Geology. — *The Rudist Fauna of Seroe Teintje Limestone (Northern Curaçao).* By H. J. MAC GILLAVRY. (Communicated by Prof. L. RUTTEN.)

(Communicated at the meeting of April 2, 1932.)

Rudist bearing limestone has been known for a long time to occur in Curaçao. Yet no good specimina had been secured. The material thus far collected consisted of shell fragments only, not permitting any exact determination of species or a fortiori of stratigraphical age. The age was inferred from the geological position and palaeontologically from the corals found together with rudists. At the end of this article I shall find occasion to discuss the age question more in detail.

Rudist fragments from Curaçao were first described by MARTIN (9, p. 239) as Dania curasavica, in 1885. In 1886 and again 1888 MARTIN (10, p. 238—240; 11, p. 21—26) recognized their real nature. According to BAILEY WILLIS (19, p. 639) STANTON on the base of MARTIN's illustrations identified them as of upper cretaceous age. Later the botanist BOLDINGH cursorily collected some material deposited in the collections of the Geological Institute of Utrecht. MOLENGRAAFF in his dissertation 1929 (12, p. 23) gives a good exposé of the stratigraphical relations, and, basing himself on GERTH's determinations of corals (5, p. 5), considers the Seroe Teintje limestone to be of lower senonian age. And thus the question remained unsolved, until ampler material should have been collected. With this end in view, during the excursion made by Prof. RUTTEN and some of his students of the university of Utrecht in 1930, the small mountain of Seroe Teintje was explored for a whole day, and not without success. The quality of the material thus collected compares remarkably well with that of other rudist material known from the West-Indies. Moreover we were lucky too in finding, besides Radiolite fragments, some Hippurite specimina not yet known to occur in Curaçao. Some of these even retained their superior valves. This probably is the second time superior valves of Hippurites have been found in America. [1])

Sometimes the fragments are rounded off and often much corroded. Moreover two Radiolite specimina were found to grow upon each other in the most irregular fashion, one growing almost diametrically opposite to the direction in which the other must have grown. In the interior cavity of one of these another Radiolite has grown concentrically with this one and in the same direction (Pl. II, fig. 6). This suggests that at the time

1) C.f. F. K. G. MÜLLERRIED. Anales del Inst. de Biologia. Mexico. T. I. N°. 2, p. 169, ? 1931.

of their occurrence the surge threw them together. This agrees with their low and spreading shape suggesting too the action of the surf upon them.

The material was collected at five localities known to, and mapped by MOLENGRAAFF. The bulk of the material including Nos. 1, 2 and 3 of the Vaccinites were actually found at Seroe Teintje. Vaccinites Nos. 4 and 5 were gathered from the Seroe Bomba Boea 400 m. N. 75 E. from the triangulation point 41. A few Radiolite fragments were found here too. Some material was also collected from the Seroe Hoba near Seroe Teintje. One Radiolite fragment was picked up on a small limestone hill 800 m. N. 62 W. from the "Landhuis Savonet". And finally some Radiolite fragments were collected on the most northern outcrops 700 m. N. 75 E. from the San Pedro church, Westpunt.

Besides rudists we found many corals and some Actaeonellae. The corals have been examined by Prof. H. GERTH. The material did not contain any species, not yet known from Curaçao. The Actaeonellae are ill-preserved; I was, in consequence, not able to identify them.

I wish to thank Mr. G. ASTRE, of Toulouse, and Mr. CH. T. TRECHMANN, of Castle Eden, who kindly gave their valuable advice about some specimina.

Vaccinites Martini. n. sp. (Pl. 1, fig. 1—6; text fig. 1, 2).

Inclination of dental apparatus	20° (30°)
Space of circumference occupied by the three infoldings .	1/5 (1/7)

Pores not very well visible.

Quality of the material:

Five specimina were found, of which numbers 1, 2 and 3 were sawn through horizontally to enable examination of the transverse sections. One was sawn through vertically (N°. 4). The superior valves are either much corroded or covered by foreign substance and particles of limestone adhering very closely to them. This is the reason why the pores are not well visible. The inferior valves are much corroded too, only Nos. 1 & 2 showing the outside decoration.

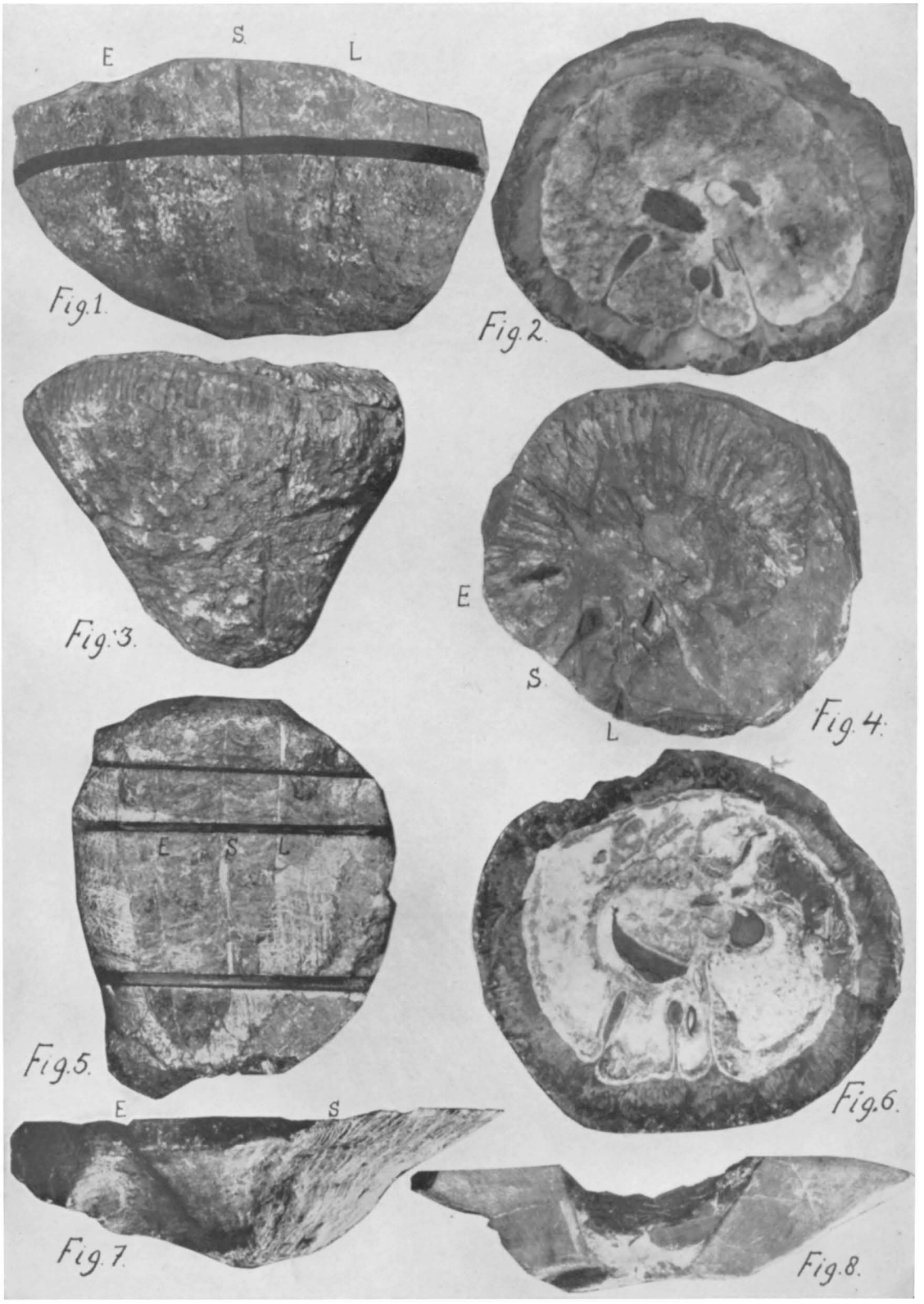
Shape and external features:

The animal has the shape of a cone spreading upwards rather broadly, the top angle being about 70 degrees! Numbers 2 & 5 present an asymmetrical cone, but since in N°. 5 the steeper side of the cone corresponds to the dorsal (ligamental) side, while in N°. 2 just the reverse is the case, this seems not to be of any importance.

The superior valve is nearly a flat disc.

The sections are somewhat elliptical with the longer axis going from the anterior to the posterior side, the short one running dorsi-ventral.

The decoration of the outer surface consists of regular rounded, longi-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tudinal ribs, some 2 mm. broad and separated by shallow sulci equally broad and rounded. Occasionally these ribs bifurcate. The three grooves corresponding with the ligamental crest and the two pillars are rather shallow too. (Pl. I, fig. 1, L. S. E.) Yet they are deeper than the sulci above-mentioned.

Measures of holotype:

Diameter of the whole animal at the top: 110 by 95 mm. As preserved, it is 52 mm. high. When complete, it must have been about 70 mm. high. The thickness of the outer shell is about 10 mm. The animal being rather variable these measures of course have no absolute value.

Internal features:

The radial canals of the upper valve are very regular, a characteristic mentioned by TOUCAS (17, p. 89) for the younger groups of Vaccinites. The disposition of the dental apparatus is quite normal. The anterior tooth *(B')* is situated on the prolongation of the ligamental crest. The posterior tooth *(B)* lies directly behind the end of this crest. The posterior myophore *(mp)* lying on the same line with the two teeth, is situated directly alongside the first pillar, not going beyond its termination. This line makes the above-mentioned angle of 20° with the ligamental crest. The ligamental crest *(L)* is long and lamelliform and remarkably thin, being only half a mm. broad in the middle and one mm. at the top. Its length is 25—30 mm. The end is rounded thus marking a later evolutional phase (cf. TOUCAS 17, p. 69). The first pillar *(S)* is well pinched at the base over more than half its length. The end is knob-shaped with a diameter of about 5 by 7 mm. Its length is 15—20 mm. The second pillar *(E)* is pinched too at the base

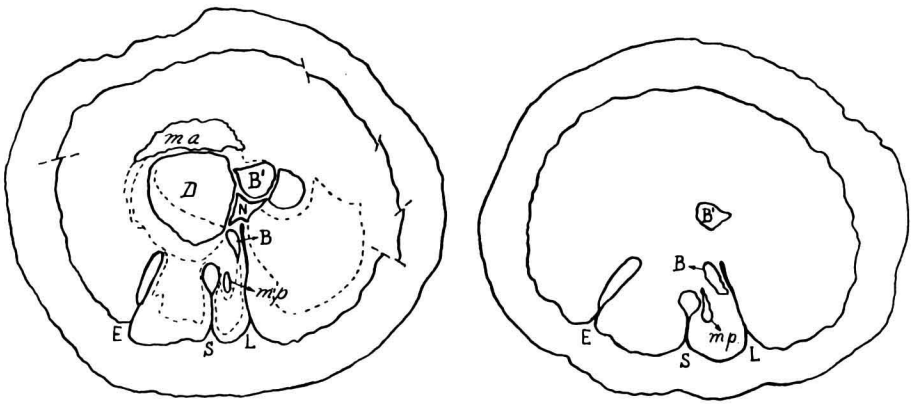

Fig. 1 *Vaccinites Marlini.* *Fig. 2 (Holotype)*

Fig. 1 is the same as Pl. I, fig. 6; Fig. 2 is the same as Pl. I, fig. 2.
L: Ligamental crest; S: First pillar; E: Second Pillar; B: Posterior tooth; B': Anterior tooth; mp: Posterior myophore; ma: Anterior myophore; N: Single tooth of the lower valve; D: Living cavity.

but only over 3 or 4 mm. Then it broadens rather abruptly to a width of 4 mm. retaining this width over 15 mm., the rest of its length, the whole length thus being 20 mm. The outlines of the single tooth *(N)* of the lower valve, as well as those of the anterior muscle *(ma)* and mostly, also those of the accessory and the living cavity *(O & D)*, are very indistinct.

Variations:

Specimen N°. 3 differs from the others in two respects: Though much corroded this much can be said about its form, that it must have been more cylindrical than the others. Further the angle of inclination of the dental apparatus is 30° (Pl. I, fig. 5).

N°. 2 again differs, since the three pillars contain between them only $^1/_7$ of the whole circumference (Pl. I, fig. 6; text fig. 1).

I took N°. 1 for holotype because it agrees in most of the features with most of the others (Pl. I, fig. 1, 2; text fig. 2).

This species I have named in honour of Prof. Dr. K. MARTIN.

Systematical place:

The sum of the characteristics show the relation of this Vaccinites to either group I 4 (group of Vaccinites giganteus), or to group II (group of Vaccinites inaequicostatus) of TOUCAS (17, p. 89 and 104). The pores only might have given decisive evidence. But in this case, since pores must be very well visible to enable discerning between reticulate *(I)* and subreticulate pores *(II)* (a very subtle difference!) we can only rely on the internal features. But these do not differ very much. TOUCAS even regards group II as derived from Vaccinites praegiganteus. ASTRE, who kindly examined one of the sections, places this Hippurite in the group of Vaccinites inaequicostatus, on account of its ligamental crest being too thin for the group of Vaccinites giganteus. He gives the determination: Vaccinites cf. Oppeli Douv. I generally agree with ASTRE, but I should like to make it a new species since it differs from Vaccinites Oppeli in several respects. First it differs in the peculiar form of the second pillar, the long stretch over which the first pillar is pinched, the length and thinness of the ligamental crest, and secondly it differs because the posterior myophore is not advanced to the interior, a characteristic given by TOUCAS (17, p. 105) for this group. Now all these features certainly are quite variable, but all the same TOUCAS' system is based on them, while moreover in my specimina they appear to be very constant. Further TOUCAS (17, p. 110) considers Vaccinites Oppeli to be only a variation of Vaccinites inaequicostatus, which my Hippurite certainly does not resemble in the least.

It may be observed that the pillars of this Vaccinites bear great likeness to those of Barrettia monilifera. But this can be considered as a mere coincidence or perhaps a convergence.

Durania curasavica (MARTIN) (Pl. I, fig. 7, 8; Pl. II, fig. 1—6; text fig. 3, 4, 5).

Some literature on comparable forms:

1833	Hippurites Mortoni	8 Mantell	p. 130.
1836	Coniae sp.	7 Lyell in Huds.	p. 104.
1838	Hippurites Mortoni	6 Gray	p. 228.
1849	**Hippurites Austinensis**	15 Roemer	p. 410.
1850	Hippurites Mortoni	4 Dixon	**p. 354. Pl. XXVI.**
1852	**Radiolites Austinensis**	16 Roemer	p. 77. Pl. VI, fig. 1a—d.
1855	Radiolites Mortoni	20 Woodward	**p. 59, 60. Pl. V, fig. 1, 2.**
	= Sauvagesia austinensis: Toucas 18, 1909,		p. 96, 97, fig. 64.
1866	Radiolites Mortoni	21 Zittel	p. 148. Pl. XXV, fig. 1—3.
	= Sauvagesia austinensis: Toucas 18, 1909,		p. 96, 97.
1885	Dania curasavica	9 Martin	p. 239, 240 (1 text fig.).
1886	Radiolites sp.	10 Martin	p. 238—240.
1888	Radiolites sp.	11 Martin	p. 21—26. Pl. II, fig. 14—21.
1900 (1901)	Sphaerulites Mortoni	14 Parona	p. 15, 16. Pl. II, fig. 3a, b, 4.
	= Radiolites Paronai Dainelli 1901 (vide et Parona 1911).		
	= (fig. 3a, b). Sauvagesia austinensis: Toucas 18, 1909,		p. 96, 97.
1906	Radiolites Austinensis	1 Boese	p. 57, 58. Pl. XI, fig. 1; Pl. XIII, fig. 8; Pl. XIV, fig. 1.
1909 (1910)	Sauvagesia austinensis	18 Toucas	p. 96, 97, fig. 64.
	Sauvagesia Mortoni	18 Toucas	p. 92, fig. 59.
1912	Radiolites sp.	19 Willis	p. 639.
1929	Radiolites sp.	12 Molengraaff	p. 23.

Quality of the material:

Most fragments found belong to the group of the Radiolitidae as is evident from the structure of the shell, typical for this group. The combination of funnel plates (PALMER 13, p. 13, 76) and prismas, which constitute the shell, cannot be confused nowadays with any other structure. Moreover the irregular polygonal form of the prismatic cells in all the fragments makes it probable that they belong to the group of Sauvagésinés, (DOUVILLÉ 2, p. 15, 16), though other Radiolites were found to have the same structure. Most pieces are much too fragmentary to say anything about their systematical place. Nor can one be sure whether they belong all to the same species, since they show great variability in size, thickness of the funnel plates (= length of prismatic cells), etc. Some fragments show the prismatic cells to be high rather than wide, while others display just the reverse. Mostly the thickplated ones belong to very small, and perhaps cylindrical forms, but that is all very uncertain. Luckily better fragments were also found by us, showing parts of the internal cavity, or fragments of the outer, cortical layer, with its decoration; one retains its dental apparatus, while in others even the siphonal bands are shown. The latter allow some farther investigation. Only one individual shows, what I take to be a part of the superior valve. I figured it on Pl. II, fig. 5, so that everybody can judge for himself.

I will now describe the only rather complete specimen found, showing the whole circumference of the lower valve with the cortex for the greater part intact. One siphonal band is well preserved, the other however somewhat corroded. Probably only the lower end of the inferior valve is preserved, perhaps it is almost the whole inferior valve. One only thing to be said with any certainty is that the superior valve is wanting.

Some features not so well developed in this holotype and evident in other fragments will be described from these fragments, as it is highly probable that these belong to the same species.

Description of holotype (Pl. I, fig. 7; Pl. II, fig. 1, 2; text fig. 5). As already stated, the holotype lacks its superior valve.

External features:

The shape is that of a very flat cone, Lapeirousia and Sphaerulites-like. This is very exceptional for Sauvagesia and Durania. Thus TRECHMANN in a letter written to me about it even thought of the possibility of constituting a new genus for it. I do not think, however, that my material would justify this, as, the upper valve absent, it is not absolutely complete. The cortical decoration consists of more or less regular longitudinal, rounded ribs, 2 mm. broad. They are separated by shallow rounded sulci. On about one fourth of the circumference, on the dorsal, ligamental side, these ribs and sulci are of a complex nature, showing small secondary ribs and sulci; sometimes in a wide primary sulcus three secondary ribs can be found (Pl. II, fig. 1). The two siphonal bands are well marked. The anterior band *(E)* is a channel rather deeply concave. Though much marred by corrosion some remnants of minor ribs can be traced. At this place the shell is at its thinnest. From the two borders of this anterior siphonal channel, the shell becomes thicker and thicker, the circumference running outwards at a tangent. When a certain thickness of shell is attained the circumference of the shell follows almost concentrically the inner cavity. The longitudinal band between the two siphonal areas is simply rounded. Its ornamentation is corroded away, but traces of it show that it probably consisted of common, larger ribs, not comparable to those of the siphonal areas. The posterior area (*S*) is well preserved. It is scarcely concave and is ornamented with rounded single minor ribs, about fifteen in number. The width of the two areas is almost alike. The anterior channel is 16 mm. wide, the posterior one 13 mm., both measured at the top.

Measures:

Diameter of the whole animal at the top: 135 by 115 mm. The inner cavity is 56 by 60 mm. The outer shell is 5 mm. thick at the anterior siphonal area, and 50 at the opposite, dorsal side. The thickness of the inner shell layer is less than 1 mm. As preserved, the lower valve is 38 mm. high. The value of these measures of course is very relative, as this species must have varied considerably both in size and shape.

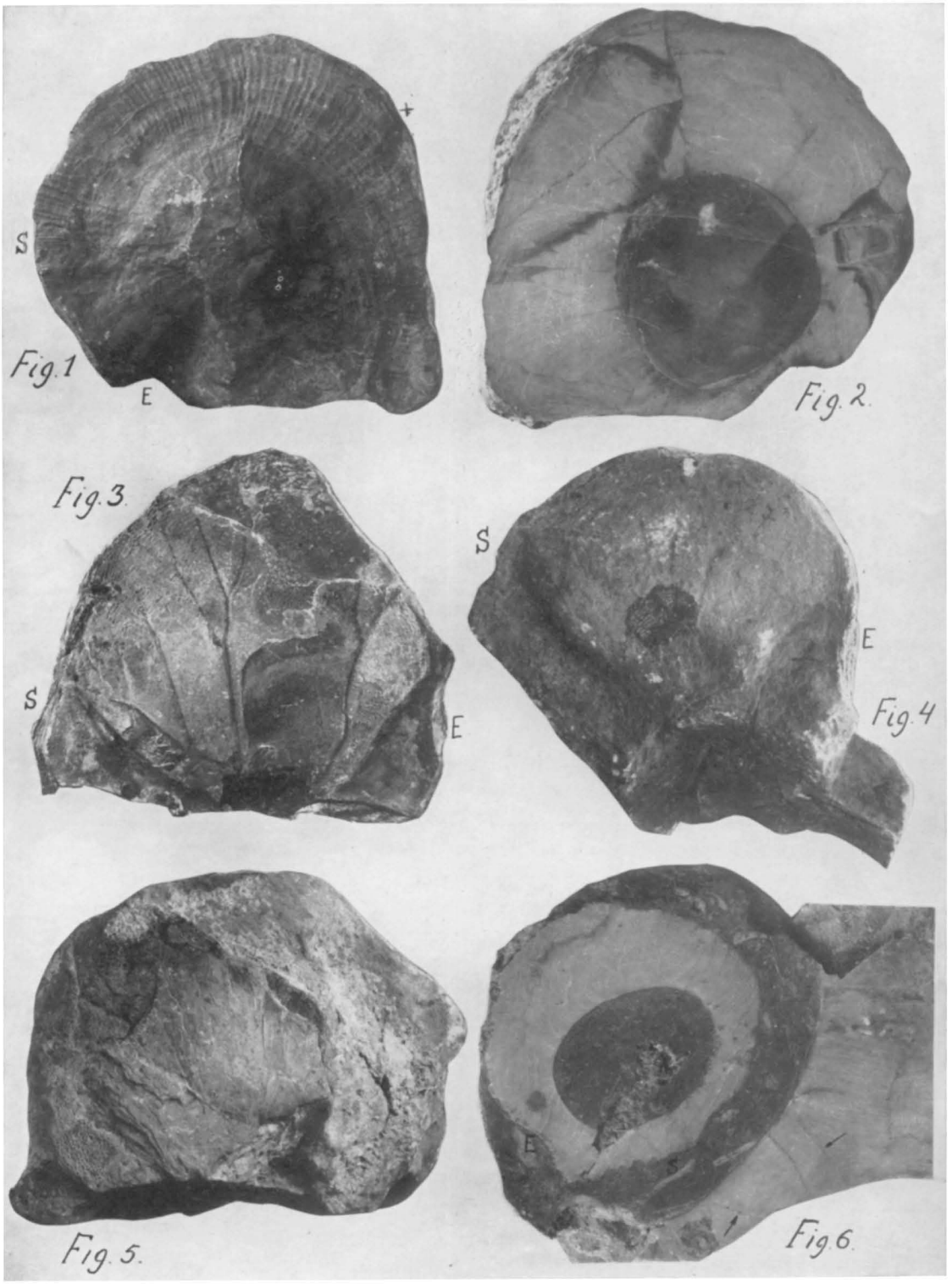
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Fig. 6

The structure of the shell:

The funnel plates or growth layers, are very thin: 0,4—0,7 mm. They are coarsely cellular. The cells are polygonal. The prismas are rather wide, their diameter being often about 1 mm. Thus their diameter is greater than their height. This is at least the case in the type specimen. Other fragments show all sorts of nuances, up to prismas with a height twice the width, but it is questionable whether these belong to the same species, their general appearance being somewhat different, as I already stated.

The radial and bifurcating vessel impressions are often very conspicuous (Pl. II, fig. 3). In cross-sections they appear as small denticles reaching from one funnel plate into the next. This resembles the feature given by DOUVILLÉ (3, p. 56) for Parabournonia as represented by his fig. 2b. Thus these denticles of Parabournonia could perhaps be explained in this way, and then of course would constitute no generic characteristic at all.

The funnel plates as a rule are wholly destitute of any undulations, and appear to have been deposited horizontally one upon the other, spreading downwards rather than upwards. Only in the two siphonal areas there are shallow, flat-bottomed, but steep-edged depressions. Thus these depressions are more or less trough-shaped. This is shown in cross-sections, because these edges betray themselves, by a radial arrangement of the funnel plate lines. Moreover as a sequel of this steepness these lines pack closely together. Thus here the shell structure seems to be more opaque [1]). The two opaque lines thus formed are as a rule more distant from each other at the inner side of the outer shell than at its outer (Pl. II, fig. 6; text fig. 5). These depressions are reminiscent of those of Tampsia (Proc. U. S. Nat. Mus. 61, 1922, p. 7).

A regular but small undulation of the growth layers is only to be found near the cortex, where the ribs begin to be marked.

The inner shell layer is very thin and opaque.

Internal features:

The circumference of the inner cavity shows no trace of a ligamental crest or inflexion. It is approximately circular showing only a slight flattening of the border line on the places corresponding to the two siphonal areas. The fig. 2, Pl. II. will show two patches of white crystalline calcite in the inner cavity on the dorsal side. Probably these are the lower ends of the two teeth of the upper valve, though they appear to be situated rather far away from the border.

Characteristics shown in other fragments:

Some features shown in other fragments better than in the holotype, but which could be traced to occur in this also, have already been described. I shall now give the features shown in other fragments only.

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[1]) This, then, very much resembles DOUVILLÉ's characteristic for „Sauvagésinées" (2), so that perhaps this also might be explained out of the shell structure.

One fragment has its dental apparatus very well preserved (text fig. 3, 4). This bears a typical Radiolite character, and is almost identical with that figured by TOUCAS (17, p. 92, fig. 59) of Sauvagesia (Durania) Mortoni.

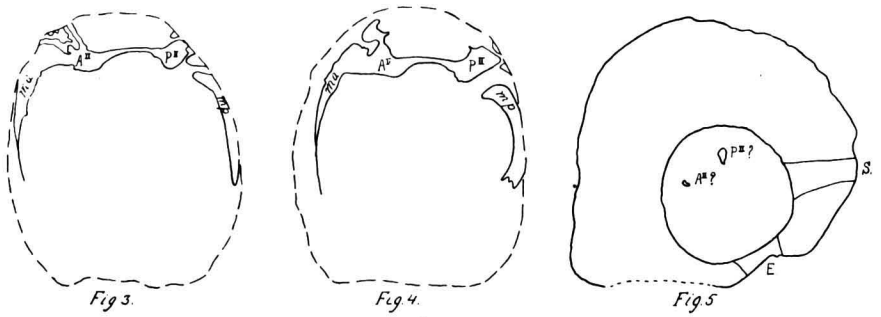

Fig. 3 and 4 : Two sections through the inner cavity of the fragment with preserved dental apparatus. Fig. 5 is the same as Pl. II, fig. 2.

AII : Anterior tooth ; PII : Posterior tooth ; ma : anterior myophore ; mp : posterior myophore ; E : Anterior siphonal channel ; S : Posterior siphonal band.

To the right of PII in fig. 3 and 4 the two ridges forming one of the two grooves serving as a sort of slot for the dental apparatus are visible.

Fig. 3 is a lower section than fig. 4.

In fig. 5 the opaque lines limiting the two trough-shaped siphonal depressions of the funnel-plates have been indicated.

This fragment resembles the holotype in shell-structure, form of inner cavity, decoration of the outer shell surface, etc. Thus I take it to belong to the same species as the type exemplar, and therefore this dental apparatus to be typical of the species.

One most peculiar individual has been found that shows in the wall of the interior cavity the existence of Lapeirousia-like pseudopillars. The funnel plates moreover are more foliaceous. Thus this specimen might be a Lapeirousia. The general bearing however does not differ much from that of the Durania fragments. The cortex is not preserved. This is greatly to be pitied, because now nothing decisive can be said about this animal.

Systematical place :

It will be clear, that this species bears a remarkable resemblance to Durania Mortoni found in the south of England, and to the Durania austinensis first found by ROEMER in Texas. Thus my description of it as a new species under the name originally given by MARTIN to the Curaçaoan fragments, will need some justification.

MANTELL in 1833 (8, p. 130) only names, not describes Hippurites Mortoni. ROEMER in 1849 and 1852 gives only a very insufficient description of a very insufficient fragment found near Austin, and names it Hippurites austinensis (15, p. 410; 16, p. 77). Later more rudists found in Europe have been compared with Durania Mortoni or austinensis and were named

accordingly by their authors. Moreover these two species were considered as identical, for instance by ZITTEL (21, p. 148). TOUCAS divided the material then found, again in two groups. Some fragments are identified by him as Sauvagesia Mortoni others as Sauvagesia austinensis. But certainly these fragments are mostly not good enough to permit this. Thus for example PARONA's fragment, or ZITTEL's (14, Pl. II, fig. 3a, b; 21, Pl. XXV, fig. 1). Moreover all these descriptions leave so much room for different interpretation that for instance TOUCAS (17, p. 97) states that Sauvagesia austinensis has no trace of a ligamental inflexion where BOESE (1, p. 57) assures us that it certainly has. The TOUCAS article appeared 3 years after that of BOESE, but TOUCAS does not mention BOESE at all. Yet some comment in so important a question clearly could be expected. Moreover the only difference to be found in TOUCAS' descriptions between Mortoni and austinensis (17, p. 92 and 96) appears to be the age of the strata in whiuh they were found.

Thus my material although incomplete too as regards the absence of the superior valves, seems to justify my describing it as a new species. The name austinensis will have to disappear from literature until a good specimen is found near Austin in the Austin chalk. Even then it will be questionable if it will not be better to give a new name than to keep the old one which has caused so much confusion.

I choose for this species the specific name originally given by MARTIN to the first fragments found by him. Though later he himself when detecting the Radiolite nature of the material, dropped this name as of course was necessary on account of its fragmentary condition, this name may now be revived. Moreover if later other Radiolite species should be found in Curaçao, it does not matter to which of these the original name is given.

Localities:

The holotype as well as most of the material figured in this article was actually found at Seroe Teintje. Only the "interbande" fragment of Pl. II, fig. 3 was found at the outcrops near Westpunt.

Stratigraphical conclusions:

Finally the age question remains to be considered. Of the group of Vaccinites inaequicostatus according to TOUCAS all members up from Vaccinites CHAPERI have rounded ligamental crests. Vaccinites CHAPERI occurs in the European Santonian strata, while Vaccinites inaequicostatus, Oppeli and vesiculosus occur in the Campanian. In the group of Vaccinites giganteus, only Vaccinites giganteus and its var. major have rounded ligamental crests. Vaccinites giganteus occurs in the Coniacien, Vaccinites giganteus var. major in the Lower Santonian strata. For Durania austinensis TOUCAS gives upper Santonian age in England and likewise in Texas. TOUCAS gives

Ligerian (lower Cenomanian) age for one specimen of Durania Mortoni, while another has been found on the limit of the Turonian and Cenomanian strata. BOESE (1, p. 24) gives Lower Senonian age for the fauna, in which his fragments of the Radiolite, described by him as Radiolites austinensis were found (1, p. 57). As I have already stated, he says that one individual found by him clearly shows a ligamental crest, which would make it principially different from my material. Moreover this would point to an older age than Senonian. (DOUVILLÉ 2, p. 23). On the other hand his figure (1, Pl. XI, fig. 1) is not very convincing, and might easily represent one of the dental or adductory ridges which form a sort of slot for the dental apparatus. In a badly preserved specimen these easily might be mistaken for a somewhat reduced ligamental inflexion, as is shown by some of my fragments.

Everything considered the facts agree quite well with the Lower Senonian age given by GERTH on account of the corals.

A more precise determination of the age is difficult to obtain. The Vaccinites is of a young type. The only other American Vaccinites known is Vaccinites Sanchezi, found by SANCHEZ and described by DOUVILLÉ (3, p. 54). It occurs on Cuba in strata of Dordonian age according to DOUVILLÉ (3, p. 50), but it is entirely different from my species.

SUMMARY:

Two new rudists are described and named Vaccinites Martini n. sp. and Durania curasavica (MARTIN). Thus far this fauna is different from any other fauna known. The age certainly is Senonian, probably Campanian or even Maestrichtian.

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*) Indicates that I could not consult the article in question.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. Vaccinites Martini N°. 1. (Holotype). Seen from the posterior dorsal side. By L., S & E the three grooves corresponding with the ligamental crest and the two pillars are indicated. They are best shown directly beneath the section. × ¾.

Fig. 2. Same specimen. Section. For explanation of details see text rig. 2. ×2/3.

Fig. 3. Same species N°. 5. Seen from the ventralside, so that the second pillar (E) is on the right. × 2/3.

Fig. 4. Same specimen as in fig. 3, seen from above showing the superior valve. This upper valve is much corroded. Thus the pores cannot be seen. The radial canals are shown; likewise the ligamental crest and the two pillars, as the upper valve is worn away over them. L.: Ligamental crest. S.: first pillar. E.: second pillar. × 2/3.

Fig. 5. Vaccinites Martini N°. 3. A more cylindrical form. The outer shell is corroded away on this side, so that the ligamental crest and the two pillars are shown. × 2/3.

Fig. 6. Vaccinites Martini N°. 2. Individual, with pillars and ligamental crest closer together than in the others. For explanation of details see text fig. 1. × 2/3.

Fig. 7. Durania curasavica (Martin). Holotype, seen from the posterior side. The concave anterior siphonal channel and the flat posterior siphonal band are well shown (E and S). × 2/3.

Fig. 8. Durania curasavica (Martin). Vertical section of other individual. Showing the horizontal funnel plates and low prismas. × 4/5.

PLATE II.

Fig. 1. Durania curasavica (Martin). Holotype. Seen from below. E.: anterior siphonal channel. S.: posterior siphonal band. On the "interbande" traces of common larger ribs are shown. From S to the cross, the ribs and sulci are complex as can be seen at several places. × ½.

Fig. 2. Durania curasavica (Martin). Holotype. Section. For explanation of details see text fig. 5. × 5/9.

Fig. 3. Durania curasavica? (Martin). "Interbande" fragment, showing cellular structure, bifurcating vessel impressions, and trough-shaped siphonal depressions of the funnel plates, S and E, as in fig. 1. × ¾.

Fig. 4. Durania curasavica (Martin). "Interbande" fragment showing the trough-shaped siphonal depressions of the funnel plates, S. and E., as in fig. 1. × 2/3.

Fig. 5. Durania curasavica? (Martin) with part of superior valve. The structure of this is not cellular and the much thinner plates are finely striated. × 4/7.

Fig. 6. Durania curasavica (Martin). Showing one individual growing in the interior cavity of another greater one. The two arrows point to the two opaque lines limiting one of the trough-shaped siphonal depressions. E. and S. as in Fig. 1. × 4/7.

Geology. — *Über die möglichen Ursachen der Undationen der Erdkruste.* Von R. W. VAN BEMMELEN. (Communicated by Prof. G. A. F. MOLENGRAAFF).

(Communicated at the meeting of April 2, 1932.)

Von HAARMANN [1]) wurde eine bikausale Darstellung der Bodenbewegungen gegeben, welche von ihm als Oszillationstheorie bezeichnet wurde. In derselben wird unterschieden zwischen: *Primärtektogenese,* welche die vertikalen Bodenbewegungen umfasst, und *Sekundärtektogenese,* wozu gerechnet werden die sekundären Reaktionen, die Abgleitung und Zerrung im gehobenen Gebiete und Zusammenpackung, Faltung und Ueberschiebung im gesenkten Gebiete herbeiführen. Die vertikalen Bodenbewegungen wurden von HAARMANN *Oszillationen* genannt.

Es ist jedoch nicht möglich, mittels dieser Oszillationen alpine Deckenstrukturen mit Total-Ueberschiebungsbeträgen von Hunderten von Kilometern zu erklären. Dies würde die Annahme von Hebungen unwahrscheinlich grossen Ausmasses erheischen.

In einer Abhandlung über die Bikausalität der Bodenbewegungen [2]) legte ich jedoch dar, dass dieser Einwand gegen die Oszillationstheorie zu beseitigen wäre, wenn die primäre Bodenbewegung nicht schlechthin aufgefasst würde als vertikale Hebungen und Senkungen an bestimmtem Orte (Oszillationen), sondern ihr räumliches und zeitliches Verhalten zurückgeführt würde auf eine Wellenbewegung der Kruste, bei welcher der Wel-

[1]) Die Oszillationstheorie. Stuttgart 1930.

[2]) Nat. Tijdschr. v. Ned.-Indië. 3e afl. 1931. Auch: "Magma- und Krustenundationen, Verhand. v. h. Vle Natuurwet. Congr. Bandoeng, Sept. 1931.