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Artikel: The larger Foraminifera of Trinidad (West Indies)
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Lithology: Often a pure *Amphistegina limestone*.
Fauna: The reefs are built of *Amphistegina*, Corals and Algae with some *Planorbulinella*. *Sorites* is abundant in the Gasparillo Quarry.
Age: *Globorotalia mayeri* to *Globorotalia menardii* Zone, Middle Miocene.

Manzanilla Formation

Location: Hibernia Estate (Montserrat Hills) western Central Range. Road cut outcrop near estate house (Type locality of *Planorbulinella trinitatensis* Vaughan & Cole).
Lithology: Brown *Operculinella* bearing limestone, associated with Montserrat sands considered to be the middle member of the Manzanilla Formation.
Fauna: *Operculinoides*, *Planorbulinella*, both possibly reworked. In the lower member of the formation (San José calcareous silt Member) they are, however, considered to be in situ. Present in the formation are also *Amphistegina* banks.
Age: *Globigerina acostaensis* to *Neogloboquadrina dutertrei* Zone, Late Miocene.

4. Conclusions on the Trinidad larger foraminifera localities

The oldest species of larger foraminifera known in Trinidad is *Orbitolina* cf. *texana*, found in rock-building quantities in two erratic blocks of Early Cretaceous (Albian?) age, in Quinam and at Pointe-a-Pierre. Larger foraminifera of Late Cretaceous age are missing. They apparently never developed here.

The Paleocene can be directly correlated with that of Soldado Rock (Caudri 1975). It is represented by many blocks and detached foraminifera of the *Ranikothalia* limestone, by a semi-autochthonous lens or small slump mass full of the same species of larger foraminifera in the Paleocene Lizard Springs marl at its type locality, and by the rootless mass of Mollusk limestone of the Marac Quarry, which carries the same fauna as Bed No. 2 of the Soldado Formation.

The larger foraminifera of the Paleocene belong to the *Ranikothalia* Zone (= Cole's *Operculina catenula* fauna; = de Cizancourt's zone des Nummulites cordelées). In Trinidad this fauna consists of the following species: *Ranikothalia catenula*, formae *antillea*, *tobleri* and *soldadensis*, *Athecocyclina soldadensis*, *Hexagonocyclina inflata* and *meandrica*, *Neodiscocyclina barkeri*, *caudriae*, *grimsdalei*, *mestieri*, *aguerreverei* and *fonslacertensis*, *Actinosiphon barbadensis*.

The Early Eocene could not be distinguished by means of larger foraminfera the way de Cizancourt was able to do for western Venezuela. In this connection it should be noted that no trace of *Alveolina* has been found in Trinidad. De Cizancourt (1951) mentions its presence in the Early Eocene of the Rio Tocuyo and in the beds of San Francisco de Cara, to our knowledge the only record of *Alveolina* on the South American mainland.

In Trinidad, the problematic *Proporocyclina tobleri* limestone (the Boca de Serpiente Formation of Soldado Rock) is represented by one erratic boulder at Lizard Springs and two in Erin. According to its fauna it should be placed at the turn of the Early to the Middle Eocene, preferably in the Middle Eocene (Caudri 1975). If that is correct, then the entire Early Eocene is devoid of larger foraminifera.

The actual Middle Eocene section begins in eastern Trinidad with the Charuma silt, which lithologically forms the transition between the Early Eocene Pointe-a-Pierre grit and the marly Navet Formation. This horizon, which apart from the surface samples in the type area, was also recognized in the nearby Calyx wells 50 and 50A at Biche, carries

a very poor but significant fauna containing *Eoconuloides* and in well 50A *Neodiscocyclina anconensis*, an assemblage that can be traced over great distances. It can be directly correlated with the Upper Scotland Formation (Murphys beds) of Barbados and with the San Eduardo limestone of southwestern Ecuador and its equivalent in northwestern Peru; further with the early Middle Eocene part of the Corinto well 1 in Campeche (Yucatan), the Peñon Seep of Cuba and the base (zone 1) of the Lake City Formation of Florida.

The Navet Formation, which follows after this silt, is developed in a marly facies without neritic phases or reefs. There are no limestones comparable to the Cuicas and El Cumbe limestones in western Venezuela, and also the *Polylepidina antillea* Zone of the Late Middle Eocene in other places did not develop in this environment. The only horizon which contains larger foraminifera, in part obviously reworked, is the controversial Dunmore Hill marl, which shows already some affinity to the Late Eocene. At the end of the Middle Eocene the sea became shallower which resulted in the development, somewhere near Trinidad, of an *Operculina-Polylepidina* reef, of which nowadays only the isolated Farallon rock off the San Fernando coast is left as an olistostrom remnant, and one boulder on Coora beach.

In most places, however, the Late Eocene sets in with a general change from the open marine marls of the Navet to the neritic sediments of the San Fernando Formation which transgresses over the Navet and older marls with a marked unconformity. This transgression, which is shown very clearly in the San Fernando area, took place in more than one phase, the glauconitic calcareous sandstone of the top of Mount Moriah being the first sediment to be deposited, followed (again with an unconformity) by the Mount Moriah conglomerate and the Vistabella marl which are Late Eocene in age. In this area, the transition from the Vistbella marl to the Oligocene Cipero marls is clearly indicated by a special zone of the Eocene, the Marabella marl or *Helicocyclina paucispira* Zone, which is not clearly defined by means of its planktic fauna but is recognized by its larger foraminifera and can be traced to other places in the Caribbean Region, northern South America, Mexico and the Gulf States.

The Cipero marl facies persisted in the southern part of Trinidad throughout the Oligocene and into the Miocene. Larger foraminifera are, however, only found in a very restricted horizon in the Early Oligocene of the type section on the Cipero coast, the so-called Flat Rock tongue (*Globigerina ampliapertura* Zone), and also in such slumped bioherms as the limestones in the Mejias and Kapur quarries (early Middle Oligocene and late Middle Oligocene, respectively) and numerous erratic blocks. To the Miocene belongs the rootless mass of limestone and marl of the Morne Diablo Quarry, which contains the last Lepidocyclinas and Miogypsinas and the first Planorbulinellas. In the nearly contemporaneous Ste. Croix Quarry the Orbitoids are already absent.

In the central part of the island the marls of the Cipero Formation are towards the end of the Oligocene replaced by the neritic Brasso Formation, which continues till the middle of the Middle Miocene and contains many bioherms. The stratigraphic sequence of these limestones ties in with Bolli's planktic zonation. At first, the reefs carry a rather complete fauna with *Lepidocyclina* and *Miogypsina*. Higher up in the section, in the *Globigerinatella insueta* Zone, after first *Lepidocyclina* and then also *Miogypsina* had died out, the open marine environment changes to a very shallow lagoonal one, characterized by a rich but monotonous fauna of *Amphistegina,* large *Operculinoides (tamanensis, tux-*

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).