Genus EPONIDES MONTFORT, 1808

Eponides pygmeus (VON HANTKEN)

Pl. VII, fig. 11

Pulvinulina pygmea VON HANTKEN, 1875, Mitt. Jahrb. K. Ungar. Geol. Anst., vol. 4, pt. 1, p. 78, pl. 10, fig. 8; ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 216, pl. 8, fig. 13.
Eponides pygmeus (VON HANTKEN), HAGN, 1952, Geol. Bav., no. 10, p. 177.
Eponides cf. *E. pygmeus* (VON HANTKEN), BHATIA, 1955, Journ. Pal., vol. 29, p. 683, pl. 67, fig. 7.

Remarks. — A number of specimens of this species were found in some of our Belgian Boom clay samples. They are fairly variable in relative thickness; one of the thicker individuals has been figured. Our specimens show scattered large pores on both sides, mainly dorsally.

Distribution.

Boom clay : AA 657, JB 359, 360, JC 585, JG 611, JH 613, JJ 620, JM 642, MA 649, 652.

Eponides umbonatus (REUSS)

Pl. VII, fig. 10

Rotalina umbonata REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 75, pl. 5, fig. 35.
Pulvinulina umbonata (REUSS), REUSS, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 162; BRADY, 1884, Rep. Voy. « Challenger », Zool., vol. 9, p. 695, pl. 105, fig. 2.
Eponides umbonatus (REUSS), TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 88, pl. 6, fig. 7.
Pulvinulina tenera BRADY, 1884, Rep. Voy. « Challenger », Zool., vol. 9, p. 665, pl. 95, fig. 11.

Remarks. — This species, originally described from the Septaria-clay of Hermsdorf and Freienwalde, was met with in many Boom clay samples.

The peculiar curvature of the ventral sutures near the closed umbilicus is variable, but never so strongly developed as in *E. umbonatus* var. *ecuadorensis* (GALLOWAY and MURRAY), (*Rotalia ecuadorensis*, GALLOWAY and MURRAY, 1929, Bull. Am. Pal., vol. 15, p. 26, pl. 3, fig. 13). Specimens with completely straight ventral sutures occur as well.

Distribution.

Boom clay : AA, AE, JA-JJ, JM, MA, ME, OA, Kuiperberg, Winterswijk.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

Genus VALVULINERIA CUSHMAN, 1926

Valvulineria petrolei (ANDREAE)

Pl. VIII, fig. 1

Pulvinulina petrolei ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 217, pl. 8, fig. 15.

Remarks. — This species, originally described from the Septaria-clay of Lobsann (Alsace) is frequent in our sample from Pietzpuhl and rare in several samples of the Boom clay and in the sample from Dingden.

Distribution.

Middle Miocene : Dingden 456.

Boom clay : AA, JF-JJ, JM, MA, ME, OA.

Septaria-clay : Hermsdorf 10445, Pietzpuhl 10447.

Genus GYROIDINA d'ORBIGNY, 1826

Gyroidina soldanii d'ORBIGNY

Pl. VII, figs. 12-15

Gyroidina soldanii d'ORBIGNY, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 278, Modèle 36; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 64.

Rotalina soldanii d'ORBIGNY, 1846, For. Foss. Vienne, p. 155, pl. 8, figs. 10-12.

Rotalia soldanii (d'ORBIGNY), BRADY, 1884, Rep. Voy. « Challenger », Zool., vol. 9, p. 706, pl. 107, figs. 6, 7.

Rotalina girardana REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 73, pl. 5, fig. 34.

Gyroidina girardana (REUSS), TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 86, pl. 6, fig. 5.

Remarks. — *G. soldanii* is rare to very abundant in many of the Boom clay samples. Especially the individuals from Hermsdorf and Pietzpuhl clearly show considerable variation.

In all our material *G. soldanii* var. *girardana* (pl. VII, fig. 12), originally described from the Septaria-clay of Hermsdorf and Freienwalde, is the most frequent form, especially among the bigger specimens. This variant is very high with deeply depressed dorsal spiral suture. Another variant, most common among the smaller individuals, is more compressed with a flattened dorsal side, broadly rounded periphery, sutures flush or slightly depressed and the umbilicus often closed. Characteristic *G. soldanii* would be somewhere intermediate in between both these extreme types.

Such forms as figured by ANDREAE (1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 224, pl. 9, fig. 5) as *Rotalia girardana* (REUSS) were equally met with. They have a flat dorsal side.

Among the smaller individuals of two samples (JF 609, JM 642) another variant with elevated dorsal spiral is present (pl. VII, fig. 15). It may be identified with *G. soldanii* var. *mamillata* (ANDREAE), (ANDREAE, 1884, op. cit., p. 234, pl. 9, fig. 4). In some specimens the spire is even more elongated than it is in ANDREAE's type specimen.

Distribution.

German Upper Oligocene : Astrup 17538.

Boom clay : AA, AE, HB, JA-JC, JE-JN, MA, ME, OA, VA Kuiperberg, Winterswijk.

Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

Nucula-clay : BZ553.

Lower Tongeren beds : Hendrik IV, 209-210 m.

Genus ROTALIATINA CUSHMAN, 1925

Rotaliatina bulimoides (REUSS)

Pl. VIII, figs. 3, 4

Rotalina bulimoides REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 77, pl. 5, fig. 38.

Rotaliatina bulimoides (REUSS), TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 87, pl. 6, fig. 4.

Remarks. — The species is rare to common in several Boom clay samples.

The type figure is rather schematic. Our specimens show some variation, which has also been mentioned in REUSS's type description : many of the individuals have a much enlarged final whorl, while in others the whorls remain increasing regularly in size. The number of coils may amount to five.

This species may be somehow related to *Turrilina alsatica* ANDREAE, which has the same type of elongate spiral with a basal slit-like aperture in the final chamber.

R. bulimoides has only been reported from Middle Oligocene clays of NW Europe.

Distribution.

Boom clay : AE, HB, JF, JJ, JL, JN, VA, Winterswijk.

Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

SUBFAMILY **CANCRININAE**

Genus CANCRIS MONTFORT, 1808

Cancris auriculus (FICHTEL and MOLL)

Pl. X, fig. 3

Nautilus auricula FICHTEL and MOLL, 1803, Test. Micr., var. α, p. 108, pl. 20, figs. *a-c*. var. β, p. 110, pl. 20, figs. *d-f*.

Cancris auriculus (FICHTEL and MOLL), CUSHMAN and TODD, 1942, Cushm. Found. For. Res., Contr., vol. 18, p. 74, pl. 18, figs. 1-11, pl. 23, fig. 6.

Remarks. — In our Miocene material there are no limits apparent between *C. auriculus, C. sagra* (D'ORBIGNY) and *C. oblonga* (WILLIAMSON), as described by CUSHMAN and TODD (1942).

The specimens from the Upper Oligocene of Astrup are on the average somewhat thicker and with less sharply acute periphery. They are evidently identical with the variety *C. auriculus* var. *primitivus* CUSHMAN and TODD (1942, op. cit., p. 77, pl. 19, figs. 1, 2), originally described from the Oligocene of Osnabrück.

Distribution.

Middle Miocene : Antwerp, Burcht, Heist 26 m, Dingden 456.

Voort sand : Lillo 84, 89.

German Upper Oligocene : Astrup 17538, Kassel 12667.

Cancris turgidus Cushman and Todd

Pl. X, fig. 5

Pulvinulina haueri Franke (not *Rotalina haueri* d'Orbigny), 1925, Abh. Ber. Mus. Nat. Heimatk. Naturw. Ver. Magdeburg, vol. 4, pt. 2, p. 183, pl. 6, fig. 58.
Cancris turgidus Cushman and Todd, 1942, Cushm. Lab. For. Res. Contr., vol. 18, p. 92, pl. 24, figs. 3, 4.

Remarks. — In our specimens there is no clear area in the wall of the last-formed chamber. Otherwise they agree well with the type description and figure.

Some specimens from the Lower Tongeren beds of shaft Hendrik IV are somewhat less elongate and have a slightly more rounded periphery than the specimens from Kassel and Astrup. A few indistinct fragmented individuals were found in the Lower Tongeren beds of Hoeselt.

This species was originally described from the Upper Oligocene of Kassel. It has also been recorded from the Lower Oligocene of Calbe near Magdeburg, and of Lattorf. Hagn (1955, Zschr., Deu. Geol. Ges., vol. 105, p. 348) mentioned it from Rupelian Chattian and Aquitanian deposits of Ortenburg (Bavaria).

Distribution.

German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Lower Tongeren beds : ?TL 529, Hendrik IV, 191-192 m, 193-195 m.

Family ANOMALINIDAE

Genus CIBICIDES Montfort, 1808

Cibicides sulzensis (Herrmann)

Pl. IX, fig. 5

Discorbina sulzensis Herrmann, 1917, Mitt. Geol. L. anst. Els.-Loth., vol. 10, pt. 3, p. 290, pl. 3, fig. 2.
Cibicides baileyi Beck, 1943, Journ. Pal., vol. 17, p. 611, pl. 109, figs. 7-9.

Remarks. — A number of *Cibicides* individuals from the Boom clay and Berg sand, agree well with the type description and figure of *Cibicides sulzensis* from the Septaria-clay of Weidenweg (Alsace).

C. sulzensis is a characteristic species for the Boom clay, in which it is of frequent occurrence. The specimens are often of brownish colour and they show but little variation. There is a more or less prominent peripheral keel; the umbilicus may have a glassy flush filling and the number of chambers in the final coil varies between five and nine, seven and eight being the most commonly observed numbers. One or more of the final chambers of some of our individuals are inflated as is the case in the specimen figured by Herrmann.

C. sulzensis is clearly separable from the *C. dutemplei* group.

According to the description and figures *C. baileyi* Beck from the Eocene Cowlitz formation of northern America would be a distinct synonym.

Distribution.

Boom clay : AA, AE, JA-JJ, JL, JM, MA, ME, OA, VA, Kuiperberg.
Berg sand : BZ 505.

Cibicides dutemplei (D'ORBIGNY)

Pl. IX, figs. 9-11

Rotalina dutemplei D'ORBIGNY, 1846, For. Foss. Vienne, p. 157, pl. 8, figs. 19-21.

Truncatulina dutemplei (D'ORBIGNY), REUSS, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 160, pl. 4, fig. 16.

Pseudotruncatulina dutemplei (D'ORBIGNY), ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 213, pl. 8, fig. 10.

Cibicides dutemplei (D'ORBIGNY), TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 99, pl. 8, fig. 3; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 72; KAASSCHIETER, 1955, Verh. Kon. Ned. Ak. Wet., Nat., ser. 1, vol. 21, no. 2, p. 94, pl. 11, fig. 3.

Rotalia taeniata BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 341, pl. 16, fig. 8.

Rotalia praecincta KARRER, 1868, Sitz.ber. K. Ak. Wiss. Wien, vol. 58, p. 189, pl. 5, fig. 7.

Truncatulina praecincta (KARRER), BRADY, 1884, Rep. Voy. « Challenger », Zool., vol. 9, p. 667, pl. 95, figs. 1-3.

Cibicides peelensis TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 100, pl. 8, fig. 8, pl. 10, fig. 10.

Remarks. — *Cibicides dutemplei* and its allies are very common in many of the stratigraphic members dealt with in the present paper, especially in the Boom clay.

These numerous *Cibicides* individuals form a highly variable group, in which clear boundaries in between distinct species could generally not be traced. A number of types could be distinguished, for each of which specific names may be easily found in the literature. Occasionally the specimens of a sample can be separated into different groups around these types, but mostly such separation is rendered illusionary through the numerous intermediates in the rich material.

C. dutemplei is the most common type in our material, occurring throughout our Oligo-Miocene stratigraphic section.

Although our specimens show a wide variation, they agree fairly well with the specimens of MARKS and KAASSCHIETER from the Vienna and Aquitaine basins respectively.

Distinct *C. dutemplei* (pl. IX, fig. 9) is biconvex, ventrally more strongly so, coarsely perforated on both sides, with the sutures depressed ventrally, flush and limbate dorsally, with mostly eight to nine chambers in the final coil (range six to thirteen, increasing in number with larger size), without ornamentation.

It is often difficult in our material to distinguish *C. dutemplei* from either *C. tenellus* or *C. ungerianus*; the species often occur together. When, however, *C. ungerianus* has its characteristic dorsal granulation or *C. tenellus* has its glassy umbilical knob, the assemblage can be easily split into distinct groups of individuals. But often distinct *C. dutemplei* is found together with variants that are intermediate between this species and the other two.

A third species that in some cases is hardly distinguishable from *C. dutemplei*, is *C. lobatulus*. Individuals were found that have a lobulated periphery in the later portion of the test, while the earlier part is clearly reminiscent of *C. dutemplei*. The determination of such specimens is a matter of opinion.

In stratigraphic order the following additional remarks may be given.

In the Lower Tongeren beds of Hoeselt and shaft Hendrik IV, there occur a number of specimens that for the greater part are distinct *C. dutemplei*. In these individuals the number of chambers never exceeds ten. They occur together with individuals that resemble *C. tenellus* but which lack the characteristic glassy knob of that species.

The brackish Upper Tongeren members yielded only a single *C. dutemplei* individual. It is of the type of *C. praecinctus* (see below) and it was found in the Oude-Biezen member.

In the Boom clay the *C. dutemplei* group is very common. Together with *Spiroplectammina carinata* it forms a substantial part of the foraminiferal fauna of that clay. REUSS (loc. cit.) and ANDREAE (loc. cit.) remarked that the number of chambers in *C. dutemplei* in the German Septaria-clay is greater than it is in typical *C. dutemplei* from the Miocene of the Vienna basin. The same holds true of the Boom clay specimens, where the observed maximum number of chambers in the last coil is eleven, mostly in the largest but occasionally also in the smaller specimens. In small ones this number is usually six or seven. Most specimens have nine or ten chambers in the final whorl.

Distinct *C. dutemplei* does occur in the Boom clay, but most specimens of this member show a tendency towards, or are even identical with *C. praecinctus* (KARRER) (pl. IX, fig. 10). They are relatively thick, with limbate and raised sutures between the chambers and the whorls. *C. praecinctus* is in our material a variant of *C. dutemplei*. *Rotalia taeniata* BORNEMANN from the Septaria-clay of Hermsdorf with its broad sutures is another, poorly figured, variant of *C. dutemplei*, close to *C. praecinctus*.

From the strata younger than the Boom clay, we have a number of distinct *C. dutemplei* specimens. Only very rarely do they have eleven chambers in the last coil. Most individuals have eight to nine visible chambers ventrally. A smaller part of them has limbate, slightly raised sutures on both sides and when they have relatively many chambers (ten, eleven) they closely resemble the *C. dutemplei* specimens from the Boom clay. Most individuals, however, have somewhat depressed sutures ventrally, which are only slightly limbate. The individuals agree perfectly with *C. dutemplei* from the Miocene of the Vienna and Aquitaine basins as found in the collections of MARKS and KAASSCHIETER. Furthermore we found specimens (pl. IX, fig. 11) that are identical with the type material of *C. peelensis* from the Miocene of the Netherlands. This species is evidently only a variant with a slightly lower number of chambers. Many intermediates occur between distinct *C. dutemplei* and *C. peelensis*, which has up to nine chambers.

Distribution.

Middle Miocene : Antwerp, Burcht, Heist 26 m, Dingden 456.
Horizon of Houthalen : Houthalen I, 80,25-80,79 m.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Voort sand : Lillo 81, 83, 84, 89, 90, 92, 98, 105, 113.
Boom clay : AA, AE, HB, JA-JD, JG-JK, JM, JN, MA, ME, OA, VA, Kuiperberg, Winterswijk.
Septaria-clay : Hermsdorf 13438, Pietzpuhl 10447.
Oude-Biezen member : BZ 540.
Lower Tongeren beds : TL 529, Hendrik IV, 190-192 m, 193-204 m, 205-207 m, 209-210 m.

Cibicides tenellus REUSS

Pl. IX, figs. 3, 4

Truncatulina tenella REUSS, 1865, Sitz.ber. K. Ak. Wiss. Wien, vol. 50, p. 477, pl. 5, fig. 6.
Cibicides tenellus (REUSS), TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 99, pl. 8, fig. 6, pl. 10, fig. 2; HAGN, 1952, Geol. Bav., no. 10, p. 187.

Remarks. — *Cibicides tenellus* was originally described from the Upper Oligocene of the Doberg near Bünde (Germany). Furthermore, TEN DAM and REINHOLD recorded this species from the Dutch Middle and Upper Oligocene.

Distinct specimens of this species were found in our material from Kassel and Astrup; at both localities it is common.

C. tenellus is characterized by the glassy knob that fills the umbilicus. Less characteristic features are the large number of chambers and the peculiar curvature of the sutures on the ventral side, which are slightly curved centrally and distinctly more so near the periphery. However, there is wide variation, which in many samples makes a separation of *C. tenellus* from *C. dutemplei* very subjective.

Distinct *C. tenellus*, as it was found in Astrup, shows a variation from seven to thirteen in the number of chambers of the final convolution. In most specimens this number is in between nine and twelve. There is no general relation between the number of chambers and the size of the individual. The ventral sutures are often depressed, but limbate sutures that are flush with the surface occur as well. The sutures on the dorsal side are just like they are in characteristic *C. dutemplei*. The wall is coarsely perforated on both sides, but in some specimens from Astrup the ventral side contains but a very small number of large pores.

Distinct *C. tenellus* is also occasionally present in the sand of Voort, in which it is accompanied by *C. dutemplei* and intermediates.

In the Lower Tongeren beds from shaft Hendrik IV and from Hoeselt, a number of *Cibicides* specimens was found, which partly resemble *C. tenellus*. However, the typical glassy knob is wanting in all these individuals. Very few of them have a depressed umbilicus with some indistinct glassy material, which does not form a knob. They agree with *C. tenellus* in the number of chambers and the curvature of the ventral sutures. Because of the absence of the glassy knob these specimens are assigned to *C. dutemplei*, to which they are connected by numerous intermediates.

In the sand of Antwerp of Burcht and of the boring Heist-op-den-Berg some distinct *C. tenellus* specimens were found. They are accompanied by a number of small individuals without glassy knob in the umbilicus.

Distribution.

Middle Miocene : Heist 26 m, Burcht.
Voort sand : Lillo 84, 88, 90, 99, 104.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Lower Tongeren beds : ?TL 529, ?Hendrik IV

Cibicides ungerianus (d'Orbigny)

Pl. IX, fig. 6

Rotalina ungeriana d'Orbigny, 1846, For. Foss. Vienne, p. 157, pl. 8, figs. 16-18.
Cibicides ungerianus (d'Orbigny), ten Dam and Reinhold, 1942, Med. Geol. St., ser. C-V, no. 2, p. 98, pl. 8, fig. 5; Marks, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 73, pl. 8, fig. 2.
Rotalina ungeriana d'Orbigny var. Bornemann, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 341, pl. 16, fig. 5.

Remarks. — Just as *C. dutemplei*, *C. ungerianus* was originally described from the Miocene of the Vienna basin.

The characteristic features of *C. ungerianus* are the strong curvature of the ventral sutures near the periphery and the coarse, granular covering of the earlier dorsal whorls.

The specimens are generally more compressed than characteristic *C. dutemplei* and they have a more acute periphery.

Distinct specimens are common, especially in some of the Boom clay samples. Part of the specimens lack the dorsal knobs. The Dingden individuals are for the greater part also without such ornamentation of the dorsal side.

Distribution.

Middle Miocene : Heist 26 m, Dingden 456.

Voort sand : Lillo 98.

German Upper Oligocene : Kassel 11315, 12667.

Boom clay : AE, HB, JF, JL, JN, VA, Winterswijk.

Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

Cibicides lobatulus (Walker and Jacob)

Pl. IX, figs. 7, 8

Nautilus lobatulus Walker and Jacob, 1798, Adams Essays, Kanm. Ed., p. 642, pl. 14, fig. 36.

Truncatulina lobatulus (Walker and Jacob), Cushman, 1918, U.S. Geol. Surv., Bull. 676, p. 16, pl. 1, fig. 10, p. 60, pl. 17, figs. 1-3.

Cibicides lobatulus (Walker and Jacob), Kaasschieter, 1955, Verh. Kon. Ned. Ak. Wet., Nat., ser. 1, vol. 21, no. 2, p. 94, pl. 11, fig. 5.

Truncatulina varians Reuss, 1861, Sitz.ber. K. Ak. Wiss. Wien, vol. 42, p. 359, pl. 2, fig. 12.

Remarks. — *Cibicides lobatulus*, as interpreted in our paper, comprises all specimens with lobulated periphery and flattened dorsal side. The species is only occasionally common and often it occurs together with one or more of the other *Cibicides* species with intermediates in between. Especially specimens of *C. dutemplei*, that have inflated later chambers and a lobulated periphery, are hardly distinguishable from *C. lobatulus*.

In this connection it is considered likely that in our material *C. lobatulus* is often a variant of *C. dutemplei*. This holds true for the few *C. lobatulus* in the Septaria-clay of Hermsdorf and Pietzpuhl and for those in the Lower Tongeren beds of mine shaft Hendrik IV. In Hendrik IV some individuals are relatively thick, becoming *Anomalina*-like (pl. IX, fig. 8).

The few *C. lobatulus* specimens in the Nucula-clay are the only representatives of the genus in this member.

The individuals of *C. lobatulus* in the sample from Astrup are partly provided with a glassy knob in the umbilicus. They may be seen as variants of the accompanying *C. tenellus*. A similar knob was observed in part of our *C. lobatulus* individuals from the Boom clay.

In Dingden *C. lobatulus* is associated with *C. ungerianus* specimens, which are for the greater part without the characteristic dorsal knobs. Both species cannot be clearly separated in our Dingden sample. Similar *C. lobatulus* specimens occur in the sand of Antwerp, at Burcht.

Truncatulina varians evidently is a synonym of *C. lobatulus*. This species was described from the « Crag von Antwerpen », which deposit belongs to the Miocene sand of Antwerp [see our remarks of *Virgulina (Virgulinella)pertusa*]. It was also recorded by Reuss (op. cit., p. 367) from Dingden. It is not clear whether Reuss included in his *T. varians* specimens that are *C. ungerianus* in our classification. In his article (1861), Reuss recorded *C. ungerianus* as *Rotalia ungeriana* from Dingden, but not from Antwerp.

Distribution.

Middle Miocene : Burcht, Heist 26 m, Dingden 456.
Voort sand : Lambroek 27.
German-Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Boom clay : JB, JF, JL, JM, MA, OA, Winterswijk.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.
Nucula-clay : TE 224, TK 522, BZ 485, 488, 504.
Lower Tongeren beds : Hendrik IV, 193-196 m, 198-199 m, 200-201 m.

Genus HANZAWAIA ASANO, 1944

Hanzawaia boueana (D'ORBIGNY)
Pl. VIII, fig. 5

Truncatulina boueana D'ORBIGNY, 1846, For. Foss. Vienne, p. 169, pl. 9, figs. 24-26.
Cibicides boueanus (D'ORBIGNY), MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 72, pl. 8, fig. 9; KAASSCHIETER, 1955, Verh. Kon. Ned. Ak. Wet., Nat., ser. 1, vol. 21, no. 2, p. 92, pl. 11, fig. 1.

Remarks. — A number of small, but distinct, specimens was found in the Miocene of Dingden and in the Miocene sand of Antwerp, both at Burcht and in the boring Heist-op-den-Berg. Some more specimens were encountered in the sand of Voort and at Kassel. The specimens perfectly agree with *H. boueana*, as found in the collections of MARKS and KAASSCHIETER, from the Vienna and Aquitaine basins respectively.

Distribution.

Middle Miocene : Burcht, Heist 26 m, Dingden 456.
Voort sand : Lillo 84.
German Upper Oligocene : Kassel 12667.

Genus ALMAENA SAMOILOVA, 1940

Almaena osnabrugensis (ROEMER)
Pl. IX, fig. 1

Planulina osnabrugensis ROEMER, 1838, N. Jhrb. Min., etc., p. 390, pl. 3, fig. 58; HOFKER, 1952, Geol. Jhrb., vol. 66, pp. 383-388, textfigs. 1-5.
Rosalina osnabrugensis (ROEMER), REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 143, pl. 5, fig. 58.
Almaena osnabrugensis (ROEMER), HAGN, 1952, Geol. Bav., no. 10, p. 185.
Planulina alticosta TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 97, pl. 8, figs. 1, 2, pl. 10, fig. 4.

Remarks. — This species is represented by only a few specimens.

Distribution.

German Upper Oligocene : Kassel 11315, 12667.
Boom clay : Kuiperberg NLD 670.

Family EPISTOMINIDAE

Genus EPISTOMINA Terquem, 1883

Epistomina elegans (d'Orbigny)

Pl. X, fig. 2

Rotalia elegans d'Orbigny, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, p. 276.
Rotalina partschiana d'Orbigny, 1846, For. Foss. Vienne, p. 153, pl. 7, figs. 28-30, pl. 8, figs. 1-3.
Rotalia partschiana (d'Orbigny), Reuss, 1863, Sitz.ber. K. Ak. Wiss. Wien, vol. 48, p. 59.
Rotalina partschiana d'Orbigny var. Bornemann, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 340, pl. 16, fig. 6.
Epistomina elegans (d'Orbigny), ten Dam and Reinhold, 1942, Med. Geol. St., ser. C-V, no. 2, p. 89, pl. 6, fig. 10; Marks, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 65; Troelsen, 1954, Medd. Dansk. Geol. For., vol. 12, p. 460.
Höglundina elegans (d'Orbigny), Brotzen, 1948, Sver. Geol. Unders., ser. C, no. 493, Arsb. 42, no. 2, p. 92.

Remarks. — *Epistomina elegans* is common in some of our Boom clay samples; it is rare in many others.

Distribution.

Middle Miocene : Burcht.
Boom clay : AA, AE, JB, JF-JJ, JM, MA, ME, OA, Winterswijk.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

Genus ALABAMINA Toulmin, 1941

Alabamina tangentialis (Clodius)

Pl. VIII, fig. 7

Pulvinulina tangentialis Clodius, 1922, Ver. Freunde Naturg. Mecklenburg, Archiv, p. 138, pl. 1, fig. 14.

Remarks. — The following re-description of this ill-known species is based on our own material.

Test trochoid, with three visible whorls, biconvex, ventrally more convex than dorsally. Periphery narrowly rounded, with a limbate rim, which is absent in the last-formed chambers of some specimens. Five, seldom six chambers in the final coil. Sutures dorsally straight, running obliquely backward, tangential to the earlier spiral suture, flush with the surface. Sutures on the ventral side radial to slightly curved backward, flush or very slightly depressed, limbate, thickening toward the umbilicus, in this respect resembling the sutures of some *Eponides umbonatus* specimens with straight ventral sutures. Umbilical region closed. Wall finely perforate. Aperture a narrow slit along the base of the apertural face of the final chamber, continuing into an elongate narrow slit along and adjoining the periphery in a depression of the apertural face.

In well-preserved bigger specimens small triangular areas are dorsally indicated, adjoining the place of the previous apertures. In related specimens from the Upper Oligocene of SW France (loc. Escornebéou, in coll. Drooger at Utrecht), which are bigger and nicely preserved, we found at this place the inward bend of the apertural face connected with the dorsal wall of the chamber, so that the peripheral part of the aperture is false in these specimens. The state of preservation of our Belgian material did not allow for similar observations.

A. tangentialis was originally described from the Middle Oligocene of Mallis and from the Miocene of northwestern Germany. In our material it was met with in the Septaria-clay, in part of the Boom clay samples, in which it is rare to common, and in the Miocene of Dingden and Heist-op-den-Berg.

Rosalina no. 366 von Schlicht (1870, For. Sept. thon, Pietzpuhl, p. 62, pl. 21, figs. 24-26), interpreted by Reuss (1870, Sitz. ber. K. Ak. Wiss. Wien, vol. 62, p. 490) as *Truncatulina variabilis* (d'Orbigny) probably belongs to the present species. The figures of von Schlicht, however, are too bad to enable a decision.

Possibly *Pulvinulina exigua obtusa* (Burrows and Holland) as described by Colom (1946, Est. Geol., no. 2, Inst. Invest. Geol. « Lucas Mallada », p. 74, pl. 5, figs. 140, 141, 146) from the Oligocene of Muru (Spain) is identical with, or closely related to *A. tangentialis*.

Distribution.

Middle Miocene : Heist 26 m, Dingden 456.

Boom clay : AE, JG, JJ, JK, JL, VA, Kuiperberg, Winterswijk.

Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

Alabamina wolterstorffi (Franke)

Pl. VIII, fig. 11

Rotalia wolterstorffi Franke, 1925, Abh. Ber. Mus. Nat. Heimatk. Naturw. Ver. Magdeburg, vol. 4, pt. 2, p. 186, pl. 6, fig. 66.

Remarks. — A small number of damaged *Alabamina* specimens from the Lower Tongeren beds of shaft Hendrik IV are identical with Franke's species, which was originally described from the Lower Oligocene of Magdeburg. The species was also encountered in a sample from « Oligozän, Grünsandton », of Nachterstedt, 45 km SSW of Magdeburg in Sachsen-Anhalt (Eastern Germany), which Dr. H. Hagn at Munich kindly put at our disposal. According to Dr. Hagn (written communication), the age of the sample may be Early Oligocene (Lattorfian).

The species has a distinct *Alabamina*-like aperture, strongly backwardly curved dorsal sutures, whilst the sutures on the ventral side are straight and radial.

A. wolterstorffi is much thicker than *A. tangentialis*.

Our figured specimen is from the above mentioned sample of Nachterstedt.

The *Alabamina* specimen figured by Cushman as *Gyroidina*(?) sp. (1949, Inst. Roy. Sci. Nat. Belg., Mém. 111, p. 47, pl. 9, fig. 3) from the coast of Belgium, is probably an individual of *A. wolterstorffi*. Cushman's specimens might have been derived from the sand of Wemmel, in which member *A. wolterstorffi* has been observed by Mr. Kaasschieter (personal communication).

Distribution.

Lower Tongeren beds : Hendrik IV, 196-197 m, 199-200 m.

Alabamina perlata (ANDREAE)

Pl. VIII, figs. 8, 9

Pulvinulina perlata ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 216, pl. 8, fig. 12.

Remarks. — This species, originally described from the Septaria-clay of Alsace, was found as a rare constituent in several samples of the Boom clay and in those of the German Septaria-clay.

The test is ventrally more convex than dorsally, but specimens with reversed relations were found as well. The periphery is rounded. Dorsally there are three whorls visible and six chambers are visible on the ventral side; the umbilicus is closed. The sutures are somewhat limbate, strongly curved backward and slightly depressed dorsally, radial and depressed on the ventral side. The wall is finely perforate with additional scattered larger pores that occur mainly dorsally and near the periphery. The aperture is a narrow, elongate slit at the base of the apertural face of the final chamber. Near the periphery it continues more or less distinctly into a narrow and deep depression of the apertural face, which depression is parallel to the periphery.

Our specimens do not exceed 0,25 mm in diameter.

ANDREAE's type figures show scattered tubercles all over the surface of the test, but according to his description this ornamentation is most distinct on the dorsal side, the ventral side being more or less smooth in its central portion. Part of our specimens from Pietzpuhl are provided with such tubercles on the dorsal side (pl. VIII, fig. 9), though they are not as strongly developed as is suggested in the figure of ANDREAE. The ventral side in most of these Pietzpuhl individuals is without ornamentation. The tubercles are elevations of shell material, which surround the larger pores. Most Belgian specimens lack distinct tubercles, but the larger pores are invariably present.

The basal slit of the aperture necessitates the placing of the species in the genus *Alabamina*, though the peripheral depression is distinctly closed in most of our specimens. The latter feature has also been described for the recent species *Pseudoparrella(?) decorata* PHLEGER and PARKER and *Pseudoparrella rugosa* PHLEGER and PARKER (1951, Geol. Soc. Am., Mem. 46, p. 28, resp. pl. 15, figs. 4, 5 and pl. 15, figs. 8, 9).

Some relation between *A. perlata* and these species may be suggested on account of the possession of similar large pores and tubercles in all of them. *Pseudoparrella pustulosa* KEYZER from the Neogene of Buton (1953, Leidse Geol. Med., vol. 17, p. 281, pl. 4, figs. 17-19) also belongs to this group.

Distribution.

Boom clay : AA, AE, HB, JB-JF, JH, JJ, MA, ME, OA, VA, Kuiperberg, Winterswijk.

Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

Genus PSEUDOPARRELLA CUSHMAN and TEN DAM, 1948

Pseudoparrella oveyi BHATIA

Pl. VIII, fig. 10

Pseudoparrella oveyi BHATIA, 1955, Journ. Pal., vol. 29, p. 684, pl. 66, fig. 29, textfig. 7.

Remarks. — A number of distinct specimens of this minute species was encountered in two Boom clay samples. It was originally described from the Oligocene Hamstead Corbula-beds of the Isle of Wight.

The individuals show considerable variation as to the elevation of the dorsal spiral. Some specimens are dorsally highly conical with a nearly flat ventral side, just as the specimens figured by BHATIA. Most of our individuals, however, are less high or even equally biconvex.

Distribution.

Boom clay : JE 607, JF 608.

FAMILY **CERATOBULIMINIDAE**

Genus ASTERIGERINA D'ORBIGNY, 1839

Asterigerina bartoniana (TEN DAM)

Pl. X, figs. 1, 8

Rotalia granulosa TEN DAM [not *Rotalia granulosa* (KARRER) = *Rosalina granulosa* KARRER], 1944, Med. Geol. St., ser. C-V, no. 3, p. 121, pl. 4, fig. 2.

Rotalia bartoniana TEN DAM, 1947, Journ. Pal., vol. 21, p. 186.

Remarks. — Re-examination of the type specimens of *Rotalia bartoniana* TEN DAM that had been derived from the « Bartonian of the Netherlands », clearly showed that TEN DAM's species belongs to the genus *Asterigerina*.

The considerable variation of our extensive *A. bartoniana* material from the Lower Tongeren beds in the Hendrik IV mine-shaft, overlaps that of *A. bartoniana* found by KAASSCHIETER (personal communication) in Upper Eocene deposits of many Belgian localities. However, neither the Lower Tongeren specimens nor the single individual from Grimmertingen (SG) agree with the type of *A. bartoniana*, our individuals always having finer granules, but such specimens occur in the Belgian Eocene as well.

Smaller specimens (pl. X, fig. 8) are for the greater part vitreous and well preserved. They have a fine granulation near the aperture, which granulation may extend over nearly half of the ventral surface. They are biconvex with the ventral side usually somewhat higher. Individuals that are more convex dorsally were found as well. In most specimens the sutures are strongly curved backward on both sides. A distinct carina is present in many of them. None of them tends to develop spines on the periphery.

Bigger specimens (up to 1,37 mm) of *A. bartoniana* are commonly less well-preserved. They are often opaque with indistinct sutures (pl. X, fig. 1). Such individuals often show a slightly convex to flat dorsal side and a conical ventral one, but bi-convex specimens and specimens that are strongly convex dorsally and only very slightly so on the ventral side occur

as well. The granulation near the aperture is again variable; it may cover nearly the entire ventral surface. The ventral sutures in these bigger specimens are generally straighter and more radial than they are in the smaller specimens.

Two of our Hendrik IV specimens (193-195 m), agree well with individuals of *Asterigerina dolfussi* CUSHMAN from the Middle Oligocene « Calcaire à Astéries » of the Aquitaine basin (KAASSCHIETER, 1955, Verh. Kon. Ned. Ak. Wet., Nat., ser. 1, vol. 21, no. 2, p. 90, pl. 10, fig. 3). *Asterigerina dolfussi* was originally described from the Stampian of Jeurs, Paris basin (CUSHMAN, 1928, Bull. Soc. Sci. Seine-et-Oise, ser. 2, vol. 9, p. 56, pl. 3, fig. 4).

Distribution.

Lower Tongeren beds : SG 198, Hendrik IV, 190-192 m, 193-196 m, 197-198 m.

Asterigerina gürichi (FRANKE)

Pl. X, figs. 6, 7

Discorbina gürichi FRANKE, 1912, Wiss. Anst. Jhrb., Hamburg, vol. 29, Beiheft 4, p. 29, p. 130, textfig. 8.
Asterigerina gürichi (FRANKE), TEN DAM and REINHOLD, 1941, Geol. Mijnb., new ser., vol. 3, p. 220, pl. 1, fig. 1; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 90, pl. 7, fig. 1; HOFKER, 1948, Journ. Pal., vol. 22, p. 509, textfigs. 1-3.
Asterigerina staeschei TEN DAM and REINHOLD, 1941, Geol. Mijnb., new ser., vol. 3, p. 222, pl. 1, fig. 2; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 91, pl. 7, fig. 2.
Asterigerina frankei TEN DAM and REINHOLD, 1941, Geol. Mijnb., new ser., vol. 3, p. 222, pl. 1, fig. 3; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 91, pl. 7, fig. 3, textfig. 9.

Remarks. — *Asterigerina gürichi* was originally described from the Upper Oligocene in a deepboring near Hamburg (Germany). A great number of specimens of this species was found in our material from Upper Oligocene and Miocene deposits of Belgium and Germany. *A. staeschei* and *A. frankei* are included as variants.

A. gürichi var. *staeschei* differs from distinct *A. gürichi* in the more convex ventral side, in the broader peripheral carina and in that the « supplementary » sutures on the ventral side are nearer to the periphery.

The features of *A. gürichi* var. *frankei* are intermediate in between those of *A. gürichi* s. str. and *A. gürichi* var. *staeschei*.

Although it is possible to separate *A. gürichi* and *A. staeschei* in our material from the sand of Voort, in which both types of *Asterigerina* frequently occur together, it is evident from the examination of the sample from Burcht (Miocene sand of Antwerp) that *A. staeschei* is merely a variety of *A. gürichi*. In the Burcht sample many distinct *A. gürichi* specimens occur together with a considerable number of *A. gürichi* var. *staeschei* individuals. Moreover many intermediates between the distinct *A. gürichi* and *A. gürichi* var. *staeschei* were found. Among these intermediates *A. gürichi* var. *frankei* is included.

In the Miocene of Dingden, the locality from which *A. staeschei* was originally described, of Heist-op-den-Berg and in the horizon of Houthalen, *A. gürichi* var. *staeschei* is the only *Asterigerina* form met with. In Kassel and in the sand of Voort at Houthalen only distinct *A. gürichi* is present.

Considering the data above, the supposed value of distinct *A. gürichi* and *A. gürichi* var. *staeschei* as index-fossils for the Middle-Upper Oligocene and the Middle Miocene in northwestern Europe respectively (TEN DAM and REINHOLD, 1941, 1942) does not appear to be absolute.

Distinct *Asterigerina gürichi* is the characteristic species of the so-called Asterigerina-zone in the Netherlands and northwestern Germany (TEN DAM and REINHOLD, 1942). In a sample

of sandy, Middle Oligocene clay, equivalent of the German Septaria-clay, from Faarup in northern Jutland (Denmark) (don. Dr. J. C. TROELSEN, Copenhagen), we also found many *A. gürichi* s. str. individuals. Probably this is another occurrence of the Asterigerina-zone.

Finally it should be remarked that *A. gürichi* var. *staeschei* probably ought to be named *A. tenuimargo* (REUSS). *Rotalia tenuimargo* REUSS (1863, Sitz.ber. K. Ak. Wiss. Wien, vol. 42, p. 359, pl. 1, fig. 11) originally described from the sand of Antwerp, shows some of the typical features of the variety, viz the carinate periphery, the strongly convex umbilical side and the backward curved sutures on the dorsal side. REUSS, however, neither mentioned nor figured the « supplementary » sutures and the granulation near the aperture, which are characteristic features of *A. gürichi* var. *staeschei*. An examination of the type of *R. tenuimargo* REUSS would be necessary to decide whether *A. gürichi* var. *staeschei* should be named *A. tenuimargo*, which would imply that *A. gürichi* s. str. ought to be called *A. tenuimargo* var. *gürichi*.

Distribution.

Middle Miocene : Antwerp, Burcht, Heist 26 m, Dingden 456.

Horizon of Houthalen : Houthalen I, 80,25-80,79 m.

Voort sand : Lambroek 23, 27, 29, 33, 37, Lillo 81, 83, 84, 94, 98, 99, 104, 105, 107, Houthalen I, 81-84 m, 98-100,50 m, II, 84-88 m.

German Upper Oligocene : Kassel 12667.

Genus CERATOBULIMINA TOULA, 1915

Ceratobulimina contraria (REUSS)

Pl. X, fig. 4

Rotalina contraria REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 76, pl. 5, fig. 37.
Pulvinulina contraria (REUSS), REUSS, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 162.
Ceratobulimina contraria (REUSS), TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 92, pl. 6, fig. 9; CUSHMAN, 1946, Cushm. Lab. For. Res. Contr., vol. 22, p. 110, pl. 17, figs. 10, 11.

Remarks. — Distinct specimens of this species occur rather frequently in the Boom clay. In one of the samples of Hermsdorf, from which locality it was originally described, the species was equally met with.

Some of the Boom clay specimens have a row of some fine, pointed teeth on one or on both sides of the apertural depression. The figured specimen (pl. X, fig. 4) shows this feature. The individuals from Hermsdorf, all of which have a broken-off last chamber, show a number of irregularly arranged, small knobs or teeth on the apertural face of the previous chamber.

Two of our Boom clay specimens (from JH 614 and ME 634) show a different aperture. They lack the typical apertural slit of *C. contraria*. In its place there is a thin pointed plate. These individuals are intermediates between distinct *C. contraria* and the specimens we found in the Miocene of Dingden and Burcht (pl. VIII, fig. 6). These Miocene specimens equally have a thin plate but no apertural slit near the open umbilicus. They are less elongate than distinct *C. contraria* and perhaps had better be regarded as *Ceratobulimina haueri* (D'ORBIGNY), (*Rotalina haueri*, D'ORBIGNY, 1846, For. Foss. Vienne, p. 152, pl. 7, fig. 22-24). Our material is too scarce, however, to clarify relations of *C. haueri* and *C. contraria*.

In the sand of Voort and in the sample from Antwerp, two damaged *C. contraria* individuals were found; the one from Antwerp belongs to the *C. haueri* group.

Distribution.

?Middle Miocene : Antwerp, Burcht, Dingden 456.

Voort sand : Lillo 113.

Boom clay : AA, JB, JC, JG-JJ, JM, MA, ME, OA, VA, Kuiperberg.

Septaria-clay : Hermsdorf 13438.

Genus STOMATORBINA DORREEN, 1948

Stomatorbina concentrica (BRADY)

Pulvinulina concentrica BRADY, 1864, Trans. Linn. Soc. Zool., vol. 24, p. 470, pl. 48, fig. 14; BRADY, 1884, Rep. Voy. « Challenger », Zool., vol. 9, p. 686, pl. 105, fig. 1.

Stomatorbina concentrica (BRADY), KAASSCHIETER, 1955, Verh. Kon. Ned. Ak. Wet., Nat., ser. 1, vol. 21, no. 2, p. 87, pl. 9, fig. 4.

Remarks. — Three small, damaged specimens were found in the Upper Oligocene of Astrup.

Distribution.

German Upper Oligocene : Astrup 17538.

FAMILY **GLOBIGERINIDAE**

Genus GLOBIGERINA D'ORBIGNY, 1826

Globigerina spp.

Pl. XI, figs. 1-5, 7, 8

Remarks. — Small *Globigerina* specimens are frequent in the Boom clay; in some samples they are very common. A specific determination would be rather arbitrary because of the small size and the complete intergradation of the various types. The same series was encountered in samples of the German Upper Oligocene.

All individuals are distinctly trochoid. They usually show 3½-4 chambers in the final coil. A slightly elevated dorsal spiral is often found together with an umbilical aperture, which more or less opens in all chambers that are ventrally visible (pl. XI, figs. 1, 2). These types are the ones that are closest to *G. bulloides* D'ORBIGNY (1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 277, Modèles 17 and 76; CUSHMAN, 1941, Cushm. Lab. For. Res. Contr., vol. 17, p. 38, pl. 10, figs. 1-13), the species most commonly cited by various earlier authors from the German Oligocene deposits.

Many specimens are different from the *G. bulloides*-type by the more flattened dorsal side or the elongate aperture in the final chamber, which features often go together (pl. XI, fig. 7). Some smaller specimens have as many as five chambers in the final coil (pl. XI, fig. 8).

Especially among the bigger variants, which are still relatively small for the genus (0,25-0,37 mm), the chambers increase more rapidly in size than in *G. bulloides*, and they are somewhat higher (pl. XI, figs. 3-5). According to Drooger (1956, Micropaleontology, vol. 2, pp. 184, 185), the latter types might be identical with *G. globularis* Roemer (1838, N. Jahrb. Min., etc., p. 390, pl. 3, fig. 57), a poorly figured and described species from Osnabrück and Kassel, probably from Upper Oligocene deposits.

Occasional specimens have an aberrant final chamber, which is smaller than it should be, and shifted towards the umbilicus, but always open at the umbilical side only. A few bigger specimens of this type, but of very bad conservation, have been met with in a few samples of the Nucula-clay and the Berg sand.

A number of individuals from the Antwerp sand of Burcht resemble *G. concinna* Reuss (1850, Denkschr. K. Ak. Wiss. Wien, vol. 1, p. 373, pl. 7, fig. 113) with a tendency towards *G. ciperoensis* Bolli (1954, Cushm. Found. For. Res. Contr., vol. 5, p. 1, textfigs. 3, 4).

Very few small and indefinite *Globigerina* specimens were found in the Lower Tongeren beds (Hendrik IV), the sand of Voort and the Miocene of Dingden.

Distribution.

Middle Miocene : Burcht, Heist 26 m, Dingden 456.

Voort sand : Lillo 81, 105.

German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.

Boom clay : AA, AE, HB, JB, JC, JE-JM, MA, ME, OA, VA, Kuiperberg.

Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

Nucula-clay : BZ 485, 486, 490, 534.

Berg sand : BZ 508.

Lower Tongeren beds : Hendrik IV, 194-195 m, 201-202 m.

Genus GLOBIGERINELLA Cushman, 1927

Globigerinella micra (Cole)

Pl. XI, fig. 6

Nonion micrus Cole, 1927, Bull. Amer. Pal., vol. 14, no. 51, p. 22, pl. 5, fig. 12.
Globigerinella(?) *micra* (Cole), Grimsdale, 1951, Proc. 3d World Petrol. Congr., Section 1, p. 468.

Remarks. — Two small specimens from the Septaria-clay of Pietzpuhl (10447) closely resemble the specimens figured as *Globigerinella pseudovoluta* Bandy (1949, Bull. Amer. Pal., vol. 32, no. 131, p. 123, pl. 24, fig. 4), which species according to Grimsdale is a synonym of *G. micra*.

Some more specimens were found in the sample from the (Lower?) Oligocene of Nachterstedt (see remarks of *Alabamina wolterstorffi*).

According to Grimsdale *G. micra* is an Eocene index-fossil, which did not cross the Eocene-Oligocene boundary. It is considered likely that our few specimens have been reworked from Eocene beds. Reworking (see also *Gümbelina gracillima*) is the more probable since the doubtful specimens always occur in the German samples of various Oligocene stratigraphic levels and never in the more numerous Belgian samples.

Family GÜMBELINIDAE

Genus GÜMBELINA Egger, 1899

Gümbelina gracillima (Andreae)

Pl. XI, fig. 9

Textilaria gracillima Andreae, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 235, pl. 8, fig. 9.

Remarks. — Occasional small *Gümbelina* specimens were found in many samples throughout the column. Mostly they are silicified or otherwise damaged. In Pietzpuhl sample 10447, a number of specimens have a better preservation. They are in fair resemblance with *G. gracillima*, as described and figured by Andreae from the Middle Oligocene Foraminifera-marl of Aue (Alsace).

No doubt, most, if not all, individuals are reworked elements from older strata (Cretaceous, ?Eocene).

Family ELPHIDIIDAE

Genus ELPHIDIUM Montfort, 1808

Elphidium subnodosum (Roemer)

Pl. VIII, figs. 12, 13

Robulina subnodosa Roemer, 1838, Neues Jhrb. Min., etc., p. 391, pl. 3, fig. 61.

Polystomella subnodosa (Roemer), Reuss, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 240, pl. 4, fig. 51; Reuss, 1866, Denkschr. id., vol. 25, p. 164; Franke, 1925, Abh. Ber. Mus. Nat. Heimatk. Naturw. Ver. Magdeburg, vol. 4, pt. 2, p. 189, pl. 6, fig. 72.

Elphidium subnodosum (Roemer), Cushman, 1939, U.S. Geol. Surv., prof. paper 191, p. 40, pl. 11, fig. 2; ten Dam and Reinhold, 1942, Med. Geol. St., ser. C-V, no. 2, p. 79, pl. 5, fig. 9.

Remarks. — *Elphidium subnodosum* was originally described from the « nord-deutschen tertiären Meeressande ».

We have distinct specimens in our material from Astrup, where the species is common, and also in our samples from Kassel, the sand of Voort and the horizon of Houthalen. The number of visible chambers varies from eight in the young to twenty in adult specimens, which may reach a diameter of 1,8 mm. A thick keel is usually present. Some specimens lack this keel and have a narrowly rounded periphery.

Smaller individuals without carina were also found in the Lower Tongeren beds of Grimmertingen and of mine-shaft Hendrik IV. One of them is figured (pl. VIII, fig. 13). The number of chambers of these individuals is between ten and fifteen. Their diametr ranges up to 0,65 mm.

E. subnodosum was also recorded from other Lower Oligocene deposits : Magdeburg and Calbe (Reuss, 1866, Franke, 1925). Moreover, we observed the species in samples from the type locality of the Barton beds.

REUSS (1866) mentioned a few specimens in the Septaria-clay of Wiepke. In our material of Boom clay and Septaria-clay, the species was not encountered.

E. subnodosum may be closely related with the Early Miocene *Elphidium dolfussi* (*Nonion dolfussi* CUSHMAN, 1936, Cushm. Lab. For. Res. Contr., vol. 12, p. 65, pl. 12, fig. 4) of southern Europe, which in general is different by the thicker, more sett-off keel, more irregular and excavated sutures and smaller umbilical boss.

Distribution.

Horizon of Houthalen : Houthalen I, 80,25-80,79 m.

Voort sand : Lambroek 23, 27, 29, Lillo 84, 88-92, 94, 98, 99, 104, 105, 107, Houthalen I, 81-84 m, 98-100,50 m, II, 84-88 m.

German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.

Lower Tongeren beds : SG 198, Hendrik IV, 191-192 m, 193-199 m, 200-202 m, 203-204 m, 205-206 m.

Elphidium minutum (REUSS)

Pl. XII, fig. 1

Polystomella minuta REUSS, 1865, Sitz.ber. K. Ak. Wiss. Wien, vol. 50, p. 478, pl. 4, fig. 6.
Elphidium minutum (REUSS), CUSHMAN, 1939, U.S. Geol. Surv., prof. paper 191, p. 40, pl. 10, figs. 22-25; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 53.

Remarks. — This species was originally described from the German Upper Oligocene.

Our specimens are but moderately preserved. The few Boom clay specimens (JC 589, JD 594) have very probably been derived from the overlying sand of Antwerp and younger strata.

Distribution.

Voort sand : Lillo 83.

Elphidium inflatum (REUSS)

Pl. XII, fig. 2

Polystomella inflata REUSS, 1861, Sitz.ber. K. Ak. Wiss. Wien, vol. 42, p. 358, pl. 1, fig. 10.
Elphidium inflatum (REUSS), CUSHMAN, 1939, U.S. Geol. Surv., prof. paper 191, p. 46, pl. 12, fig. 7; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 78, pl. 5, fig. 8.

Remarks. — The species was originally described from the sand of Antwerp. Distinct specimens were found in samples from the Miocene of Dingden and of the boring Heist-op-den-Berg and in the sand of Voort (deepboring Lillo). The Lillo individuals were possibly derived from the overlying Miocene deposits.

Distribution.

Middle Miocene : Heist 26 m, Dingden 456.

?Voort sand : Lillo 81, 83.

Elphidium ungeri (Reuss)

Pl. XII, fig. 3

Polystomella ungeri Reuss, 1850, Denkschr. K. Ak. Wiss. Wien, vol. 1, p. 369, pl. 48, fig. 2.
Elphidium ungeri (Reuss), Cushman, 1939, U.S. Geol. Surv., prof. paper 191, p. 44, pl. 11, fig. 20; ten Dam and Reinhold, 1942, Med. Geol. St., ser. C-V, no. 2, p. 79, pl. 5, fig. 7; Marks, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 54.

Remarks. — *Elphidium ungeri* was originally described from the Miocene of the Vienna basin.

Some distinct specimens were encountered in the Miocene sand of Antwerp.

Distribution.

Middle Miocene : Burcht.

Elphidium hiltermanni Hagn

Pl. XII, fig. 4

Elphidium hiltermanni Hagn, 1952, Geol. Bav., no. 10, p. 163, pl. 1, fig. 6, pl. 2, fig. 14.

Remarks. — Our specimens differ slightly from original *Elphidium hiltermanni* from the Bavarian Middle Oligocene to Lower Miocene. They have mostly five chambers in the last coil while the typical ones have six chambers. The aperture is surrounded by many very fine papillae both on the apertural face of the final chamber and on the adjoining part of the previous convolution.

In our material the species is a rare constituent in some samples from the Upper Oligocene and Miocene.

Distribution.

Middle Miocene : Burcht, Dingden 456.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.

Family PLANORBULINIDAE

Genus PLANORBULINA d'Orbigny, 1826

Planorbulina difformis Roemer

Pl. IX, fig. 2

Planorbulina difformis Roemer, 1838, N. Jhrb. Min., etc., p. 390, pl. 3, fig. 59.
Planorbulinella larvata (Parker and Jones) var. *cojimarensis* Palmer, 1941, Soc. Cubana Hist. Nat. Min., vol. 15, p. 198, pl. 31, fig. 3.

Remarks. — The species was originally described from Osnabrück. Our specimens are from Astrup, a locality in the neighbourhood of that town. It may have been recorded from other places under various other names. According to the description and figures, *Planorbulinella larvata* var. *cojimarensis* from the Tertiary Cojimar formation of Cuba would be a distinct synonym.

The specimens are dorsally flattened with limbate sutures and without ornamentation. The ventral sutures are depressed and in most specimens the ventral surface is covered with an irregular granular ornamentation, mainly in the central part. The early chambers are spirally arranged, the later ones irregularly in an orbitoid-like manner.

Several specimens show two apertures in many of the peripheral chambers. The flattened test is often undulated in various ways.

P. difformis differs from *P. mediterranensis* d'Orbigny in the irregular arrangement of the later chambers and from *P. larvata* Parker and Jones in the absence of ornamentation on one of the sides.

Distribution.

German Upper Oligocene : Astrup 17538.

Genus GYPSINA Carter, 1877

Gypsina globulus Reuss

Ceriopora globulus Reuss, 1848, Haid. Naturw. Abh. vol. 2, pt. 1, p. 33, pl. 5, fig. 7.
Gypsina globulus (Reuss), Brady, 1884, Rep. Voy. « Challenger », Zool., vol. 9, p. 717, pl. 101, fig. 8; Franke, 1925, Abh. Ber. Mus. Nat. Heimatk. Naturw. Ver. Magdeburg, vol. 4, pt. 2, p. 187, pl. 6, fig. 67.

Remarks. — Two specimens of this species were found in our sample from Astrup.

Distribution.

German Upper Oligocene : Astrup 17538.

Family **ROTALIIDAE**

Genus ROTALIA Lamarck, 1804

Rotalia kiliani (Andreae)
Pl. XII, fig. 8

Pulvinulina kiliani Andreae, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 256, pl. 11, fig. 1; Paalzow, 1912, Offenbacher Ver. Naturk., Ber. 51-53, p. 71, pl. 2, fig. 6; Paalzow, 1924, id., Ber., p. 27, pl. 2, fig. 11.
Eponides kiliani (Andreae), Paul, 1938, Mitt. Bad. Geol. L.anst., vol. 12, pt. 1, p. 45.
Rotalia aff. *R. papillosa* d'Orbigny, Bhatia, 1955, Journ. Pal., vol. 29, p. 684, pl. 66, fig. 31.

Remarks. — A rather small number of specimens from the Henis clay are considered to belong to *R. kiliani*. They show the following characteristics.

Test biconvex, more or less flattened, consisting of three whorls; periphery broadly rounded. Six to nine chambers in the final whorl, not or only slightly inflated. Sutures flush or slightly depressed, somewhat limbate, evenly curved backward and ventrally often excavated toward the umbilicus. Umbilicus filled with granular shell material. Aperture a narrow slit at the base of the final chamber. Wall finely perforate.

R. kiliani was originally described from the Middle Oligocene Meletta-beds of Alsace. PAUL (1938) recorded it from the same beds. SPANDEL (1909, Offenbacher Ver. Naturk., Ber. 43-50, p. 109), PAALZOW (1912, 1922) and DOEBL (1954, Notizbl. Hess. L.-amt. Bodenf., vol. 82, pp. 105-107) recorded *R. kiliani* from the uppermost Septaria-clay, Schleichsand, Corbicula-marl and Cerithium-sands of the Mainz basin. BHATIA (1955) found it in the Headon beds of Isle of Wight, where the species is more common in the more brackish sediments.

R. kiliani evidently preferred a more or less brackish-water environment.

Distribution.

Henis clay : TB 215, TG 228, BZ 551.

Rotalia beccarii (LINNÉ)

Pl. XII, fig. 10

Nautilus beccarii LINNÉ, 1758, Syst. Nat., ed. 10, vol. 1, p. 710, Cornu Hammonis, pl. 1, fig. 1.
Rotalia beccarii (LINNÉ), CUSHMAN, 1931, U.S. Nat. Mus., Bull. 104, pt. 8, p. 61, pl. 12, figs. 1-7, pl. 13, figs. 1, 2.

Remarks. — Some specimens of *Rotalia beccarii* were found in the horizon of Houthalen. A single specimen was met with in the sand of Voort of the boring Lillo, which occurrence may be due to contamination of the sample (no. 80).

The individuals in sample JD 594 from Elversele have certainly been derived either from the sand of Antwerp or from the Pleistocene sand of Tielrode.

Distribution.

Horizon of Houthalen : Houthalen I, 80,25-80,79 m.

Rotalia propingua REUSS

Pl. XII, fig. 11

Rotalia propingua REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 241, pl. 4, fig. 53.

Remarks. — The species was originally described from the Upper Oligocene of Kassel.

Our specimens, for the greater part also from Kassel, differ from *R. propingua* as originally described and figured by REUSS, in the ornamentation of the umbilical region.

According to REUSS the species would have a flush, closed umbilicus. In some of our specimens there are a number of irregular knobs, in others there is a small rounded mass of clear shell material, flush with the surface. A damaged individual showed the umbilical plug. Our specimens are thick-walled and finely perforate. Some of them are dorsally more convex than ventrally.

At Bilzen and Tongeren a number of juvenile specimens of the species were found.

Distribution.

German Upper Oligocene : Kassel 11315, 12667.

Nucula-clay : TK 526.

Oude-Biezen member : TA 579.

Rotalia trochus Roemer

Pl. XII, fig. 9

Rotalia trochus Roemer, 1838, N. Jhrb. Min., etc., p. 388, pl. 3, fig. 47; Reuss, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 242, pl. 5, fig. 55.

Remarks. — Roemer's figures are very poor, but his description : « Oben gewölbt, mit schwachen spiralen Linien, unten etwas gewölbt, mit 6 ausstehenden, den scharfen Rand nicht erreichenden Furchen » is entirely applicable to our specimens. Probably Roemer's types came from the Upper Oligocene of either Kassel or Osnabrück.

One of our specimens is ventrally flat and therefore it agrees best with Roemer's and Reuss's descriptions and figures. The other individuals are biconvex.

Distribution.

German Upper Oligocene : Astrup 17538, Kassel 12667.

Rotalia canui Cushman

Pl. XII, figs. 5-7

Rotalia canui Cushman, 1928, Bull. Soc. Sci. Seine-et-Oise, sér. 2, vol. 8, p. 55, pl. 3, fig. 2; Bhatia, 1955, Journ. Pal., vol. 29, p. 684, pl. 66, fig. 32.

Rotalia stellata Reuss, (not Ehrenberg), 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 242, pl. 5, fig. 54; Reuss, 1869, id., vol. 59, p. 463, pl. 2, fig. 4.

Pulvinulina stellata (Reuss), Franke, 1925, Abh. Ber. Mus. Nat. Heimatk. Naturw. Ver. Magdeburg, vol. 4, pt. 2, p. 183, pl. 6, fig. 59.

Rotalia stellata Reuss, Staesche and Hiltermann, 1940, Abh. Reichsst. Bodenf., new. ser., vol. 201, pl. 21, fig. 1.

?*Rotalia* cf. *spinigera* Terquem, Staesche and Hiltermann, 1940, id., vol. 201, pl. 24, fig. 9, pl. 51, fig. 10.

Rotalia spinigera Terquem, Gullentops, 1956, Mém. Inst. Géol. Univ. Louvain, vol. 20, p. 17, pl. 1, figs. 15, 16.

Remarks. — This variable species was found in the finest wash-residue of several samples from the Tongeren region.

Test biconvex. Periphery broadly rounded to subacute, often with a single short spine on each chamber. Chambers inflated, five to six in the last whorl. Sutures on the dorsal side curved backward, depressed and limbate, in the centre of the test ornamented with irregular knobs. In some specimens the dorsal sutures are flush with the surface. Ventral sutures strongly depressed and radial. Umbilical region more or less completely filled with a large umbilical knob, surrounded by a deep furrow. Wall rather coarsely perforated, often dorsally more distinctly so than on the ventral side. Aperture varying between a large opening along nearly the entire ventral inner margin of the last-formed chamber and an elliptical narrow opening in the apertural face, somewhat removed from the base of this chamber, provided with a slight neck or lip. The last-mentioned position of the aperture is typical for the genus *Pararotalia* Yolande le Calvez (1947, For. Lut. Paris, vol. 2, p. 33, pl. 3, figs. 54-56). In our specimens this type of aperture probably always belongs to penultimate chambers, visible when the final chambers have been broken off.

Individuals of *R. canui* with subacute periphery, less inflated chambers and with rather sharp points towards the umbilicus (pl. XII, fig. 6) fall within the range of variation of young individuals of *R. audouini* d'Orbigny from Aquitanian-Burdigalian deposits of Southwestern France (Kaasschieter, 1955, Verh. Kon. Ned. Ak. Wet., Nat., ser. 1, vol. 21, no. 2, p. 84, pl. 9, fig. 3).

Part of our specimens resemble *Globorotalia spinigera* (TERQUEM) from the Lutetian deposits of the Paris basin as figured by YOLANDE LE CALVEZ (1947, id., vol. 2, p. 39, pl. 6, figs. 97-99). They have a *Globorotalia*-like aperture and lack an umbilical plug. Other specimens with the same type of aperture but with distinct umbilical plug are more common.

It must be remarked that according to REUSS's description the diameter of his *R. stellata* is greater (0,42 mm) than that of CUSHMAN's *R. canui* (0,28 mm). The diameter of our individuals ranges from 0,19 mm to 0,32 mm.

The few specimens from Kassel have thick sutures, which in part of them are ornamented dorsally with some irregular knobs.

The species was originally described from the Stampian deposits of the Paris basin. It has furthermore been recorded from the Oligocene of Gaas (SW France), of Isle of Wight and of northwestern Germany. In our material the species occurs in the Lower Tongeren beds of shaft Hendrik IV, in the Oude-Biezen member, the Nucula-clay and in the Upper Oligocene of Kassel.

Distribution.

German Upper Oligocene : Kassel 12667.
Nucula-clay : TK 522-524, BZ 487, 490-493, 504, 552.
Oude-Biezen member : TA 579, BZ 540, 541, 545.
Lower Tongeren beds : Hendrik IV, 193-196 m.

FAMILY NUMMULITIDAE

SUBFAMILY NUMMULITINAE

Genus NUMMULITES LAMARCK, 1801

Nummulites germanicus (BORNEMANN)

Pl. XII, fig. 12; Pl. XIII, figs. 1-7

Amphistegina nummularia REUSS (not *Camerina nummularia* BRUGUIÈRE), 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 238, pl. 4, figs. 46-50.

Nummularia germanica BORNEMANN, 1860, Zschr. Deu. Geol. Ges., vol. 12, p. 158, pl. 6, figs. 3-9.

Nummulites germanicus (BORNEMANN), REUSS, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 164; FRANKE, 1925, Abh. Ber. Mus. Nat. Heimatk. Naturw. Ver. Magdeburg, vol. 4, pt. 2, p. 190, pl. 6, fig. 73.

Remarks. — A number of distinct specimens of this species, which was originally described from the Lower Oligocene of Westeregeln near Magdeburg (Germany), was found in the Lower Tongeren beds of shaft Hendrik IV. They agree well with the original descriptions and figures by REUSS (1856) and BORNEMANN (1860).

The specimens are flat, with a bluntly rounded periphery in adult individuals, the largest of which has a diameter of 4 mm. Most specimens have an irregularly reticulated surface. The pits of this reticulation are often each filled with a quartz or glauconite grain. The molluscs in the samples, from which our *N. germanicus* specimens were derived, show the same reticulation. In a few specimens with undamaged surface no ornamentation of the wall was observed, except for a rounded umbilical knob which is especially found in smaller individuals. It follows that our *N. germanicus* orginally had a smooth surface, which also could be seen in the earlier whorls of broken specimens.

From a number of sections (pl. VIII, figs. 1-7), it appeared that there are more macrospheric than microspheric individuals. The macrospheric specimens have a proloculum with a diameter varying from 120 to 190 μ.

Our specimens resemble *N. wemmelensis* De la Harpe and Van den Broeck as figured by De Neve (1945, Verh. Geol. Mijnb. Gen. Nederl. Kol., geol. ser., vol. 14, p. 354, pl. 1, fig. 4, pl. 4, figs. 1-3) from « Bartonian » deposits of the Netherlands and *N. tournoueri* De la Harpe as figured by Flandrin [1938, Mat. Carte Géol. Algérie, ser. 1, pal., no. 8, p. 35, pl. 3, figs. 5-7 (not fig. 8)] from Oligocene deposits of the Oran region (Algeria).

In the literature *N. germanicus* was recorded mainly from Upper Eocene and Lower Oligocene deposits of northwestern Germany. Reuss (1866) mentioned the species as being very rare in the Septaria-clay of Stettin (Germany). In our material of the Septaria-clay and of the Boom clay it was never met with. It is quite possible that Reuss's Stettin specimens had been derived from older sediments.

Distribution.

Lower Tongeren beds : Hendrik IV, 193-198 m.

SUMMARY

A systematic study has been made of the Foraminifera from the Oligocene of Belgium. We have also dealt with the Foraminifera of some Belgian and German Miocene deposits and of a few Oligocene localities in northern Germany and the Netherlands.

Altogether some 140 species are recognized. The original descriptions of many of them had already been published in the second half of the nineteenth century by several authors, especially by Reuss.

Only two of the species are new : *Bulimina kasselensis* and *B. dingdenensis*.

The Ostracoda of most of our samples have been described by Keij (1957).

The samples have mainly been derived from clay and sand pits. A minor part of them has been obtained from borings and mine-shafts. The sections of the sampled localities have also been given. Among them there are several classic localities of the Oligocene and also of the Miocene.

Some remarks concerning the stratigraphy and the sedimentary environments of the studied deposits have been added and the foraminiferal associations are discussed. It has been tried to make a clear distinction between rock-stratigraphic and time-stratigraphic units.

Serious doubt is expressed upon the current view to regard the Tongrian-Rupelian-Chattian as a time-stratigraphic subdivision of the Oligocene. Parts of the Tongrian and Rupelian are considered to be of the same age. Similar relations may exist between Rupelian and Chattian.

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ADDENDUM

On the occasion of the writer's taking his degree at the State University of Utrecht in November 1956, a summary of the present paper has been published in dutch. This summary also bears the title « Foraminifera of the Oligocene of Belgium ». It has occasionally been mentioned in the literature.

While the paper was in press an important article appeared on the stratigraphy of the Latdorfian (KRUTZSCH, W. and D. LOTSCH, September 1957, Zur stratigraphischen Stellung der Latdorfstufe im Paläogen, Geologie, Vol. 6, pt. 5, pp. 476-501). On the basis of the stratigraphic relations and the pollen, spore, mollusc and Foraminifera contents of several German Eocene and Oligocene deposits, it was concluded that the Latdorf (9) beds are the sandy, near-shore equivalent of part of the more clayey Upper Eocene deposits (« Eozän 5 ») that are found in the centre of the northern German basin. KRUTZSCH and LOTSCH consider the Belgian Upper Tongeren beds and Berg sand and the German Conow beds, Magdeburger Sande and Neuengammer Gassande to be « Unter Oligozän ». In this way they introduce an entirely new concept of the Lower Oligocene, which is more or less identical with our Lower Rupelian.

Except for this addendum the manuscript of the present paper has not been modified after its fulfilment in November 1956.

(9) According to KRUTZSCH and LOTSCH, Latdorf (not Lattorf) is the correct spelling of the name of the type locality.

INDEX OF SPECIES AND VARIETY NAMES

Names figuring both at the head of the articles dealing with the various species and in the lists of synonymy, are in italics. Names, that occur only in the remarks are in roman type.

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In the following list most of the consulted papers have been incorporated. Those marked with an asterisk (*) contain illustrations of Foraminifera.

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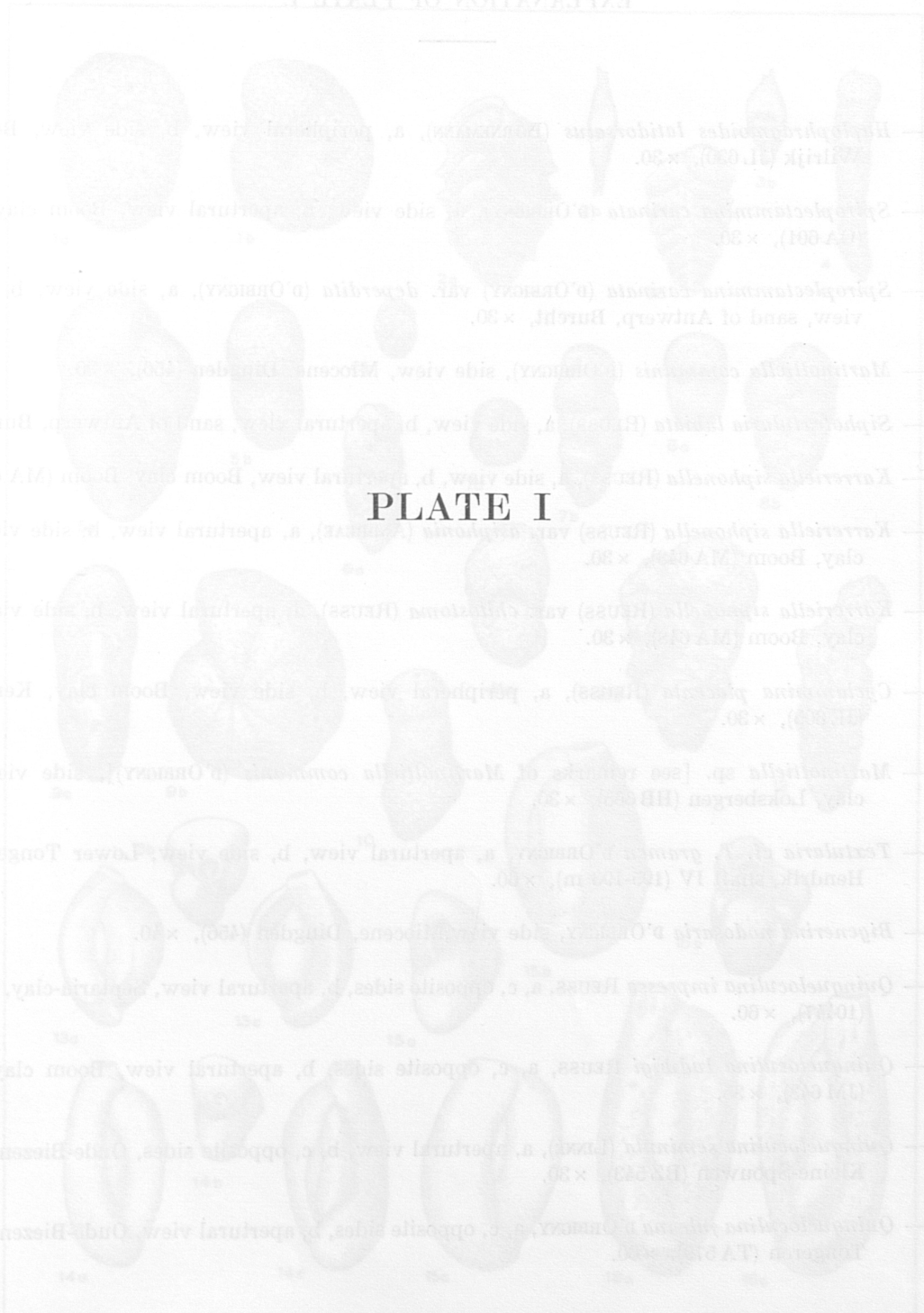
CONTENTS

PLATE I



EXPLANATION OF PLATE I.

FIG. 1. — *Haplophragmoides latidorsatus* (BORNEMANN), a, peripheral view, b, side view, Boom clay, Wilrijk (JL 630), ×30.

FIG. 2. — *Spiroplectammina carinata* (D'ORBIGNY), a, side view, b, apertural view, Boom clay, Stekene (OA 601), ×30.

FIG. 3. — *Spiroplectammina carinata* (D'ORBIGNY) var. *deperdita* (D'ORBIGNY), a, side view, b, apertural view, sand of Antwerp, Burcht, ×30.

FIG. 4. — *Martinottiella communis* (D'ORBIGNY), side view, Miocene, Dingden (456), ×20.

FIG. 5. — *Siphotextularia labiata* (REUSS), a, side view, b, apertural view, sand of Antwerp, Burcht, ×60.

FIG. 6. — *Karreriella siphonella* (REUSS), a, side view, b, apertural view, Boom clay, Boom (MA 648), ×30.

FIG. 7. — *Karreriella siphonella* (REUSS) var. *asiphonia* (ANDREAE), a, apertural view, b, side view, Boom clay, Boom (MA 648), ×30.

FIG. 8. — *Karreriella siphonella* (REUSS) var. *chilostoma* (REUSS), a, apertural view, b, side view, Boom clay, Boom (MA 648), ×30.

FIG. 9. — *Cyclammina placenta* (REUSS), a, peripheral view, b, side view, Boom clay, Kemzeke-Hol (JE 605), ×30.

FIG. 10. — *Martinottiella* sp. [see remarks of *Martinottiella communis* (D'ORBIGNY)], side view, Boom clay, Loksbergen (HB 665), ×30.

FIG. 11. — *Textularia* cf. *T. gramen* D'ORBIGNY, a, apertural view, b, side view, Lower Tongeren beds, Hendrik, shaft IV (195-196 m), ×60.

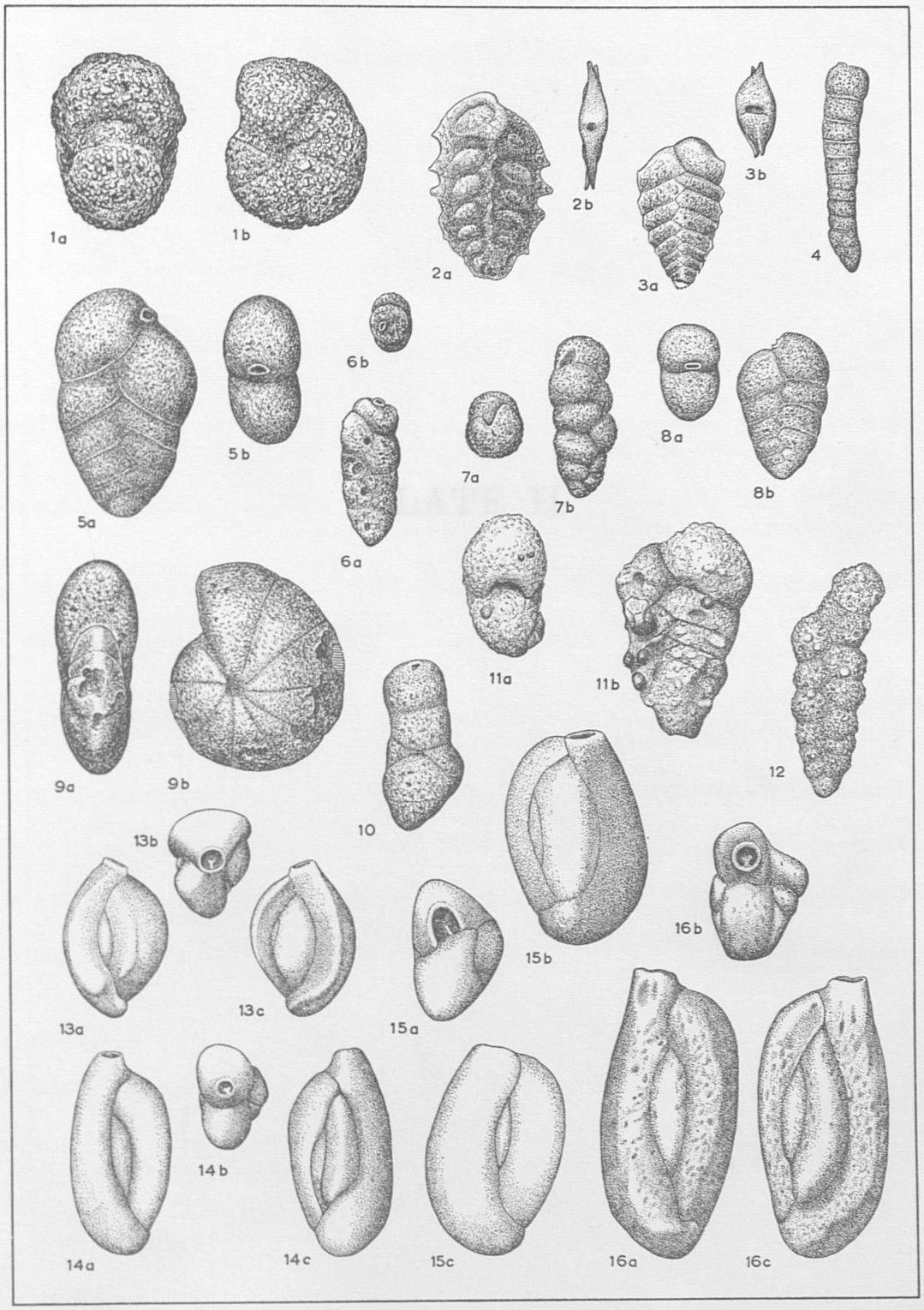
FIG. 12. — *Bigenerina nodosaria* D'ORBIGNY, side view,Miocene, Dingden (456), ×40.

FIG. 13. — *Quinqueloculina impressa* REUSS, a, c, opposite sides, b, apertural view, Septaria-clay, Pietzpuhl (10447), ×60.

FIG. 14. — *Quinqueloculina ludwigi* REUSS, a, c, opposite sides, b, apertural view, Boom clay, Schelle (JM 643), ×35.

FIG. 15. — *Quinqueloculina seminula* (LINNÉ), a, apertural view, b, c, opposite sides, Oude-Biezen member, Kleine-Spouwen (BZ 543), ×30.

FIG. 16. — *Quinqueloculina juleana* D'ORBIGNY, a, c, opposite sides, b, apertural view, Oude-Biezen member, Tongeren (TA 579), ×60.



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EXPLANATION OF PLATE II.

FIG. 1. — *Scutuloris oblongus* (MONTAGU), a, c, opposite sides, b, apertural view, Oude-Biezen member, Tongeren (TA 579), ×95.

FIG. 2. — *Triloculina tricarinata* D'ORBIGNY, a, c, side views, b, apertural view, Nucula-clay, Berg (BZ 487), ×60.

FIG. 3. — *Spiroloculina canaliculata* D'ORBIGNY, a, side view, b, apertural view, Septaria-clay, Pietzpuhl (10447), ×90.

FIG. 4. — *Quinqueloculina parisiensis* D'ORBIGNY, a, b, opposite sides, c, apertural view, Oude-Biezen member, Oude-Biezen (BZ 521), ×50.

FIG. 5. — *Sigmoilina* cf. *S. miocenica* CUSHMAN [see remarks of *S. tenuis* (CZJZEK)], a, c, opposite sides, b, apertural view, Boom clay, Herselt (AE 664), ×85.

FIG. 6. — *Spirolina* sp., a, side view, b, peripheral view, Henis clay, Tongeren (TB 216), ×90.

FIG. 7. — *Lenticulina* (*Robulus*) sp., a, peripheral view, b, side view, Lower Tongeren beds, Hendrik, shaft IV (192-193 m), ×10.

FIG. 8. — *Lenticulina* (*Vaginulinopsis*) *gladia* (PHILIPPI), a, side view, b, apertural view, horizon of Houthalen, Houthalen, shaft I (80,25-80,79 m), ×10.

FIG. 9. — *Lenticulina* (*Robulus*) sp., a, side view, b, peripheral view, Boom clay, Boom (MA 652), ×30.

FIG. 10. — *Lenticulina* (*Robulus*) sp., a, peripheral view, b, side view, Nucula-clay, Berg (BZ 559), ×40.

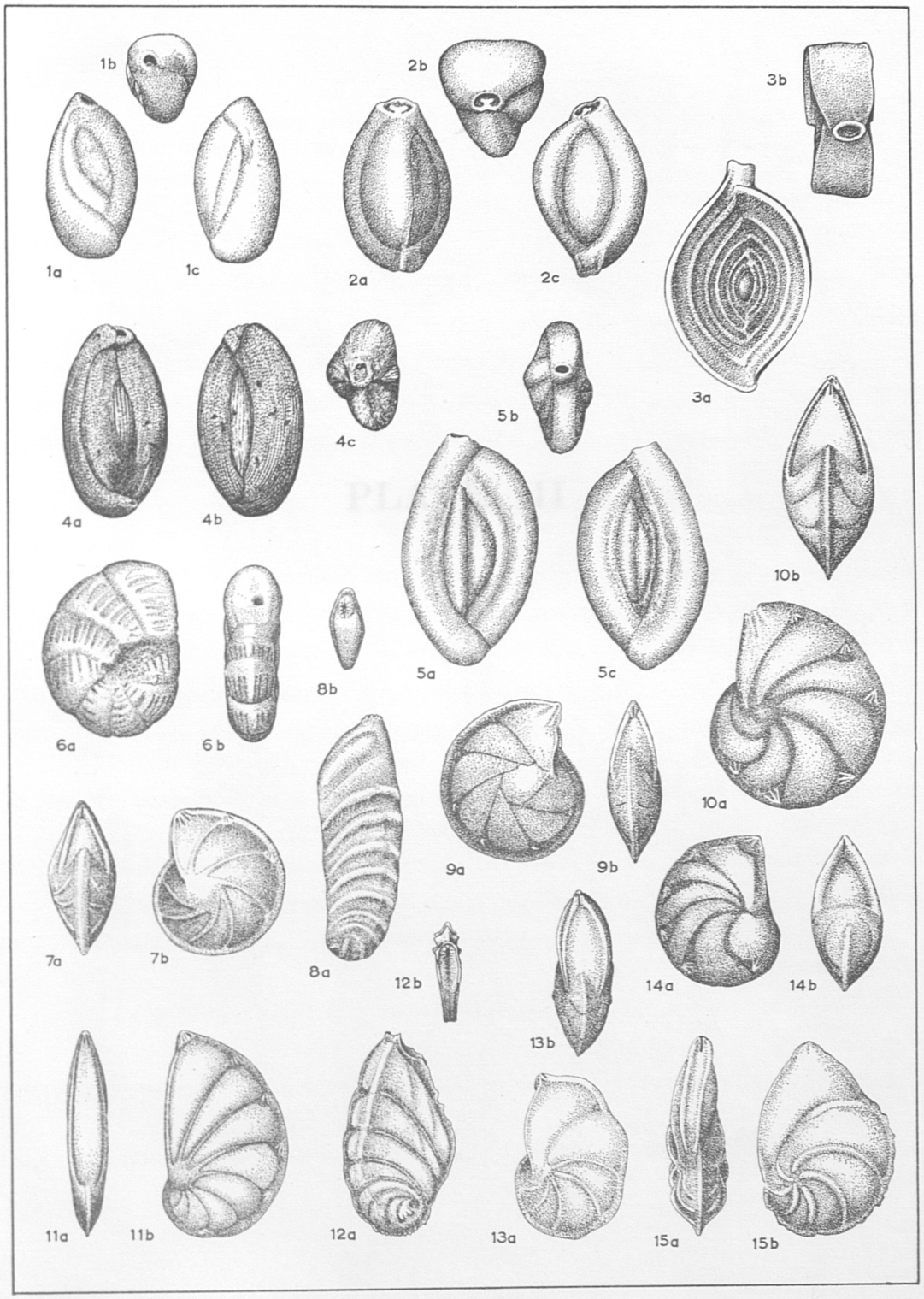
FIG. 11. — *Lenticulina* (*Planularia*) sp., a, peripheral view, b, side view, Boom clay, Boom (MA 369), ×20

FIG. 12. — *Lenticulina* (*Planularia*) *auricula* (ROEMER), a, side view, b, peripheral view, Kasseler Meeressand, Kassel (12667), ×15.

FIG. 13. — *Lenticulina* (*Robulus*) sp., a, side view, b, peripheral view, Boom clay, Niel (JB 358), ×30.

FIG. 14. — *Lenticulina* (*Robulus*) sp., a, side view, b, peripheral view, Nucula-clay, Kleine-Spouwen (TE 224), ×40.

FIG. 15. — *Lenticulina* (*Robulus*) sp., a, peripheral view, b, side view, Boom clay, Niel (JB 355), ×30.



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EXPLANATION OF PLATE III.

FIGS. 1-3. — *Frondicularia oblonga* (ROEMER), 1, 2, microspheric specimens, 3, macrospheric specimen. 1, side view, Upper Oligocene Mergelsand, Astrup (17538), ×10; 2, a, apertural view, b, side view, Kasseler Meeressand, Kassel (11315), ×10; 3, side view, Upper Oligocene Mergelsand, Astrup (17538), ×15.

FIG. 4. — *Frondicularia nysti* REUSS, a, side view, b, apertural view, sand of Antwerp, Antwerp, ×10.

FIG. 5. — *Nodosaria koninckı* (REUSS), side view, Miocene, Dingden (456), ×15.

FIG. 6. — *Lagena striata* (D'ORBIGNY), side view, sand of Antwerp, Burcht, ×60.

FIG. 7. — *Lagena* (*Entosolenia*) *lagenoides* (WILLIAMSON), side view, Septaria-clay, Pietzpuhl (10447), ×85.

FIG. 8. — *Frondicularia seminuda* REUSS, side view, Septaria-clay, Hermsdorf (13438), ×30.

FIG. 9. — *Lagena squammosa* (MONTAGU) var. *hexagona* (WILLIAMSON), side view, Septaria-clay, Pietzpuhl (10447), ×90.

FIG. 10. — *Vaginulina obtusicosta* TEN DAM and REINHOLD, a, side view, b, apertural view, sand of Antwerp, Burcht, ×30.

FIG. 11. — *Lagena isabella* (D'ORBIGNY), side view, Boom clay, Niel (JB 358), ×90.

FIG. 12. — *Siphonodosaria hirsuta* (D'ORBIGNY), side view, Boom clay, Kemzeke-Hol (JF 609), ×30.

FIG. 13. — *Nodosaria spinescens* (REUSS), side view, Boom clay, Kemzeke-Hol (JF 609), ×60.

FIG. 14. — *Saracenella böttcheri* (REUSS), a, side view, b, apertural view, Nucula-clay, Berg (BZ 513), ×55.

FIGS. 15, 16. — *Nodosaria ludwigi* (REUSS), 15, microspheric specimen, side view, Boom clay, Stekene (OA 600); 16, macrospheric specimen, side view, Boom clay, Steendorp (JJ 622), ×15.

FIGS. 17,18. — *Nodosaria soluta* (REUSS), 17, side view, Nucula-clay, Bilzen-Katteberg (TK 526); 18, juvenile specimen, side view, Boom clay, Tielrode (JH 614), ×15.

FIG. 19. — *Nodosaria vertebralis* (BATSCH), side view, Upper Oligocene Mergelsand, Astrup (17538), ×15.

FIG. 20. — *Nodosaria emaciata* (REUSS), side view, Boom clay, Steendorp (JJ 625), ×30.

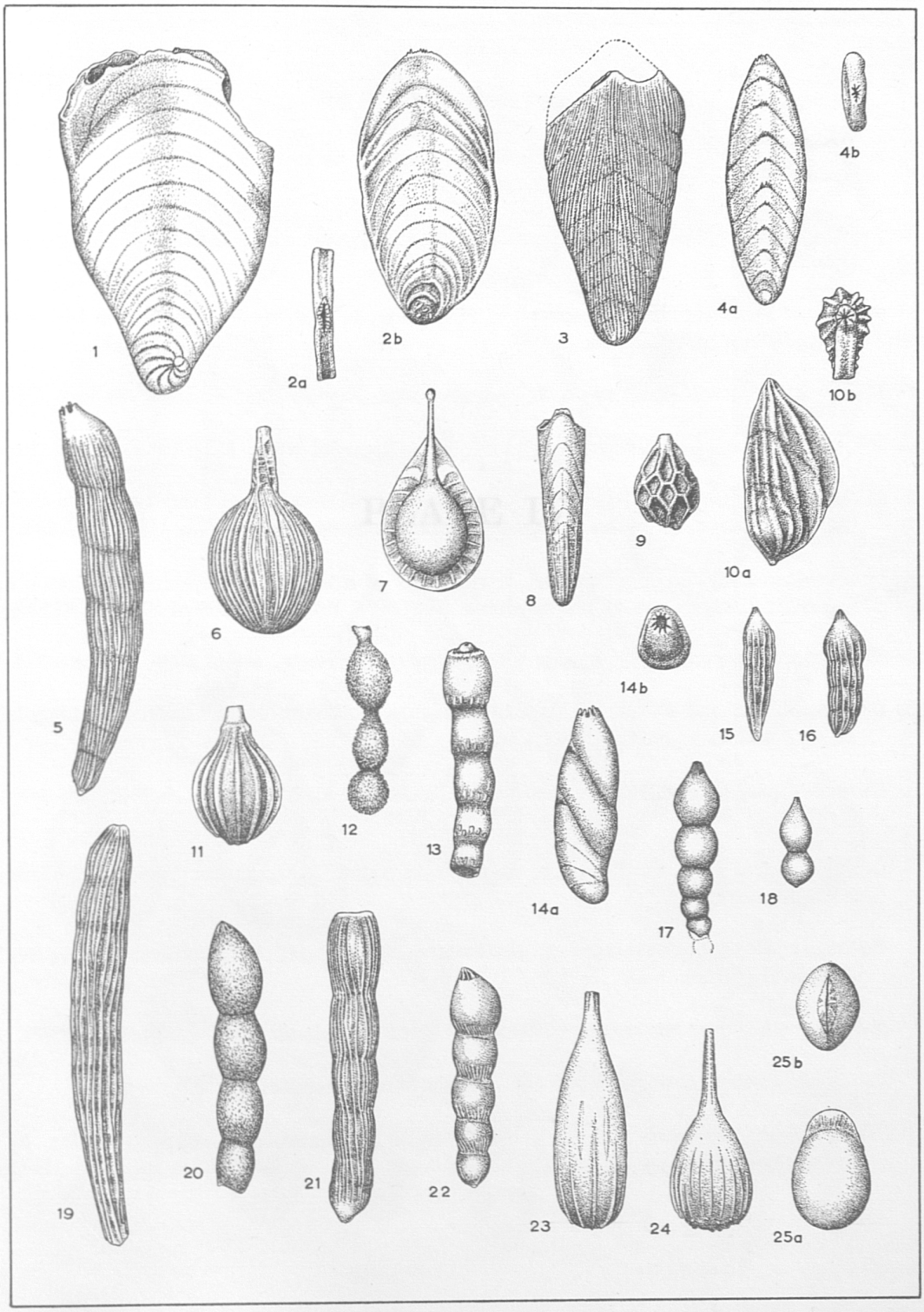
FIG. 21. — *Nodosaria emaciata* (REUSS) var. *multilineata* (BORNEMANN), side view, Septaria-clay, Hermsdorf (13438), ×30.

FIG. 22. — *Nodosaria intermittens* ROEMER, side view, Boom clay, Boom (MA 373), ×15.

FIG. 23. — *Lagena tenuis* (BORNEMANN), side view, Boom clay, Stekene (OA 601), ×90.

FIG. 24. — *Lagena* sp. [see remarks of *Lagena tenuis* (BORNEMANN)], side view, Boom clay, Boom (MA 652), ×85.

FIG. 25. — *Lagena* (*Fissurina*) *laevigata* (REUSS), a, side view, b, apertural view, Miocene, Dingden (456), ×110.



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EXPLANATION OF PLATE IV.

FIG. 1. — *Pseudopolymorphina obscura* (ROEMER), a, b, opposite sides, Kasseler Meeressand, Kassel (12667), ×20.

FIG. 2. — *Sigmomorphina regularis* (ROEMER), a, side view, b, apertural view, Upper Oligocene Mergelsand, Astrup (17538), ×20.

FIG. 3. — *Pyrulina fusiformis* (ROEMER), a, b, opposite sides, Nucula-clay, Bilzen-Katteberg (TK 526), ×30.

FIG. 4. — *Pseudopolymorphina subnodosa* (REUSS), a, b, opposite sides, sand of Antwerp, Burcht, ×30.

FIGS. 5, 6. — *Glandulina aequalis* REUSS, 5, side view of macrospheric specimen, Nucula-clay, Berg (BZ 513), ×60; 6, side view of microspheric specimen, Nucula-clay, Berg (BZ 488), ×40.

FIGS. 7, 8. — *Glandulina laevigata* (D'ORBIGNY), 7, side view of macrospheric specimen, Boom clay, Schriek (AA 657); 8, side view of microspheric specimen, Boom clay, Sint-Niklas (JC 589), ×40.

FIG. 9. — *Globulina gibba* D'ORBIGNY, a, side view, b, apertural view, Boom clay, Stekene (OA 601), ×40.

FIG. 10. — *Guttulina problema* D'ORBIGNY, variant with depressed sutures, a, c, opposite sides, b, apertural view, Boom clay, Niel (JB 364), ×55.

FIG. 11. — *Guttulina problema* D'ORBIGNY var. *frankei* CUSHMAN and OZAWA, a, b, opposite sides, c, apertural view, Boom clay, Stekene (OA 601), ×55.

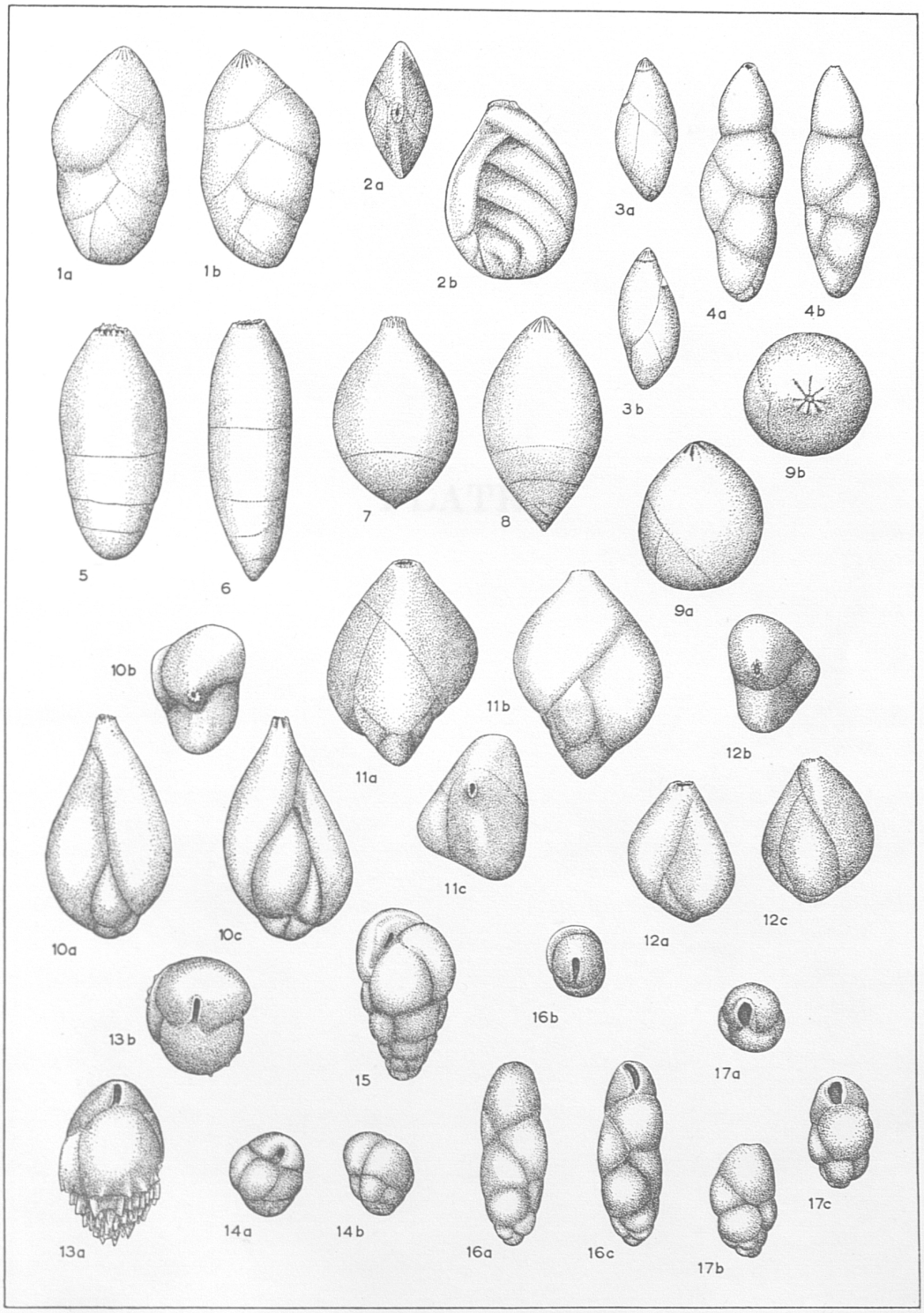
FIG. 12. — *Guttulina problema* D'ORBIGNY, a, c, opposite sides, b, apertural view, Boom clay, Schelle (JM 645), ×20.

FIG. 13. — *Bulimina alsatica* CUSHMAN and PARKER, a, side view, b, apertural view, Septaria-clay, Pietzpuhl (10447), ×85.

FIG. 14. — *Buliminella carteri* BHATIA, a, b, opposite sides, Nucula-clay, Bilzen-Katteberg (TK 524), ×90.

FIG. 15. — *Turrilina alsatica* ANDREAE, side view, Boom clay, Steendorp (JJ 626), ×95.

FIGS. 16, 17. — *Bulimina elongata* D'ORBIGNY, 16, elongate specimen, a, c, opposite sides, b, apertural view; 17, shorter specimen, a, apertural view, b, c, opposite sides, Miocene, Dingden (456), ×60.



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EXPLANATION OF PLATE V.

FIGS. 1-3. — *Bulimina dingdenensis* nov. sp., 1, holotype, a, c, side views, b, apertural view, ×90; 2, 3, side views of paratypoids, Miocene, Dingden (456), ×85.

FIGS. 4-6. — *Bulimina kasselensis* nov. sp., 4, holotype, a, c, side views, b, apertural view, ×90; 5, 6, side views of paratypoids, Kasseler Meeressand, Kassel (11315); 5, ×85, 6, ×90.

FIG. 7. — *Virgulina* (*Virgulinella*) *pertusa* REUSS, a, b, opposite sides, sand of Antwerp, Burcht, ×40.

FIG. 8. — *Reussella spinulosa* (REUSS), a, apertural view, b, side view, Kasseler Meeressand, Kassel (11315), ×60.

FIG. 9. — *Bolivina dilatata* REUSS, a, side view, b, apertural view, Miocene, Dingden (456), ×90.

FIG. 10. — *Bolivina beyrichi* REUSS var. *melettica* ANDREAE, a, apertural view, b, side view, Boom clay, Kemzeke-Hol (JF 609), ×60.

FIG. 11. — *Bolivina beyrichi* REUSS, a, apertural view, b, side view, Septaria-clay, Hermsdorf (10445), ×60.

FIG. 12. — *Bolivina fastigia* CUSHMAN, side view, Upper Oligocene Mergelsand, Astrup (17538), ×90.

FIG. 13. — *Bolivina floridana* CUSHMAN var. *imporcata* CUSHMAN and RENZ, a, side view, b, apertural view, Miocene, Dingden (456), ×90.

FIG. 14. — *Loxostomum digitale* (D'ORBIGNY), side view, Upper Oligocene Mergelsand, Astrup (17538), ×60.

FIG. 15. — *Loxostomum sinuosum* CUSHMAN, a, apertural view, b, side view, Miocene, Dingden (456), ×85.

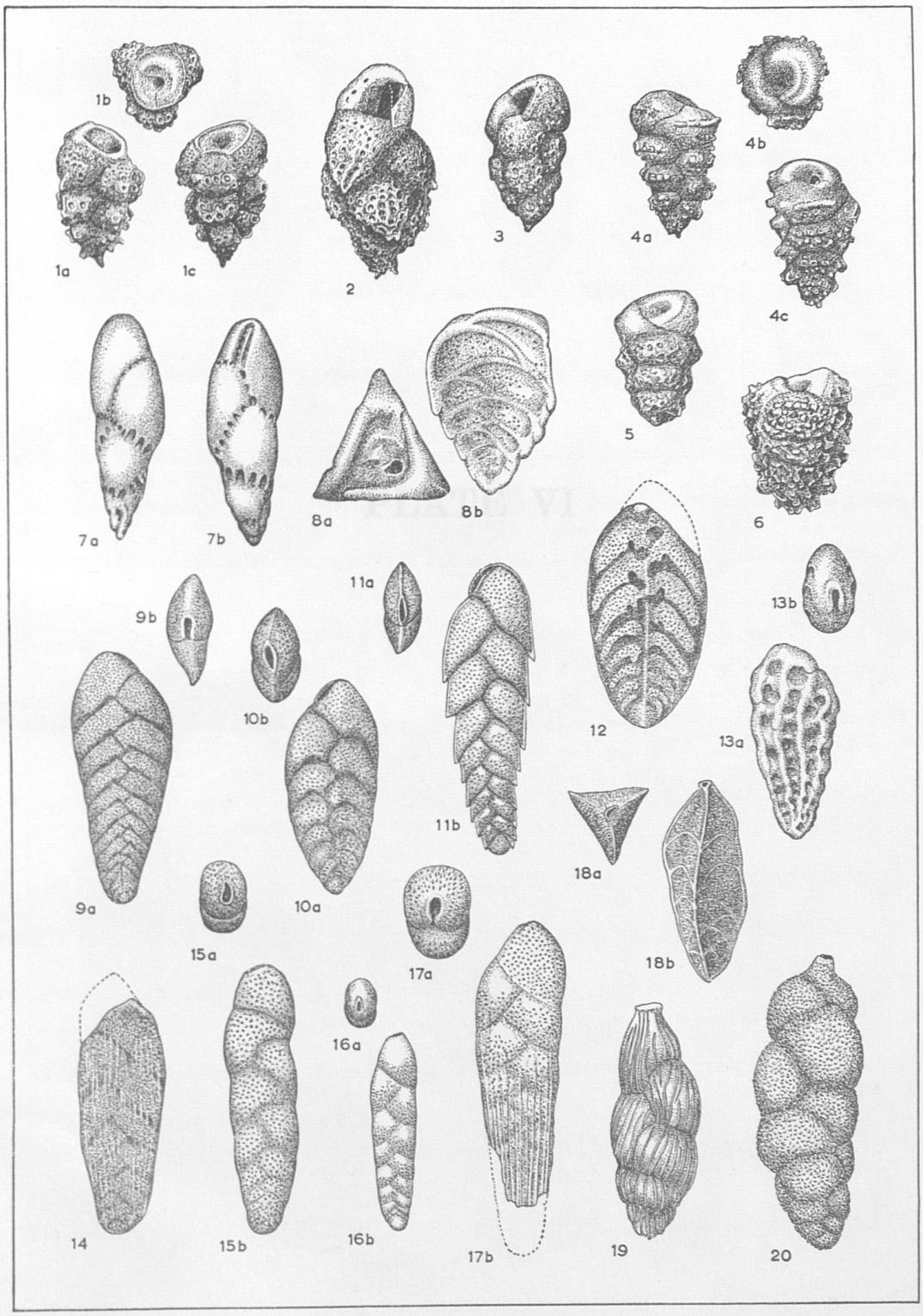
FIG. 16. — *Loxostomum minutissimum* (SPANDEL), a, apertural view, b, side view, Septaria-clay, Pietzpuhl (10447), ×90.

FIG. 17. — *Loxostomum teretum* CUSHMAN, a, apertural view, b, side view, Septaria-clay, Pietzpuhl (10447), ×90.

FIG. 18. — *Trifarina bradyi* CUSHMAN, a, apertural view, b, side view, sand of Antwerp, Burcht, ×85.

FIG. 19. — *Uvigerina rugulosa* REUSS, side view, sand of Antwerp, Burcht, ×95.

FIG. 20. — *Uvigerina tenuipustulata* VAN VOORTHUYSEN, side view, sand of Antwerp, boring Heist-op-den-Berg (26 m), ×60.



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EXPLANATION OF PLATE VI.

FIG. 1. — *Angulogerina gracilis* (REUSS) var., side view of smooth specimen, Septaria-clay, Pietzpuhl (10447), ×90.

FIG. 2. — *Angulogerina gracilis* (REUSS), side view, Septaria-clay, Hermsdorf (10445), ×90.

FIG. 3. — *Angulogerina gracilis* (REUSS) var. *oligocaenica* (ANDREAE), Septaria-clay, Hermsdorf (13438). ×90.

FIG. 4. — *Angulogerina gracilis* (REUSS) var. *germanica* CUSHMAN and EDWARDS, Boom clay, Boom (MA 649), ×85.

FIG. 5. — *Angulogerina gracilis* (REUSS) var. *tenuistriata* (REUSS), Septaria-clay, Pietzpuhl (10447), ×95.

FIG. 6. — *Robertina declivis* (REUSS) a, b, opposite sides, Boom clay, Boom (MA 649), ×60.

FIG. 7. — *Cassidulina carapitana* HEDBERG, a, peripheral view, b, side view, Boom clay, Boom (MA 652), ×60.

FIG. 8. — *Pullenia quinqueloba* (REUSS), a, peripheral view, b, side view, Boom clay, Kuiperberg near Ootmarsum (Netherlands) (NLD 672), ×90.

FIG. 9. — *Pullenia bulloides* (D'ORBIGNY), a, side view, b, peripheral view, Boom clay, Stekene (OA 601), ×90.

FIG. 10. — *Cassidulina subglobosa* BRADY var., a, apertural view, b, side view, Septaria-clay, Pietzpuhl (10447), ×95.

FIG. 11. — *Sphaeroidina bulloides* D'ORBIGNY, a, b, opposite sides, Boom clay, Tielrode (JA 355), ×60.

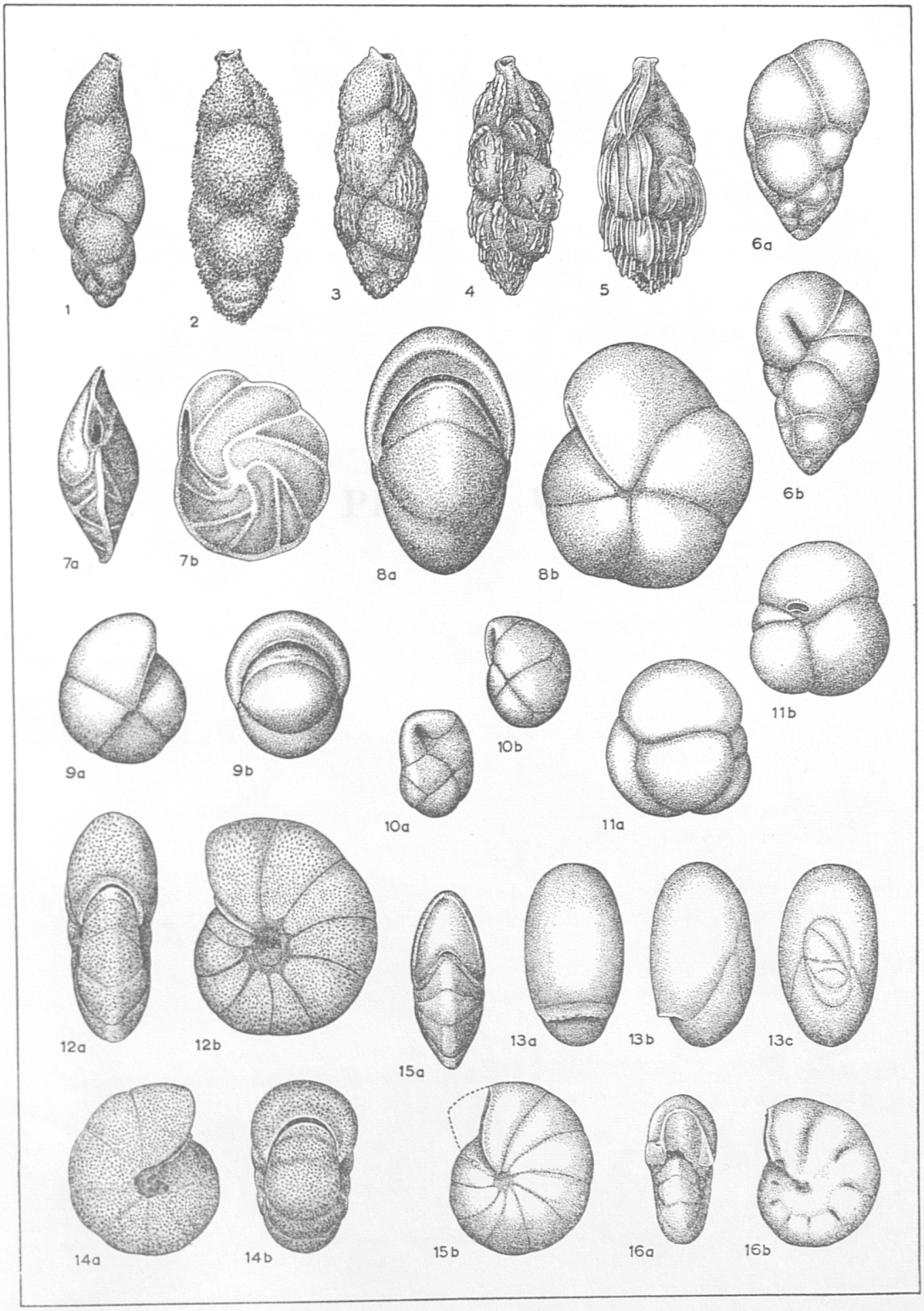
FIG. 12. — *Nonion affine* (REUSS), a, peripheral view, b, side view, Boom clay, Loksbergen (HB 665), ×90.

FIG. 13. — *Chilostomella cylindroides* REUSS, a, c, opposite sides, b, side view, Septaria-clay, Pietzpuhl (10447), ×55.

FIG. 14. — *Nonion pompilioides* (FICHTEL and MOLL), a, side view, b, peripheral view, sand of Antwerp, Burcht, ×60.

FIG. 15. — *Nonion buxovillanum* (ANDREAE), a, peripheral view, b, side view, Boom clay, Tielrode (JG 612), ×90.

FIG. 16. — *Nonion perfossum* (CLODIUS), a, peripheral view, b, side view, Miocene, Dingden (456), ×90.



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EXPLANATION OF PLATE VII.

FIGS. 1-3. — *Nonion granosum* (D'ORBIGNY), aa, peripheral views, bb, side views; 1, Nucula-clay, Berg (BZ 552); 2, Nucula-clay, Bilzen-Katteberg (TK 523); 3, Henis clay, Berg (BZ 551), ×90.

FIG. 4. — *Nonionella lobsannensis* (ANDREAE), a, ventral view, b, peripheral view, c, dorsal view, Septaria-clay, Pietzpuhl (10447), ×90.

FIG. 5. — *Nonion roemeri* CUSHMAN, a, side view, b, peripheral view, sand of Voort, deepboring Lillo (90), ×60.

FIG. 6. — *Nonion boueanum* (D'ORBIGNY) var. *dingdenensis* CUSHMAN, a, side view, b, peripheral view, Miocene, Dingden (456), ×55.

FIG. 7. — *Nonion boueanum* (D'ORBIGNY), a, side view, b, peripheral view, sand of Voort, deepboring Lillo (83), ×45.

FIGS. 8, 9. — *Nonionella limba* (D'ORBIGNY), 8, a, peripheral view, and b, ventral view of specimen with closed umbilicus; 9, specimen with open umbilicus, a, ventral view, b, peripheral view, c, dorsal view, sand of Antwerp, Burcht, ×90.

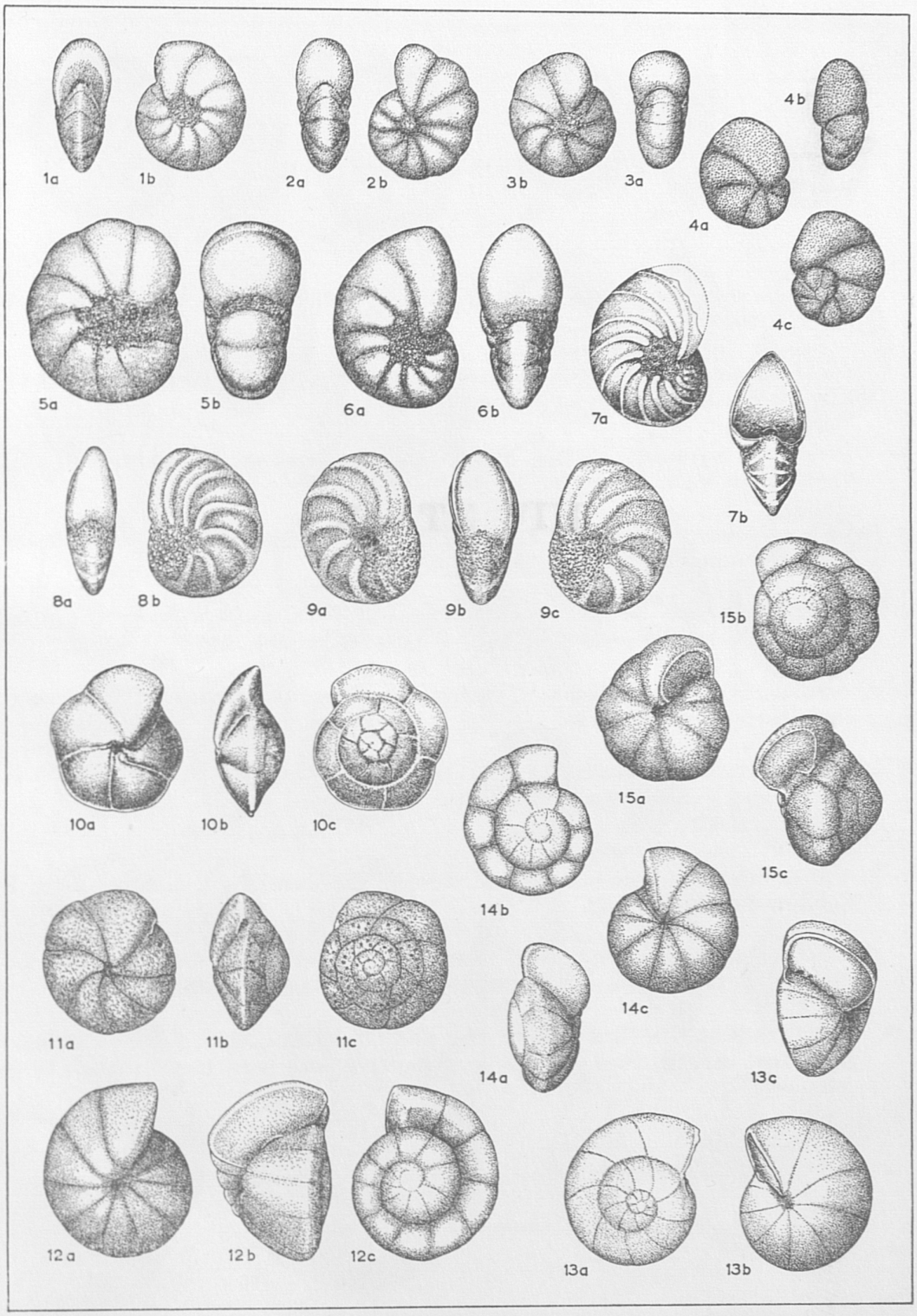
FIG. 10. — *Eponides umbonatus* (REUSS), a, ventral view, b, peripheral view, c, dorsal view, Septaria-clay, Pietzpuhl (10447), ×60.

FIG. 11. — *Eponides pygmeus* (VON HANTKEN), a, ventral view, b, peripheral view, c, dorsal view, Boom clay, Boom (MA 649), ×90.

FIG. 12. — *Gyroidina soldanii* D'ORBIGNY var. *girardana* (REUSS), a, ventral view, b, peripheral view, c, dorsal view, Septaria-clay, Hermsdorf (13438), ×60.

FIGS. 13, 14. — *Gyroidina soldanii* D'ORBIGNY, 13, a, dorsal view, b, ventral view, c, peripheral view, Boom clay, Schelle (JM 642); 14, a, peripheral view, b, dorsal view, c, ventral view, Boom clay, Kemzeke-Hol (JF 609), ×60.

FIG. 15. — *Gyroidina soldanii* D'ORBIGNY, var. *mamillata* (ANDREAE), a, ventral view, b, dorsal view, c, peripheral view, Boom clay, Kemzeke-Hol (JF 609), ×80.



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EXPLANATION OF PLATE VIII.

FIG. 1. — *Valvulineria petrolei* (ANDREAE), a, dorsal view, b, peripheral view, c, ventral view, Boom clay, Stekene (OA 601), ×95.

FIG. 2. — *Discorbis globularis* (D'ORBIGNY), a, dorsal view, b, peripheral view, c, ventral view, Oude-Biezen member, Kleine-Spouwen (BZ 541), ×90.

FIGS. 3, 4. — *Rotaliatina bulimoides* (REUSS), 3, side view, Septaria-clay, Pietzpuhl (10447); 4, a, ventral view, b, side view, Boom clay, Herselt (AE 661), ×90.

FIG. 5. — *Hanzawaia boueana* (D'ORBIGNY), a, dorsal view, b, peripheral view, c, ventral view, sand of Antwerp, boring Heist-op-den-Berg (26 m), ×85.

FIG. 6. — *Ceratobulimina contraria* (REUSS) var. cf. *Ceratobulimina haueri* (D'ORBIGNY), a, dorsal view, b, peripheral view, c, ventral view, sand of Antwerp, Burcht, ×30.

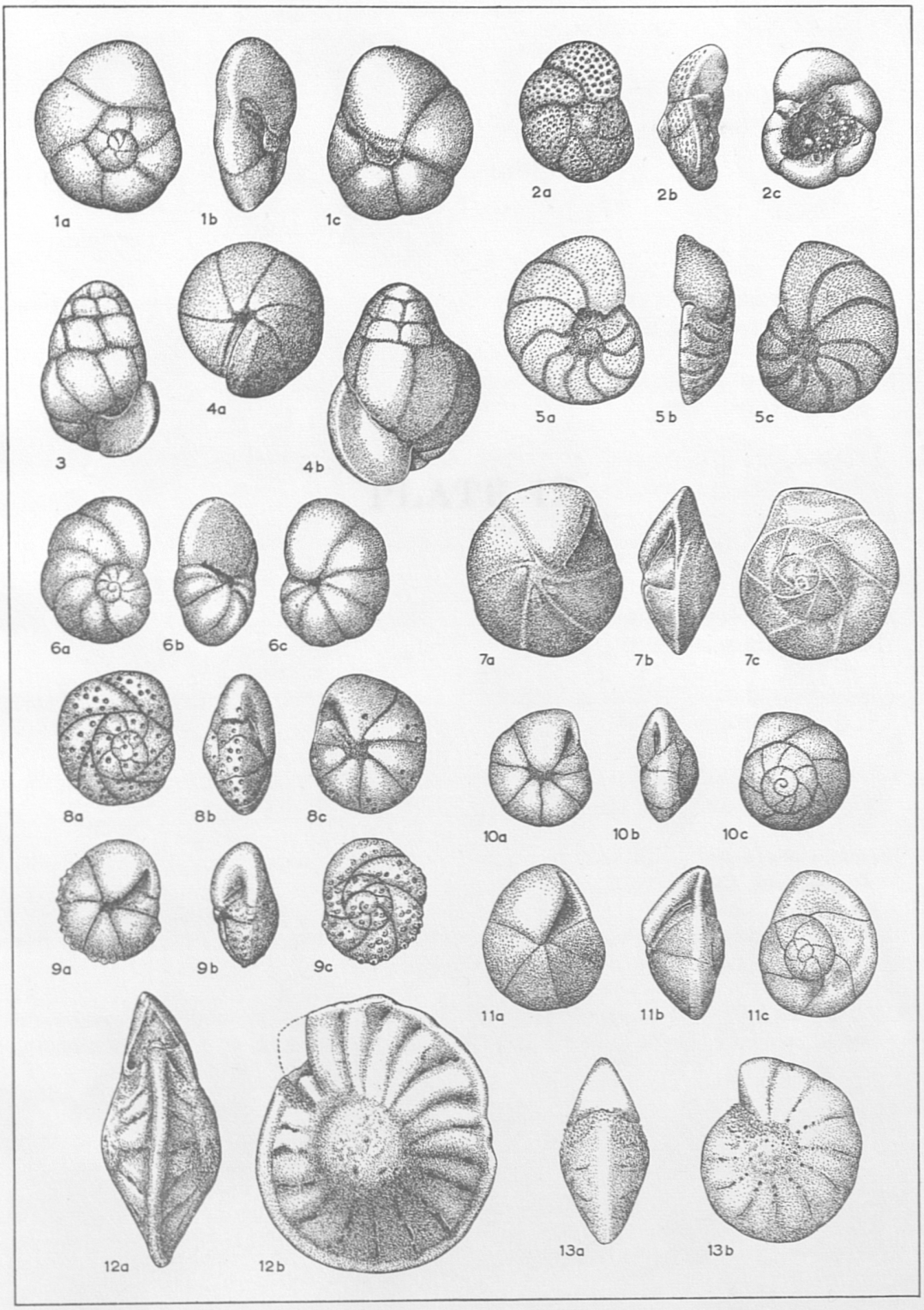
FIG. 7. — *Alabamina tangentialis* (CLODIUS), a, ventral view, b, peripheral view, c, dorsal view, Septaria-clay, Pietzpuhl (10447), ×90.

FIGS. 8, 9. — *Alabamina perlata* (ANDREAE), 8, a, dorsal view, b, peripheral view, c, ventral view, Boom clay, Herselt (AE 661); 9, a, ventral view, b, peripheral view, c, dorsal view, Septaria-clay, Pietzpuhl (10447), ×85.

FIG. 10. — *Pseudoparrella oveyi* BHATIA, a, ventral view, b, peripheral view, c, dorsal view, Boom clay, Kemzeke-Hol (JF 608), ×85.

FIG. 11. — *Alabamina wolterstorffi* (FRANKE), a, ventral view, b, peripheral view, c, dorsal view, ? Lower Oligocene, « Grünsandton », Nachterstedt (Sachsen-Anhalt, Germany), ×55.

FIGS. 12, 13. — *Elphidium subnodosum* (ROEMER), aa, peripheral views, bb, side views; 12, sand of Voort, Houthalen, shaft II (84-88 m), ×30; 13, Lower Tongeren beds, Hendrik, shaft IV (201-202 m), ×55.



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EXPLANATION OF PLATE IX.

FIG. 1. — *Almaena osnabrugensis* (ROEMER), a, dorsal view, b, peripheral view, c, ventral view, Kasseler Meeressand, Kassel (11315), ×50.

FIG. 2. — *Planorbulina difformis* ROEMER, a, ventral view, b, dorsal view, Upper Oligocene Mergelsand, Astrup (17538), ×25.

FIGS. 3, 4. — *Cibicides tenellus* (REUSS), aa, ventral views, bb, peripheral views, cc, dorsal views, Upper Oligocene Mergelsand, Astrup (17538), ×50.

FIG. 5. — *Cibicides sulzensis* (HERRMANN), a, ventral view, b, dorsal view, c, peripheral view, Boom clay, Stekene (OA 601), ×50.

FIG. 6. — *Cibicides ungerianus* (D'ORBIGNY), a, dorsal view, b, ventral view, c, peripheral view, Boom clay, Loksbergen (HB 665), ×50.

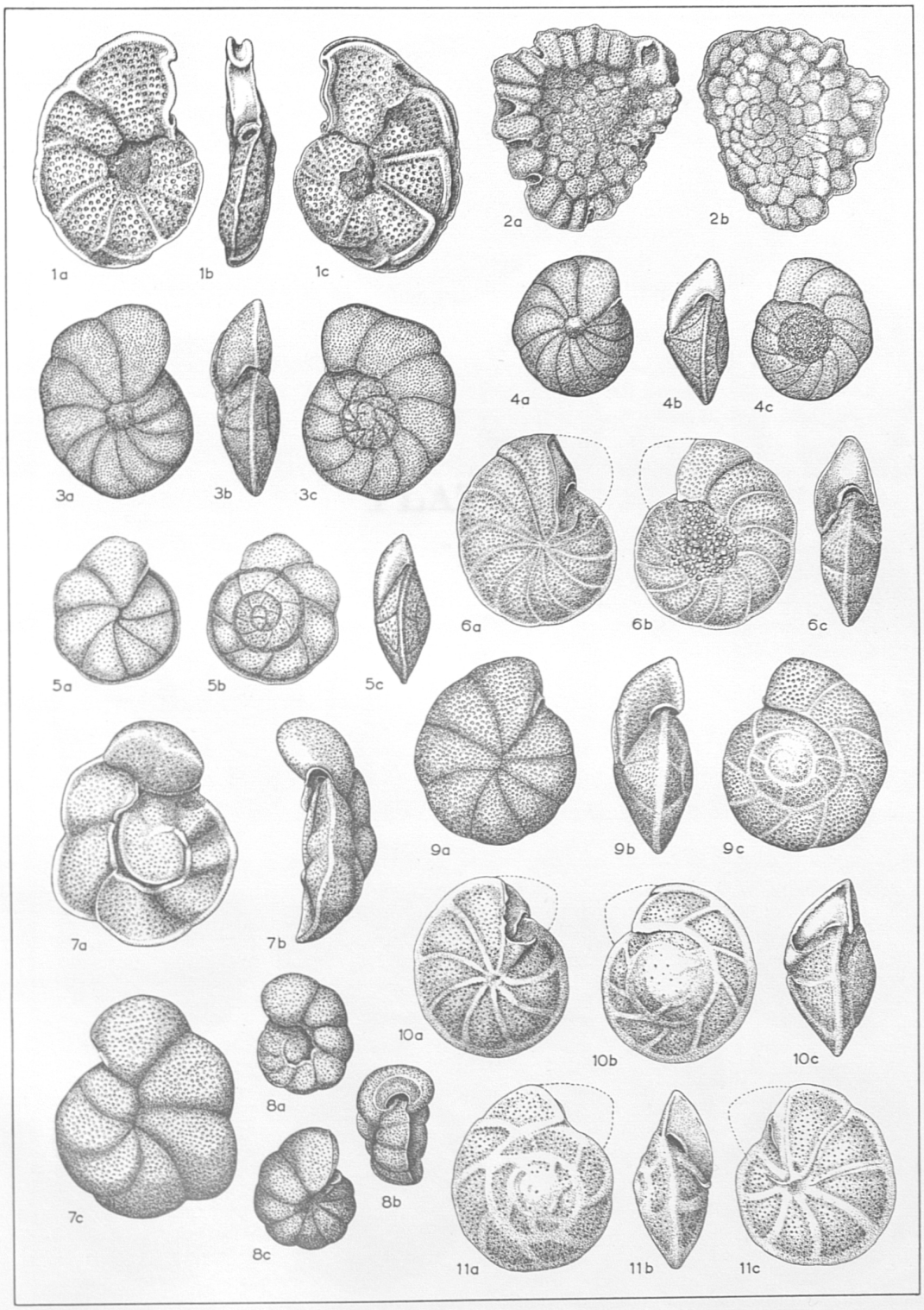
FIG. 7. — *Cibicides lobatulus* (WALKER and JACOB), a, dorsal view, b, peripheral view, c, ventral view, sand of Antwerp, Burcht, ×50.

FIG. 8. — *Cibicides lobatulus* (WALKER and JACOB) var., a, dorsal view, b, peripheral view, c, ventral view, Lower Tongeren beds, Hendrik, shaft IV (193-194 m), ×50.

FIG. 9. — *Cibicides dutemplei* (D'ORBIGNY), a, ventral view, b, peripheral view, c, dorsal view, Kasseler Meeressand, Kassel (11315), ×50.

FIG. 10. — *Cibicides dutemplei* (D'ORBIGNY) var. *praecinctus* (KARRER), a, ventral view, b, dorsal view, c, peripheral view, Boom clay, Lier (VA 656), ×50.

FIG. 11. — *Cibicides dutemplei* (D'ORBIGNY) var. *peelensis* TEN DAM and REINHOLD, a, dorsal view, b, peripheral view, c, ventral view, horizon of Houthalen-sand of Voort, Houthalen, shaft II (80,50-81,52 m), ×50.



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EXPLANATION OF PLATE X.

FIGS. 1, 8. — *Asterigerina bartoniana* (TEN DAM),1, a, dorsal view, b, ventral view, c, peripheral view, Lower Tongeren beds, Hendrik, shaft IV (193-194 m); 8, a, peripheral view, b, dorsal view, c, ventral view, Lower Tongeren beds, Hendrik, shaft IV (191-192 m), ×50.

FIG. 2. — *Epistomina elegans* (D'ORBIGNY), a, ventral view, b, peripheral view, c, dorsal view, Boom clay, boring Heist-op-den-Berg (28 m), ×80.

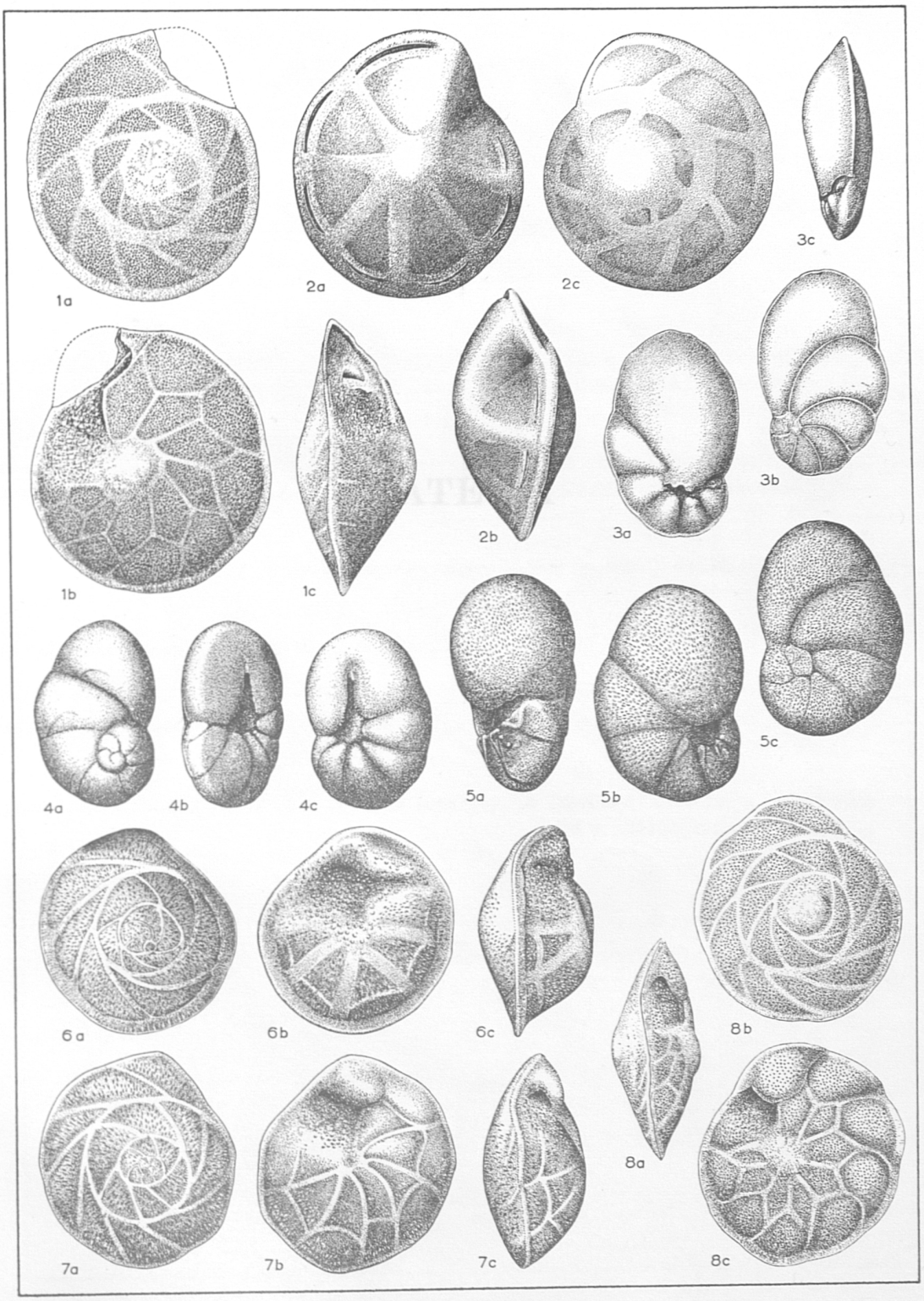
FIG. 3. — *Cancris auriculus* (FICHTEL and MOLL), a, ventral view, b, dorsal view, c, peripheral view, Miocene, Dingden (456), ×50.

FIG. 4. — *Ceratobulimina contraria* (REUSS), a, dorsal view, b, apertural view, c, ventral view, Boom clay, Boom (MA 650), ×80.

FIG. 5. — *Cancris turgidus* CUSHMAN and TODD, a, peripheral view, b, ventral view, c, dorsal view, Kasseler Meeressand, Kassel (11315), ×75.

FIG. 6. — *Asterigerina gürichi* (FRANKE) var. *staeschei* TEN DAM and REINHOLD, a, dorsal view, b, ventral view, c, peripheral view, Miocene, Dingden (456), ×75.

FIG. 7. — *Asterigerina gürichi* (FRANKE), a, dorsal view, b, ventral view, c, peripheral view, sand of Voort, deepboring Lillo (116), ×75.



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EXPLANATION OF PLATE XI.

FIGS. 1, 2. — *Globigerina bulloides* D'ORBIGNY, 1, a, ventral view, b, peripheral view, c, dorsal view, Boom clay, Boom (MA 373); 2, a, ventral view, b, dorsal view, c, peripheral view, Boom clay, Boom (MA 648), × 105.

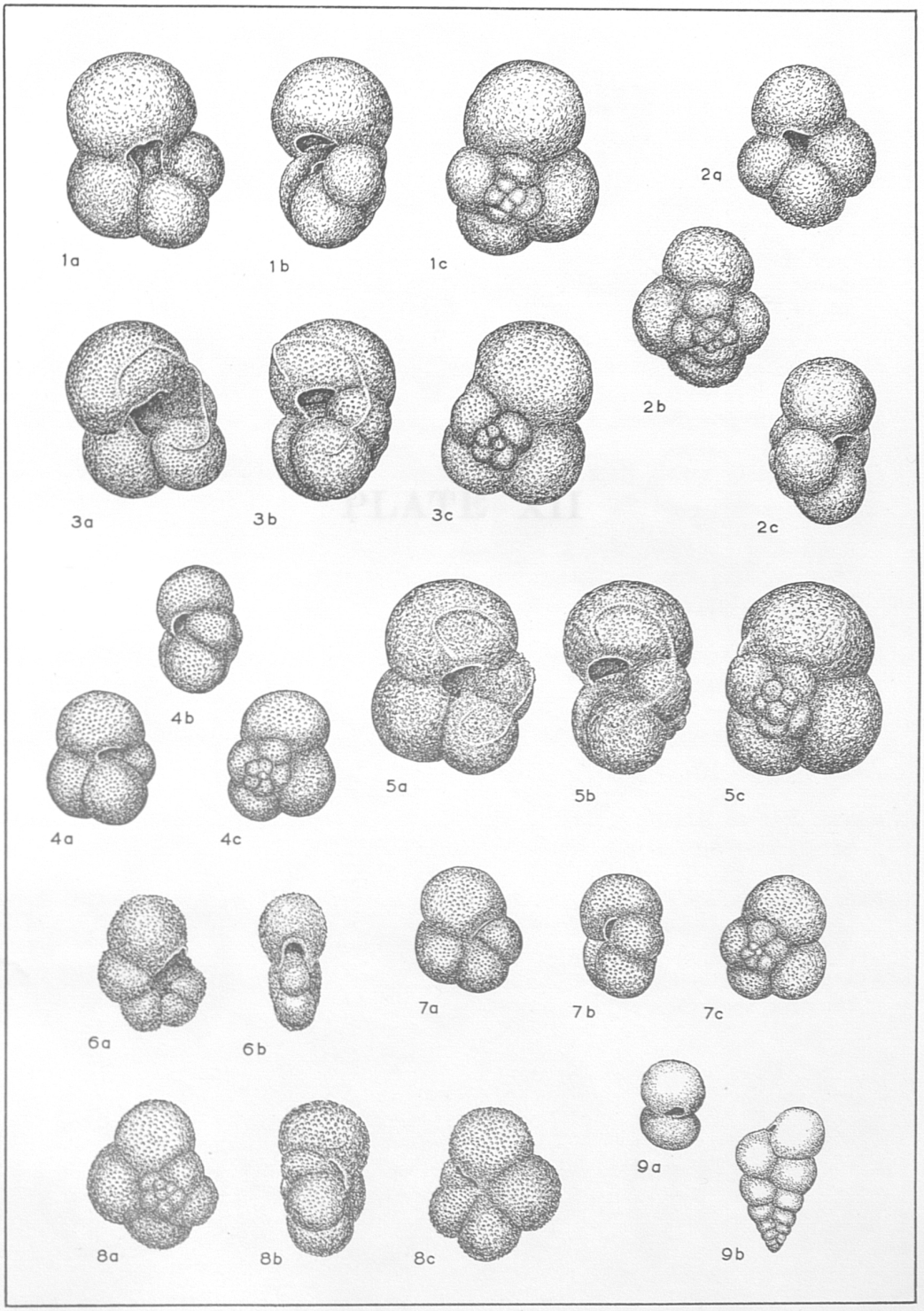
FIGS. 3, 4, 5. — *Globigerina globularis* ROEMER, aa, ventral views, bb, peripheral views, cc, dorsal views; 3, Boom clay, Boom (MA 373); 4, Boom clay, Boom (MA 651); 5, Boom clay, Stekene (OA 601), × 110.

FIG. 6. — *Globigerinella micra* (COLE), a, side view, b, peripheral view, probably reworked, Septaria-clay, Pietzpuhl (10447), × 105.

FIG. 7. — *Globigerina* sp., a, ventral view, b, peripheral view, c, dorsal view, Boom clay, Boom (MA 651), × 95.

FIG. 8. — *Globigerina* sp., a, dorsal view, b, peripheral view, c, ventral view, Boom clay, Boom (MA 648), × 100.

FIG. 9. — *Gümbelina gracillima* (ANDREAE), a, apertural view, b, side view, probably reworked, Septaria-clay, Pietzpuhl (10447), × 105.



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EXPLANATION OF PLATE XII.

FIG. 1. — *Elphidium minutum* (REUSS), a, side view, b, peripheral view, sand of Voort, deeporing Lillo (83), ×60.

FIG. 2. — *Elphidium inflatum* (REUSS), a, side view, b, peripheral view, Miocene, Dingden (456), ×65.

FIG. 3. — *Elphidium ungeri* (REUSS), a, side view, b, peripheral view, sand of Antwerp, Burcht, ×65.

FIG. 4. — *Elphidium hiltermanni* HAGN, a, peripheral view, b, side view, sand of Antwerp, Burcht, ×95.

FIGS. 5-7. — *Rotalia canui* CUSHMAN, 5, a, dorsal view, b, ventral view, c, peripheral view, Nucula-clay, Bilzen-Katteberg (TK 522); 6, a, dorsal view, b, peripheral view, c, ventral view, Nucula-clay, Bilzen-Katteberg (TK 523); 7, a, ventral view, b, peripheral view, c, dorsal view, Nucula-clay, Berg (BZ 492), ×85.

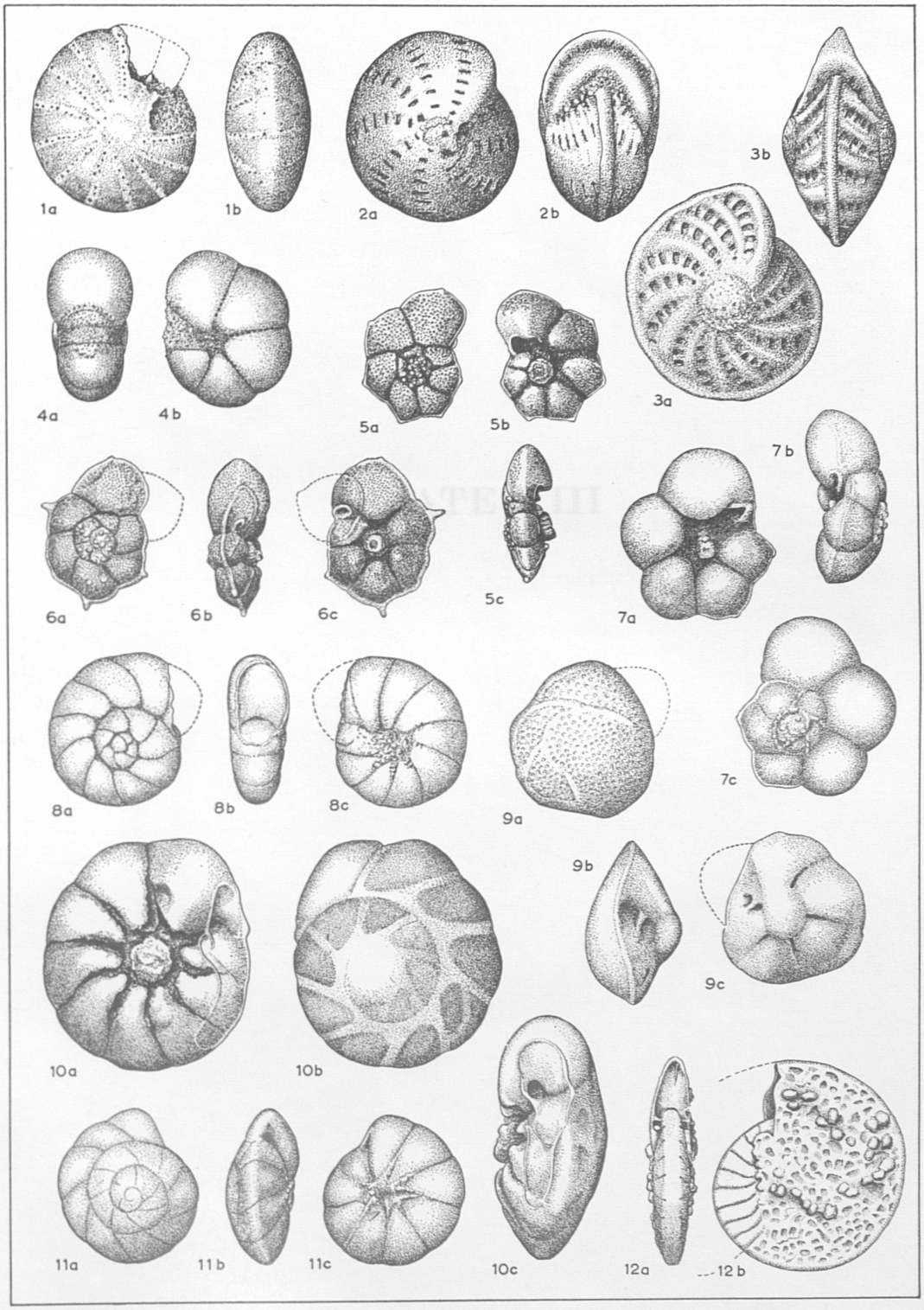
FIG. 8. — *Rotalia kiliani* (ANDREAE), a, dorsal view, b, peripheral view, c, ventral view, Henis clay, Oude-Biezen (TG 228), ×85.

FIG. 9. — *Rotalia trochus* ROEMER, a, dorsal view, b, peripheral view, c, ventral view, Upper Oligocene Mergelsand, Astrup (17538), ×85.

FIG. 10. — *Rotalia beccarii* (LINNÉ), a, ventral view, b, dorsal view, c, peripheral view, horizon of Houthalen, Houthalen, shaft I (80,25-80,79 m), ×50.

FIG. 11. — *Rotalia propingua* REUSS, a, dorsal view, b, peripheral view, c, ventral view, Kasseler Meeressand, Kassel (11315), ×50.

FIG. 12. — *Nummulites germanicus* (BORNEMANN), a, peripheral view, b, side view, Lower Tongeren beds, Hendrik, shaft IV (194-195 m), ×15.



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EXPLANATION OF PLATE XIII.

Nummulites germanicus (BORNEMANN), Lower Tongeren beds, Hendrik, shaft IV (194-195 m).

FIG. 1. — Median section of microspheric specimen, ×20.

FIG. 2. — Median section of macrospheric specimen, ×20.

FIG. 3. — Transversal section of macrospheric specimen, ×30.

FIGS. 4-7. — Median sections of macrospheric specimens, ×20.

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