PSEUDORBITOIDS FROM THE PARGUERA LIMESTONE, PUERTO RICO, AND FROM THE BACK RIO GRANDE LIMESTONE, JAMAICA, WITH REMARKS ON THE PSEUDORBITOIDAL EVOLUTIONARY PATTERN

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ABSTRACT

Krijnen, J. P. (1978). Pseudorbitoids from the Parguera Limestone, Puerto Rico, and from the Back Rio Grande Limestone, Jamaica, with remarks on the pseudorbitoidal evolutionary pattern. *In:* H. J. Mac Gillavry & D. J. Beets (eds.): The 8th Caribbean Geological Conference (Willemstad, 1977). Geol. Mijnbouw, 57, p. 233-242.

Pseudorbitoides curacaoensis and *P. israelskyi* are described from two localities near Parguera, SW Puerto Rico, and *P. trechmanni trechmanni* and *P. ?rutteni rutteni* from respectively the Back Rio Grande and Rio Grande (Blue Mountain inlier, Jamaica).

The evolutionary pattern of the pseudorbitoids is discussed on the basis of the present material and of samples described previously from Curaçao and from western Jamaica.

INTRODUCTION

From earlier studies of pseudorbitoids (MAC GILLAVRY, 1963; KRIJNEN, 1967, 1971, 1972) it is apparent that successive populations of the subfamily Pseudorbitoidinae RUTTEN 1935 were subjected to an evolutionary development which started with the introduction of a so-called retrovert aperture in a late ontogenetic stage of a *Sulcoperculina* ancestor. Subsequently a progressively earlier ontogenetic appearance of the retrovert aperture caused a gradual reduction of the number of primary chambers and a change in the arrangement of juvenile chambers from uniserial to quadriserial. In addition, there has been a gradual increase in size of the proto- and deuteroconch and of a number of primary chambers; this trend may be connected with the increase in cyclicity of the 'adult' equatorial layer.

The gradual change of the average number of primary chambers (Y) and of the average diameter of the protoconch (P) suggests that the various samples belong to a single phylogenetic lineage from *Pseudorbitoides curacaoensis* through *P. chubbi, P. israelskyi, P. trechmanni* to *P. rutteni*. Of course, such an evolutionary model assumes that there are populations with values intermediate between those of the known populations.

Another uncertain factor is the difficulty in evaluating the importance of certain 'diagnostic' features by which some forms have been considered to be separate taxa. Examples are *Sulcorbitoides* (characterized by a pseudorbitoid layer composed of a relatively simple system of radial rods), *Historbitoides* (with a stellate equatorial layer and a pseudorbitoid layer composed of divergent and convergent radial plates), and *Rhabdorbitoides* (with a pseudōrbitoid layer composed of a complex system of radial rods). The Y- and P-values of these forms do not justify their separation as separate genera or lineages. These morphologic differences, moreover, are not sufficiently constant and may occur within the range of variation of some populations. Their diagnostic value is accordingly considered to have been overrated. The Y- and P-values are considered to be the best means of fitting the various populations into a taxonomic classification and into a reliable evolutionary model. For the time being the assumption of a single *Pseudorbitoides*-lineage, as already proposed earlier (KRIJNEN, 1972), will be retained. The following species are recognized:
Juvenarium uniserial:

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Pseudorbitoides curacaoensis KRIJNEN, 1967 (= *?Pseudorbitoides pardoi* (BRÖNNIMANN, 1954)).
Pseudorbitoides chubbi BRÖNNIMANN, 1958 (= *Pseudorbitoides* (?) *chubbi* BRÖNNIMANN, 1958).
Juvenarium uniserial-biserial:
Pseudorbitoides israelskyi VAUGHAN & COLE, 1932.
Juvenarium uniserial-biserial-triserial-quadriserial:
Pseudorbitoides trechmanni trechmanni DOUVILLE, 1922.
Pseudorbitoides trechmanni pectinata KRIJNEN, 1972.
Juvenarium quadriserial:
Pseudorbitoides rutteni rutteni BRÖNNIMANN, 1955.
Pseudorbitoides rutteni kozaryi (BRÖNNIMANN, 1956) (= *Historbitoides kozaryi* BRÖNNIMANN, 1956).
Pseudorbitoides rutteni hedbergi (BRÖNNIMANN, 1955) (= *Rhabdorbitoides hedbergi* BRÖNNIMANN, 1955).

Additional data obtained from new samples from the Parguera Limestone, Puerto Rico (collected by H. J. Mac Gillavry and D. J. Beets on the occasion of the Virgin Islands Conference, 1968), and from the Blue Mountain inlier, eastern Jamaica (collected by the author in 1975), have been plotted in the Y-P-diagram which shows the assumed evolutionary trend of *Pseudorbitoides* as expressed by a decrease of the Y-values and an increase of the P-values.

LOCALITIES OF NEW SAMPLES

P 335, Puerto Rico

Locality: N. Sohl 2006 and Pessagno 2590-2593, Isla Magueyes (P.R. grid 87318 × 15149). The sample is about 3.30 m from the base of a rubbly bioclastic impure limestone unit, approximately 7 metres thick. Associated fossils in the limestone unit: *Sulcoperculina* and *Barrettia monilifera* s.l. (det. VAN DOMMELEN, 1971, p. 92).

P 326 and P 327, Puerto Rico

Locality: N. Sohl 546 and Pessagno 2541-2542, road cuts of secondary road and hill slopes directly north of Isla Guayacán, Barrio Llanos, Municipio Llanos (P.R. grid 82825-83000 × 14800-14900; USGS Mesozoic Loc. 27018). The samples are taken from rubbly bioclastic limestones belonging to the Parguera Limestone. Fossils: abundant larger foraminifera together with *Barrettia monilifera s.l.*, *Praebarrettia corrali* (PALMER), *Plagioptychus* cf. *P. jamaicensis*, *Plagioptychus?* sp., *Durania lopeztrigoi?*, *Mitrocaprina?* sp. and corals (provisional determinations by N. Sohl; *Barettia* determination, see VAN DOMMELEN, 1971, p. 92; the presence of *Praebarrettia corrali* needs to be confirmed).

Sample P 327 has been taken approximately 10 metres stratigraphically below P 326.

K 75-168, Jamaica

Located on the western bank of the Back Rio Grande, approximately a quarter of a mile due north of the Catalina River confluence (= classical outcrop with *Barrettia monilifera;* J. Nat. grid 71126 × 43903).

The exposed unit, designated as the Back Rio Grande Limestone member, consists of grey rubbly, in part biostromal limestone. The top part of the section contains many volcanic rock fragments and, within a comperatively short interval, the limestone grades into tuffaceous calcareous sandstones. The sample comes from the tuffaceous upper part of the section. Associated fossils: *Barrettia monilifera* clusters from the conglomeratic rubbly basal part, and radiolitids from the biostromal part of the section.

K 75-79, Jamaica

Located on the western bank of the Rio Grande between Alligator Church and Ginger House (J. Nat. grid 74509 × 42596). The sample was taken from the top part of the approximately 80 metres thick Rio Grande Limestone. This limestone unit is composed of massive impure sandy limestone, rubbly reefal deposits and bioclastic calcarenites with larger foraminifera (*Orbitoides* cf. *O. media, Vaughanina cubensis, Pseudorbitoides ?rutteni* and *Sulcoperculina*), *Titanosarcolites, Distefanella mooretownensis,* radiolitids, *Plagioptychus, Chiapasella,* gastropods (*Acteonella, Nerinea*), corals, bryozoa and algae.

Table I
Number of observations, mean and unbiased estimate of the standard deviation of the number of primary chambers and of the diameter of the protoconch; P in measuring units of 0.21 μm.

	megalospheric forms			microspheric forms			megalospheric forms			microspheric forms		
sample	N	$\bar{Y}$	s_y	N	$\bar{Y}$	s_y	N	$\bar{P}$	s_p	N	$\bar{P}$	s_p
P 335	14	24.29	2.55	1	70		22	270	46.1	2	66.5	
P 326	46	9.17	1.37	2	22.5		63	465	113.1	3	89.7	
P 327	101	8.81	1.51	6	22.0	3.69	137	489	117.4	4	87.5	6.35
K 168	26	5.96	1.37	1	19		26	521	148.2	1	66	

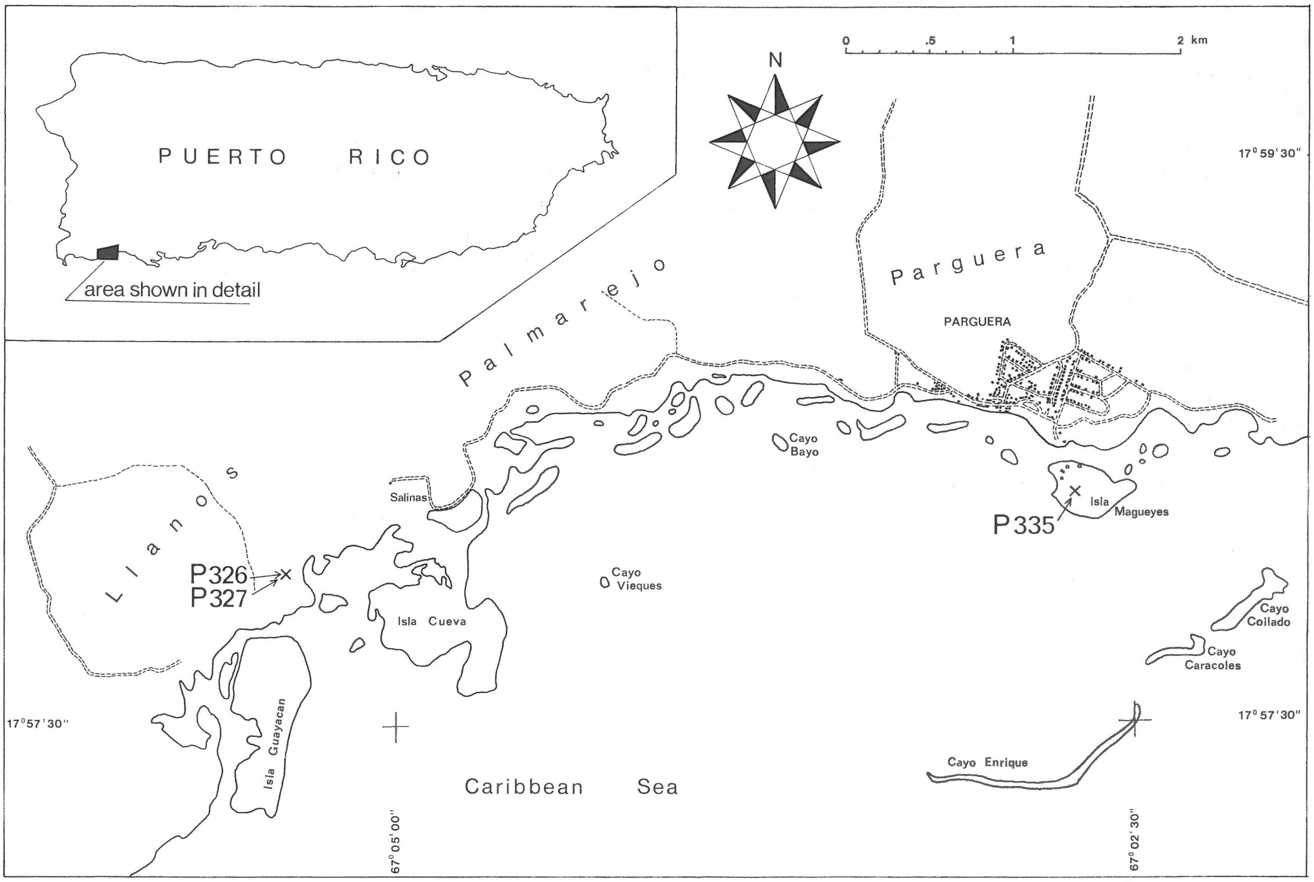


Fig. 1
Locality map of the samples P 335, P 326 and P 327, Parguera Quadrangle, SW Puerto Rico.

DESCRIPTION OF SPECIES

Pseudorbitoides curacaoensis KRIJNEN, 1967 (Table I; Pl. I, Figs. 1-4).

? 1954 *Sulcorbitoides pardoi* BRÖNNIMANN, p. 56-62, pl. 9, figs. 1-4, pl. 10, figs. 1-9, pl. 11, figs. 1-10, text figs. 1-5.
1967 *Sulcorbitoides pardoi* BRÖNNIMANN - Krijnen, p. 155-156, pl. 4, figs. 3-7, pl. 5, fig. 2, pl. 6, fig. 1, text figs. 4 e, f, tables II, IV.
1967 *Aktinorbitoides browni* BRÖNNIMANN - Krijnen, p. 156, 157, pl. 5, figs. 3, 4, pl. 6, figs. 2-5, tables III, IV.
1967 *Pseudorbitoides curacaoensis* KRIJNEN, p. 146, 150-154, pls. 1-3, pl. 4, figs. 1, 2, pl. 5, fig. 1, text figs. 2, 3, 4 a-d, 7, tables I, IV.
1970 *Sulcorbitoides pardoi* BRÖNNIMANN - Cole & Applin, p. 57, 58, pl. 10, fig. 9, pl. 12, figs. 1-12, pl. 13, fig. 9, pl. 17, fig. 4.
1970 *Vaughanina cubensis* PALMER - Cole & Applin, p. 62-64, pl. 13, figs. 5, 7, 10.
1974 *Sulcorbitoides pardoi* BRÖNNIMANN - Frost, p. 272-276, pl. 2, fig. 2, pl. 3, figs. 1-8, pl. 4, figs. 1-5, pl. 5, figs. 1-4.

Locality and material - Sample P 335 from Isla Magueyes, SW Puerto Rico (see text fig. 1). The sample was taken from a rubbly bioclastic limestone unit yielding many free specimens of pseudorbitoids, from which 47 specimens have been drawn for the purpose of grinding horizontally.

Description - Tests thick lenticular, circular to sub-circular in outline, ranging from 0.95-2.20 mm in diameter and 0.50-1.35 mm in thickness. The surface, especially near the umbo, studded with stout pustules.

Dimorphism is present, but no differentiation between micro- and megalospheric forms based on the size of the test seems possible. Both generations are orbitoid in structure, i.e. with an equatorial layer and adjacent layers of lateral chambers.

The uniserial primary chamber spiral of the juvenarium consists of a spherical protoconch measuring from 38-82 microns in diameter, an arcuate deuteroconch ranging from 32-72 microns in maximum diameter, and 16-26 arcuate undivided primary chambers, arranged in a regular spiral of $1^1/_2$ to $2^1/_4$ volutions (Plate I, Figs. 2, 3). So-called juvenarial secondary chambers may occur inside the final whorl of the primary chamber spiral; their presence, however, is obscured by traversing radial elements of limited length, protruding from primary chambers from the preceding whorl.

The radial elements of the 'adult' equatorial layer are very prominent and almost conceal the presence of true equatorial chambers. They generally fan outwards from the juvenarium to the periphery in a rather irregular manner: at various points they seem to bifurcate, at others they abruptly change direction. This feature is very common in all pseudorbitoids, and it is argued that the radial elements, as being structural elements of true equatorial chambers, keep pace with the intermittent cyclical growth, each time protruding more or less perpendicularly from the walls of the peripheral equatorial chambers during the various cyclical (= ontogenetic) stages. In this way irregularities in the radial pattern of the pseudorbitoid layer can easily be explained as the result of irregularities in the cyclical growth of the equatorial chambers, a wide-spread feature in most orbitoids.

Vertical sections across some megalospheric forms reveal a weak trochoid, fairly large sulcoperculinoid juvenarium, a pseudorbitoid layer with an indistinct pattern of radial elements bordered on both sides by low equatorial chamber 'halves' (Plate I, Fig. 4). Eccentric vertical sections often show the two systems of radial rods, separated by a median gap, although there is evidence of plate-like developments comparable to those in the higher evolved *P. israelskyi* and *P. trechmanni*.

Horizontal sections across the equatorial layer of some microspheric forms show an unusually large juvenarium, with only a small zone of 'adult' equatorial layer surrounding it. The protoconch is very small (in the two specimens encountered 56 and 77 microns), and is surrounded in one of the two specimens by a primary chamber spiral counting 70 primary chambers (the protoconch included), arranged in slightly more than 4 volutions. Secondary chambers are faintly visible mainly outside the juvenarium, but also inside the final whorl of the primary chamber spiral. Secondary chambers within as well as outside the juvenarium are almost completely concealed by the radial elements (see Plate I, Fig. 1).

Pseudorbitoides israelskyi VAUGHAN & COLE, 1932
(Table I; Pl. I, Figs. 5-8)

1932 *Pseudorbitoides israelskyi* VAUGHAN & COLE, p. 614, pl. 2, figs. 1-6.
1941 *Lepidorbitoides (Lepidorbitoides) nortoni* COLE, p. 40, 41, pl. 12, figs. 1-8 (not *Orbitocyclina nortoni* VAUGHAN, 1929).
1957 *Pseudorbitoides israelskyi* VAUGHAN & COLE, - Brönnimann, p. 592-603, pls. 1, 2, text figs. 1-11.
1960 *Pseudorbitoides israelskyi* VAUGHAN & COLE - Glaessner, p. 39-41, pl. 6, figs. 1-8.
1970 *Pseudorbitoides trechmanni* DOUVILLÉ - Cole & Applin, p. 60-63, pl. 15, figs. 4, 6, 8, 9, pl. 16, figs. 2, 3, 6, 7.

Locality and material - Samples P 326 and P 327, SW Puerto Rico (see text fig. 1). Both samples contain abundant free specimens of pseudorbitoids, from which 88 have been drawn from sample P 326, and 166 from sample P 327 for the purpose of grinding horizontally.

Description of P 326 material - Tests lenticular, circular to sub-circular in outline (plate I, Figs. 5-6). The surface generally papillated, occasionally with some heavier pillars in the umbonal region. Dimorphism is present, full grown specimens of microspheric forms being distinctly larger than the megalospheric forms. Megalospheric forms range in diameter from 0.60-2.60 mm, and in thickness from 0.25-1.10 mm. Five microspheric specimens encountered range in diameter from 1.85-4.55 mm, and in thickness from 0.80-1.45 mm. Both micro- and megalospheric forms are orbitoid in structure showing adjacent layers of lateral chambers on both sides of the equatorial layer.

Central horizontal sections are in general agreement with Brönnimann's description. A spherical protoconch measuring 55-156 microns in diameter (width) and an arcuate deuteroconch with a maximum diameter ranging from 61-186 microns, are in all cases followed by one principal auxiliary chamber. From the latter chamber either one spiral of juvenarial chambers has developed (uniserial juvenarium), or two spirals (biserial juvenarium), with one protoconchal spiral of primary chambers and one deuteroconchal spiral of secondary chambers. The length of the primary chamber spiral, expressed by the number of primary chambers, depends on the position of the first counter spiral of secondary chambers, and thus, on the position of the first retrovert aperture developed during ontogeny. In biserial juvenaria such a counter spiral is developed out of the third juvenarial equatorial chamber (the principal auxiliary chamber), whereas in the uniserial forms the retrovert aperture appears in a later ontogenetic stage. Individuals with a uniserial juvenarium show primary chamber spirals consisting of 10-13 chambers. In specimens with a biserial juvenarium 7-9 primary chambers have been counted, so that the total Y-value for all megalospheric forms in the sample ranges from 7-13 (proto- and deuteroconch included).

The pseudorbitoid layer is well developed. Arcuate equatorial chambers are occasionally faintly visible through the densely spaced radial elements which count approximately 30-40 per quadrant along the periphery of full-grown specimens. Usually the equatorial layer (and pseudorbitoid layer) surround the juvenarium on all sides, but in a few cases it is interrupted by an actinate interradius filled with concave rows of lateral chambers. Generally it is considered that the formation of interradial lateral chambers, once they start interrupting the formation of equatorial chambers, will continue up to the periphery. In one case, however, the equatorial layer is interrupted by two actinate interradii, of which one is subsequently enclosed by radial elements, converging from the two sides (KRIJNEN, 1972, text fig. 8).

Microspheric forms have a uniserial juvenarium which is much smaller than the juvenarium in megalospheric forms. The diameter of the protoconch could be measured in three

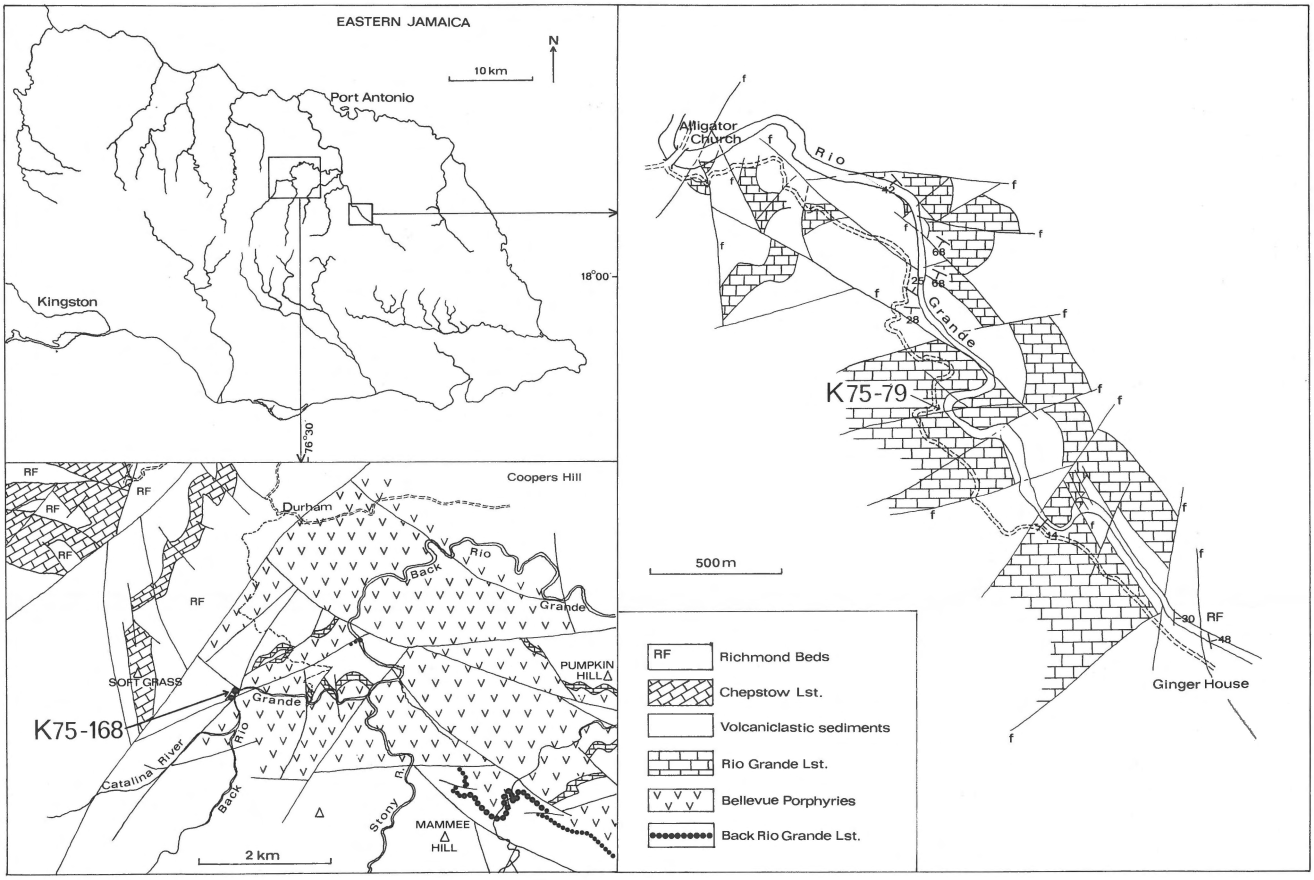


Fig. 2
Locality map of the samples K 75-168 and K 75-79, Blue Mountain inlier, E. Jamaica.

specimens, giving values of P = 16, 17 and 23 microns. The number of primary chambers could only be counted in two specimens, giving values of Y = 21 and Y = 24 (proto- and deuteroconch included).

The 'adult' (post-juvenarium) equatorial layer occupies the major portion in horizontal sections. Arcuate equatorial chambers are here and there faintly visible through the densely spaced, fairly delicate radial elements which approximately number 70-80 per quadrant in full-growth specimens, counted along the periphery. Irregularities in the radial pattern of the radial elements are numerous (Plate I, Fig. 5, upper right).

Description of material from sample P 327 - The description of this material (Plate I, Figs. 7-8) is almost identical with that of sample P 326. Megalospheric forms: diameter of the test 0.55-2.05 mm; thickness of the test 0.20-0.90 mm; protoconchal diameter 45-173 microns; deuteroconchal diameter 43-177 microns.

Microspheric forms: diameter of the test 1.30-4.80 mm; thickness of the test 0.30-1.20 mm; protoconchal diameter 17-20 microns.

The major difference from material from sample P 326 is the occurrence of quadriserial juvenaria in approximately 5% of the megalospheric specimens analysed. The overwhelming majority consists of forms with biserial juvenaria (83%), the rest of the specimens having a uniserial juvenarium (12%). The megalospheric Y-values are Y: 6 or 7 (quadriserial nepionts); Y: 7, 8, 9 or 10 (biserial nepionts) and Y: 10, 11, 12 or 15 (uniserial nepionts), with a total range of Y = 6-15. The microspheric Y-values of the exclusively uniserial juvenaria range from Y = 17-28.

Remarks - In spite of the occurrence of quadriserial juvenaria in some of the megalospheric specimens, the population is referred to *P. israelskyi* because of the overwheling majority of individuals with a uniserial to biserial juvenarium. However, this sample may represent a population which has an intermediate evolutionary position between *P. israelskyi* and *P. trechmanni*.

Pseudorbitoides trechmanni trechmanni DOUVILLE, 1922 (Table I; Pl. I, Figs. 9-11)

1922 *Pseudorbitoides Trechmanni* nov. gen., nov. sp. - Douvillé, p. 204, fig. 1.
1955 *Pseudorbitoides trechmanni* DOUVILLÉ - Brönnimann, p. 58, pls. 9, 10, text figs. 1, 2-7.
1972 *Pseudorbitoides trechmanni trechmanni* DOUVILLÉ - Krijnen, p. 46-49, text fig. 10, tables 3, 5, 6, pls. 5-9, 14-20.

Locality and material - Sample K 75-168, Back Rio Grande, Jamaica (see text fig. 2). The sample contains ample material of free specimens from which 27 have been drawn for the purpose of grinding horizontally.

Description - Test often thick lenticular, circular to sub-circular in outline, the surface generally papillated. Dimorphism is present, with megalospheric forms ranging up to 2.80 mm in diameter, and up to 1.90 mm in thickness of the test, and with microspheric forms ranging up to 5.60 mm in diameter and 2.05 mm in thickness of the test.

Both megalo- and microspheric forms are orbitoid in structure, with layers of lateral chambers on both sides of the equatorial layer. A detailed description of the morphology of the test is not given here. For this, reference is made to almost identical descriptions by BRÖNNIMANN (1955) and KRIJNEN (1972) of *P. trechmanni* from the type locality in the Green Island inlier, Jamaica.

Specific data from the Back Rio Grande material regarding megalo- and microspheric juvenaria are as follows:
Megalospheric juvenaria: generally quadriserial with two principal auxiliary chambers, both giving rise to a deutero-conchal and a protoconchal spiral of chambers. Biserial and uniserial juvenaria, both with one principal auxiliary chamber, are also present, but to a lesser extent.

The diameter of the protoconch (P) ranges from 56-182 microns. The primary chamber spiral (in quadriserial forms this is the protoconchal spiral which contains the larger principal auxiliary chamber) counts Y = 5-11 primary chambers, the proto- and deuteroconch included. One micro-spheric juvenarium: uniserial, with a protoconch measuring 14 microns in diameter, and a primary chamber spiral counting Y = 19 chambers the proto- and deuteroconch included.

Pseudorbitoides ?rutteni rutteni BRÖNNIMANN, 1955 (Pl. I, Figs. 12, 13).

1955 *Pseudorbitoides rutteni* BRÖNNIMANN, p. 68-75, pls. 11, 12, text figs. 8-17.
1963 *Pseudorbitoides rutteni* BRÖNNIMANN - Seiglie & Ayala-Castañares, p. 45, 46, pl. 10, figs. 2, 3, pl. 11, 12, 13.

Locality and material - Sample K 75-79, Blue Mountain inlier, along the western bank of the Rio Grande between Ginger House and Alligator Church, E. Jamaica (see text fig. 2). The sample is taken from a compact bioclastic calcarenitic unit in the top part of the Rio Grande Limestone member, locally 80 meters thick. The limestone contains *Pseudorbitoides* and *Orbitoides,* but no free specimens could be obtained. The specimens studied are random sections accidentally cut while sectioning the rock. Only vertical sections of the pseudorbitoids are available of which a couple were cut exactly across the juvenarium casu quo protoconch.

Description - Test lenticular, orbitoid in structure with layers of lateral chambers on both sides of the equatorial layer. Dimorphism is supposed to be present, although no vertical section shows a microspheric juvenarium with certainty.

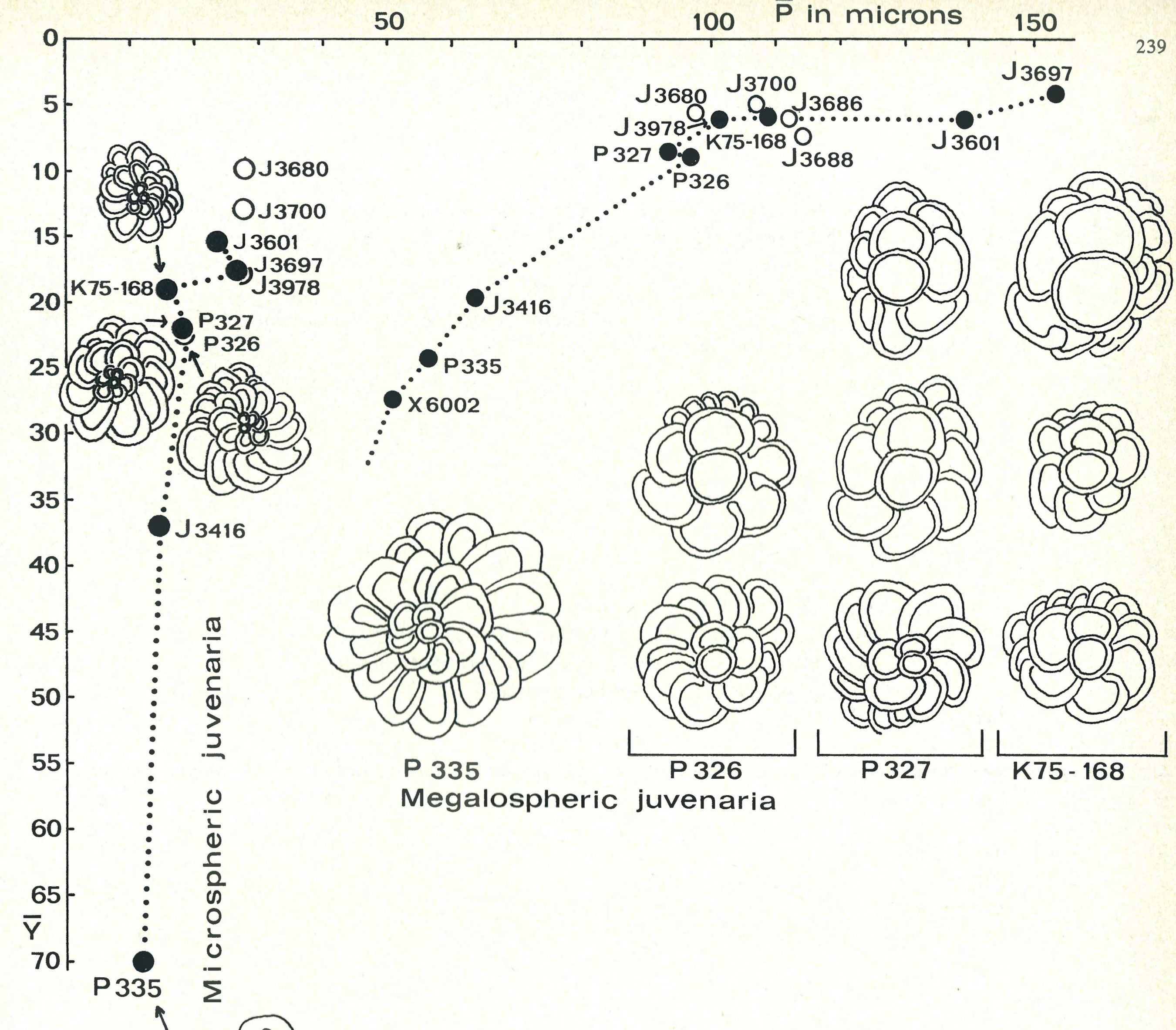
As measured from the vertical sections the diameter of various tests varies from 2.0-5.5 mm (megalospheric forms!), their thickness ranging from 1.0-1.8 mm. From two centered vertical sections across megalospheric juvenaria the maximum diameter of the protoconch could be obtained, measuring 109 and 170 microns.

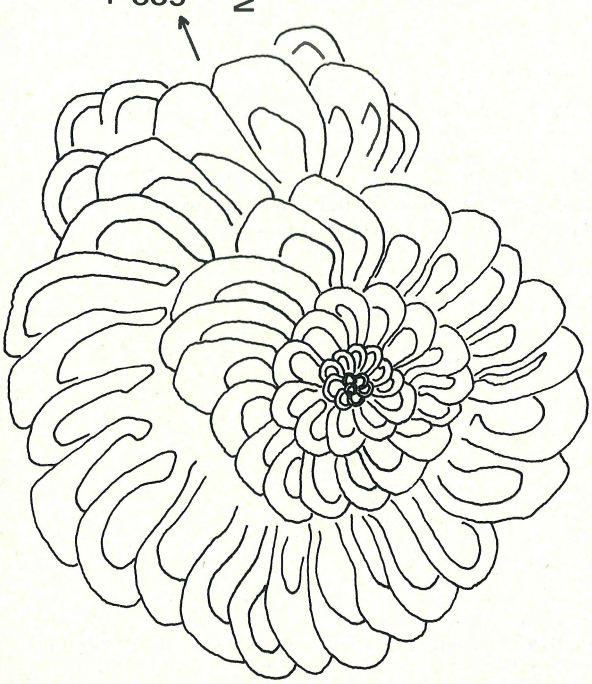
The equatorial layer is very distinct, and gradually widens from the juvenarium towards the periphery. Two rows of relatively 'high' equatorial chamber 'halves' are clearly visible, divided by the pseudorbitoid layer which seems to be composed of a number of minute canals especially near the periphery. In this respect there is some resemblance with the structure of the pseudorbitoid layer in microspheric forms from the Sunderland inlier, Jamaica (sample J 3419; KRIJNEN, 1972, *P. trechmanni trechmanni,* pl. 20, figs. 4-6).

Remarks - A definite identification of this material is not possible because of the lack of free specimens. The determination is based on the presence of a complex pseudorbitoid layer of radial elements *(P. rutteni - Historbitoides* pattern), and on the advanced type of juvenarium which, on the evidence of central vertical sections, must be quadriserial or biserial. If biserial nepionts should be prevalent, then the material may also belong to *P. trechmanni trechmanni,* but this is not considered likely because of its occurrence in a formation considerably younger than the Back Rio Grande Limestone.

FINAL REMARKS

Specimens with one or more actinate interradii, filled with lateral chambers and interrupting the equatorial layer, appear to occur frequently in primitive populations of pseudorbitoids, although they have occasionally been noticed in more highly evolved specimens (Plate I, Fig. 10). As has been pointed out earlier (KRIJNEN, 1972, p. 25), the development of these interradii seems to be favoured by the relatively slow growth of the primitive uniserial juvenarium, occasionally allowing juvenile lateral chambers (generated in the juvenarial stage) to reach the periphery of the juvenarium, and to block the formation of secondary





J 3688, J 3686, J 3680, J 3700: *P. trechmanni pectinata,* Sunderland inlier, Jamaica.
J 3697, J 3601: *P. trechmanni trechmanni,* Sunderland inlier, Jamaica.
J 3978: *P. trechmanni trechmanni,* Green Island inlier, Jamaica.
K 75-168: *P. trechmanni trechmanni,* Blue Mountain inlier (Back Rio Grande), Jamaica.
P 327, p 326: *P. israelskyi,* Parguera Lst. (N.Sohl's loc. 546), Puerto Rico.
J 3416: *P. chubbi,* Sunderland inlier, Jamaica.
P 335: *P. curacaoensis,* Isla Magueyes, SW Puerto Rico.
X 6002: *P. curacaoensis,* Cas Abao Lst., Curaçao, Netherl. Antilles.

Fig. 3
Diagram showing plots of megalospheric and microspheric $\bar{Y}$ and $\bar{P}$-values of various populations from Curaçao, Jamaica and Puerto Rico.

PLATE I

Figs. 1-4
Pseudorbitoides curacaoensis KRIJNEN, 1967 (N. Sohl's locality no. 2006 = Pessagno 2590-2593) from Isla Magueyes, SW Puerto Rico.

Fig. 1
Central horizontal section of a microspheric specimen (P 335-44), 31 x.

Figs. 2-3
Central horizontal sections of megalospheric specimens (2: P 335-21; 3: P 335-60), 31 x

Fig. 4
Central vertical section of a megalospheric specimen (P 335-83), 55 x.

Figs. 5-8
Pseudorbitoides israelskyi VAUGHAN & COLE, 1932 from N. Sohl's locality no. 546 (= Pessagno 2541-2542) directly north of Isla Guayacán, SW Puerto Rico.

Figs. 5, 7
Central horizontal sections of microspheric specimens (5: P 326-2, 20 x; 7: P 327-6, 24 x).

Figs. 6, 8
Central horizontal sections of megalospheric specimens (6: P 326-123, 45 x; 8: P 327-100, 27 x).

Figs. 9-11
Pseudorbitoides trechmanni trechmanni DOUVILLÉ, 1922 from the Back Rio Grande, Blue Mountain inlier, Jamaica.

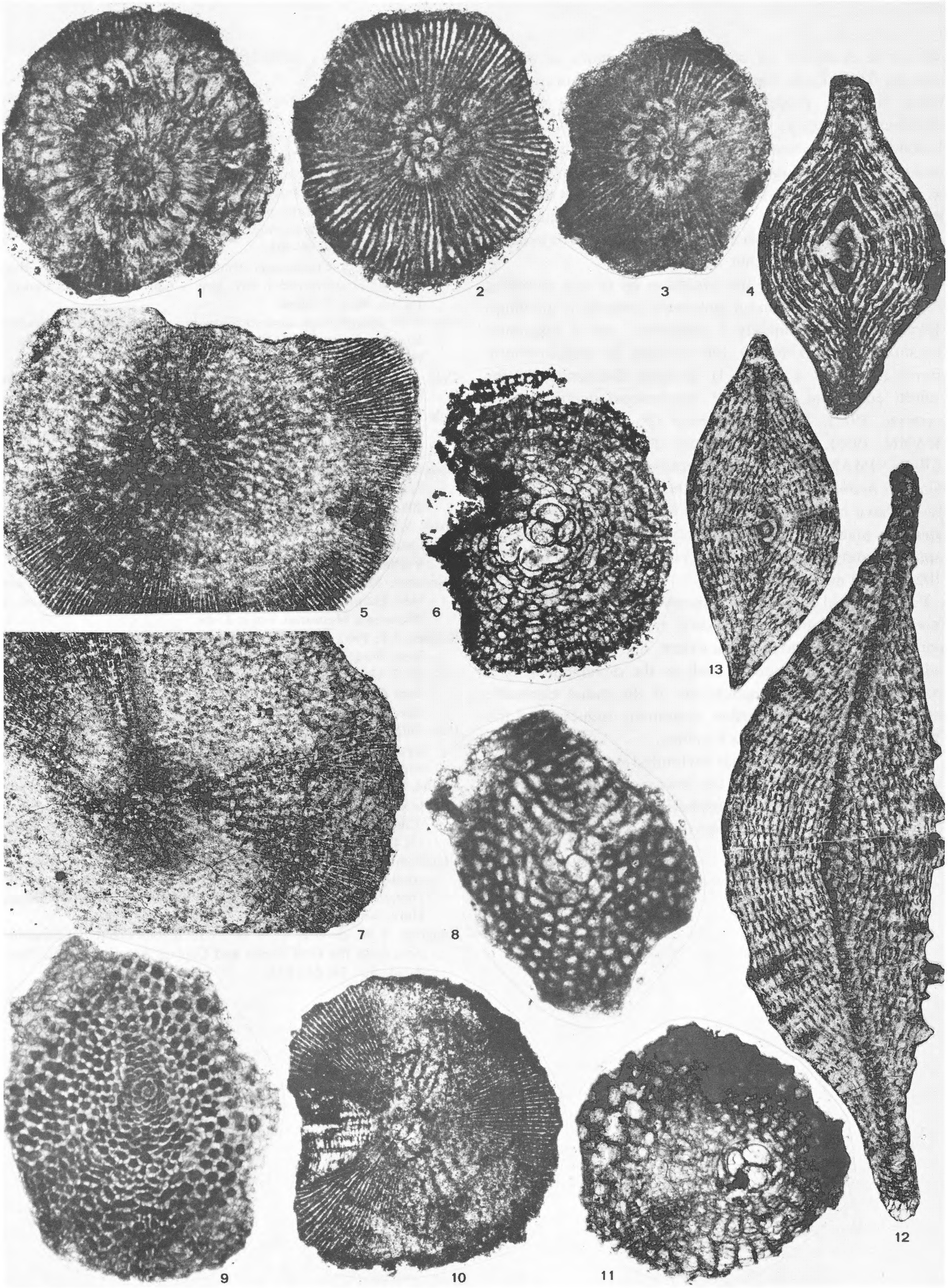
Fig. 9
Central horizontal section of a microspheric specimen (K 75-168/6), 22 x.

Figs. 10-11
Central horizontal sections of megalospheric specimens (10: K 75-168/8, 20 x; 11: K 75-168/5, 31 x).

Figs. 12-13
Pseudorbitoides ?rutteni rutteni BRÖNNIMANN, 1955, Rio Grande, Blue Mountain inlier, Jamaica.

Fig. 12
Eccentric vertical section of a probably microspheric specimen (K 75-79, slide 3), 20 x.

Fig. 13
Almost central vertical section of a megalospheric specimen (K 75-79, slide 2), 24 x.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equatorial chambers by covering one or more peripheral stolons. This idea is supported by their rate of occurrence being inversely proportional to the number of primary chambers (roughly, and in megalospherical forms). Individuals with actinate interradii generally represent only a minor fraction of a sample and thus should be considered as variants. Since, moreover, interradii have been observed in both subfamilies, the Pseudorbitoidinae and the Vaughanininae, their presence or absence cannot be used for the discrimination of higher taxa either.

It can be shown that the evolution up to and including *P. trechmanni trechmanni* proceeds towards a minimum Y-value of approximately 5 chambers, and a maximum P-value of approximately 150 microns in megalospheric forms (See Fig. 3. Table I). Despite differences in the 'adult' equatorial layer in *P. trechmanni pectinata* (see KRIJNEN, 1972), *P. rutteni rutteni (P. rutteni* BRÖNNIMANN, 1955), *P. rutteni kozaryi (Historbitoides kozaryi* BRÖNNIMANN, 1956), and *P. rutteni hedbergi (Rhabdorbitoides hedbergi* BRÖNNIMANN, 1955), by which those forms have been separated by Brönnimann, their megalospheric juvenaria remain quadriserial, with Y-values approximately stationary, and P-values fluctuating between 100 and 150 microns.

Pseudorbitoid evolution is apparently limited by this stage. Younger populations may vary randomly around this equilibrium stage and, to some extent, in the development of adult morphologic features such as the development of a pectinate flange or complications of the radial elements; there is, however, no further systematic reduction of the Y-values or increase of the P-values.

Evolution of the Y-values is not limited in the same manner in the microspheric forms, the lowest number of primary chambers observed in a microspheric specimen is Y: 10 (the P-values, of course, remain approximately constant throughout).

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