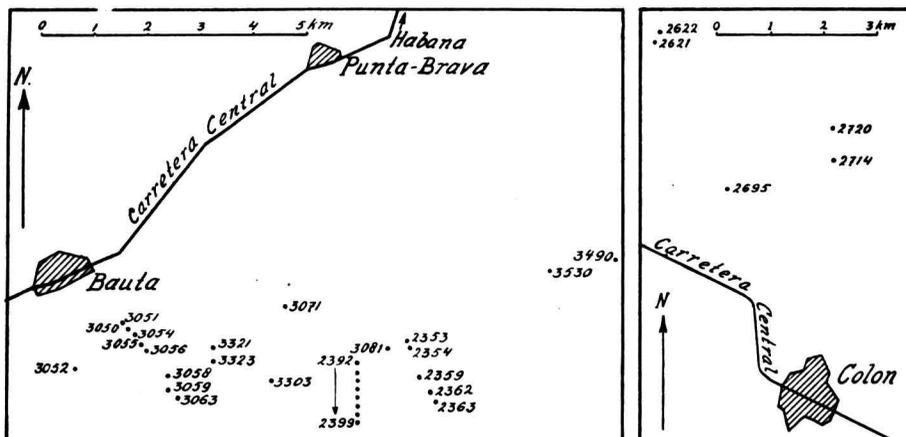


**Palaeontology.** — *Smaller Foraminifera from the Lower Oligocene of Cuba.* By R. C. VAN BELLEN, J. F. C. DE WITT PUYT, A. C. RUTGERS and J. VAN SOEST. (Communicated by Prof. L. RUTTEN.)

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Some years ago the geological institute of the university of Utrecht received from the Bataafsche Petroleum Maatschappij at The Hague a collection of washing-residues of marly clays from Cuba. The localities have been indicated on the map; they are situated to the WSW of Habana and in the neighbourhood of the town of Colon. The geologists of the B. P. M. regarded these claymarls as oligocene. The results of the study of this collection are to be found in this communication. In the tabular enumeration at the end of this communication have been indicated: 1. the different species and varieties which compose the fauna, 2. the localities, where each faunal element has been found, 3. the literature for each species, 4. data on the occurrence of each species in the Upper Cretaceous and in the great subdivisions of the Tertiary of Tropical America and in the recent fauna.



There have been found 140 species and varieties, 12 of which are new. The following may be said with regard to the age of the fauna.

8 species have been found in the Upper Cretaceous of Tropical America. Of these, 7 do not have any stratigraphical value, as they have lived as long as the Miocene, or partly do occur still in the recent fauna. *Spiroplectoides clotho* is the only species which has been found until now exclusively in upper cretaceous deposits; its determination, however, is uncertain. Our fauna, therefore, shows no relation at all with upper cretaceous faunas.

Not less than 61 species and varieties have been found in the Eocene of Tropical America. More than the half — 38 — are known also from the Oligocene of Tropical America, and 7, although not known from the Oligocene, have been found in younger tertiary deposits of Tropical America or occur in the recent fauna. A large percentage of the fauna, 16 species, viz. *Gaudryina cubana*, *Clavulinoides cubensis*, *Cl. havanensis*, *Cl. marielinus*, *Karrerriella chapapotensis*, *Listerella venezuelana*, *Planularia westermanni*, *Nonion mexicanum*, *Bolivina malkinae*, *Uvigerina havanensis*, *Siphogenerina transversa*

var. *cubensis*, *Valvulineria jacksonensis*, *Globigerina eocaena*, *Ruttenia coronaeformis*; *Planulina cocoaensis* and *Planulina cocoaensis* var. *coöperensis* has been found until now in Tropical America exclusively in the Eocene; 6 of these are restricted to Cuba. It is clear that the fauna has strong eocene affinities. On the other hand, the absence of the genus *Hantkenina*, so common in eocene deposits with this facies suggests a posteocene age.

Still more species and varieties — 75 — are known from the Oligocene of Tropical America. Of these, 38 occur also in the Eocene, and 13, whilst not being known from the Eocene have been found in miocene deposits or occur in the recent fauna. Not less than 24 species seem to be confined in Tropical America to the Oligocene, viz.: *Textularia mississippiensis* var. *alazanensis*, *Dorothia cylindrica*, *Cristellaria kemperi*, *Cr. peregrina* var. *matanzana*, *Cr. subpapillosa*, *Planularia thiadensi*, *Marginulina sublitua*, *Nodosaria* aff. *carinata*, *N. matanzana*, *N. obliquata*, *Saracenaria schencki*, *S. senni*, *Vaginulna elegans* var. *mexicana*, *Lagena sulcata* var. *strumosa*, *Gümbelina cubensis*, *Bolivina matanzana*, *Uvigerina canariensis* var., *U. cubana*, *Eponides byramensis* var. *cubensis*, *Siphonina advena*, *Anomalina alazanensis*, *Planulina alazanensis* and *Cibicides mexicanus*; of these, 10 have been found exclusively in Cuba. The affinities with oligocene faunae are apparently very great.

Only 40 species and varieties are known from the Miocene of Tropical America, and 29 of these have been found also in the Oligocene or Eocene of the region. Affinities with the Miocene, therefore, certainly exist, but they are much smaller than the affinities with the Eocene and Oligocene.

If all the washing-residues are from one and the same formation, there is no doubt that the faunula is of oligocene age, and, given the strong relations with the Eocene, may be regarded as Lower Oligocene. It is, however, very well possible that not all the samples are of the same age. The samples 2353—2363 f.i. which are located along a line about vertical to the general strike of the island may very well belong to lower and upper parts of one formation or even to two formations. Generally, the faunula of each sample is, however, too poor to discuss its age separately. Our conclusion is, therefore, that the general aspect of the whole of the samples is so that it suggests a lower oligocene age, that, therefore, certainly a part, probably even the greatest part of the samples must belong to the lower oligocene, but that it is possible that some of the samples belong to an older or younger stratigraphical unit.

A description of the new species and varieties and some remarks on other species are following here.

*Gaudryina jacksonensis* CUSHMAN (lit. 18, 32).

Our specimens differ from CUSHMAN's description by: 1. too large dimensions (average length 2.5 mm; maximum length 3.6 mm; breadth 1.1—1.75 mm), 2. having hardly visible sutures on triserial part. Moreover, there are in our material transitional forms between *G. jacksonensis* and *G. trinitatensis*. *G. trinitatensis* is triangular in cross section in the triserial part of the test, subcircular in the biserial part, where ribs are lacking. *G. jacksonensis* is triangular throughout, while ribs are lacking only on the last two chambers. The ribs on the transitional forms occur on some of the older biserial chambers, but are lacking on the last 3—5 chambers, which are more inflated than the preceding ones.

*Planularia brandsi* n. sp. DE WITT PUYT. (Fig. 37).

Test much flattened, spirally coiled, with a broad and thin keel. Chambers very distinct, strongly inflated, regularly increasing in size. Sutures limbate, depressed, straight, somewhat broadening towards periphery. Length 2 mm; breadth 1.3 mm; thickness 0.44 mm; thickness of strongly inflated proloculum 0.68 mm.

*Planularia westermanni* PIJERS. (Fig. 34).

For a full discussion of this species see lit. 79. In this publication *Pl. venezuelana* has been placed in the synonymy of *Pl. westermanni*. By a study of Cuban oligocene material,

recently received in Utrecht it turned out that *Pl. venezuelana* must be regarded as a distinct species.

*Planularia thiadensi* n. sp. DE WITT PUYT. (Fig. 38).

Synon. *Planularia* sp. in lit. 77, p. 94, pl. 16, fig. 2, 3.

Two specimens of our material agree very well with the form which THIADENS described from the oligocene of Santa Clara, Cuba. It differs from *Pl. cubensis* BERM. by its dimensions, by the curved "dorsal" and the straight "ventral" outline, by the broader sutures, the large number and the shape of chambers. It is very near to *Pl. dentata* (KARRER) as described and figured by LIEBUS from the dalmatian Eocene which is probably not the same as *Pl. dentata* (KARRER) described by KARRER from Moravia and Austria. Dimensions:  $3.2 \times 1.6 \times 0.2$  mm.

*Saracenaria schencki* CUSHM. a. HOBSON var. DE WITT PUYT. (Fig. 35, 36).

The specimens differ from *S. schencki* in lacking the distinct spinose processes and the keel. They might as well be regarded as a variety of *S. italica* DEFRANCE. Length 1.4 mm.

*Spiroplectoides clotho* (GRZYBOWSKI).

It is not sure, whether our specimens are arenaceous or non-arenaceous; in the first case they would belong to *Textularia*, in the second to *Spiroplectoides*. Test flattened with nearly parallel sides. Chambers numerous and of equal size in adult. Initial chambers hardly visible, arranged in a flat spiral. Aperture transverse and elliptic. Length 1.3 mm; breadth 0.37 mm.

*Bulimina inflata* SEGUENZA.

The Cuban specimens have an initial spine.

*Uvigerina auberiana* D'ORBIGNY. (Fig. 31, 32).

The Cuban specimens lack the initial spine, mentioned in lit. 42, p. 363. They are finely hispid; the short spines being locally arranged in rows.

*Uvigerina canariensis* D'ORBIGNY, var. NUTTALL. (Fig. 27, 28, 29, 30).

Some specimens agree very well with NUTTALL's variety; other ones differ by the presence of very faint striae covering the whole fossil or by complete smoothness of the test.

*Uvigerina havanensis* CUSHMAN and BERMUDEZ, var.

At the side of specimens, well agreeing with *U. havanensis* there are much smaller forms with an average length of 0.55 and a breadth of 0.37 mm with many basal spines and built up by fewer chambers, arranged in an elongate spiral, and with sutures not passing from one chamber to the next one. They are nearly related to *U. yazoensis* CUSHMAN.

*Pullenia sphaeroides* D'ORB., var. *cubensis* n. var. DE WITT PUYT. (Fig. 33).

The only difference with *P. sphaeroides* is the presence of 5 or, rarely, 6 chambers in the last coil.

*Eponides byramensis* CUSHM., var. *cubensis* PALMER a. BERM. (lit. 68).

According to the authors this variety is almost equally biconvex. In the typefigure, however, the ventral side is much more convex than the dorsal side. Our specimens agree with the typefigure. The limbation is very strong. Ventral umbo usually not filled. Diameter  $\leq 1.3$  mm, height  $\leq 0.8$  mm.

*Eponides haidingeri* (D'ORBIGNY).

According to different authors the number of chambers in the last formed whorl varies

strongly: 6 (lit. 66), 9 (litt. 5), 9 (lit. 59), 9 (lit. 10), 7 (lit. 28) and 5 (lit. 42). Probably this is caused by the indistinctness of the sutures. Our specimens have 9 chambers in the last formed whorl. The dorsal sutures are somewhat raised and limbate. The whole surface is finely perforated. On the ventral side the sutures are invisible. Diameter  $\leq$  0.9 mm.

*Eponides tschoppi* n. s. VAN BELLEN (Fig. 10, 11, 12).

Test biconvex. Ventral side somewhat more convex than dorsal side. Periphery rounded, not lobate, not keeled. Dorsal side showing 3 coils. Dorsal sutures limbate, flush with surface, somewhat oblique. Spiral suture limbate, flush with surface. About 8 chambers in last whorl. Ventral sutures indistinct, limbate, flush with surface, last one slightly depressed. Ventral umbo sometimes with area of clear shell material, produced by the meeting of the limbate sutures. Surface perforated. Aperture a slit at ventral side, from periphery to about  $\frac{1}{3}$  of distance to umbilicus. Diameter 1.10 mm; height 0.44 mm. Differs from *E. praecinctus* in missing the strongly limbate and raised ventral sutures, in having an umbonal mass of clear shell material, in having only 8 chambers in last whorl. Differs from *E. coccaensis* (lit. 23) in being ventrally more convex than dorsally and in having only 8 chambers in last whorl. It may be observed that in lit. 31 the description of *E. coccaensis* does not agree with the figures: see number of chambers in last whorl, dimension of last chamber, planoconvexity of test.

*Rotalia cubensis* n. s. VAN BELLEN. (Fig. 13, 14, 15).

Test almost equally biconvex. Dorsal side showing  $3\frac{1}{2}$  whorls, last one with about 10 chambers. Spiral suture limbate, somewhat raised. Dorsal sutures limbate, flush with surface. Ventral sutures emerging obliquely from the umbo, with a slight curvature backward near the periphery, last two depressed, rest flush with surface. Umbo filled with a knob of clear shell material. Periphery acute with a slight keel, well developed at the beginning of the last whorl and gradually disappearing to the end. Surface coarsely perforated. Aperture between umbo and periphery at ventral side, near to the periphery, but only visible in 2 of the 10 specimens. Diameter  $\leq$  0.5 mm; height  $\leq$  0.2 mm. Differs from *R. cf. partschiana* WHITE in being equally biconvex and in having more chambers in last whorl. Differs from *Cibicides ungerianus* by its aperture, in missing the typical hispid, dorsal umbo and in being equally biconvex.

*Siphonina advena* CUSHMAN.

Our specimens agree well with the description and figures in lit. 21. The description in lit. 47 does, however, not at all agree with the figure: see number of chambers in last whorl and diameter. Nor does the general aspect of the figure in lit. 21 agree with that in lit. 47. We have presumed that the descriptions in lit. 21 and lit. 47 and the figures in lit. 21 may be regarded as characteristic for the species. It differs from *S. bradyana* in missing the broad carina and the broad flaring lip, in having a longer neck and depressed sutures on the ventral side. Moreover the keel is not tubulated. It differs from *S. tenuicarinata* by the not-tubulated keel and the shape of the aperture.

*Siphonina tenuicarinata* CUSHMAN.

There is some variation in diameter of test, in form of aperture, in length of neck and development of keel.

*Siphonina reticulata* (CZJZEK).

There are two differences with the description: our form has 5 chambers in the last whorl and a not-wholly tubulated keel.

*Siphonina tubulosa* CUSHMAN.

There is some variation in diameter of test (0.25–0.37 mm) and in number of chambers in the last whorl (4–5). It differs from the foregoing species in having a wholly tubulated keel.

*Siphonia cubensis* n. sp. VAN BELLEN. (Fig. 1, 2, 3).

Test equally biconvex; periphery subacute; not keeled. Dorsal sutures very indistinct, curved, somewhat limbate, strongly oblique, flush with surface. Ventral sutures somewhat limbate, curved, flush with surface. Last chamber inflated. Aperture a broadly elliptical opening with a well developed neck and phialine lip, on the ventral side, close to the periphery; the axis of the ellipse making an angle with the plane of the periphery. Whole surface finely porous. Diameter  $\leq 0.62$  mm; height  $\leq 0.35$  mm. Differs from *S. pulchra* by situation of aperture, by absence of larger pores in central part of ventral face, by more distinct sutures, by smaller dimensions.

*Pulvinulinella cubensis* n. sp. VAN BELLEN. (Fig. 24, 25, 26).

Test biconvex, ventrally somewhat more than dorsally. Periphery acute, with a broad, thin carina. On dorsal side  $2\frac{1}{2}$  whorls visible, last one with about 10 chambers. Dorsal sutures strongly oblique, limbate, very slightly raised or flush with surface. Spiral suture limbate and raised. Ventral sutures oblique, limbate, flush with surface, near periphery slightly depressed. No ventral umbo. Aperture only visible in one of the six specimens. Differs from *P. velascoensis* in missing the strongly elevated sutures between the excavated areas over the dorsal side of chambers, in having limbate, ventral sutures, in missing the ventral umbo.

*Anomalina cubensis* n. sp. VAN BELLEN. (Fig. 4, 5, 6).

Dorsal side convex, ventral flat. Periphery subacute. Sutures strongly limbate and raised. About 15—16 chambers in last whorl. Dorsal side showing  $1\frac{1}{2}$ —2 whorls, the first small and covered by secondary shells substance, the last lying on a somewhat higher level. Ventral side with depressed umbilicus, in which sometimes small boss of clear shells substance. Aperture over the periphery, somewhat extending on dorsal side. Length 0.64 mm; breadth 0.54 mm; height 0.22 mm. Differs from *A. alazanensis* in having a dorsal convex side and a flattened ventral side and in having more limbate sutures. Differs from *A. mecatepecensis* in having not so strongly limbate sutures and in missing the coarsely perforated boss at the dorsal side. Differs from *A. bilateralis* in being planoconvex, in having more limbate sutures, in missing the dorsal umbonal boss.

*Planulina cocoaensis* CUSHMAN.

Our specimens differ from type specimens in having a mass of clear shells substance at dorsal side in stead of small protuberances.

*Planulina palmerae* n. sp. VAN BELLEN. (Fig. 7, 8, 9).

Our forms agree closely with the description of *P. marielana* by PALMER a. BERMUDEZ (lit. 68), which, however, does not agree with the original description by HADLEY (lit. 51). The differences are:

HADLEY:	PALMER-BERMUDEZ:
9 chambers in last whorl.	12—14 chambers in last whorl.
Ventral umbo a small, slightly depressed area.	Ventral umbo a slightly elevated knob of clear shells substance.
Diameter 0.5 mm.	Diameter 1.6 mm.
Dorsal side showing only last whorl, rest hidden by secondary shells substance.	Dorsal side showing $2\frac{1}{2}$ —3 whorls.
Sutures slightly limbate and elevated.	Sutures heavily limbate and elevated.

The specimen of PALMER and BERMUDEZ has therefore to be renamed; the new name has been given in honour of Mrs. PALMER. In our forms the sense of involution is sometimes clockwise, sometimes anticlockwise.

*Planulina mexicana* CUSHMAN.

Has more chambers (11) in last whorl than *P. cocoaensis* var. *cooperensis*.

*Planulina wuellerstorfi* (SCHWAGER).

Is very near to *Cibicides americanus*, the only difference being the raised ventral sutures of *P. wuellerstorfi*; the ventral sutures are depressed in *Cibicides americanus*. Diameter  $\leq 1$  mm.

*Cibicides americanus* (CUSHMAN).

Our specimens differ from original description (lit. 11) in having a small ventral umbonal knob. This is also visible in the figure of lit. 26.

*Cibicides floridanus* (CUSHMAN).

Ventral sutures of our specimens are slightly depressed. There is always a flat border; at about  $\frac{1}{6}$  of radius begins the convexity of the ventral side. Diameter 0.33—0.84 mm.

*Cibicides lobatulus* (D'ORBIGNY).

Concave-convex as well as biconvex forms have been brought to this species. Our form agrees closely with the original figure of D'ORBIGNY (lit. 66). It is ventrally convex, dorsally concave. Periphery strongly limbate and irregular. Ventral side showing only last whorl, dorsal side obscured by bad conservation. In last whorl 7 chambers. Ventral sutures depressed and curved; they meet each other in depressed umbilicus. Dorsal sutures depressed. Diameter 0.7 mm.

*Cibicides subtenuissimus* (NUTTALL).

The bosses not so pronounced as in NUTTALL's typefigures (lit. 59).

*Cibicides cubensis* n. sp. VAN BELLEN. (Fig. 21, 22, 23).

Test biconvex, dorsal side very slightly, ventral side more strongly so. Subacute keel. Dorsally  $1\frac{1}{2}$ —2 whorls visible. Dorsal sutures limbate, raised, oblique. Spiral sutures strongly limbate. Surface coarsely perforated. About 9 chambers in last whorl. Ventrally large, central boss of clear shellmaterial. Sutures strongly limbate, flush with surface. Aperture invisible in consequence of small diameter (0.3 mm). Height 0.18 mm. Diameter of ventral boss 0.11 mm. Agrees with *Cibicides spec. A* CUSHMAN in lit. 44.

*Cibicides tshoppi* n. sp. VAN BELLEN. (Fig. 16, 17, 18, 19, 20).

Dorsal side flattened, ventral side convex. Periphery subacute with thickened keel, which is well developed on early chambers, but gradually disappears on final whorl. Dorsal side only showing last whorl, rest hidden by irregular mass of clear shellmaterial. Dorsal sutures curved; strongly limbate and raised in early part of last whorl, slightly limbate and depressed in last part. Spiral suture strongly limbate. Last whorl with 10—13 chambers. Ventral side somewhat evolute, showing slightly more than 1 whorl. Umbo with boss of clear shellmaterial. Sutures curved, slightly depressed. Surface coarsely perforated. Aperture an arched slit over the periphery. Diameter  $\leq 1.05$  mm; height  $\leq 0.4$  mm. Differs from *C. sassei* in having larger size and more chambers in last whorl, from *Eponides cocoaensis* in being planoconvex, in having a dorsal mass of clear shellmaterial, in having limbate dorsal sutures, and in its larger size, from *Planulina wuellerstorfi* in having a dorsal umbonal knob of clear shellmaterial and in its larger size, from *C. pseudoungerianus* in being planoconvex, in having a coarsely perforated ventral side, in having a keel and a not-lobulated periphery.

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