. s. and consequently *Hexagonocyclina* a synonym of *Discocyclina*. His arguments remain, however, unconvincing because the characteristic quadriserial nepiont is not taken into consideration.

The holotype of *Discocyclina cristensis* (Vaughan 1924b, pl. 36:8) is of little value for the generic determination as the section does not pass through the center of the early chambers.

In 1929b Vaughan repeated that description verbatim, in spite of the fact that by then he had a much better specimen at disposal (pl. 2:1), which he himself designated as a plesiotype, but never really analysed.

In fact, this latter illustration is, so far, the only good representative picture of *Discocyclina cristensis* in existence. The photograph shows a quadriserial nepiont such as has never been found in *Discocyclina* s. s., and it is this specimen which was chosen by Caudri as a sort of co-genotype of *Hexagonocyclina*.

In 1945, Vaughan goes into great detail describing two other topotypes, unfortunately without giving illustrations. One of these (a badly oriented section) seems to have an enlarged auxiliar chamber, which is certainly not typical for *Discocyclina*; the other one may be a true *Discocyclina* or rather a *Neodiscocyclina*. But even if additional topotype material should prove to contain specimens of *Neodiscocyclina*, this plesiotype of 1929 continues to be a type specimen of *Discocyclina cristensis* Vaughan and for its quadriserial nepiont it has to be recognized as a *Hexagonocyclina*. Systematically, as well as from a standpoint of nomenclature, *Hexagonocyclina* thus remains a valid genus.

Subsequent records of *Discocyclina cristensis* are not quite convincing, but it is pro-

bable that most of them will turn out to refer to *Hexagonocyclina*. Vaughan's figure of a specimen form Chalma (Veracruz, Mexico; 1945, pl. 25:1) suggests the presence of at least one well-developed large auxiliar chamber straddling the division between proto- and deuteroconch and two of the four nepiontic spirals. Specimens from Yucatán (Butterlin & Bonet 1960) leave no doubt as to their hexagonoycline nepiont.

Sachs (1957) does not pay any attention to the early development of his *Discocyclina cristensis* from Cuba, but his material also looks more like *Hexagonocyclina* than a true *Discocyclina*.

De Cizancourt's *Discocyclina cristensis* from Venezuela (1951) is probably an entirely different species; the horizontal section shows predominantly rectangular median chambers, very broad in the central part and quite unlike those of *Discocyclina cristensis* or *Hexagonocyclina* as determined elsewhere.

The material of *Hexagonocyclina cristensis* from all the different localities should be carefully compared with *Hexagonocyclina inflata* and *meandrica* to check the validity of these three forms as separate species.

The systematic place of *Hexagonocyclina* within the Discocycliniformes is still open. Judging by its megalospheric nepiont, it is not directly related to the Discocyclinidae and might rather belong to the Orbitoclypeidae (Caudri 1972a). But it seems to be different from the rest of those in the position of the annular stolon. In *Hexagonocyclina meandrica*, wherever the radial walls show signs of not being fully developed, it is always the distal end that is missing or tapering out, which would suggest a distal and not a proximal stolon. The microspheric nepiont is as yet unknown.

The wide distribution of the Hexagonocyclinas throughout the Caribbean Region is already established beyond doubt (Barbados, Trinidad, Venezuela, Mexico, Cuba).

Hexagonocyclina belongs to the *Ranikothalia* fauna of Paleocene to early Early Eocene age (Cole's *Operculina catenula* fauna). De Cizancourt's record of its occurrence in the upper part of the Early Eocene in Venezuela, above her nummulites cordelées (*Ranikothalia*) is doubtful. Specimens found in younger deposits, like the Late Eocene of Trinidad, where they are quite frequent, are considered reworked.

Hexagonocyclina meandrica CAUDRI
Pl. 4:3; pl. 6:11; Pl. 12:9–10

1944   *Hexagonocyclina meandrica*, Caudri, p. 363, pl. 2:7, 9.
1975   *Hexagonocyclina meandrica*, Caudri, p. 543, pl. 3:1, 12; pl. 9:8–12; pl. 10:1, 3–5.

Hexagonocyclina meandrica is distinguished from *H. inflata* by the shape of the test and the pattern of the lateral chambers. Even in small specimens of *H. meandrica*, and in the inner layers of larger ones, the lateral chambers are already elongate in shape and look very different from the regular reticulate surface pattern of *H. inflata*.

Occurrence: Lizard Springs (Mky. 102b III type locality of the Lizard Springs Formation, Paleocene), Soldado Rock (K. 2950, K. 2951, Rz. 255, Paleocene, slump).

Hexagonocyclina inflata CAUDRI
Pl. 6:9; Pl. 12:3–5

1944   *Hexagonocyclina* sp., undescribed small robust lenticular species from Trinidad and Soldado Rock, Caudri, p. 365.
1948   *Bontourina inflata*, Caudri, p. 477, pl. 73:6; pl. 74:5.
1975   *Hexagonocyclina inflata*, Caudri, p. 544, pl. 3:2–4, 11, 13; pl. 9:2–7; pl. 10:2.

Occurrence: Point Bontour (Paleocene limestone blocks, St. 48), reworked in the San Fernando Formation (St. 49, 61a, 63, 67, 68, 68a, 75, 77, 84?; Cd. 18), San Fernando Hospital site (Rz. 127a, block), Soldado Rock (in redeposited Paleocene fauna of Bed 3, K. 2950, in Paleocene block, Rz. 248, and reworked in Late Eocene, K. 1321?, 2951b, 3690; Rz. 250?).

Genus *Neodiscocyclina* CAUDRI

Neodiscocyclina grimsdalei (VAUGHAN & COLE)
Pl. 12:7

1941   *Discocyclina (Discocyclina) grimsdalei*, Vaughan & Cole, p. 9, 24–25, 58, pl. 18:8–9; pl. 19:1–3; pl. 21:3.
1975   *Neodiscocyclina grimsdalei*, Caudri, p. 552, pl. 3:8; pl. 15; pl. 23:2.

The species has been extensively described and figured by Vaughan & Cole (1941), Vaughan (1945) and Caudri (1975).
Occurrence: Soldado Rock (Bed 3, K. 2950 rare, K. 2951 abundant), Lizard Springs (Mky. 102b III, one specimen in situ, Paleocene), Biche, Calyx well 50 (one doubtful specimen reworked in Middle Eocene), Dunmore Hill vicinity (reworked in Middle Eocene), Point Bontour (in Paleocene blocks abundant, as detached reworked specimens in Late Eocene), San Fernando area (various other Late Eocene localities, reworked).

Neodiscocyclina aguerreverei (CAUDRI)
Pl. 12:6

1944   *Discocyclina aguerreverei*, Caudri, p. 361, 378–379, 398, pl. 2:8, 11; pl. 3:13; pl. 4:17.
1975   *Neodiscocyclina aguerreverei*, Caudri, p. 553.

The species was described in 1944 as practically indistinguishable from *N. grimsdalei*. The main difference lies in its nucleoconch, which is nephrolepidine instead of showing the loose, floating protoconch in a circular second chamber, as is typical of the latter. It also seemed different in having two enlarged semi-crescent periembryonic chambers which symmetrically cover the protoconch.
Occurrence: Soldado Rock (Bed 3, re-deposited Paleocene, reworked in Late Eocene), Lizard Springs (Mky. 102b III, Paleocene, one doubtful specimen), Point Bontour (St. 48, Paleocene limestone block, common, reworked in Late Eocene at St. 67, St. 89, Cd. 18, several specimens), Dunmore Hill vicinity (N.E. corner of the type outcrop of the Dunmore Hill marl, and at nearby Hindustan Village (reworked in the Middle Eocene).

?Neodiscocyclina mestieri (VAUGHAN)

1945   *Discocyclina (Discocyclina) mestieri,* Vaughan, p. 18–19, 37, 65, 104, 112, pl. 12:1–6.
1975   *?Neodiscocyclina mestieri,* Caudri, p. 554.

The species is probably closely related to *Neodiscocyclina grimsdalei* as it has the same kind of embryonic apparatus and shows the same degree of thickening of the annular walls of the equatorial chambers. For these reasons, *Discocyclina mestieri* is tentatively placed in the Neodiscocyclinas along with *N. grimsdalei,* though nothing is known about the microspheric form. The main difference between the two species lies in the lateral chambers: in *N. grimsdalei* the test shows a definitive depression in the center (or is at least flattened), whereas *Discocyclina mestieri* is a thick lenticular form without a hint of a depression and develops a great number of lateral layers over the center.

Occurrence: Hermitage Quarry (boulder in Plaisance conglomerate), ?Point Bontour (boulder), ?Marac Well 1 (core 7452–7458 feet), Soldado Rock (*Ranikothalia* limestone and reworked in Late Eocene).

Neodiscocyclina fonslacertensis (VAUGHAN)
Pl. 12:2; Pl. 30:5, 7

1941   *Discocyclina (Discocyclina) crassa,* Vaughan & Cole, p. 59, pl. 20:4–7.
1945   *Discocyclina (Discocyclina) fonslacertensis,* Vaughan, p. 72, 107, 112, pl. 24:3–6; pl. 26:3.
1975   *Neodiscocyclina fonslacertensis,* Caudri, p. 554, pl. 3:10; pl. 16.

Occurrence: Lizard Springs (type locality of Lizard Springs Formation, Ravine Ampelu, Mky. 102b III, in situ), Lizard Springs area (floats T.3, Z. 93b, M. 12, reworked in the Late Eocene), Charuma (A.E.G. 3635, reworked in Middle Eocene, one specimen), Soldado Rock (common A-forms and rare B-forms, reworked in Late Eocene).

Neodiscocyclina bullbrooki (VAUGHAN & COLE)
Pl. 13:9

1941   *Discocyclina (Discocyclina) bullbrooki,* Vaughan & Cole, p. 59, pl. 21:4–5; pl. 22:1–2.
1975   *Neodiscocyclina bullbrooki,* Caudri, p. 555, pl. 17; pl. 19:2, 5; pl. 23:3.

Only three A-forms and one B-form were so far found in Trinidad. The species is characterized by its very thin walled, in part hexagonal equatorial chambers arranged in wavy circles or irregular polygons, the B-forms with a very large trochoid initial spiral, the A-form with a thin walled embryonic apparatus of the nephrolepidine type (for illustrations see Caudri 1975).

Occurrence: Dunmore Hill type locality (A-form), Dunmore Hill marl at Hindustan Village (B-form), Point Bontour (Late Eocene, St. 67, 77, A-forms).

Neodiscocyclina anconensis (BARKER)
Pl. 12:8, 13, 17

1932   *Discocyclina anconensis,* Barker 1932b, p. 303–304, pl. 21:1, 4; textfig. 1.
1975   *Neodiscocyclina anconensis,* Caudri, p. 557–559, pl. 18:2–3.

Occurrence: Biche, Calyx Well 50A (Core 232–233 feet, Charuma silts, early Middle Eocene).

Neodiscocyclina barkeri (VAUGHAN & COLE)
Pl. 12:11, 16

1941   *Discocyclina (Discocyclina) barkeri*, Vaughan & Cole, p. 9, 24–25, 57, pl. 18:4, 6–7 (not 5); pl. 21:1–2.
1975   *Neodiscocyclina barkeri*, Caudri, p. 555, pl. 3:7, 9; pl. 14:1–4, 6–10; pl. 23:1.

The species has been extensively described and illustrated by Vaughan & Cole (1941) and by Vaughan (1945). Caudri (1975) stressed the shape of the main auxiliary chambers as one of the most important characteristics of the species, and drew attention to the tendency towards a polygonal arrangement of the median chambers.
Occurrence: Soldado Rock (Bed 3, redeposited Paleocene, Bed 4, isolated specimens in
    Late Eocene), Dunmore Hill vicinity (type locality of Dunmore Hill marl, Ha.
    2119, Moruga Road junction, R.C.M. 2907, reworked in Middle Eocene), Point
    Bontour (reworked in several Late Eocene samples).

Neodiscocyclina caudriae (VAUGHAN)
Pl. 12:14–15

1945   *Discocyclina (Discocyclina) caudriae*, Vaughan, p. 70, pl. 23:1–4.
1975   *Neodiscocyclina caudriae*, Caudri, p. 552, pl. 14:5.

Occurrence: Lizard Springs (Mky. 102b III, Paleocene), Ramdat marl (K 4006, Early Eo-
    cene, probably reworked), ?Soldado Rock (Bed 3, K. 2950, 2951 redeposited Pa-
    leocene; Bed 4, 2951b heavily pillared variety of *Neodiscocyclina barkeri*? re-
    worked in Late Eocene), Dunmore Hill type locality (Ha. 211 reworked in Middle
    Eocene).

Genus *Stenocyclina* CAUDRI

This genus was introduced by Caudri (1972a) for those Pseudophragminas that differ from all others by the exceptionally narrow rings of equatorial chambers. Vaughan (1945) distinguished them as the group of *Pseudophragmina advena*, and tentatively kept them in the subgenus *Proporocyclina*.
    One doubtful sepcimen of *Stenocyclina* and a fragment were found in the type materi-al of the Lizard Springs Formation (Mky. 102b III, Paleocene) and two tiny fragments (probably of the same species) in the Dunmore Hill marl at its type locality (Ha. 215, Middle Eocene, Pl. 12:12), either in situ or reworked. A hardly recognizable form turned up in Bed 11 of Soldado Rock (E.L. 1440, Early to Middle Eocene).
    The stratigraphic range of *Stenocyclina* is not yet clear. Its main distribution seems to be in the Middle Eocene, but it also goes into the Late Eocene. The lower limit lies in the Early Eocene or even in the Paleocene.
    The Trinidad material is too scanty for a specific determination. The specimen from Dunmore Hill is smooth, without pillars or granulations, the lateral chambers covering the median layer are meandric.

Genus *Pseudophragmina* DOUVILLÉ

Pseudophragmina bainbridgensis (VAUGHAN)
Pl. 27:17

1945   *Pseudophragmina (Pseudophragmina) bainbridgensis*, Vaughan, p. 86, pl. 33:1–4; pl. 34:1–3.
1974   *Pseudophragmina bainbridgensis*, Frost & Langenheim, p. 116, pl. 28:1–3.

Only one isolated specimen was found in Trinidad (Point Bontour, St. 46). In contrast with Vaughan's material which contained only megalospheric forms, this one is microspheric. Its nepionic development is of the simple spiral type, which places the genus in the family of the Orbitoclypeidae.

Genus *Asterocyclina* GÜMBEL

Stellate Discocycliniformes have been described under a number of different names. Vaughan (1924b) traced the classification back to Schlotheim, who in 1822 described a stellate microfossil as *Asteriacites patellaris*, and who as early as 1813 mentioned such forms under the name of *Asteriatites*. Both names have been rejected in 1926 by Hodson, because originally they did not refer to foraminifera. Also invalid is Schafhäutl's generic name *Asterodiscus* of 1863, which was applied to the right class of organisms but proved to be a homonym of *Asterodiscus* Ehrenberg 1839 (= *Planorbulina* d'Orbigny 1826).

In 1866 Guppy described the abundant stellate microfossils from the Trinidad Eocene under the name of *Cisseis asteriscus*. In spite of the fact that his types were lost (Nuttall 1928; Hodson 1926), there is no doubt about the identity of the form in question and at the time the genus seemed to be valid. Helen Hodson designated new cotypes and also made a thorough study of the material from Guppy's original Point Bontour locality.

The extreme variability in shape of the specimens within the Point Bontour population caused her to believe that only one of them, the usually four-rayed stellate form, represented the typical *Cisseis asterisca*; the others she described as different species. Vaughan & Cole (1941) came to the conclusion that all these varieties belonged to one and the same species (see also Caudri 1975, pl. 4). An additional description, of material from other localities in the San Fernando area, was given by Nuttall (1928), together with a comparison of *Asterocyclina asterisca* (Guppy) with *Asterodiscus asteriscus* (Kaufmann), a homonym, and *Cisseis georgiana*.

Vaughan (1928) found out that the name *Cisseis* was preoccupied and had to be replaced by *Asterocyclina*, proposed by Gümbel (1870). The genotype is *Asterocyclina stella* (d'Archiac).

In the Caribbean region, *Asterocyclina* occurs regularly from the Gulf States to the northern part of South America. Its most northerly occurrence is in California; its southern limits coastal Ecuador (Stainforth 1948) and Peru (Vaughan 1945). This is roughly the same distribution as for *Neodiscocyclina*. *Asterocyclina* first appeared in the Early Eocene (Jamica, Robinson 1968) or already in the Late Paleocene of Cuba (Beckmann 1968).

Most probably, the phylogenetic lineage of the American Asterocyclinas has sprung from some Paleocene form of *Neodiscocyclina barkeri*, which often shows a marked tendency towards a polygonal equatorial pattern. The development of *Asterocyclina* from

Neodiscocyclina may also have taken place at several levels. In the Middle Eocene Socorro Formation of Ecuador occurs a transitional form between the two genera: *Actinocyclina* cf. *asterisca* (Barker 1932b). A similar form was recorded from the Late Eocene of Cuba (M.G. Rutten 1935a). A very primitive *Asterocyclina (A. habanensis)*, which resembles the long-extinct *Neodiscocyclina barkeri*, even in the characteristic pair of wedge-shaped auxiliar chambers, occurs in the Cuban Middle Eocene (Cole & Bermudez 1932).

Asterocyclina asterisca (GUPPY)
Pl. 6:3–8; Pl. 13:2–4; Pl. 30:8

1866   *Cisseis asteriscus*, Guppy, p. 584, pl. 25:19a–b (in Hodson 1926, 11–12).
1926   *Cisseis asteriscus*, Nuttall, p. 105–107, pl. 8:8–9, testfig. 11.
1941   *Discocyclina (Asterocyclina) asterisca*, Vaughan & Cole, p. 20, 27, 60, pl. 23.
1975   *Asterocyclina asterisca*, Caudri, p. 560, pl. 4:1–12, 14–16; pl. 21:1, 3–5, 9–10; pl. 22:2, 5–6; pl. 23:4–5.

Together with *Lepidocyclina pustulosa* and *Operculinoides* sp. sp., *Asterocyclina asterisca* is one of the predominant components of the Late Eocene fauna in Trinidad. In a number of samples whole populations are found, including all shapes and ranging from minute embryos to fully grown forms of 8 mm and more; the fine residue is often flooded with specimens of less than 1 mm. The best material for a special study comes from Soldado Rock (K. 1316, 1500, 2854, 2855), from one restricted bed or pocket in the Vistabella Quarry (Cd. 218) and from the Navette area (R.M. 1337). In most other places, especially in the poorer faunas, *A. asterisca* does not attain its maximum size.

As a rule, the number of rays in *A. asterisca* is four or five. Occasionally, 6-rayed specimens are found (Point Bontour, Vistabella, Soldado Rock) and isolated specimens may have only three, or even two rays (Vistabella, Mount Moriah). In some samples 4-rayed forms are predominant, in others they are outnumbered by 5-rayed ones.

The Middle Eocene predecessor *Asterocyclina preasterisca* of Margarita Island has invariably four rays and also the calcareous sandstone member on the top of Mount Moriah, the oldest Late Eocene deposit, carries practically nothing but 4-rayed specimens.

In Douvillé's material from Point Bontour (coll. Tobler) most of the specimens have 5 rays, but in Hodson's material from the same locality 5-rayed specimens are rare. In the Vistabella Quarry 4-rayed forms predominate in most samples.

The Late Eocene Vistabella marl in the Vistabella section carries abundant *Asterocyclina asterisca*: More 4-rayed in St. 147, equal numbers in St. 45, 151, 5-rayed ones predominant in St. 148. In the overlying uppermost Late Eocene Marabella marl (St. 155, E.L. 1431c, 1434, 1435; F.S. 4622) there are only few and small Asterocyclinas, nearly all 4-rayed.

A remarkable feature of *Asterocyclina asterisca* is that the microspheric form is considerably smaller than the megalospheric one.

In the Vistabella Quarry, B-forms were observed in samples K. 2664a, 2664b, 25231 (Texaco cat. No. 48196), Cd. 15 and C.J. 28-12-29 (Texaco cat. No. 863). At Vistabella Estate (St. 147) the number of rays varies from four to six.

Asterocyclina asterisca is one of the most constantly present components of the Late Eocene fauna of Trinidad, but its abundance and individual development vary greatly from place to place, or even from sample to sample in the same locality. The species seems to have been extremely sensitive to differences in environment. In most cases, the

forms remained small and unspectacular but, given optimal conditions, they were able to grow very large and develop their astonishing array of different shapes. Such assemblages occur, for instance, in Bed 9a of Soldado Rock (K. 1316, 2854 and others), at Point Bontour, in certain beds of the Vistabella Quarry and in the Navette area (R.M. 1337, bottom of pit). No explanation can be given for this explosive local development, though it is no doubt governed by environmental factors. In the Morne Roche Quarry the Asterocyclinas are particularly concentrated in the less gritty spots of the reef which also carry an abundance of algae, but the depositional circumstances in this locality seem to have been rather abnormal and mechanical segregation of the various kinds of foraminifera may certainly have come into play.

Asterocyclina asterisca is a typical Late Eocene fossil. It is present, often in floods, in the Late Eocene of Trinidad and Soldado Rock, and also in the basal beds of the Late Eocene on Mount Moriah. It continues, less numerously, into the uppermost part of the Eocene at Vistabella, the Marabella marl.

Occurrence: Late Eocene: Calcareous sandstone member, Vistabella marl and Marabella marl, Point Bontour, Hospital Hill (type locality of Hospital Hill marl), San Fernando Railway Station, Mount Moriah, Vistabella Quarry, Vistabella (Schlumberger office section), Vistabella (Calyx wells 57 and 59), Vistabella Estate (Vistabella and Marabella marls), Tarouba Estate, Morne Roche Quarry, Brighton and Vessigny wells (near Pitch Lake), Penal-Rock Road, Cortez Trace, Moruga, Erin Point, Lizard Springs area, Navette area (R.M. 1337), Charuma, Soldado Rock (Beds 4, 7, 9, 10). Middle Eocene: Hindustan-Monkey Town Road junction, type locality of the Dunmore Hill marl (R.M. 2932, very rare).

Asterocyclina rutteni VAUGHAN
Pl. 13:8

1945   *Discocyclina (Asterocyclina) rutteni*, Vaughan p. 82, pl. 30:1–5.

The specimen illustrated in fig. 8 on pl. 13, was found among the routine sections of *Asterocyclina asterisca*. Its periembryonic chambers show more affinity to Vaughan's *Asterocyclina rutteni* from the Late Eocene of Cuba (1945, pl. 30:4).

Asterocyclina vaughani (CUSHMAN)
Pl. 7:1; Pl. 13:10; Pl. 28:1

1917   *Orthophragmina vaughani*, Cushman, p. 118, pl. 43:4–5.
1941   *Discocyclina (Asterocyclina) vaughani*, Vaughan & Cole, p. 20, 27, 61, pl. 20:10.
1975   *Asterocyclina vaughani*, Caudri 1975, p. 563.

The species is characterized by its flat webbed test with 4–6 inflated radii and more or less clearly developed secondary swellings in between them. It was described by Cushman from the Ocala limestone in Georgia as a rare species, and so it is also in the Caribbean Region. Gorter & van der Vlerk found one or two specimens in material from Falcón, Venezuela, and also in Trinidad and Soldado Rock only very few isolated specimens can be referred to it.

Of the few Trinidad specimens the best one comes from Point Bontour (Pl. 13:10). It

was found amongst Douvillé's type material of *Asterodiscus (Asterocyclina) asteriscus* collected by A. Tobler (Douvillé 1915). It has a diameter of 7.5 mm and shows the typical secondary swellings very clearly. A second, less pronounced form was found also at Point Bontour (St. 63).

Another very good specimen, with rounded ridges and secondary swellings, comes from Vistabella St. 148. A specimen from the Vistabella Calyx well 59 (used for a horizontal section) was flat and square, with distinct secondary bulges on its outline between the four main points.

Occurrence: Point Bontour (coll. A. Tobler, unnumbered sample, Texaco cat. No. 13572; St. 634), Vistabella (St. 148; Calyx 59, 390–400 feet).

Asterocyclina soldadensis CAUDRI
Pl. 6:14; Pl. 13:1, 5–7

1975   *Asterocyclina soldadensis*, Caudri, p. 563, pl. 4:13; pl. 21:2, 6–8; pl. 22:1, 3–4.

This form is readily distinguished from *Asterocyclina asterisca* in all its varieties by its blunt shape and the much coarser structure of its chambers. Maximal diameter 6.5 mm in the San Fernando area and on Soldado Rock, up to 8 mm in the Navette area. *Asterocyclina soldadensis* has not been found with certainty outside Trinidad, though judging from the general aspect of the horizontal section, part of Cole's material of *A. mariannensis* from Panama may refer to *A. soldadensis*. *A. soidadensis* is locally common in the Soldado section; it is scarce but consistently present in the San Fernando area, and is particularly abundant and well developed in the Navette area (R.M. 1337). Occasionally, it occurs in the uppermost Middle Eocene (one small, pillarless, but typical sepecimen in the limestone of Farallon Rock); but essentially the species is a marker for the Late Eocene (Vistabella marl).

Occurrence: Soldado Rock (Bed 7 and 9; Upper Eocene), Farallon Rock (S.L. 99, uppermost Middle Eocene), Point Bontour (Late Eocene), Vistabella Quarry (Late Eocene Vistabella marl), Vistabella Estate (Schlumberger office section, Late Eocene Vistabella marl), Vistabella (Calyx 59, Late Eocene Vistabella marl), Navette area (R.M. 1337, pit, middle and lower part, in lower part megalospheric form abundant, microspheric form scarce).

Asterocyclina cf. *barbadensis* VAUGHAN

1945   *Discocyclina (Asterocyclina) barbadensis*, Vaughan, p. 42, pl. 15:1–3.

A single specimen from the latest Middle Eocene Farallon Rock (Texaco Cat. no. 28401) is tentatively referred to this species, but it may also correspond with *Asterocyclina monticellensis* from the Punto Mosquito Formation, Margarita Island (Caudri 1975).

It is a very small, thin-walled, 5-rayed specimen, characterized by solid radial ridges on the surface, which shows particularly clearly in tangential section. In texture, it is more or less intermediate betweeen the very fine *A. asterisca* and the much coarser *A. soldadensis* in the Trinidad fauna.

Genus *Actinosiphon* VAUGHAN

Actinosiphon barbadensis (VAUGHAN)
Pl. 12:1

1944   *Lepidorbitoides* cf. *planasi*, Caudri, p. 16–17, pl. 1:3; pl. 2:10; pl. 3:14.
1945   *Lepidocyclina (Polylepidina) barbadensis*, Vaughan, p. 49–50, pl. 19:6–9 (not fig. 5).
1975   *Actinosiphon barbadensis*, Caudri, p. 542, pl. 9:1.

In Trinidad, *Actinosphon barbadensis* was not found in situ. Isolated reworked specimens occur in the Late Eocene of Soldado Rock, the San Fernando area, the Middle Eocene of Dunmore Hill and the Calyx wells in Biche.

Occurrence: Soldado Rock (K. 2951b, one rather doubtful microspheric specimen reworked in Late Eocene), Point Bontour (St. 63, reworked in Late Eocene), Dunmore Hill vicinity (type locality of Dunmore Hill marl, Ha. 215, Cd. 205, reworked in Middle Eocene), S.E. of Moruga Road junction (R.C.M. 2907, reworked in Middle Eocene), Biche, Calyx 50 and 50A (Charuma silts, early Middle Eocene, reworked habitus).

Genus *Lepidocyclina* GÜMBEL

Lepidocyclina s. l. has its roots in the Middle Eocene of the Western Hemisphere, from where it spread eastwards and soon gained worldwide distribution. In America it died out in Early Miocene and survived in the East until Early Pliocene.

From the beginning there has been a great diversification of species in *Lepidocyclina*. Efforts to place all these forms into rigid subgenera according to the shape of their nucleoconch *Polylepidina*, *Isolepidina* = *Lepidocyclina* s. s., *Pliolepidina*, *Nephrolepidina*, *Eulepidina*, etc. have failed. The best way to recognise true relationships is by comparing the chambers of the median layer, the shape and arrangements of which depends in first place on the framework of the stolons by which they are connected.

The first to use stolons in systematics were van de Geyn & van der Vlerk (1935), who created a new genus, *Orbitoina* (with subgenera *Polyorbitoina*, *Isorbitoina* and *Pliorbitoina*), for those Eocene forms which have only four stolons between chambers (as against six in the Oligo-Miocene forms). This is an oversimplification of the real state of affairs and moreover the names that are proposed are not in accordance with the International Rules of Zoological Nomenclature (Schenck & Frizzell 1936; Brönnimann 1946). But the principle is sound. The idea was followed up by Tan Sin Hok (1936a,b).

In 1959 the same criterion was taken up by Grimsdale in a more elaborate study. Grimsdale came to the conclusion that the genus was diphyletic, descending on one hand along a line (his Lineage Y) which is characterized by a system of crossed stolons (four in the proximal part of the test and six in the distal part where an annular stolon is added), and on the other hand along a second line (Lineage X) which has only four uncrossed, stolons all the way through. The stolon system of the Lineage X needs extensive study. Its principal Oligocene representative, *Lepidocyclina yurnagunensis* (Grimsdale 1959) has both annular and radial stolons in addition to the diagonal system (Vaughan & Cole 1941, pl. 38:6–7). According to Grimsdale, the Lineage Y can be traced back via *Polylepi-*

dina, Eulinderina and *Helicolepidinoides to Tremastegina.* This sequence was illustrated by Barker & Grimsdale in 1936.

The origin of Lineage X is not as clear. In each lineage the forms are grouped according to specific resemblances. No subgenera are recognized, although the author thought of re-introducing *Polylepidina* (his group of *Lepidocyclina antillea*) as a special group slightly more different from the rest. The terms polylepidine, isolepidine, nephrolepidine, pliolepidine, eulepidine, etc. are used only in the specific descriptions to indicate the shape of the nucleoconch in individual cases.

Grimsdale's paper was only an «interim review». Much detailed work lies ahead, for instance on the stolon system of the Polylepidinas. These forms are generally of the four-stolon type (Vaughan & Cole 1941) but little is known about the nature of these stolons, whether they are crossed or uncrossed. Perhaps both types are represented in them. They show some complications within the group; no straight line of descent of one species to another can be followed. *Polylepidina nitida* from the uppermost Middle Eocene of Trinidad, for instance, is as regards its nepionic stage nearly as primitive as the oldest form *Polylepidina antillea,* but in contrast with that species its lateral tissue is very advanced. Moreover, there is a difference between the species in the nepionic development of the microspheric form.

Our arrangement of the species on the following pages does not follow Grimsdale to the letter. We do not include the Paleocene form *Actinosiphon* in the Lepidocyclinidae like he does, and because of its helicolepidinoid development in the B-form, we have tentatively put *Lepidocyclina vichayalensis* in the Polylepidinas instead of in the most primitive group of the Lineage X. All Polylepidinas are described as one group, but instead of continuing with the Lineage Y, they are followed by the rather obvious phylogenetic series of *Lepidocyclina peruviana, pustulosa, subglobosa, yurnaguensis, vaughani* and *tempanii* (Lineage X) because it starts in the Middle Eocene along with the Polylepidinas. The first species of Lineage Y to be described is *Lepidocyclina sanfernandensis* (not mentioned by Grimsdale) with its mature form *depressata,* which starts in the Late Eocene (Marabella marl) but continues in the Oligocene. After that the typically Oligocene group of *Lepidocyclina undosa* and the other Oligocene and Miocene species of the Lineage Y are discussed.

Apart from *Polylepidina nitida* and *Lepidocyclina spatiosa* and *L. nuda,* no important forms have been added to the list given by Vaughan & Cole in 1941. On the contrary, some of the names they mention are omitted in the new list. Their *L. aurarensis* has been placed in the synonymy of *L. pustulosa,* the sp. aff. *ocalana* var. *pseudocarinata* is most probably our *L. spatiosa,* and *mortoni?* remains indeterminable. *L. sanluisensis* did not turn up in our material and neither did *L. macdonaldi* which was reported from the Penal-Rock Road.

Several of the specific names afterwards scrapped by Cole (1952, 1957, 1961) have been revived in the following pages. According to Cole, a drastic reduction of the number of species is justified by the fact that many of the so-called specific characteristics are extremely variable and that everywhere the species are linked by transitional forms. From a biological standpoint and within a given assemblage this attitude may be correct, but to paleontologic work it can be a disservice because it may cause the permanent loss of previous observations, especially when such gradual differences prove to be of stratigraphic significance, for instance in the case of *Lepidocyclina sanfernandensis* versus

Lepidocyclina chaperi. Careful evaluation of the overall appearance of such forms is sometimes of more importance than the scrupulous comparison of minute details and measurements.

Further studies should be made along the lines suggested by Grimsdale and by Tan Sin Hok. Some of the ample material from Trinidad (Mount Moriah, Vistabella Quarry, Cipero coast, Morne Diablo Quarry) might serve as a starting point.

Subgenus *Polylepidina* VAUGHAN

The interesting group of the Polylepidinas, considered by Vaughan as a subgenus of *Lepidocyclina*, has never been firmly outlined and the diagnoses of the species are vague. The differences between *Polylepidina* and *Lepidocyclina* are not even clear in the exhaustive study on the subject by Tan Sin Hok (1939).

Vaughan (1924b, 807–812, textfig. 5–6, pl. 30–32) based his new subgenus on the three Mexican species *chiapasensis, adkinsi* and *proteiformis. P. chiapasensis* was designated the subgenotype, chiefly because they seemed to have a greater number of chaotically arranged embryonic chambers than the rest of the Lepidocyclinas (the «mulberry mass» type of embryo according to Vaughan 1929e). In reality, however, there is a normal bilocular nucleoconch, followed by one or two auxiliary chambers, often very different in size, and one to four corresponding periembryonal spirals. The primary auxiliary chamber and one or two chambers of the primary spiral (the one which embraces the protoconch) may be as large or even larger than the embryonic chambers, which may create the impression of a multilocular nucleoconch. Vaughan presents photographs of all three of the original species, of which at least *adkinsi* and *proteiformis* clearly show the bilocular nucleoconch; the section of *chiapasensis* is not exactly in the equatorial plane and is less convincing.

Apart from the peculiar spiral nepiont, Vaughan's second criterion for the subgenus lies in the equatorial chambers, which are described as being similar to those of *Lepidorbitoides* or *Orbitoides*: arcuate outer walls, pointed or truncate inner ends, a greater tangential than radial diameter, and a pronounced tendency to appear in radial rows. Vaughan also stresses the rapid increase in height of the median layer towards the periphery in *chiapasensis* and *adkinsi*, this in contrast to *proteiformis*, which shows little increase.

In 1928 Galloway, who raised the Polylepidinas to generic rank, added *Lepidocyclina antillea* Cushman from St. Bartholomew to the genus.

Polylepidina antillea is generally speaking uniserial, it has one auxiliary chamber and one long spiral one, surrounding the protoconch and often continuing around part of the deuteroconch as well (Cole 1938, pl. 10:3; 1960, pl. 10:1; pl. 12:8; pl. 13:1–2, 5; Caudri 1974, pl. 8:7). However, from a comparative study of material from St. Bartholomew and from Jamaica, Eva (1980) observed that various nepionic types are represented in this species. From St. Bartholomew he had specimens with only one spiral, but even more were biserial ones, mostly with one auxiliary chamber with two spirals. Whereas amongst the material from Jamaica there was not one uniserial specimen but nearly all were biserial and some had a second auxiliary chamber and were triserial or quadriserial. But even the last-mentioned form was asymmetric because the primary auxiliary chamber and its main spiral are predominant over the weakly developed other elements.

Other species which vary from uniserial to biserial are *Polylepidina gardnerae* Cole

from the Claiborne Formation in Texas and from Florida (Tan 1939) and *Polylepidina chiapasensis* from Vera Cruz (Barker & Grimsdale 1936). *Polylepidina nitida*, however, is nearly exclusively uniserial.

Apart from the asymmetrical Polylepidinas mentioned above, there are also symmetrical forms. The best example of these is *Polylepidina proteiformis* from the late Middle Eocene of Mexico, which has two equally big auxiliary chambers and four short subequal periembryonic spirals, closed off by symmetric chambers where they meet (Vaughan 1929e).

Superficially, this looks the same as the nepiont of the Late Eocene species *Lepidocyclina subglobosa*. It would be an error, though, to see in the latter an offspring of *Polylepidina proteiformis*. The shape of the median chambers and the development of the lateral tissue in *Lepidocyclina subglobosa* are too different to consider a close relationship between the two.

It is rather difficult to decide which species of *Lepidocyclina* are to be considered as *Polylepidina* and which are not. Several of the species listed by Barker & Grimsdale (1936) do not belong to *Polylepidina* at all. Apart from *cardenasensis, vanslobbeni* and *variabilis*, which were already eleminated by Vaughan, the forms described by Hodson from the Late Eocene of Venezuela should also be dropped: *Polylepidina churuguaritana, mirandana* and *zuliana* and *Lepidocyclina maracaibensis*. They belong to the group of *Lepidocyclina pustulosa tobleri*. Vaughan's *Polylepidina kinlossensis* from Jamaica, considered by Barker & Grimsdale as a variety of *Polylepidina chiapasensis*, is insufficiently diagnosed; it may even represent more than one species.

On the other hand the present author is inclined to consider *Eulinderina semiradiata* Barker & Grimsdale (1936) as the most primitive of the Polylepidinas because of its efforts to develop slit-like lateral chambers, and we tentatively place *Lepidocyclina ariana* Cole & Ponton from the Lisbon Formation of Florida in the genus *Polylepidina*. This form was included by Grimsdale (1959) in the group of *Lepidocyclina macdonaldi*, but in its equatorial pattern it is much closer to the Polylepidinas, especially *Polylepidina proteiformis* than to *Lepidocyclina macdonaldi* (compare Cole & Ponton 1934, pl. 2:4–5; Cole 1944, pl. 16:11–13; Caudri 1974, pl. 11:1–2, 13; pl. 14:4 with Vaughan & Cole 1941, pl. 31:2). *Polylepidina ariana* probably includes *Lepidocyclina claibornensis* Gravell & Hanna, found in Mississippi, 55 feet above the zone of *Polylepidina gardnerae* (Cole 1944).

Also the still problematic species *Lepidocyclina vichayalensis* L. Rutten seems to belong to the Polylepidinas. Apart from the American species, *Polylepidina* is also reported from the Eastern Hemisphere, but apart from the record of *Lepidocyclina* sp. from the base of the Middle Eocene of Senegal (van Raadshooven 1951) these appear to be suspect (Butterlin 1987).

Polylepidina antillea, nitida, chiapasensis gardnerae and *semiradiata* are a-symmetric, having in principal one predominant auxiliary chamber with one nepionic spiral, whereas others, like *adkinsi, discoidalis, vichayalensis, proteiformis* and *ariana*, have a symmetric nepiont with two subequal auxiliary chambers, each with two periembryonic spirals which, together with a symmetric chamber at their meeting point, enclose the entire nucleoconch. The systematic place of *Polylepidina* is not quite clear yet. Vaughan called it a subgenus of *Lepidocyclina* though there does not seem to be a direct connection with that genus. Cole followed that line and so did van de Geyn & van der Vlerk, although under the different name *Polyorbitoina*. This name is a synonym of *Polylepidina*, in spite

of the different subgenotype chosen for the group: *Orbitoina (Polyorbitoina) proteiformis*. Moreover, the type figure presented with it does not depict *Polylepidina proteiformis*, but is a reproduction of one of Cole's type figures of *Lepidocyclina (Polylepidina) gardnerae*.

Galloway (1928), Barker & Grimsdale (1936) and Eva (1980) separated *Polylepidina* as an independant genus, developing side by side with the most primitive Lepidocyclinas (*Lepidocyclina pustulata* s. l. and *peruviana*), with which we agree. Barker & Grimsdale's phylogenetic line, which shows the gradual transition from the spirally wound *Amphistegina (Eoconuloides) lopeztrigoi* via *Helicostegina* and *Eulinderina* to *Polylepidina chiapasensis* and *Polylepidina proteiformis* does not represent the ancestry of *Lepidocyclina* but of *Polylepidina,* culminating in *Polylepidina proteiformis*. Eva widens the gap between the two genera by placing *Polylepidina* in a different subfamily of the Lepidocyclinidae, the Helicolepidininae. This conclusion is probably correct. Eva states that the difference between the subfamilies of the Lepidocyclininae and the Helicolepidininae lies in the fact that the deuteroconch in the former has many apertures giving rise to ad-auxiliary chambers, which in their turn lead to the cyclic growth of the median chambers, whereas in the latter the wall of the deuteroconch has only one or two apertures where it joins the protoconch, opening into the auxiliary chambers, and the nepionic tissue surrounding the nucleoconch is formed by a number of spirals, often of a very reduced nature of one or two chambers only.

In spite of Tan's very detailed study of the Polylepidinas (1939), the differences between the species, in part based on the periembryonic ring only and on insufficient material remain vague. It is possible that various species in the list above will prove to be synonyms. In 1944 Cole put *Lepidocyclina chiapasensis* and *gardnerae* in synonymy with *Lepidocyclina antillea*, thus eliminating the subgenotype designated by Vaughan. This was accepted by Grimsdale (1959) but needs further confirmation. Maybe the genus will have to be subdivided: Barker & Grimsdale's transition from *Polylepidina semiradiata* via *chiapasensis* and *discoidalis* to *proteiformis* seems quite logical, but it is impossible to find a place in this sequence for *Polylepidina nitida*, with its long primitive uniserial spiral and its lateral tissue which is far more developed than in *Polylepidina proteiformis*. If we may trust our scanty information, there also exist differences in the initial part of the microspherical forms. Some species begin with a simple spiral, e.g. *Polylepidina antillea* (Vaughan 1929e, fig. 7; Cole 1960c, pl. 12:8), *semiradiata* (Barker & Grimsdale 1936, pl. 35:2), *discoidalis* (ibid., pl. 36:6) and *birmanica* (Rao 1942), while others develop from a helicolepidinoid center, e.g. *Polylepidina vichayalensis* (Pl. 14:12), *P. zeijlmansi* (Tan 1936d, pl. 1:10).

As a group, *Polylepidina* is often considered as an indication of the Middle Eocene (Grimsdale 1959; Cole & Applin 1964), but one cannot fully rely on that. *Polylepidina vichayalensis*, for instance, is known to occur in abundance in the Middle Eocene of Eastern Mexico (Grimsdale 1959), but its type level is the Late Eocene Verdun Formation in Peru. Barring massiv reworking at the Peruvian locality, as suggested by Grimsdale, this would mean that the species crosses the boundary between the Middle and Late Eocene. In Trinidad one encounters *Polylepidina vichayalensis* in the Late Eocene where there is no indication of reworking from the Middle Eocene. Also for *Polylepidina nitida* a Middle Eocene age cannot be guaranteed, as it was also found in the lowest level of the Late Eocene Mount Moriah calcareous sandstone.

Lepidocyclina (Polylepidina) nitida CAUDRI, n. sp.
Pl. 2:12–13; Pl. 14:3–8; Pl. 30:3

1948   *Polylepidina* aff. *chiapasensis*, Caudri, pl. 73:8.

Exterior: Test lenticular, sharp-edged; maximal diameter 2.2 mm, thickness up to 0.7 mm (exceptionally 0.9 mm), ratio fairly constant; pillars numerous, not very heavy, evenly distributed over the central part; peripheral area pillarless, often showing radial rows of lateral chambers separated by radial ribs.

Horizontal section: Mostly megalospheric, rarely microspheric; in the A-forms nucleoconch 145–232 µ (usually 175–200 µ), consisting of a round protoconch and a subequal deuteroconch, generally thin-walled but outer spiral wall sometimes thickened, in which case the deuteroconch may be asymmetric; one large auxiliar chamber followed by a single spiral of 3 to 6 (mostly 4) conspicuously large nepionic chambers; median chambers arranged in radial rows which at first do not divide, so that with the increase of the circumference of the test, the chambers attain an extraordinary width (up to 150 µ); transition from the initial spiral to the normal equatorial pattern via several secondary spirals, depending on the individual; later, the rows split and the chambers are reduced to normal proportions (75–90 µ by 60 µ); microspheric form with the same radial pattern; initial spiral composed of about 15 chambers; nepionic development helicolepidine.

Vertical section: Equatorial layer sometimes faintly conical; height of equatorial layer only slowly increasing towards the edge; curved chamber walls; lateral chambers thin-walled and spacious, arranged in 5–7 continuous layers rather than vertical tiers; roofs variable in thickness but never heavy as in *Polylepidina antillea*.

Holotype: Pl. 2:12 (C 35930).

Type locality: Farallon Rock, unnumbered sample collected by Stainforth, Renz & Rutsch in 1939.

Type level: Uppermost Middle Eocene.

Occurrence: Farallon Rock (especially abundant in type sample and in S.L. 99, only megalospheric specimens observed); top of Mount Moriah (A.G.H. 5550, rare but also B-form, ?A.G.H. 5584, M. 12924); Point Bontour (reworked, St. 67, 68, 68a; St. 71, rare but also B-form, Grimsdale 4); ?Vistabella Quarry (reworked); ?Charuma (Late Eocene block A.E.G. 1580A, reworked).

Polylepidina nitida resembles *P. antillea* Cushman in the radial arrangement of its median chambers, but in vertical section it shows a much better development of the lateral tissue.

The megalospheric form is characterized by a short uniserial spiral of very large periembryonic chambers and radially arranged neanic chambers, the early ones of which are exaggeratedly wide. The microspheric generation has a spiral of around 15 chambers possibly followed by a helicolepidinoid nepiont. The vertical section shows very well developed spacious lateral chambers. The equatorial layer increases only slowly in height towards the periphery.

It is remarkable that the many specimens from Farallon that were sectioned all proved to be megalospheric. The very rare microspheric forms that were found, in combination with megalospheric ones, at Point Bontour and on Mount Moriah, do not differ externally from the latter and they also show the same pattern of the equatorial cham-

bers in horizontal section. One specimen from Point Bontour had an embryonic spiral of 15 chambers forming 1.75 coil. The helicolepidine development of the nepiont is reminiscent of *Lepidocyclina vichayalensis*, but the latter has a shorter embryonic spiral.

In the megalospheric generation, the transition from the initial spiral to the neanic radial growth pattern shows a lot of individual variation. In most cases, however, each chamber of the primary spiral apart fom the auxiliary chamber gives rise to a short secondary spiral which swings backwards over the first. One of these secondary spirals. as a rule the one originating from the first or from the second nepionic chamber, is better developed, encircles the auxiliar chamber and part of the deuteroconch and meets the end of the primary spiral in a symmetric chamber. A similar development which suggests, also in the A-form, a close relationship between *Polylepidina* and *Helicolepidina*, has also been observed in *Polylepidina chiapasensis* (Barker & Grimsdale 1936, pl. 35:8) and *P. gardnerae* (Cole 1938, pl. 9:2, 4?, 5; pl. 10:4).

In terms of nepionic acceleration, *Polylepidina nitida* seems to be midway between *Lepidocyclina antillea* with its slightly longer initial spiral in both generations (Cole 1938, pl. 10:3; 1960c, 61–62, pl. 12–13) and *L. gardnerae* which sometimes tends to develop a reduced biserial nepoint (Cole 1929, pl. 2:2; 1938, pl. 9:3; Tan 1939, 61–62, pl. 2:5). For that reason, it could be placed at the same level als *L. chiapasensis* as presented by Barker & Grimsdale (1936). We know, however, that the stratigraphic level of the species is the very highest Middle Eocene, way above the level of *L. chiapasensis*.

In other respects its place remains equally uncertain. The thickening of the outer wall of the nucleoconch and of the nepionic spiral is a primitive feature reminiscent of *Eulinderina*. Primitive are also the outward curvature of the walls of the aequatorial chambers and the arrangement of the lateral chambers in helicolepidinoid layers, but their roofs are never as heavy as in *Lepidocyclina antillea* or *L. gardnerae*. Not primitive are, however, the spaciousness of those lateral chambers and the thinness of the aequatorial layer, in which the species approaches *Lepidocyclina proteiformis*.

All these contradictory data do not encourage simply phylogenetic speculations, but suggest the existence of several parallel lines of descent within the group of the Polylepidinas. The radial arrangement of the equatorial chambers suggests the presence of a distal stolon as in *Lepidocyclina vichayalensis*, but such a stolon was not actually observed in our material of *L. nitida*.

The stratigraphic range of the species is still a puzzle. There is no doubt that it is in situ in the Farallon limestone where it occurs in great numbers and in very good preservation. But, as in the case of the other peculiar Farallon forms (*Operculina bontourensis* and *Helicolepidinoides intermedius*), it is doubtful the scattered specimens found at Point Bontour and on Mount Moriah are also autochthonous or just reworked. It may be interesting that at Point Bontour occurred a few heavily pillared specimens with a granulated flange and also some with an abnormally flat test, varieties that were not spotted on Farallon Rock, which might have something to do with a difference of environment. In this context one wants to spotlight also the curious fact that only in this Late Eocene material, where *Lepidocyclina nitida* is scarce, does one come across the microspheric form. If reworked, it seems that those specimens must at least have come from a different locality than where the limestone block of Farallon Rock has originated. But it may also be that the species did cross over into the Late Eocene.

Lepidocyclina (Polylepidina) vichayalensis L. RUTTEN
Pl. 14:9, 11–12

1928   Lepidocyclina (?Polylepidina) vichayalanesis, L. Rutten, pl. 15:24f–k, n–p; pl. 2:25–26.
1935   Actinosiphon vichayalensis, M.G. Rutten 1935b, 546–547, fig. 1–2.
1948   Lepidocyclina vichayalensis, Stainforth, 134.

The specific determination of the Trinidad specimens of this curious species was based on the resemblance in horizontal section to M.G. Rutten's figures of the Type material from Peru (1935). It was confirmed in 1949 by T.F. Grimsdale, who was familiar with the species from Mexico, where it forms entire populations, together with *Lepidocyclina peruviana* (Grimsdale 1959).

In Trinidad, *Polylepidina vichayalensis* has been found chiefly in the Mount Moriah calcareous grit at the base of the San Fernando Formation and in the lower part of the Vistabella marls in Charuma. In both places microspheric and megalospheric specimens exist sporadically; the species occurs also in the Vistabella marl at Point Bontour, in the Vistabella Quarry and in the lower part of Calyx well 59 on Vistabella Estate.

Occurrence: Top of Mount Moriah (base Late Eocene: A.G.H. 5550 frequent, A.G.H. 5583, A.G.H. 5584, also B-form); Charuma (Late Eocene: A.E.G. 1580A, 1580B, common, also a few B-forms, 1580C, 2740); Point Bontour (Late Eocene: St. 63); Vistabella Quarry (Late Eocene: Cd. 12–14); Vistabella Calyx well 59, 440–450 feet (Late Eocene).

Lepidocyclina (Polylepidina) proteiformis VAUGHAN
Pl. 14:10

1924   Lepidocyclina (Polylepidina) proteiformis, Vaughan 1924b,810, textfig. 6; pl. 32:1–7.

The Lepidocyclinas of Grimsdale's (1959) Lineage X

The Trinidad species that belong to this lineage are *Lepidocyclina peruviana, pustulosa* and its varieties, *spatiosa, yurnagunensis-subglobosa, vaughani* and *tempanii*.

Lepidocyclina peruviana CUSHMAN
Pl. 6:12; Pl. 15:4, 6

1922   Lepidocyclina (Nephrolepidina) peruviana, Cushman, 138, pl. 24:1.
1975   Lepidocyclina peruviana, Caudri, 573, pl. 5:4; pl. 25:7–14; pl. 26:1–4, 8.

In Trinidad, the species occurs everywhere together with the Lepidocyclinas of the *pustulosa*-group. It is particularly common on Soldado Rock, in the transgressive beds on the top of Mount Moriah and in Charuma. Specimens may attain a diameter of 3 mm, but they are often very small. In several samples these small specimens form the main component of the finer fractions of the residue.

Lepidocyclina peruviana nana CAUDRI

1975   *Lepidocyclina peruviana* var. *nana*, Caudri, 574, pl. 26:5.

Of the very small specimens of *L. peruviana* which can be so overwhelmingly numerous in the Late Eocene assemblages of Trinidad and Soldado Rock, most turn out to be immature forms consisting of the nepionic stage only, surrounded by a few neanic median chambers.

However, there are amongst them also a fair number of true miniature forms, which are fully developed tests of the same general aspect as *L. peruviana* but on a much smaller scale.

Lepidocyclina pustulosa (H. DOUVILLÉ)
Pl. 6:10; Pl. 15:1, 5, 8

1917   *Isolepidina pustulosa*, H. Douvillé, 843, textfig. 1–4.
1928   *Lepidocyclina trinitatis* and *Pliolepidina tobleri*, Nuttall, 103, 105, fig. 10.
1941   *Lepidocyclina (Pliolepidina) pustulosa* s. s., forma *trinitatis* and forma *tobleri*, Vaughan & Cole, 20, 27,
        64–67, pl. 24–30 (with extensive synonym list).
1975   *Lepidocyclina pustulosa*, Caudri, 374, pl. 5:1, 3, 5–6; pl. 26:6–7, 9, 12–14; pl. 27; pl. 28:1, 3–4; pl. 29:5.

The Trinidad material of *Lepidocyclina pustulosa* has been extensively described and figured by Vaughan & Cole (1941). They studied large suites of specimens and came to the conclusion that, though the extreme variants may be very different indeed, it is impossible to divide the series into separate species. They, therefore, united Douvillé's *Isolepidina pustulosa* and *I. trinitatis*, including also his *Pliolepidina tobleri* (the teratological form) under one species name: *Lepidocyclina pustulosa*. In contrast to Vaughan & Cole's views the present author prefers to maintain *I. trinitatis* and *I. tobleri* as subspecies of *Lepidocyclina pustulosa*.

The B-forms of *Lepidocyclina pustulosa* from the San Fernando area (Vistabella Quarry) are in their early development very different from those in the Navette area. The first type shows a short spiral of rounded chambers, followed by an area in which the chambers are arranged in radial rows, very similar to *L. peruviana*. The latter type has a smaller and more tightly wound spiral and lacks the zone of radially arranged chambers. The difference is so striking that we must conclude that the form determined as *L. pustulosa* represents more than one species. On Soldado Rock the two types occur together in the same sample.

The Trinidad material of *Lepidocyclina pustulosa* is excellently suited for an extensive study as some of the faunas can be considered as real autochthonous populations. The best material comes from Soldado Rock (K. 903, 1316, 1499, 1500, 2854, 2855, 3677, 10716, etc.; see Kugler & Caudri 1975; Caudri 1975), from the Vistabella Quarry and from the Navette area.

Lepidocyclina pustulosa trinitatis (H. DOUVILLÉ)
Pl. 15:3, 9

1924   *Isolepidina trinitatis*, H. Douvillé, 34, pl. 1:4; textfig. 7–12.
1975   *Lepidocyclina pustulosa trinitatis*, Caudri, 575, pl. 1:17–18; pl. 5:3, 5–6; pl. 26:14; pl. 27:1, 9–11; pl. 29:7.

The best populations to study this form are from Soldado Rock (K. 2854, 3677, 10716). The specimens from K. 10716 often show the same peculiar little solid squares at the intersection of the walls of the median chambers that are such a constant chracteristic of *Lepidocyclina yurnagunensis*. The same was also noticed in a few specimens from Point Bontour (St. 63).

Lepidocyclina pustulosa tobleri (H. DOUVILLÉ)
Pl. 15:7, 12

1917   *Pliolepidina tobleri* H. Douvillé, 844, textfig. 5–6.
1975   *Lepidocyclina pustulosa tobleri*, Caudri, 575, pl. 27:4–7.

The systematic place of the subspecies is still problematic. Brönnimann (1946) considers it as a valid species and Grimsdale (1959) not only recognizes it as a separate species but distinguishes it as a group of *Lepidocyclina* by itself. Cole's final conclusion (1963) is followed here: The form is left within the species *pustulosa*, as many transitional forms between the isolepidine type of nucleoconch and the forma *tobleri* are found in the lower(?) bed of the Vistabella Quarry and several specimens have a double nucleoconch or are completely abnormal.
Occurrence: Point Bontour (Vistabella marl, type locality of the subspecies); Morne Roche (basal beds of Late Eocene); Vistabella marl (frequent), Charuma (frequent), Navette area (abundant), San Fernando Railway Station (Marabella marl, Cd. 208); Lizard Springs area (Late Eocene blocks, Z. 456a).

In Trinidad, *Lepidocyclina pustulosa* continues into the uppermost Late Eocene Marabella marl, where it is associated with *Lepidocyclina subglobosa, yurnagunensis* and *sanfernandensis* and *Helicocyclina paucispira*, but does not go beyond.

Lepidocyclina pustulosa compacta CAUDRI
Pl. 15:2

1974   *Lepidocyclina pustulosa*, small-chambered variety, Caudri, 312, pl. 12:1.
1975   *Lepidocyclina pustulosa* forma *compacta*, Caudri, 575, pl., 26:12.

This mostly small form is scattered throughout the San Fernando Formation, from the basal deposits (Mount Moriah calcareous sandstone) up to the uppermost Eocene beds at the San Fernando Railway Station (Marabella marl). It is nowhere common. Some very small microspheric forms with the same characteristics were also found.

Lepidocyclina spatiosa CAUDRI
Pl. 7:4, 9; Pl. 16:1–4

1941   *Lepidocyclina (Lepidocyclina)* sp. aff. *ocalana* var. *pseudocarinata*, Vaughan & Cole, 68, pl. 31:10–11.
1974   *Lepidocyclina «spatiosa»*, Caudri, 312, pl. 12:2.
1975   *Lepidocyclina spatiosa*, Caudri, 576, pl. 1:21; pl. 28:2; pl. 29:1–2.

Lepidocyclina spatiosa is closely related to *L. pustulosa*. On the other hand, it resembles *L. supera* which, in Trinidad, has been found in the Cipero section. Topotype material of *L. supera* at our disposal shows this species to have likewise meandrine lateral chambers on the surface and very small median chambers along the unbroken undamaged edge of adult forms. But it has a smaller and more compact nucleoconch, without large periembryonic chambers around it, and the equatorial chambers are not rhomboid or ogival but spatulate to rounded-hexagonal (Pl. 28:4). *L. supera* is an Oligocene species.
Occurrence: Soldado Rock (K. 1316, 1499, 2854); Navette area (R.M. 1337, pit, middle and lower part); Point Bontour (G.F. 4123, very small St. 63?).

Group of *Lepidocyclina yurnagunensis*

Lepidocyclina yurnagunensis (CUSHMAN)
Pl. 3:6; Pl. 7:2, 5; Pl. 17:1–3, 7–8, 10–15; Pl. 30:4

1919   *Lepidocyclina canellei* var. *yurnagunensis*, Cushman, 57, pl. 12:7–8; textfig. 6.
1941   *Lepidocyclina (Lepidocyclina) yurnagunensis*, Vaughan & Cole, 22, 28, 64, 70, 72, pl. 33:1–7.
1975   *Lepidocyclina* cf. *yurnagunensis*, Caudri, 577.

Lepidocyclina yurnagunensis is one of the most easily recognizable species amongst the American Lepidocyclinas. It is a relatively small delicately built form, characterized by thin-walled lozenge-shaped median chambers arranged in a fan-like pattern, which generally show a minute square of solid shell material at the intersection of their walls. In vertical section it shows spacious thin-walled rectangular lateral chambers. The nucleoconch consists of two thick-walled chambers of near equal size, and its periembryonic ring is composed of large broad irregularly shaped chambers, as in *L. pustulosa*.

In Trinidad, *L. yurnagunensis* occurs in great quantities in various Oligocene localities, in first place in the basal Oligocene at Point Bontour, in the Early Oligocene of the Cipero section and in the hard rocks of the Mejias Quarry. The Cipero material is exceptionally well preserved. It is a mixture of countless juvenile and adult specimens of all sizes and shapes, and represents a natural population in all its variations. Nearly all of the specimens are megalospheric, but there are also a few microspheric forms, which distinguish themselves somewhat in general shape but not in size.

Part of the microspheric specimens has a close-wound initial spiral with a thick outer wall, like those of *Lepidocyclina pustulosa* from the Navette area. Others, however, have a spiral of rounded more spacious thick-walled chambers, sometimes forming a well-defined initial shell before going on with the regular rhomboid median chambers.

The stratigraphic range of the species in Trinidad is uppermost Eocene to Middle Oligocene.
Occurrence: Cipero section; Flat Rock rongue (Early Oligocene); Mejias Quarry (Middle Oligocene); Vistabella reservoir (E.L. 1207, uppermost Eocene); Vistabella Calyx

well 57 (Oligocene and uppermost Eocene); Vistabella Estate (uppermost Eocene Marabella marl, E.L. 1209); Point Bontour (basal Oligocene and uppermost Eocene); Coora-Quinam Road (Oligocene, block, Vaughan & Cole (1941) mention the species also from Erin, erratic blocks in mudflows); Chagonary Point; Penal-Rock Road; old Guayaguayare Road; Lizard Springs area; Tamana-Biche Road. The B-form was found in the Cipero section, at Point Bontour (Cd. 1211) and at the Vistabella reservoir (E.L. 1207).

Lepidocyclina yurnagunensis var. *inflata* CAUDRI, n. var.
Pl. 3:6

Holotype: Pl. 3:6 (C 35972).
Type locality: Cipero coast, Grimsdale 2.
Type level: Early Oligocene.

The megalospheric new variety is as a rule a very small form. An exceptionally large specimen (3.5 mm) which was left intact, is suspected to be a B-form. The central pillar can be as much as 1.1 mm in diameter and is surrounded by rather large lateral chambers; towards the edge they become very small. In horizontal section the variety is indistinguishable from typical *Lepidocyclina yurnagunensis*.

Lepidocyclina subglobosa NUTTALL
Pl. 7:6–7; Pl. 17:4–6, 9

1928   *Lepidocyclina subglobosa*, Nuttall, 104, pl. 8:3, 5–7.
1941   *Lepidocyclina* (*?Pliolepidinaa*) *subglobosa*, Vaughan & Cole, 65, 67, pl. 31:8–9.
1975   *Lepidocyclina subglobosa*, Caudri, 576, pl. 26:10–11.

The species was first described from wells on the Tarouba and Palmira Estates North of San Fernando (Marabella marl).

Small specimens of *Lepidocyclina yurnagunensis* with large irregular periembryonic chambers occur together with *L. subglobosa* already in the uppermost beds of the Eocene Marabella marl at Point Bontour and in Vistabella Calyx well 57 and surface samples. *L. subglobosa* is represented in large quantities in the finer fractions of the washed samples from the basal Oligocene at Point Bontour and from the Early Oligocene Flat Rock tongue of the Cipero section. This small form has up to now been overlooked amongst the floods of the more conspicuous larger specimens of *L. yurnagunensis*.

In Trinidad *Lepidocyclina subglobosa* ranges from uppermost Eocene to Early Oligocene.

Occurrence: Tarouba-Palmyra Estates (Marabella marl); Vistabella Calyx 57 and 59 (surface sample E.L. 1207, 1435); San Fernando Railway Station; Point Bontour (Basal Oligocene); Cipero section (Early Oligocene); Mejias Quarry (Oligocene); Coora-Quinam Road.

Lepidocyclina vaughani CUSHMAN

1918   (1919) *Lepidocyclina vaughani*, Cushman, 93, pl. 37:4; pl. 38.

In Trinidad, the species occurs in considerable numbers in the limestone of Kapur Quarry (Lz. 3465), associated with abundant Lepidocyclinas of the *undosa-favosa-gigas*-group. It also is present in several erratic blocks of Oligocene limestone in the South of the Island.

Towards the end of the Middle Oligocene, *L. vaughani* and *tempanii* take over from *L. yurnagunensis*, which appears in the uppermost Eocene and has, in Trinidad, its main development in the Early Oligocene and the early part of the Middle Oligocene.

Occurrence: Kapur Quarry (especially Lz. 3465); Erin, Tapara Point (Cole 1968, Locality 11); Penal-Rock Road (K. 409a = Cole 1968, locality 12).

Lepidocyclina tempanii VAUGHAN & COLE
Pl. 7:3; Pl. 17:16–17

1924   *Nephrolepidina tournoueri*, H. Douvillé, 47–48, textfig. 44–45 (not *Lepidocyclina tournoueri* P. Le-
           moine & R. Douvillé 1904).
1941   *Lepidocyclina (Nephrolepidina) tempanii*, Vaughan & Cole, 12, 75, pl. 39:5–9.

Because of its spacious delicate build, especially clear in the vertical section, this small species belongs to the same group as *Lepidocyclina yurnagunensis*, but it has a nephro-lepidine embryonic apparatus and elongated hexagonal equatorial chambers, which do not show the fan-like pattern of the other members of the group.

Occurrence: Kapur Quarry, Logeon area, Guayaguayare (Lz. 3464, 3465, 3473, 3475, abundant); Charuma (A.E.G. 4567, abundant); Vaughan & Cole report the species from several other localities, all near or along the South coast: Erin Bay, Erin Point, Tapara Point, Chagonary Point, Penal-Rock Road, Marac River and along the old Rio Claro-Guayaguayare Road.

The Lepidocyclinas belonging to Grimsdale's (1959) Lineage Y are *Lepidocyclina sanfernandensis*, the group of *L. undosa, L. supera, L. forresti* and the group of *L. canellei*.

Lepidocyclina sanfernandensis VAUGHAN & COLE
Pl. 16:5–7

1941   *Lepidocyclina* (Nephrolepidina) *sanfernandensis*, Vaughan & Cole, 27, 73, cotypes: pl. 42:5a, 6; pl.
           43:1–2; paratypes: pl. 42:1a–d, 2a–b, 3a–b, 4, 5b–c; pl. 43:3; pl. 44:1.

The species was described by Vaughan & Cole from a locality northwest of San Fernando (K. 3762), from a bed designated as «slightly younger than typical Vistabella» or «above the Mount Moriah Formation but in association with some Mount Moriah species».

L. sanfernandensis was subsequently found in several samples from the San Fernando area. Like *L. yurnagunensis, L. subglobosa* and *Helicocyclina paucispira*, it does not appear before the uppermost beds of the Eocene San Fernando Formation (Marabella marl), and, also like the other Lepidocyclinas mentioned above seems to continue into

the Oligocene. In the Eocene *L. sanfernandensis* stands out against the bulk of *L. pustulosa* by its flatness and delicate build. It is often broken up into fragments.

Our material comes from the Vistabella reservoir (E.L. 1207). In contrast with the type locality, where the majority of the specimens are microspheric, most of ours are megalospheric: even one of the larger pieces, of 8 mm diameter, proved to be an A-form.

Occurrence: Northeast of San Fernando (K. 3762, type locality, uppermost Eocene, Marabella marl); Vistabella reservoir (E.L. 1207; uppermost Eocene, Marabella marl); Point Bontour (St. 84, 85; basal Oligocene, specimens weathered and probably reworked from the Eocene).

Lepidocyclina sanfernandensis var. *depressata* CAUDRI n. var.
Pl. 3:1–2, 7; Pl. 30:9

Exterior: Apart from the central depression the form is externally similar to *Lepidocyclina favosa*. Like that species, it is pillarless and covered with a network of thick-walled lateral chambers that, however, are somewhat smaller than in favosa.

Horizontal section: Embryonic apparatus eulepidine with a tendency towards the nephrolepidine type; outer wall rather thin. Median layer flat or slightly undulated, consisting of irregular rounded-hexagonal median chambers, indistinguishable from those of *L. sanfernandensis*.

Vertical section: Median chambers irregular, with convex vertical walls. Lateral chambers in tiers, with thick-straight walls but lenticular cavities; number of lateral layers very variable; central depression clearly derived from the peculiar curvature of these layers (not caused by erosion). The lateral tissue seems to cover the median layer to the edge (vertical section very different from the thin-walled *L. favosa*).

Holotype:Pl. 3:1 (C 35998).
Type locality:Cipero coast, C.S. 11.
Type level:Early Oligocene.
Occurrence:Cipero coast (C.S. 11); Point Bontour (Cd. 211).

In a few Oligocene localities occurs a very conspicuous robust *Lepidocyclina* which stands out by its peculiar shape. It is fairly large up to 7 oder 8 mm, and has a highly inflated body with a pronounced central depression and a thin flange. Such forms are here placed in the new variety *depressata* of *L. sanfernandensis*. Smaller and flatter specimens of the new variety cannot be distinguished from the typical Late Eocene *L. sanfernandensis*. It is therefore considered to be the typical, fully developed form of that species, but is kept apart for the following reasons: The new variety has so far only been found in the Oligocene. It however may be that, like *L. yurnagunensis*, the variety first occurred already in the latest part of the Late Eocene but did not reach its full development until the Oligocene in which case it may also be of stratigraphic value.

Group of *Lepidocyclina undosa*

As is the case with the group of *Lepidocyclina pustulosa*, we also have in *Lepidocyclina undosa* a group which consists of a series of species that resemble each other to such an extent that no sharp lines can be drawn between them. They are: *Lepidocyclina undosa, favosa, gigas*, its variety *duncanensis,* and *L. nuda.*

It is easy to separate the large sellaeform specimens of *L. undosa* from a typical *sub-globosa* flanged *L. favosa* but, through the forms described by Vaughan as *L. undosa* var. *tumida*, they are intricately linked together and a firm specific determination of the many non-typical and intermediate cases becomes impossible. Moreover, because all these forms generally occur together, a rigid separation is of little consequence.

Nevertheless, we follow Cole (1952), though *Lepidocyclina undosa, favosa* and the microspheric form *gigas* most probably belong together, the three names should be continued, as a fusion would do more to obscure the picture of a given fauna than to clarify it.

Lepidocyclina undosa CUSHMAN
Pl. 20:1; Pl. 21:1

1919   *Lepidocyclina undosa*, Cushman, 65, pl. 2:1a.
1941   *Lepidocyclina (Eulepidina) undosa*, Vaughan & Cole, 75, pl. 34:5; pl. 41:1–3.

The best saddle-shaped forms occur in the Kapur Quarry; the specimens from the Cipero section are as a rule small and of non-typical habitus.
Occurrence: Vaughan & Cole recorded the species from the Cipero coast, Erin Point, Tapara Point, Penal-Rock Road, Mejias Quarry, old Rio Claro-Guayaguayare Road and the Lizard Springs area; added here is the Kapur Quarry.

Lepidocyclina favosa CUSHMAN
Pl. 20:2–3; Pl. 21:2

1919   *Lepidocyclina favosa*, Cushman, 66, pl. 3:1, 2b; pl. 15:4.
1941   *Lepidocyclina (Eulepidina) favosa*, Vaughan & Cole, 75, pl. 40:1–4.

Lepidocyclina favosa is characterized by the even curvature of the body surface and by the peculiar thick-walled lateral chambers on the surface, features which grade into *L. undosa*.
Occurrence: Kapur Quarry, Logeon, Guayaguayare area; Vaughan & Cole recorded the species from the Cipero coast, Erin Bay, Mapapire River and along Kapur Ridge.

Lepidocyclina gigas CUSHMAN
Pl. 21:3; Pl. 23:1

1919   *Lepidocyclina gigas*, Cushman, 64, pl. 1:3–5; pl. 5:4.
1941   *Lepidocyclina gigas*, Vaughan & Cole, 76.

The limestone of the Kapur Quarry contains the typical huge form of *Lepidocyclina gigas*. The specimens could not be detached without damage, and the diameter could not be measured exactly, but it is far in excess of 50 mm. The inflated central body occupies about 10–12 mm and has a thickness of 9–10 mm. The flange is flat or slightly undulated.

L. gigas is considered to be the microspheric generation of *L. undosa* as well as of *L. favosa*, both also present in the megalospheric form in this material.
Occurrence: Kapur Quarry Logeon, Guayaguayare area; Vaughan & Cole recorded it from Penal-Rock Road, Mejias Quarry, Marac River, Erin Point, and upper reaches Navette River (Lizard Springs area).

Lepidocyclina gigas Cushman *duncanensis* Cole

1928   *Lepidocyclina gigas* var., Vaughan, 295.
1934   *Lepidocyclina gigas* var., *duncanensis*, Cole, 27, pl. 3:16; pl. 4:1.
1941   *Lepidocyclina gigas* var. *duncanensis*, Vaughan & Cole, 70.

Vaughan & Cole do not mention *L. gigas* from the Cipero coast where very large specimens occur in the Oligocene Flat Rock tongue that are here placed in this subspecies.

They are somewhat smaller and a good deal thinner than the typical *L. gigas* as known from Kapur Quarry and other places in southern Trinidad.

The state of preservation of the Cipero material is not favourable for a specific study. The specimens are broken up into tiny fragments, to the extent that they crumble away beyond recognition the moment the sample which contains them is soaked in water. For that reason they are bound to be overlooked in the washed residue, but on the weathered surface of the rock they are very conspicuous and look exactly like Cole's figure of one of his Florida specimens (pl. 4:1).

Occurrence: Cipero coast.

Lepidocyclina nuda Caudri, n. sp.
Pl. 28:5–7

Exterior: Diameter up to 6 mm. Test lenticular, rather flat, slightly depressed in the center, with gently sloping flanks; no distinct flange but very thin towards the edge. Large meandric lateral chambers and small pillars developed all over the central part of the test. Peripheral parts of the shell devoid of lateral tissue, showing the very large median chambers on the surface.

Horizontal section: Nucleoconch very large, thin-walled, nephrolepidine or eulepidine. Median chambers very large, elongated-spatulate; sometimes the chambers in the center are smaller, more or less like *Lepidocyclina undosa*, but in other specimens the large spatulate chambers are present right from the beginning.

Vertical section: unknown.

Holotype: Pl. 28:6 (C 36061).

Type locality: Flat Rock tongue, Cipero coast (Grimsdale 2).

Type level: Early Oligocene.

Lepidocyclina nuda resembles in its shape *L. supera* from the same sample and in the meandric lateral chambers, but it differs by the very large naked median chambers which are clearly visible on the peripheral part of the test. The new species is based on eight adult specimens and three loose embryos composed of the nucleoconch and the first 2–3 rings of median chambers only.

Lepidocyclina supera (Conrad)
Pl. 28:2, 4

1865   *Orbitolites supera*, Conrad, Catalogue of Eocene Annulata, Foraminifera, Echinodermata and Cirripedia of the United States, Philadelphia Aca. Nat. Sci., Proc., 74.
1941   *Lepidocyclina (Lepidocyclina) supera*, Vaughan & Cole, 70, pl. 33:5–8; pl. 34:2–4.

The species is very rare in Trinidad. Vaughan & Cole (1941) recorded its presence only in one sample from the Cipero section.

The Trinidad form is characterized by the meandric lateral chambers on the surface and the small but rather conspicuous pillars.

Occurrence: Cipero coast (Grimsdale 2, K. 251); Vistabella, Calyx well 57, 730–740 feet (basal Oligocene, one specimen).

Lepidocyclina cf. *supera* (CONRAD), large variety
Pl. 3:3, 5

A single specimen stood out for its exceptional appearance among the other Lepidocyclinas of the Cipero coast material (Grimsdale 2). In the following it is tentatively described as a variety of *Lepidocyclina supera*.

Exterior: Diameter about 3 mm (damaged edge). Flat lenticular with a distinct narrow flange; entire test covered with close-set equally sized rounded beads of about 100 µ on the central body and somewhat smaller on the flange. Lateral chambers obscured by the pillars but, where visible, small, irregular, partly meandric.

Horizontal section: Median plane strongly undulated. Nucleoconch of the *Lepdocyclina* s. s. type, with a straight dividing wall; 550 µ in diameter. Median chambers rounded-hexagonal, thick-walled.

Vertical section: Unknown, but the broken edge shows long, very low lateral chambers with straight horizontal walls.

Lepidocyclina forresti VAUGHAN
Pl. 7:11; Pl. 19:2–5; Pl. 22:3; Pl. 23:2; Pl. 29:1

1927   *Lepidocyclina (Lepidocyclina) forresti*, Vaughan 1927a, 1, pl. 1:1–4; pl. 2:1–6.
1941   *Lepidocyclina (Lepidocyclina) forresti*, Vaughan & Cole, 70, pl. 35:1–3.

Vaughan & Cole (1941) identified the prominent large Lepidocyclinas in a sample from the Morne Diablo Quarry limestone (K. 2864) as *Lepidocyclina forresti*, an isolepidine species with a pronounced circular arrangement of the median chambers.

Among our extensive material from this locality, sample K.S. 70 showed the most complete array of forms of this species. There were countless megalospheric and microspheric specimens, in all varieties from pillarless to fairly heavily pillared, with and without a central knob, and a large number of juvenile forms consisting of a central knob and a thin flange or just of the small central body alone. These juvenile specimens are composed of little more than the nucleoconch with the very first rings of equatorial chambers, covered by one or two layers of lateral tissue. Intermediate forms abound and there was no reason to separate these forms from one another. Also, in the horizontal and vertical sections there is no difference between the pillarless and the pillared individuals.

The large B-forms of *Lepidocyclina forresti* in the Morne Diablo Quarry are not all of the same type in their initial development. Some have a simple embryonic spiral, others show a peculiar helicolepidinoid nepiont (Pl. 22:3).

Occurrence: Morne Diablo Quarry.

Group of *Lepidocyclina canellei*

Because it is difficult to draw the line between the Lepidocyclinas of this group (*canellei, pancanaalis, parvula, waylandvaughani, asterocolumnata, asterodisca, miraflorensis, giraudi* and *antiguensis*), Cole thought in 1961 that they might be different variations of one and the same species, to which the name of *Lepidocyclina canellei* should be applied. He came to the conclusion that in the American post-Eocene there are only two species of *Lepidocyclina* sensu stricto: *L. canellei* and *L. mantelli*. This generalization goes in our opinion too far. For instance, Cole's megalospheric specimens of *L. giraudi* from the Morne Diablo Quarry (1957b, pl. 4:3; pl. 5:1–2; pl. 6:2) and his microspheric *L. parvula* from Panama (1952, pl. 15:8) cannot be identified with *canellei*, and also several vertical sections of *L. waylandvaughani* (Vaughan 1933; Cole 1952, 1957b) are too different from those of typical *L. canellei* to be united with it.

Lepidocyclina canellei LEMOINE & R. DOUVILLÉ
Pl. 18:1–2; Pl. 29:4; Pl. 30:1

1904   *Lepidocyclina canellei*, Lemoine & R. Douvillé, Soc. Géol. France, Mém., vol. 12, 20, pl. 1:1; pl. 3:5.
1941   *Lepidocyclina (Lepidocyclina) canellei*, Vaughan & Cole, 70–71, pl. 35:6–7; pl. 41:4–5.

The large form of *Lepidocyclina canellei* is by no means common in Trinidad. Even in the Morne Diablo Quarry, where the canellei-group is well developed, this large form is rare in comparison with *L. pancanalis*, and is not typical either as far as the external features are concerned. The Morne Diablo specimens resemble the original pillarless type in their flat lenticular shape (sometimes with a definite flange), but nearly all of them show fine granulations on the surface (Pl. 29:4). Such granulated specimens occur also in the Cipero material. The pattern of the median layer is often fairly irregular due to growth disturbances and regeneration (Pl. 30:1).
Occurrence: Morne Diablo Quarry and Charuma, doubtful in the Mejias Quarry and the Cipero section.

Lepidocyclina pancanalis VAUGHAN & COLE
Pl. 7:8; Pl. 18:3–4

1932   *Lepidocyclina (Lepidocyclina) pancanalis*, Vaughan & Cole, 510, fig. 1–9.
1933   *Lepidocyclina (Lepidocyclina) pancanalis*, Vaughan 1933a, 15, pl. 6:6.
1941   *Lepidocyclina (Lepidocyclina) pancanalis*, Vaughan & Cole, 71, pl. 35:8–9.

Occurrence: Morne Diablo Quarry; Cunapo River (common); Baccus River, Guaico-Tamana Road, Charuma, Cascas River (K.R. 17725, specimens are dwarfed, at most 1.0 mm diameter); Vaughan & Cole report this species also from Erin Bay and Penal-Rock Road.

Lepidocyclina parvula CUSHMAN
Pl. 18:5–7; Pl. 29:2

1919   *Lepidocyclina parvula*, Cushman 1919a, 58, pl. 3:4–7.
1941   *Lepidocyclina (Lepidocyclina) parvula*, Vaughan & Cole, 20, 28, 71, pl. 36:1–5.

This species includes the centrally inflated heavily pillared representatives of the *canellei*-group. It is in this form that the group is chiefly represented in the Cipero section, but it is equally well developed in the Morne Diablo Quarry and elsewhere.

Sometimes the pillars are very large and arranged in a ring, but in the megalospheric specimens from Trinidad they are not fused to form radial ridges. Typical *L. parvula* var. *crassicosta* is absent in our material.

In the Morne Diablo material there is also a peculiar subglobose or biconical flanged form which, because of the general pattern of its lateral tissue, must likewise be considered as a form of *L. parvula*.

Occurrence: Morne Diablo Quarry, Cipero section, Mejias Quarry, Baccus and Cunapo rivers (Tamana area). Vaughan & Cole list it also from Erin Bay, Erin Point, Tapara Point, Penal-Rock Road, Marac River and Lizard Springs area. Microspheric forms occur in the Morne Diablo Quarry.

Lepidocyclina giraudi R. DOUVILLÉ
Pl. 7:10; Pl. 18:8; Pl. 19:1; Pl. 22:4

1907   *Lepidocyclina giraudi*, R. Douvillé, Bull. Soc. Géol. France, sér. 4, vol. 7, 305–311, pl. 10:9–10, 15–16.
1941   *Lepidocyclina (Lepidocyclina) giraudi*, Vaughan & Cole, 71, pl. 36:6–7; pl. 37.

Only the typical form with radial costae on the surface was listed under the name of *Lepidocyclina giraudi*; microspheric specimens with more or less heavy individual pillars but without costae were included in *L. parvula*-B on the fossil lists.

Occurrence: Morne Diablo Quarry, Chagonary Point.

Lepidocyclina waylandvaughani COLE

1928   *Lepidocyclina (Lepidocyclina) waylandvaughani*, Cole, 221, pl. 35:1–10.
1941   *Lepidocyclina (Lepidocyclina) waylandvaughani*, Vaughan & Cole, 70, 1. 35:4–5.

This species is characterized by its small inflated central body, surrounded by a wide thin flange, and one or more rings of heavy pillars in the center. Cole now includes it in *Lepidocyclina canellei*, but this is accepted with some reservation as the lateral tissue, as seen in vertical section, seems less spacious.

The sepcimen from the Cipero section yielded three typically developed A-forms and one B-form. In these, the central body is well set off against the flat flange. The pillars are arranged in strikingly regular circles, especially in the B-form; they are heavy in the center but turn to fine granulations on the flange. The lateral chambers are small and polygonal.

In the same sample there were also three specimens with a much flatter central body which grades into the flange and in which the distribution of the pillars is less regular. The pillars in this form are small but prominent; no granulations on the flange. The lateral chambers are meandric rather the polygonal. These specimens correspond with the form figured by Cole from the Panama Canal Zone (1952).

Occurrence: Erin Point (Vaughan & Cole 1941, one specimen); Cipero section (four typical specimens).

Lepidocyclina asterocolumnata CAUDRI, n. sp.
Pl. 2:14

Exterior: Diameter 3.5 mm (edge broken off), thickness 1.2 mm. Inflated central body, gradually sloping down and surrounded by a thin flat flange, here 0.3–0.5 mm wide but possibly much wider in undamaged condition; lateral tissue continued on flange. The new species is characterized by the peculiar pattern of pillars and lateral chambers in its center. About 20 large composite pillars surrounded by large rounded lateral chambers (100 μ) with extremely thin but finely granulated walls; the pillars consist of a small star-shaped central granule, mostly forming an asterisk of 100–150 μ in combination with the radiating walls of the chambers which are thickened to tiny rods or rows of elongated granules.
    The sloping flanks are covered with coarse granulations which obscure the here much smaller lateral chambers; on the flange the chambers are clearly visible and are separated by minute granules arranged in regular circles; the median chamber layer is rather high at the edge and not subdivided.
Holotype: Pl. 2:14 (C 36060).
Type locality: Cipero coast, Grimsdale 2.
Type level: Early Oligocene.

Variations in the external ornamentation of the test of larger foraminifera are not usually considered an important systematic feature. An exception is here made for the new species *Lepidocyclina asterocolumnata* which is characterized by the development of very peculiar stellate pillars.
    The new species appears at first sight closely related to *L. waylandvaughani* Cole, it is based on a single isolated specimen of which no sections were made.

Lepidocyclina asterodisca NUTTALL
(see illustrations in: Vaughan & Cole, 1941)

1932   *Lepidocyclina (Lepidocyclina) asterodisca*, Nuttall, 34, pl. 7:5, 8; pl. 9:10.
1941   *Lepidocyclina (Lepidocyclina) asterodisca*, Vaughan & Cole, 73, pl. 39:1–7.

In this species, characterized by the polygonal arrangement of the equatorial chambers, the diameter, the number of rays and the shape of the test (webbed or star-shaped) are variable. In horizontal section the form shows very regular hexagonal chambers which are not even elongated in the radii.
Occurrence: Mejias Quarry and two localities on the Penal-Rock Road; one small, badly preserved four-rayed specimen from Penal-Rock Road.

Genus *Eoconuloides* COLE & BERMUDEZ

Eoconuloides cf. *lopeztrigoi* (D. PALMER)
Pl. 27:1

1948   *Amphistegina* sp. (heavily pillared, belonging to the group of *Amphistegina lopeztrigoi*?), Caudri, 479.

The only Trinidad specimen which can tentatively be referred to this species is one obviously reworked glauconitic specimen in the Late Eocene of Point Bontour (St. 89).

It is the specimen mentioned by Brönnimann as *Tremastegina senni?* from the Mount Moriah boulder bed (1950). It has well developed counter-septal hooks.

Eoconuloides senni (CUSHMAN)
Pl. 8:18

1945   *Amphistegina senni*, Cushman (in Vaughan 1945, 49, pl. 19:1–4).

The Trinidad specimens of *Eoconuloides senni* are very small, much smaller than the types from Barbados. They are poorly preserved and do not lend themselves to photography either of the external appearance or of the thin sections.
In Charuma, the species occurs in great numbers to form a typical *Amphistegina* fauna comparable to that of the type locality in Barbados.

The age of the fauna is early Middle Eocene, as indicated by the presence of *Neodiscocyclina anconensis* in Calyx well 50A, Biche, at a depth of 232 to 233 feet. This assemblage can be directly compared with the fauna in Barbados. Both in Biche and in Charuma the assemblage contains reworked Paleocene foraminifera, the same as in Barbados.
Occurrence: Biche, Calyx well 50, at 44–54 feet, Charuma silt (early Middle Eocene); Calyx well 50A, at 101–102, 194–199, 232–233 feet; Charuma silt (early Middle Eocene); Charuma silt (A.E.G. 3635, 3635A, 3635B, early Middle Eocene); T.P.D. Esmeralda well 1, SE of Mayo, at 2630–2650 feet.

Eoconuloides senni var. *conicus* CAUDRI, n. var.
Pl. 2:11

Holotype: Pl. 2:11 (C 36032).
Type locality: Charuma, A.E.G. 3635B.
Type level: Early Middle Eocene.

A variety of *Eoconuloides senni* (Cushman) in which the dorsal side is high conical with a central pillar, while the ventral side is completely flat. Although it is linked with the normal form by a whole range of transitional specimens, it is set apart as a variety.

Eoconuloides wellsi COLE & BERMUDEZ

1944   *Eoconuloides wellsi*, Cole & Bermudez, 11, pl. 1:4–10.

This is an exceedingly high conical species with thick walls and a smooth surface, conspicuously different from *Eoconuloides senni*. Two or three specimens of this form were found at Biche, in Calyx well 50A at 232–233 feet, together with *E. senni*.

Genus *Helicolepidinoides* TAN

Helicolepidinoides intermedius CAUDRI, n. sp.
Pl. 2:3–8; Pl. 27:9, 13–15

1951   *Helicostegina soldadensis,* de Cizancourt, pl. 5:14–15.
1960   *Helicostegina polygyralis* pro parte, Cole 1960c, 59, pl. 11:12.

Exterior: Diameter 1.2–1.3 mm; test often more or less oval in shape, with a blunt edge;
    heavy pillars in center and radial rows of fine granulations on the flanks; near the
    periphery the septal lines are often visible, as is also the network of secondary
    chamberlets in transparent specimens.
Horizontal section: Megalospheric and microspheric forms; innermost chamberlets elon-
    gate, slanting and imbricated as in *Helicolepidina polygyralis*; megalospheric nu-
    cleoconch followed by 2 to 5 undivided chambers.
Vertical section: Thick solid roofs separated only by the undivided lumen of the alar pro-
    longations of the inner chamberlets; no lateral chambers developed.
Holotype: Pl. 2:7 (C 36038).
Type locality: Point Bontour, St. 68 (reworked material).
Type level: Late Middle Eocene (Farallon Rock).
Occurrence: Farallon Rock off Point Bontour (late Middle Eocene, S.L. 99, Stainforth,
    Renz & Rutsch coll. 1933; A-form abundant, B-form frequent); Top of Mount
    Moriah (calcareous sandstone member of the Late Eocene, A.G.H. 5550, 5584, M.
    12282, 12283a, scarce); Point Bontour (Late Eocene, St. 63, both A- and B-forms,
    scarce, rare at St. 49, 61a, 68, 68a, 71, 86, Cd. 211); Vistabella Quarry (Late Eo-
    cene, coll. Lehner 1933 cat. No. 20001, scarce, also B-forms, Cd. 215 rare, C.J. 28-
    12-29 very rare, unnumbered sample coll. H.G. Kugler); Charuma (lower part of
    Late Eocene, A.E.G. 1580A scarce, A.E.G. 2740 rare); Point Fortin West (well
    F.W. No. 181, 8687–8707 feet, Late Eocene).

The new species occurs in abundance in the hard limestone of Farallon Rock (Middle
Eocene). However, detached specimens from the Late Eocene of Point Bontour lend
themselves better for description and diagnosis and were chosen as the type material, in
spite of the fact that they are reworked. Morphologically, *Helicolepidinoides intermedius*
can be placed between the Helicosteginas of Barker & Grimsdale, 1936, and *Helicolepi-
dina polygyralis* Barker (1934).

At first sight, it resembles *Helicostegina dimorpha* Barker & Grimsdale, but it has only
very few undivided chambers in the center and the spiral continues right through the edge,
enclosing all the secondary chamberlets. There is no trace of an annular flange. On the
other hand, the species can hardly be distinguished from *Helicolepidina polygyralis* though
it is somewhat closer coiled, but lacks the lateral chambers which are typical of the latter
species. Therefore, this form has to be assigned to the genus *Helicolepidinoides*. For com-
parison are presented here illustrations of typical *Helicolepidina polygyralis* (Pl. 2:9–10).

Helicolepidinoides intermedius is abundant in the late Middle Eocene of the Farallon
Rock off Point Bontour and rare to sporadic in the Late Eocene of Trinidad, including
the Marabella marl. Because of this distribution, the horizon of the Farallon limestone
(not found in situ) is considered as the type level. The Farallon material seems to repre-
sent an entire population of specimens ranging from very small to the normal adult size.

It may even be that the species is restricted to the late Middle Eocene, though the basal beds of the Late Eocene should perhaps be included. The specimens in the Late Eocene and younger beds are probably all reworked; they are often more recrystallized than the rest of the fauna in which they are found.

The Farallon specimens are weathered, broken and covered with detritus. As in the case of *Operculina bontourensis*, which belongs to the same Farallon fauna, one has to turn to Point Bontour for type material, where it is reworked.

Helicolepidinoides intermedius is a conspicuous form, easily distinguished from the somewhat similar *Helicosteginopsis soldadensis* which abounds in the accompanying Late Eocene fauna. It is larger (1.2–1.3 mm), often more or less oval in shape with a blunt edge and with heavier pillars in the center. On the flanks there are radial rows of fine granulations and near the periphery the wavy septal filaments are often visible through the smooth wall. Exceptionally transparent specimens (Point Bontour) may even show the entire pattern of secondary chamberlets along the edge.

The damaged material from Farallon is very instructive as to the internal structure of the test. Often the septal filaments of the various coils are beautifully exposed. In the inner coils they are more or less regular with a strong backwards slant. Later, they assume a complicated pattern of meandric anastomosing walls, at first still with the tendency to curve backwards but finally developing into a network of irregular elongated chambers. These are not true lateral chambers, though, as they form only one layer between the consecutive roofs, it is easy to imagine how this pattern can be converted into that of *Helicolepidina polygyralis*.

Real pillars are developed in the center only. The granulations showing on the flanks are the heads of internal supports between the roofs of the alar prolongations. Pillars and granulations are always placed on the filaments, not between them.

In horizontal section the species shows the same elongated slanting and imbricated spiral chamberlets as *Helicolepidina polygyralis*, very different from those of *Helicosteginopsis soldadensis*, where they tend to be rounded like a string of pearls. The nepionic development is slightly more primitive than in *Helicolepidina polygyralis*, whereas in the latter, the formation of secondary chamberlets starts from the beginning, with the first spiral chamber after the auxiliar chamber. There are as a rule 2 to 5 undivided spiral chambers in *Helicolepidinoides intermedius*.

The foregoing description would suggest that *Helicolepidinoides intermedius* is the ancestral form of *Helicolepidina polygyralis*, but there is no stratigraphic support for such a theory. On the contrary, if one considers the type locality of *Helicolepidina polygyralis* (the Socorro Formation of Northwest Ecuador) and the Colombian locality, from where comes the material illustrated here, as Middle Eocene, the latter may even precede the more primitive *Helicolepidinoides*. But there is no doubt that they are very closely related, and in random sections in hard rock it is difficult to distinguish one from the other. *Helicolepidinoides intermedius* may occur in a *Helicolepidina* limestone from northern Colombia (collection J. Butterlin, Paris).

Also the *Helicostegina soldadensis* reported by de Cizancourt (1951, pl. 5:14–15) from the late Middle Eocene El Cumbe limestone of western Venezuela seems to belong to *Helicolepidinoides intermedius*. Apart from these somewhat doubtful occurrences, *H. intermedius* has so far not been recorded from outside Trinidad including Farallon Rock. It is however absent in the Late Eocene of Soldado Rock.

Genus *Helicolepidina* TOBLER

Helicolepidina spiralis TOBLER
Pl. 4:1–2; Pl. 6:13; Pl. 15:10–11; Pl. 30:6

1922   *Lepidocyclina (Helicolepidina) spiralis,* TOBLER 1922a, 343.
1928   *Helicolepidina spiralis,* Nuttall, 105.
1941   *Helicolepidina spiralis,* Vaughan & Cole, 76, pl. 45:1.
1975   *Helicolepidina spiralis,* Caudri, 572, pl. 25:2–6.

Helicolepidina spiralis was described by Tobler (1922a) from a limestone intercalation in the Upper Pauji shales, East of Lake Maracaibo, Venezuela, in combination with material from Point Bontour near San Fernando, Trinidad.

In Trinidad, the only Middle Eocene record of the typical form is from the type locality of the Dunmore Hill marl. The specimens from Farallon Rock belong to the form described below as *Helicolepidina* cf. *nortoni,* which is a nearly spiral-less variety. *Helicolepidina* cf. *spiralis* is generally present and often abundant in the Late Eocene (Vistabella marl). It also occurs at localities which are considered the base of the Late Eocene (top of Mount Moriah, calcareous sandstone member of the San Fernando Formation). In the uppermost part of the Late Eocene (Marabella marl, transitional beds to the Oligocene) its presence is somewhat erratic. It is conspicuously absent in Calyx well 57 at Vistabella, but occurs in considerable numbers in the equivalent bed at the San Fernando Railway Station (Cd. 208).

Occurrence: Dunmore Hill marl, type locality (late Middle Eocene); top of Mount Moriah (calcareous sandstone member of the San Fernando Formation, base Late Eocene); Morne Roche Quarry (base Late Eocene); Charuma (blocks, Late Eocene); Navette area (pit, R.M. 1337, Late Eocene); Hospital Hill marl, type locality (Late Eocene); Point Bontour (Late Eocene); Vistabella Quarry (Late Eocene); Vistabella Calyx well 59, bottom part (Vistabella marl, Late Eocene); Vistabella, Schlumberger office section, bottom part (Vistabella marl, Late Eocene); Tarouba Estate, test well A (Marabella marl, uppermost Late Eocene); San Fernando Railway Station (Marabella marl, uppermost Late Eocene); Soldado Rock, Bed 4 (A- and B-forms), Bed 7, Bed 9 (common to abundant, A- and B-forms), Bed 10 (common to abundant, A- and B-forms, also rare tricarinate forms in K. 1500), Bed 9a (both A- and B-forms common).

Helicolepidina cf. *nortoni* VAUGHAN
Pl. 14:1–2

1922   *Lepidocyclina (Helicolepidina) spiralis,* pars, Tobler 1922b.

In typical *Helicolepidina spiralis* the main spiral of the test begins soon after the nepionic spirals and surrounding chambers are formed, and continues right through to the edge. Specimens where this main spiral does not start right away and has an indefinitive beginning and no firm development were distinguished by Vaughan as *Helicolepidina nortoni.*

Some rather rare forms occur in Trinidad where the spiral is indefinite or not at all developed. Rather arbitrarily they were determined as *Helicolepidina* cf. *nortoni,* but they may just as well be considered as a variety of *Helicolepidina spiralis.*

Occurrence: All localities are Late Eocene except Farallon Rock. Point Bontour (St. 63);
    Vistabella, Schlumberger office section (St. 148); Vistabella Quarry (C.J. 28-12-29,
    Texaco cat. No. 863); Vistabella Calyx well 59, 500–510 feet (Vistabella marl), Top
    of Mount Moriah (A.G.H. 5550, M. 12924, calcareous sandstone); Charuma
    (A.E.G. 1580A, 1580B?, 1580C?); Farallon Rock (S.L. 99, Middle Eocene); Solda-
    do Rock, Bd 10, K. 10716.

Family Amphisteginidae

Genus *Amphistegina* d'ORBIGNY

In Trinidad, *Amphistegina* of the type of *A. lessonii* s. l. occur in great numbers in some
of the younger Tertiary beds, also flat forms covered with small pustules arranged in ra-
dial rows (*A.* cf. *radiata*) are frequent; none of these have been studied in detail.

    More attention was paid to the Eocene species and their relationship to *Helicostegi-
nopsis* and *Helicocyclina*.

Amphistegina undecima CAUDRI

1975   *Amphistegina undecima*, Caudri, 564, pl. 1:8–9; pl. 5:11–12; pl. 19:6; pl. 20:1–5, 7; pl. 23:6–16, 20–21.

In Trinidad, the species occurs in the Paleocene limestone of the Marac Quarry and re-
worked in the type sample of the Dunmore Hill member of the Navet Formation, Rz.
476.

Amphistegina grimsdalei CAUDRI
Pl. 8:15–16; Pl. 27:5–6

1941   *Amphistegina* sp. indet., Vaughan & Cole, 77, pl. 45:3.
1975   *Amphistegina grimsdalei*, Caudri, 566, pl. 5:8–9, 13–14; pl. 24:1–3 (fig. 2 = HT).

In Trinidad, *Amphistegina grimsdalei* ranges throughout the Late Eocene from the basal
beds of Mount Moriah through the Marabella marl.

Amphistegina pregrimsdalei CAUDRI
Pl. 8:14

1974   *Amphistegina pregrimsdalei*, Caudri, 303, pl. 1:6–7, 10–11; pl. 2:14–17; pl. 5:6, 8–9, 12; pl. 6:1–4.
1975   *Amphistegina* sp. cf. *pregrimsdalei*, Caudri, 566, pl. 24:4–7.

The common *Amphistegina* from Farallon Rock probably belong to this species.

Amphistegina farallonensis CAUDRI, n. sp.
Pl. 2:1–2

Exterior: Diameter up to 1.4 mm. Test flat-lenticular often with a concentration of numerous pillars in the central area, sometimes with a larger knob in the center. Septal filaments, and along the edge also the septa, clearly marked in well preserved specimens. No ramification of the filaments.

Horizontal section: Closely wound spiral; thick spiral wall. Chambers very long and curved from the beginning. No septal or counter-septal hooks developed.

Vertical section: Extremely thick-walled, with hardly any space left for the alar prolongations between the walls.

Holotype: Pl. 2:1 (C 35945).

Type locality: Farallon Rock, S.L. 99.

Type level: Late Middle Eocene.

Occurrence: Farallon Rock.

The species resembles *Amphistegina grimsdalei* in many respects, externally as well as in horizontal section, but is larger, the septal filaments are straighter and the septa are much more apparent on the outside. The curvature of the chambers is considerable, but never as exaggerated as in the outer coils of *A. grimsdalei*. In vertical section the two forms are entirely different.

Genus *Helicosteginopsis* CAUDRI

Helicosteginopsis soldadensis (GRIMSDALE)
Pl. 8:17; Pl. 27:2, 7, 11–12, 16; Pl. 28:3; Pl. 30:2

1941   *Helicostegina soldadensis*, Grimsdale, 86, pl. 46:1–7.
1975   *Helicosteginopsis soldadensis*, Caudri, 570, pl. 5:7, 10, 15–16; pl. 24:8–15, 19?, 20.

Helicosteginopsis soldadensis is one of the most characteristic forms in the Late Eocene Vistabella Quarry and Marabella marls of Trinidad and on Soldado Rock.

The megalospheric form of *H. soldadensis* is by far the most abundant; microspheric specimens are sporadic in comparison, and it is an exception when they occur in considerable quantity in any particular sample.

Occurrence: Point Bontour; Vistabella Quarry (Cd. 12 abundant, also B-form; Cd. 13–16, also wide-flanged variety; Cd. 17, 206, abundant, no B-forms; Cd. 218–220, abundant; Cd. 221, K. 2664b, K. coll. 25-2-31, cat. No. 48196, also B-form; C.J. coll. 28-12-29; Lehner coll. 31933, cat. No. 20001); Vistabella Estate (St. 45, also B-form; St. 145, 147, 148, 151 also B-form; St. 155; Calyx well 57, 900–1010 feet; Calyx well 59, 50–6780 feet, also wide-flanged variety); San Fernando Railway Station (also B-form); Hospital Hill marl type locality (Rz. 75); T.P.D. well Marabella 1; Boussignac (Rz. 383, also B-form); Brighton and Vessigny wells AB No. 1, AV No. 4 and 32 (also wide-flanged variety); Cush River W of Biche (Rz. 383, also B-form). Navette area (R.M. 1337, pit, lower and middle part, numerous B-forms); Lizard Springs area (Z. 456a, Z. 459a, also B-form); Charuma (Eocene, A.E.G. 1549A, 1580B, 1580C, 2740 also B-form).

Genus *Helicocyclina* TAN

Helicocyclina paucispira (BARKER & GRIMSDALE)
Pl. 8:19; Pl. 27:3–4, 8, 10

1936   *Helicolepidina paucispira*, Barker & Grimsdale, 243, pl. 31:11–12; pl. 33:4–6; pl. 36:1, 3; pl. 38:4.
1941   *Helicolepidina paucispira*, Vaughan & Cole, 76, pl. 45:2.
1975   *Helicocyclina paucispira*, Caudri, 571, pl. 24:18, 22–23; pl. 25:1

g*Helicocyclina paucispira* is a short ranged species and in general is considered as a marker for the uppermost Eocene, typical in association with *Lepidocyclina subgbbosa*, *yurnagunensis* and *sanfernandensis*. *Helicocyclina paucispira* has evolved from *Helicosteginopsis soldadensis* towards the close of the Eocene. In Trinidad, the geographical occurrence of the *Helicocyclina paucispira* Zone is restricted to the San Fernando area. The species is found in the Eocene of the San Fernando Railway Station and a certain Eocene level in the section of Point Bontour, but it is also typical of the Marabella marl in Vistabella.

Occurrence: Point Bontour (St. 79, Cd. 211; probably reworked in St. 80, 85, Basal Oligocene); Vistabella Estate (St. 155; E.L. 1435, common); Vistabella Reservoir (E.L. 1207); Vistabella Calyx well 57 (900–910 feet, 1000–1010 feet); Vistabella Calyx well 59 (40–50 feet, 260–290 feet, 300-310 feet, 340–350 feet); San Fernando Railway Station (also B-form, Cd. 208 and Cole's samples 1963, loc. 7a; 1969, loc 6).

Family Miogypsinidae

Genus *Miogypsina* SACCO

Miogypsina (Miogypsinoides) complanata SCHLUMBERGER
Pl. 24:1

1900   *Miogypsina complanata*, Schlumberger, Bull. Soc. géol. France, sér. 3, tome 28, 330, pl. 2:13-16; pl. 3:18–21.
1941   *Miogypsina (Miogypsinoides) complanata* Schlumberger, Vaughan & Cole, 79–79.

Occurrence: Boussillac well 1 at 3790 feet; Mejias Quarry (sample Terpstra 143); N of Brasso-Tamana Road, W of Tumpuna River (A.E.G. 6616 auger hole, 18–30 feet).

Miogypsina (Miogypsina) gunteri COLE
Pl. 8:1; Pl. 24:2–4

1938   *Miogypsina (Miogypsina) gunteri*, Cole, 13, 42, pl. 6:10–12, 14; pl. 8:1–9.
1941   *Miogypsina (Miogypsina) gunteri*, Vaughan & Cole, 79, pl. 45:8.

Occurrence: Mejias Quarry, Kapur Quarry, Penal-Rock Road at 14 miles (K. 409a), Penal-Rock Road at 14 1/2 miles (K. 432).

Miogypsina (Miogypsina) hawkinsi HODSON
Pl. 8:5; Pl. 24:6, 7?

1926   *Miogypsina hawkinsi*, Hodson, 28, pl. 7:9; pl. 8:1–2.
1941   *Miogypsina (Miogypsina) hawkinsi*, Vaughan & Cole, 79, pl. 45:9.

Occurrence: Oligocene: Penal-Rock Road, at 14$1/2$ and 15$1/4$ miles (K. 431, J.A.B.
    43), Marac River (K. 482 = K. 911), Erin (J.A.B. 22), Tapara Point, Cunapo River
    (J.A.B. 148, 150, 157). Miocene: Morne Diablo Quarry (J.A.B. 34, K.S. 21, 69, 70,
    77, M. 13600B), Calyx well 42, drilled in the quarry at 130–133 and 170–173 feet.

Miogypsina (Miogypsina) bramletti GRAVELL
Pl. 8:4; Pl. 24:5, 8–11

1933   *Miogypsina bramletti*, Gravell, 32, pl. 6:5–10.

Occurrence: Morne Diablo Quarry (Early Miocene, throughout section).

Miogypsina (Miolepidocyclina) staufferi KOCH
Pl. 8:2; Pl. 25:1–8

1926   *Miogypsina staufferi*, Koch, 751–753, pl. 28:1–3.

Occurrence: Morne Diablo Quarry (Early Miocene, throughout section).

Family Planorbulinidae

Genus *Planorbulinella* CUSHMAN

Planorbulinella trinitatensis (NUTTALL)
Pl. 8:8–10; Pl. 10:15–17

1928   *Planorbulina larvata* Parker & Jones var. *trinitatensis*, Nuttall, 65, 97, Table I (No. 27, pl. VII:1–2.
1941   *Planorbulinella trinitatensis*, Vaughan & Cole, 24, 29, 80.

Occurrence: Tarouba Estate; Ste. Croix Quarry (Early Miocene); Morne Diablo Quarry
    (Early Miocene); Miocene limestones in Central Range (Biche Quarry, along
    Guaico-Tamana Road, Tamana-Carmichael Road, Mayo Quarry, Guaracara
    limestone); Hibernia Estate (Late Miocene).

Family Soritidae

Genus *Sorites* EHRENBERG

Sorites sp.
Pl. 8:11–12; Pl. 29:5–6

1935   *Sorites* sp., Senn, 82–83.
1941   *Amphisorus* sp. cf. *A. duplex* (Carpenter, Vaughan & Cole, 29, 80, pl. 45:10–12.

This species, which sometimes occurs in rock-building quantities in the more silty hori-
zons of the Miocene reefs, is not an *Amphisorus*, but a *Sorites*. Although it shows a dou-
ble row of apertures on its edge, the layer of chambers is single throughout. In Trinidad it
does not appear until the last Miogypsinas are extinct.
Occurrence: Ste. Croix, Biche, Gasparillo quarries.

Annotations to Figure 7

The ranges of *Polylepidina nitida*, *Helicolepidinoides intermedius* and *Operculina bontou-rensis* are not yet completely known. All three are autochthonous in the uppermost Middle Eocene of Farallon Rock, but in the Late Eocene (and even the Oligocene) of Point Bontour, at Vistabella and especially in Charuma where the preservation of the specimens looks suspect, they are considered reworked. However, about their occurrence in the basal part of the Late Eocene, the Mount Moriah calcareous sandstone, one can not be so sure. Here, in contrast with the rich Farallon fauna where only megalospheric specimens were found, *Polylepidina nitida* is also represented by its microspheric form, which might suggest an independent development at this level. The Farallon fauna (*Polylepidina* and *Helicolepidinoides*) has, therefore, been marked on the charts with reservations as in situ on Mount Moriah.

What would weigh in favour of their being reworked in the entire Late Eocene is the observation that none of these forms occur on Soldado Rock, in particular not in Bed 10 which is the equivalent of the Mount Moriah sandstone.

Lepidocyclina vaughani is very closely related to *Lepidocyclina yurnagunensis* but has more elongated diamond-shaped median chambers and a nephrolepidine nucleoconch. It forms a transition between the latter species and *Lepidocyclina (Nephrolepidina) tempa-nii*, in which the median chambers are elongated hexagonal instead of diamond-shaped. Short-chambered *L. yurnagunensis*, after a hesitating start in the Marabella marl, is typical of the lower levels of the Oligocene (Cipero coast, Mejias Quarry, etc.); in the higher levels (Kapur Quarry) *Lepidocyclina vaughani* and *L. tampanii* make their appearance, at first still accompanied by typical *L. yurnagunensis*, but the exact top of the latter remains vague as we had only hard limestone to work with, which does not lend itself to such detailed studies.

The Paleocene-Eocene part of the distribution chart for Trinidad is in complete harmony with that given for Soldado Rock (Kugler & Caudri 1975). In general character the assemblages of Trinidad are far more similar to what, up to now, is known of the South American mainland and Barbados than to the faunas of Florida and the other Gulf States and of the Greater Antilles. There is a great difference between our two charts and that given by Beckmann (1958) for Cuba and by Robinson (1968) for Jamaica. Not only do the latter contain a number of genera which for environmental or geographical reasons are absent in Trinidad, but of several genera they do have in common, the stratigraphic range is different, e.g. *Asterocyclina* which over there has its roots as low as the Paleocene or Early Eocene, and *Pliolepidina* in the Middle to Late Eocene. The last mentioned subgenus has, however, to be taken in the sense of Cole; in other words, as *Lepidocyclina pustulosa* s. l. and *Lepidocyclina peruviana*, and is not necessarily the *Pliolepidina* s.s. *tobleri* which in Trinidad and Soldado Rock is indicative of the Jacksonian and post-Jacksonian Late Eocene.

Fig. 7. Distribution chart of Trinidad localities

Legend:
- ● autochthonous
- ○ reworked

Column headings (top of chart): AGE — FORMATION — STRATIGRAPHIC UNITS — LOCALITIES

Age divisions: Early Cretaceous (APTIAN); PALEOCENE; EOCENE (Middle, Late); OLIGOCENE (Early, Middle, Middle to Late, Late); MIOCENE (Early, Middle, Late)

Names of fossils in alphabetical order

No.	Name
17	Actinosiphon barbadensis
39	Amphistegina farallonensis
51	Amphistegina grimsdalei
99	Amphistegina lessonii s. l.
38	Amphistegina sp. (cf. pregrimsdalei)
16	Amphistegina sp. ind. div.
110	Archaias sp.
43	Asterocyclina asterisca, A-form
56	Asterocyclina asterisca, B-form
26	Asterocyclina cf. barbadensis
27	Asterocyclina soldadensis, A-form
62	Asterocyclina soldadensis, B-form
63	Asterocyclina vaughani
8	Athecocyclina soldadensis
100	Carpenteria (in rockbuilding quantities)
77	Cycloloculina jarvisi
91	Cycloloculina sp. ind.
65	Ecoonuloides cf. lopeztrigoi
19	Ecoonuloides senni & var. conica
23	Ecoonuloides wellsi
20	Eulinderina ?
64	Gypsina sp. div.
76	Halkyardia sp.
68	Helicocyclina paucispira
31	Helicolepidina cf. nortoni
21	Helicolepidina spiralis, A- and B-forms
32	Helicolepidinoides intermedius, A- and B-forms
52	Helicosteginopsis soldadensis, A-form
60	Helicosteginopsis soldadensis, B-Form
98	Heterostegina antillea
58	Heterostegina indicata
6	Hexagonocyclina inflata
5	Hexagonocyclina meandrica
95	Lepidocyclina asterodisca
89	Lepidocyclina asterocolumnata
85	Lepidocyclina canellei
86	Lepidocyclina aff. canellei (pillared form)
79	Lepidocyclina favosa
115	Lepidocyclina forresti
94	Lepidocyclina gigas (typical)
82	Lepidocyclina gigas duncanensis
104	Lepidocyclina giraudi (typical)
93	Lepidocyclina pancanalis
84	Lepidocyclina parvula, A- and B-forms
116	Lepidocyclina aff. parvula (subglobose, flanged)
28	Lepidocyclina peruviana
42	Lepidocyclina pustulosa s. s. and undiff.
48	Lepidocyclina pustulosa compacta
59	Lepidocyclina pustulosa tobleri
49	Lepidocyclina pustulosa trinitatis
50	Lepidocyclina pustulosa, B-forms
22	Lepidocyclina s. l. ind.
75	Lepidocyclina sp. ind. 3
73	Lepidocyclina sanfernandensis ("typical")
74	Lepidocyclina sanfernandensis depressata
61	Lepidocyclina spatiosa, A- and B-forms
69	Lepidocyclina subglobosa
80	Lepidocyclina supera
87	Lepidocyclina cf. supera (large form)
102	Lepidocyclina tempani
78	Lepidocyclina undosa
101	Lepidocyclina vaughani
88	Lepidocyclina waylandvaughani
70	Lepidocyclina yurnagunensis
83	Lepidocyclina yurnagunensis inflata
71	Lepidocyclina yurnagunensis marginopsis
72	Lepidocyclina yurnagunensis, B-form
113	Miogypsina bramletti
97	Miogypsina gunteri
103	Miogypsina hawkinsi
106	Miogypsina s. l. sp. ind. div. (triangular and lenticular)
114	Miogypsina & Miolepidocyclina, B-forms
96	Miogypsinoides complanata
107	Miolepidocyclina staufferi-mexicana
10	Neodiscocyclina aguerreverei
25	Neodiscocyclina anconensis
13	Neodiscocyclina barkeri
44	Neodiscocyclina bullbrooki, A-form
45	Neodiscocyclina sp. ind., B-form
12	Neodiscocyclina caudriae
11	Neodiscocyclina fonslacertensis
9	Neodiscocyclina grimsdalei
14	Neodiscocyclina mestieri
15	Neodiscocyclina sp. ind.
57	Nummulites striatoreticulatus
33	Operculina bontourensis
34	Operculinoides aff. Operculina bontourensis
111	Operculinoides bullbrooki, A-form
112	Operculinoides bullbrooki, B-form (juvenile)
47	Operculinoides kugleri
24	Operculinoides sp. ind. (aff. kugleri)
35	Operculinoides ocalanus
92	Operculinoides semmesi
81	Operculinoides semmesi ciperensis
55	Operculinoides spiralis
67	Operculinoides suteri
119	Operculinoides tamanensis
37	Operculinoides trinitatensis
120	Operculinoides tuxpamensis
1	Orbitolina cf. texana
118	Peneroplis sp.
117	Planorbulina sp. ind. div.
108	Planorbulinella trinitatensis
90	Planorbulinella sp. ind. div.
29	Polylepidina nitida
66	Polylepidina proteiformis
54	Polylepidina vichayalensis
30	Polylepidina sp. (with 2 auxiliar chambers)
46	Proporocyclina mirandana
18	Proporocyclina tobleri
53	Pseudophragmina bainbridgensis
2	Ranikothalia antillea
4	Ranikothalia soldadensis
3	Ranikothalia tobleri
109	Sorites sp.
40	Sphaerogypsina globulus s. l.
105	Spiroclypeus bullbrooki
7	Stenocyclina sp. (cf. advena)
41	Tubulostium leptosoma clymenioides (gastropod)

Names of fossils in stratigraphical order

No.	Name
1	Orbitolina cf. texana
2	Ranikothalia antillea
3	Ranikothalia tobleri
4	Ranikothalia soldadensis
5	Hexagonocyclina meandrica
6	Hexagonocyclina inflata
7	Stenocyclina sp. (cf. advena)
8	Athecocyclina soldadensis
9	Neodiscocyclina grimsdalei
10	Neodiscocyclina aguerreverei
11	Neodiscocyclina fonslacertensis
12	Neodiscocyclina caudriae
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14	Neodiscocyclina mestieri
15	Neodiscocyclina sp. ind.
16	Amphistegina sp. ind. div.
17	Actinosiphon barbadensis
18	Proporocyclina tobleri
19	Ecoonuloides senni & var. conica
20	Eulinderina ?
21	Helicolepidina spiralis, A- and B-forms
22	Lepidocyclina s. l. ind.
23	Ecoonuloides wellsi
24	Operculinoides sp. ind. (aff. kugleri)
25	Neodiscocyclina anconensis
26	Asterocyclina cf. barbadensis
27	Asterocyclina soldadensis, A-form
28	Lepidocyclina peruviana
29	Polylepidina nitida
30	Polylepidina sp. (with 2 auxiliar chambers)
31	Helicolepidina cf. nortoni
32	Helicolepidinoides intermedius, A- and B-forms
33	Operculina bontourensis
34	Operculinoides aff. Operculina bontourensis
35	Operculinoides ocalanus
36	Operculinoides soldadensis
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42	Lepidocyclina pustulosa s. s. and undiff.
43	Asterocyclina asterisca, A-form
44	Neodiscocyclina bullbrooki, A-form
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46	Proporocyclina mirandana
47	Operculinoides kugleri
48	Lepidocyclina pustulosa trinitatis
49	Lepidocyclina pustulosa compacta
50	Lepidocyclina pustulosa, B-forms
51	Amphistegina grimsdalei
52	Helicosteginopsis soldadensis, A-form
53	Pseudophragmina bainbridgensis
54	Polylepidina vichayalensis
55	Operculinoides spiralis
56	Asterocyclina asterisca, B-form
57	Nummulites striatoreticulatus
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59	Lepidocyclina pustulosa tobleri
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81	Operculinoides semmesi ciperensis
82	Lepidocyclina gigas duncanensis
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