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New Maastrichtian Rotaliids from Iran and Libya

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With 7 figures in the text

The here described complex rotaliids viz *Sirtina orbitoidiformis* Brönnimann and Wirz, n. gen., n. sp., and *Vanderbeekia trochoidea* Brönnimann and Wirz, n. gen., n. sp., resemble in their external and in some of their internal features orbitoidal Foraminifera. On the spiral side of *S. orbitoidiformis*, n. sp., occur layers of lateral chambers as known from typical orbitoids, and *V. trochoidea*, n. sp., in addition to layers of lateral chambers on the spiral side of the test, has a layer of equatorial chambers. The tests of the two forms are lenticular and the central portion of the surface is pustulate as in orbitoidal Foraminifera.

The new rotaliids were first discovered by Wirz in cuttings of Pan American International Oil Company's well A-1, located in the Persian Gulf, coordinates 29° 17′ 41″ N. and 49° 31′ 35″ E. The cuttings are from 165 ft of lower Maastrichtian glauconitic limestones, calcisiltites and silty marls regarded as the equivalent of the Qurna formation of the Kuwait–Basra area (Owen and Nasr, 1958). Besides *S. orbitoidiformis*, n. sp. and *V. trochoidea*, n. sp., ostracodes, fragments of bryozoa, pelecypods and echinoderms, and representatives of the benthonic foraminiferal genera *Anomalina, Cibicides, Elphidiella, Fissoelphidium, Frondicularia, Gyroidina, Goupillaudina, Rotalia, Stensiöina, Valvulineria, Clavulinoides, Gaudryina* and *Marssonella*, Wirz also identified the following planktonic species:

Globigerinella messinae messinae Brönnimann
Heterohelix spp.
Pseudoguembelina spp.

This assemblage is from beds of Lower Maastrichtian age which disconformably overlie an Upper Campanian or Lower Maastrichtian marl with:

Globotruncana cf. *fornicata* Plummer
Globotruncana cf. *contusa* (Cushman)
Globotruncana cf. *arca* (Cushman)
Globotruncana cf. *tricarinata* (Quereau)
Globotruncana stuarti (de Lapparent) group.

Lithology and faunal elements of the Qurna formation equivalent suggest a depositional environment of middle to outer shelfal waters. Wirz kindly sent the orbitoid-like rotaliids to Brönnimann who subsequently encountered numerous

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oblique axial sections of *S. orbitoidiformis*, n. sp., in cores of Esso Libya's well Zelten C10-6 and of Esso Sirte's well Raguba E7-20 both located in the Sirte basin, Cyrenaica, Libya. On the other hand, *V. trochoidea*, n. sp., was not found in the Libyan material. The cores with the complex rotaliids are from calcarenites of the *Rugotruncana gansseri*-bearing Lower Maastrichtian upper Zmam formation. The Libyan and the Iranian forms, therefore, occur in beds of the same age representing very similar depositional environments. The calcarenite from E7-20, core No. 5 at 5704 ft, is composed of closely packed and poorly sorted angular fragments of mollusks, echinoderms and algae. In addition to *S. orbitoidiformis*, n. sp., the thin sections show fragments of other orbitoidal Foraminifera, miliolids and of nondescript benthonic Foraminifera. The calcarenite from C10-6, core No. 8, 7815–7845 ft, contains much argillaceous material, partly replaced by clear calcite, abundant angular fragments derived from the tests of organisms among which are spines of *Siderolites calcitrapoides* LAMARCK, and common planktonic microfossils. There occur also scattered angular quartz grains. The planktonic assemblage is characterized by *Rugotruncana gansseri* (BOLLI), *Globotruncana stuarti* (DE LAPPARENT), *Pseudotextularia elegans* (RZEHAK), *Rugoglobigerina rugosa* (PLUMMER) group, *Pseudoguembelina* spp. and *Heterohelix* spp. The depositional environment of the Zmam formation as represented by the core from E7-20 is interpreted as inner shelfal, probably littoral, that from C10-6 as shelfal, possibly middle to outer shelf, as indicated by the admixture of much argillaceous material to the calcarenaceous texture and by the common planktonic Foraminifera.

Depositorium:

The illustrated material will be deposited in the collections of the U.S. National Museum, Washington 25, D.C.

Genus *Sirtina* BRÖNNIMANN and WIRZ, n. gen.

Genotype: *Sirtina orbitoidiformis* BRÖNNIMANN and WIRZ, n. sp.

Definition: Test rotaloid, trochoid during early ontogeny, planispiral-involute in the adult. Umbilical mass composed of tightly packed pillars devoid of lacunes or of lateral chambers. There are thin vertical canals between the pillars of the umbilical mass. Dorsal side with several layers of lateral chambers and with pillars.

Differences: The only genus similar to *Sirtina*, n. gen., is the late Campanian *Arnaudiella* H. DOUVILLÉ. *Arnaudiella* is devoid of equatorial formations and combines test and lateral chambers of an orbitoid with a rotaloid spiral. *Arnaudiella*, however, differs from *Sirtina* by a perfectly bilateral-symmetric test, with layers of lateral chambers of orbitoidal type on both sides of the involute spiral, and by its thickened marginal wall which, according to the cross section of *A. grossouvrei* H. DOUVILLÉ, 1907, exhibits some sort of radial structure reminiscent of that encountered in the thickened walls and spines of *Siderolites* LAMARCK and in the thickened walls of *Pseudosiderolites* SMOUT (H. DOUVILLÉ, 1907, p. 599, fig. 12).

Age and occurrence: Lower Maastrichtian, *Rugotruncana gansseri zone*, Iran, Libya.

Sirtina orbitoidiformis BRÖNNIMANN and WIRZ, n. sp.
Text-figs. 1–6

Holotype: *Sirtina orbitoidiformis* BRÖNNIMANN and WIRZ, text-figs. 2 a–c. Lower Maastrichtian, *Rugotruncana gansseri* zone. Pan American International Oil Company's well A-1, Persian Gulf, Iran, cuttings from 6470 ft.

Description

Exterior: The description of the exterior of *S. orbitoidiformis*, n. sp., is based on the fairly well preserved free specimens from Iran. The Libyan forms are known only by oblique axial sections in thin sections of cores. The test is relatively small and subcircular to broad-ellipsoid in outline. In its overall appearance it is *Miogypsina*-like (text-figs. 2, 3). The greatest diameter ranges from 0.42 to 1.5 mm and the thickness from 0.2 to 0.65 mm (text-fig. 1). Adult specimens have a wide and thin peripheral flange composed of narrow, radially elongate involute chambers

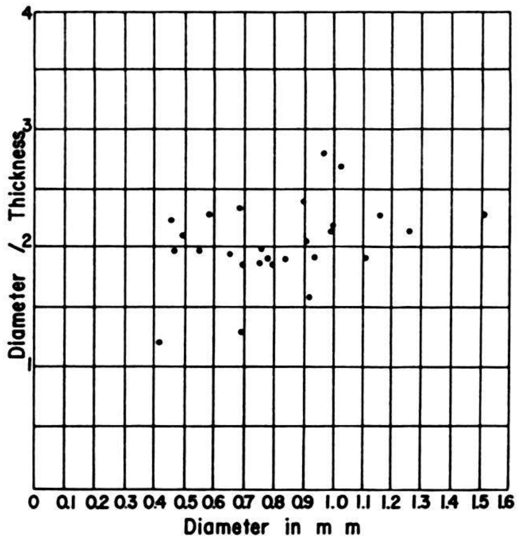

Fig. 1. Diagram of dimensions of the test of *Sirtina orbitoidiformis* BRÖNNIMANN and WIRZ, n. sp.

suggesting a planispiral rotaloid internal structure. The margin of the test is distinctly acute and thin-walled. The surfaces of the axial thickenings or umbos are pustulate. The dorsal and ventral pustulate thickenings may be equally developed, or one side may show a more prominent thickening than the other side. This feature changes from specimen to specimen. As may be seen in axial sections, the stronger thickening with its umbilical mass of conical pillars usually indicates the ventral side of the test. The septa of the involute spiral chambers extend on both sides of the test deep into the lateral thickenings where they gradually disappear between the pustules. Young individuals are trochoid with a slightly convex and relatively finely pustulate dorsal side and a stronger convex and relatively coarser pustulate ventral side (text-figs. 3 d–e). The umbilicus is completely filled by a ventral mass of pillars whose surface is covered by strong pustules. Being centrally masked by the pustulate lateral thickening, the dorsal spiral shows only the final whorl of broad and low chambers formed by thick and strongly curved septa. In adult specimens the differentiation into dorsal and ventral sides can no longer be maintained, not only because the trochoid spiral tends to become involute but also because dorsal and ventral types of pustulation, so different in

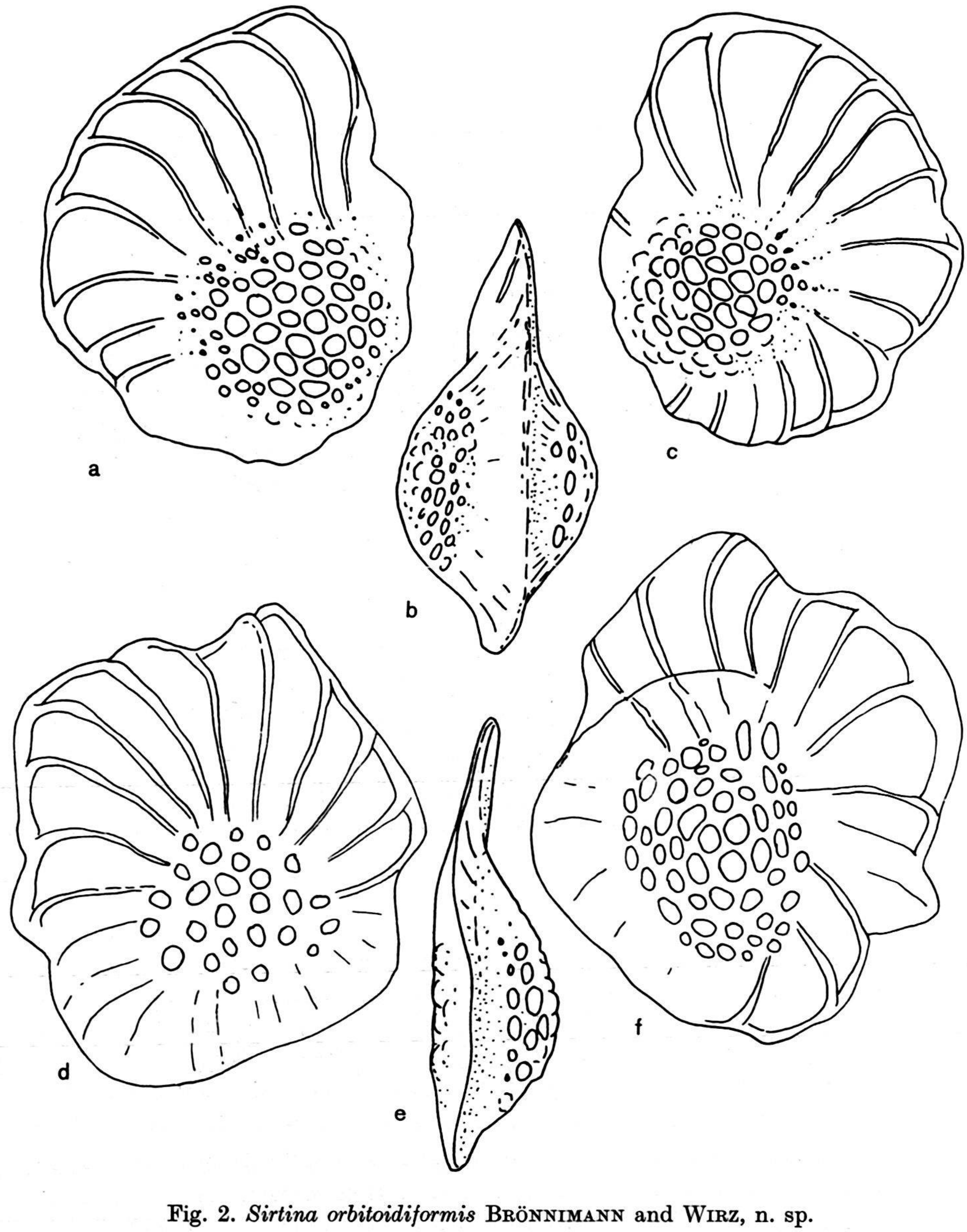

Fig. 2. *Sirtina orbitoidiformis* BRÖNNIMANN and WIRZ, n. sp.
a–c Holotype. Pan American International Oil Company's well A-1. Cuttings at 6470 ft.
a, dorsal view b, side view c, ventral view
d–f Pan American International Oil Company's well A-1. Cuttings at 6470 ft (specimen sectioned, see text-fig. 6). All ×57.
d, dorsal view e, side view f, ventral view

young individuals, grow extremely similar. The occasional and variable axial asymmetry of the adult test, however, may still reflect the early ontogenetic trochoid differentiation.

Interior: The rotaliid nature of the superficially orbitoid-like test is revealed by axial sections which in the form of more or less oblique cuts are the normal

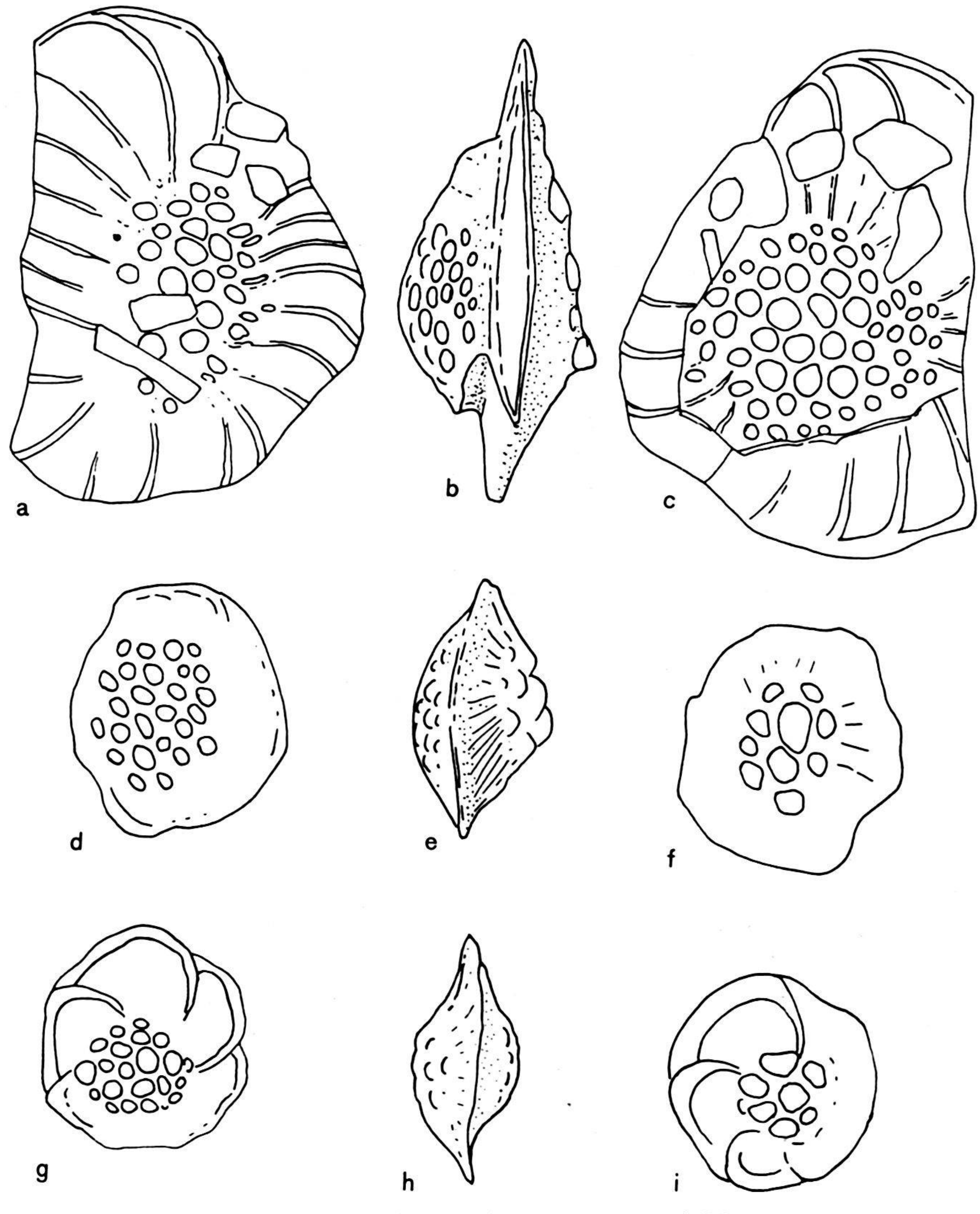

Fig. 3. *Sirtina orbitoidiformis* BRÖNNIMANN and WIRZ, n. sp.
a–c Pan American International Oil Company's well A-1. Cuttings at 6140 ft.
a, dorsal view b, side view c, ventral view
d–f As above. Cuttings at 6400 ft. Young specimen.
d, dorsal view e, side view f, ventral view
g–i As above. Cuttings at 6430 ft. Young specimens.
All ×57.

ones in thin sections of rock pieces. In the course of ontogeny the early trochoid spiral is followed by an almost involute to completely involute adult spiral. The umbilical region is filled by tightly packed robust pillars. The ventral mass is devoid of lacunes or of lateral chambers. Between pillars there appear to be thin vertical canals. The spiral side, on the other hand, is covered by 3 to 6 layers of lateral chambers interspersed by relatively delicate pillars. Communication between lateral chambers is by basal stolos and by numerous fine pores. The dorsal mass, therefore, shows all the characteristics of the lateral layers of a typical orbitoidal foraminifer. The strongest development of umbilical pillars and of

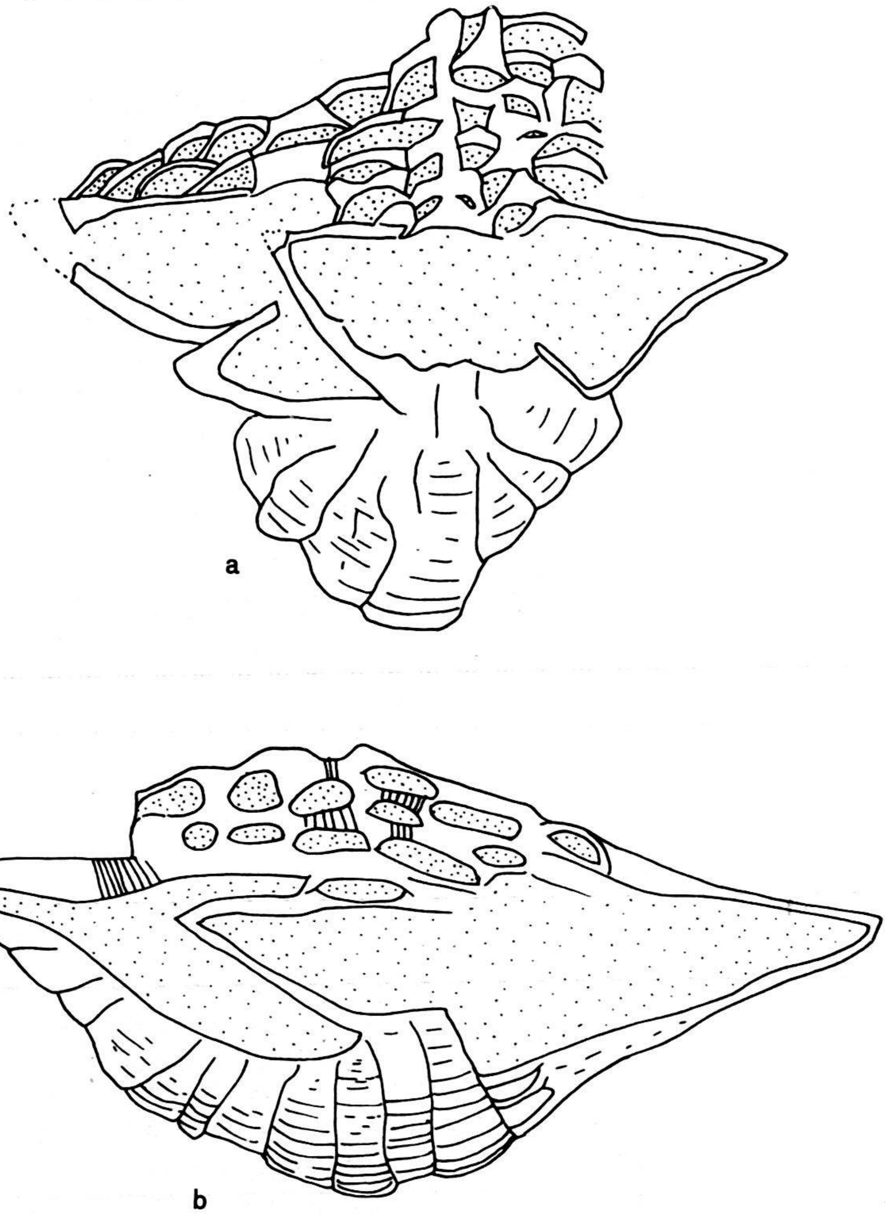

Fig. 4. *Sirtina orbitoidiformis* BRÖNNIMANN and WIRZ, n. sp.
a Oblique axial section. Esso Sirte Raguba well E7-20, core no. 5, at 5704 ft.
b Oblique axial section. Pan American International Oil Company's well A-1. Cuttings at 6480 ft.
Both ×112,5

dorsal lateral layers is in the direction of the axis of the rapidly opening spiral. This explains the *Miogypsina*-like asymmetry of the adult test.

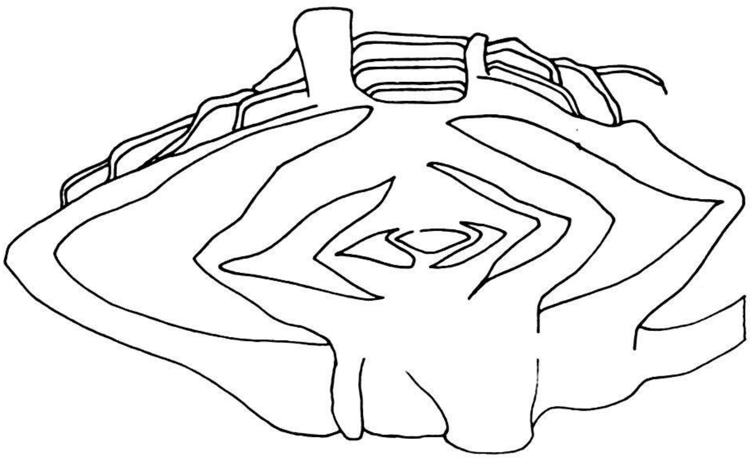

Fig. 5. *Sirtina orbitoidiformis* BRÖNNIMANN and WIRZ, n. sp. Oblique axial section of a virtually planispiral individual. Esso Libya Zelten well C10-6, core no. 8, at 7815–7845 ft. ×112,5

The following measurements are from the illustrated oblique axial sections (text-figs. 4a, 4b and 5):

		Specimen	
	E7-20	C10-6	A-1, 6480 ft
Diameter of test	0.74 mm	0.99 mm	0.85 mm
Thickness of test	0.6 mm	0.35 mm	0.44 mm
Thickness of lateral layers	192 μ	57 μ	128 μ
Layers of lateral chambers	5–6	3	3–4
Length of lateral chambers of last-formed layers	70–90 μ	60–100 μ	38–55 μ
Height of lateral chambers of last-formed layers	25–30 μ	15–20 μ	±25 μ
Diameter of umbilical mass	383 μ	256 μ	381 μ
Thickness of umbilical mass . . .	228 μ	115 μ	120 μ
Diameter of umbilical pillars . . .	30–100 μ	±75 μ	20–65 μ
Diameter of dorsal pillars	±25 μ	10–38 μ	±30 μ

The centered horizontal section of *S. orbitoidiformis*, n. sp., is characterized by a rapidly opening spiral of about 3 whorls. The radial diameter of spiral chambers has been measured in the illustrated axial section of the specimen from C10-6 (text-fig. 5). It almost quadruples from 35 to 128 μ within a single complete pre-adult whorl. In the illustrated horizontal section of the specimen from Iran, the radial diameter of spiral chambers opens from about 50 μ to about 150 μ after one whorl, to about 260 μ after the second and to 285 μ after the third whorl (text-fig. 6). The spiral begins with a relatively small bilocular embryo. Protoconch and deuteroconch are both subcircular and equidimensional. The connection between the embryonic chambers was not seen. The early ontogenetic spiral chambers are rather broad, the later ones become relatively narrow and radially elongate. The spiral chambers seem to be connected by basal stolos. The septa are doublewalled, strongly curved in the early portion of the test and almost straight in the final ontogenetic stages.

Fig. 6. *Sirtina orbitoidiformis* BRÖNNIMANN and WIRZ, n. sp. Centered equatorial section prepared from specimen illustrated by text-fig. 2, d–f. ×112,5

The below listed measurements are from the centered horizontal section of an Iranian specimen illustrated by text-fig. 6:

Diameter of test	1.0 mm
Diameter of protoconch (incl. walls)	51 μ
Diameter of deuteroconch (incl. walls)	51 μ
Radial diameter of average adult spiral chamber . .	285 μ
Tangential diameter of average adult spiral chamber.	100–130 μ
Thickness of septum of adult chamber	8– 13 μ

Genus *Vanderbeekia* BRÖNNIMANN and WIRZ, n. gen.

Genotype: *Vanderbeekia trochoidea* BRÖNNIMANN and WIRZ, n. sp.

Definition: Test rotaloid, ventral side with spiral chambers throughout ontogeny. Umbilical mass composed of tightly packed pillars devoid of lacunes or lateral chambers. Apparently with vertical canals between pillars. Dorsal side with numerous layers of lateral chambers and with pillars separated from the ventral spiral chambers by a layer of equatorial chambers slightly inclined from the periphery to the center of the test.

Differences: Morphologically, *Vanderbeekia*, n. gen., is related with *Sirtina*, n. gen. Both are rotaliids and both carry systems of lateral chambers with pillars on the dorsal side and a pillared mass on the ventral side. However, in contrast to *Sirtina*, n. gen., *Vanderbeekia*, n. gen., develops a layer of equatorial chambers between the lateral chambers of the dorsal side and the ventral spiral chambers. By this new feature *Vanderbeekia*, n. gen., is more orbitoid-like than *Sirtina*, n. gen., which may be its ancestral form. The phylogenetic relationship between *Sirtina*, with lateral chambers, and *Vanderbeekia*, with lateral and equatorial chambers, is similar to that between the rotaloid *Sulcorbitoides* BRÖNNIMANN from the Upper Cretaceous of the Caribbean area, with lateral chambers, and *Pseudorbitoides* H. DOUVILLÉ, where in addition to lateral chambers a distinct layer of equatorial elements occurs.

Age and occurrence: Lower Maastrichtian, *Rugotruncana gansseri* zone. Associated with *Sirtina*, n. gen., Iran.

Vanderbeekia trochoidea BRÖNNIMANN and WIRZ, n. sp.
Text-fig. 7

Holotype: *Vanderbeekia trochoidea* BRÖNNIMANN and WIRZ, n. sp., text-fig. 7. Lower Maastrichtian, *Rugotruncana gansseri* zone. Pan American International Oil Company's well A-1, Persian Gulf, Iran, cuttings from 6480 ft.

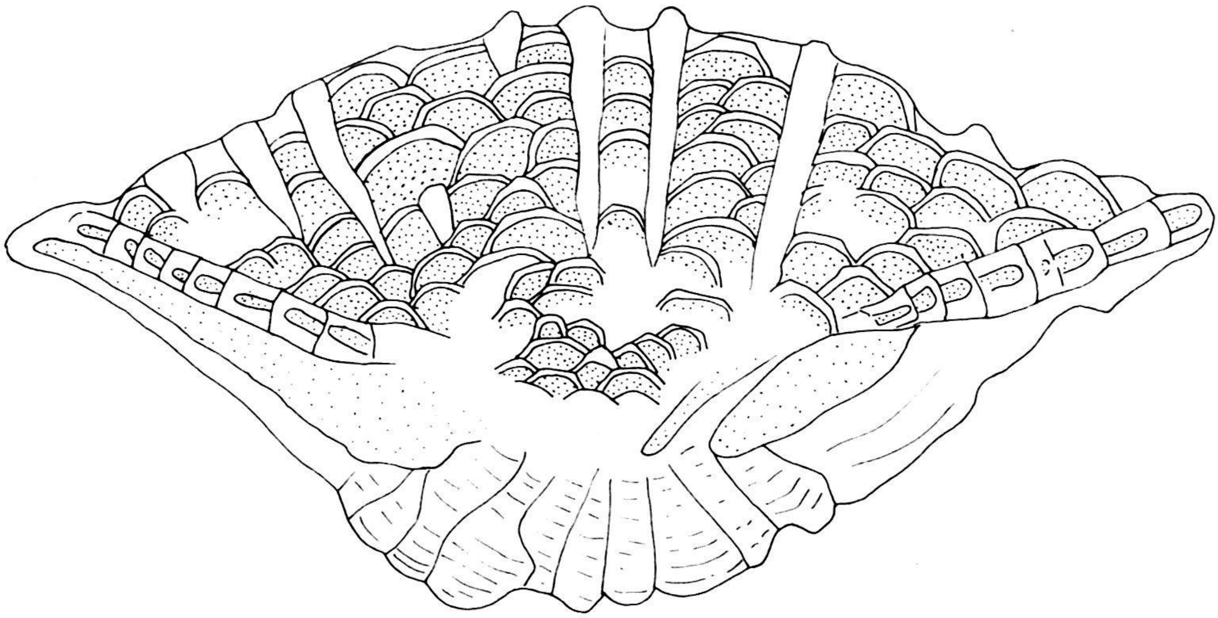

Fig. 7. *Vanderbeekia trochoidea* BRÖNNIMANN and WIRZ, n. sp. Holotype. Pan American International Oil Company's well A-1. Cuttings at 6480 ft. ×112,5

Description

V. trochoidea, n. sp., is known only from oblique axial sections. The surface of the ventral side with its spiral chambers and strongly papillate umbilical mass is virtually identical with that of the ventral side of *S. orbitoidiformis*, n. sp. The dorsal side is completely covered by lateral chambers with interspersed thin pillars and, therefore, its surface must appear like that of any typical orbitoidal foraminifer. The axial section exhibits a single layer of rather thick-walled distally rounded equatorial chambers of small lumina. The equatorial layer is somewhat inclined from the periphery to the center of the test forming a wide-angle cone. The shape of the equatorial chambers in equatorial section is unknown. The lateral chambers are peripherally rounded and connected by basal stolos and by fine pores. The pillars are thin. The umbilical mass is composed of robust pillars. There probably occur, as in *S. orbitoidiformis*, n. sp., thin canals between the pillars. The embryonic chambers are unknown.

The following measurements are from the illustrated oblique axial section text-fig. 7.

Diameter of test	1.27 mm
Thickness of test	0.63 mm
Thickness of equatorial layer	51–65 μ
Diameter of ventral mass	0.51 mm
Thickness of ventral mass	0.13 mm
Diameter of ventral pustule	25–55 μ
Diameter of dorsal pustule	20–40 μ
Length of average peripheral lateral chamber	50–90 μ
Height of average peripheral lateral chamber without walls	25–38 μ

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