Some of the species of this list may be index-fossils of the Oligocene. They may at least be index-fossils for the rock-stratigraphic unit of Boom clay and Septaria-clay. The occurrences of these species are given below.

Karreriella siphonella has been recorded from the Septaria-clay and from Upper Oligocene and Miocene deposits of northwestern Europe. It occurs also in several members of the Oligocene of the Mainz-Alsace region (Pechelbronn beds, Septaria-clay, Foraminifera-marl, Corbicula-marl) and in the Oligocene Molasse of Bavaria.

Turrilina alsatica is only known from the Boom clay, the Septaria-clay of northwestern Germany and from the Septaria-clay, Meletta- and Amphisyle-beds, Foraminifera-marl and Corbicula-marl of the Mainz basin and Alsace. All these deposits are usually regarded as Middle Oligocene.

Nonion buxovillanum is a small species only known from the Boom clay, the Meletta-beds of Alsace and the Corbicula-marl of the Mainz basin.

Eponides pygmeus is known from Oligocene deposits in Hungary, Bavaria, Alsace, Belgium and Wight. Possibly it occurs also in the Upper Eocene Asse clay of Belgium.

Rotaliatina bulimoides is only known from the Boom clay and the Septaria-clay of northwestern Germany, but not from the Mainz basin and Alsace.

Alabamina perlata occurs in the Boom clay, in the Septaria-clay of northwestern Germany and Alsace and in the Foraminifera-marl of Alsace.

Cassidulina carapitana and *Pseudoparrella oveyi* are as yet unknown from the German Septaria-clay. *Cassidulina carapitana* has a wide geographic distribution in the Tertiary of the Caribbean-Antillean area (Renz, 1948), but this is the first time that it is recorded from Europe. It is a rather big, remarkable species.

Pseudoparrella oveyi on the contrary is a minute species, that might have been overlooked easily by Reuss and Bornemann. Andreae (1884), who figured several small species did not find the species in the Oligocene deposits of Alsace. *Pseudoparrella oveyi* is only known from the Oligocene Hamstead Corbula-beds of Wight and from the Belgian Boom clay.

The other enumerated species are either too scarce in our material, or their specific distinction may be considered dubious.

There is no doubt concerning the correlation of the Boom clay with the German Septaria-clay. Fauna and sediment of these members show perfect resemblance. The distribution of the Foraminifera distinctly points to a free connection of the northwest-European basin and the Mainz-Alsace region during Oligocene time.

Further southward relations are less clear. Hagn (1952) found that the foraminiferal fauna of the Middle Oligocene Molasse of Bavaria showed more resemblance with the associations of contemporaneous deposits in Hungary than with that of the Middle Oligocene of Alsace.

Among the Oligocene Foraminifera of Wight, recently described by Bhatia (1955), there are some characteristic species, viz *Buliminella carteri, Bolivina fastigia, Angulogerina gracilis, Pseudoparrella oveyi* and *Rotalia kiliani*, that occur also in our Oligocene material (Henis, Nucula- and Boom clays). Thet suggest marine connections between the Hampshire basin and Belgium during considerable parts of Oligocene time.

The few Foraminifera in the Oligocene of the Paris basin, described by Cushman (1928), do not allow for a correlation with the Oligocene of the northwest European and Hampshire basins.

Nor do the assemblages of other Oligocene deposits, in Italy, Spain and southern France show distinct affinities to the Oligocene associations of northwestern Europe and the Mainz-Alsace region.

THE GERMAN UPPER OLIGOCENE

(Table 4)

Our samples of the Kasseler Meeressand (Kassel 11315, 12667) and from a marly sand of Astrup near Osnabrück (17538) yielded some fifty species.

Angulogerina gracilis, Cibicides dutemplei and *Cibicides tenellus* are very common.

Less common species are : *Bulimina kasselensis, Nonion affine, Nonion granosum, Cibicides lobatulus, Hanzawaia boueana, Almaena osnabrugensis, Elphidium subnodosum, Rotalia propingua* and *Rotalia canui.*

These species and big specimens of the Lagenidea, especially of *Frondicularia oblonga, Lenticulina (Vaginulinopsis) gladia,* several *Nodosaria, Guttulina problema, Pseudopolymorphina obscura* and *Sigmomorphina regularis,* are characteristic constituents of the Kassel and Astrup deposits.

Because of the small number of samples we have no sufficient basis for comparison of the foraminiferal contents of this Upper Oligocene with those of Boom and Septaria-clay. Nevertheless a few remarks may be given.

Some species which are absent from the Boom clay and the Septaria-clay of Hermsdorf, occur both in the samples of Kassel and Astrup and in the Nucula-clay. Two of them are rare in the sample of Septaria-clay from Pietzpuhl. These species are : *Bolivina fastigia, Nonion granosum* (also at Pietzpuhl), *Discorbis globularis* (also at Pietzpuhl), *Rotalia propingua* and *Rotalia canui.*

Three other species of the German Upper Oligocene are absent from Boom and Septaria-clay, but they were found in the Lower Tongeren beds : *Cancris turgidus, Elphidium subnodosum* and *Rotalia canui.*

These species evidently preferred a more near-shore environment with deposition of sandy material material rather than the depositional environment of the Boom clay.

THE SAND OF VOORT

(Table 4)

The samples from two of the classical sections in the sand of Voort (Lambroek, Lillo) and from the nearby mine-shafts at Houthalen, contain some twenty species, which are always rare.

Nonion roemeri, Cibicides dutemplei, Asterigerina gürichi and Elphidium subnodosum are the most frequent among them. Rare, but characteristic are the big individuals of *Lenticulina (Vaginulinopsis) gladia, Frondicularia oblonga* and *Guttulina problema.*

Some specimens of *Elphidium inflatum* were found only in the two uppermost Foraminifera-bearing samples from the boring Lillo. They were possibly derived from the overlying Miocene deposits.

Although it is much less diversified, the Foraminifera-assemblage of the Voort sand fairly well resembles that of the German Upper Oligocene. A difference is the greater frequency of *Asterigerina gürichi* in the Voort sand.

This species has a remarkable stratigraphic distribution. It is characteristic for the so-called Asterigerina-zone, which occurs in the upper part of the Boom or Septaria-clay of northern Germany (Staesche and Hiltermann, 1940) and the Netherlands (ten Dam and

REINHOLD, 1942, TEN DAM, 1945). The sediments of the Asterigerina-zone are often sandy, while the microfauna is said to have still the features of our Boom clay associations. *Asterigerina gürichi* was not found in our material of the Belgian Boom clay and the German Septaria-clay.

Julija INDANS recently (1956) recorded the presence of many *Asterigerina* individuals, which very probably belong to *Asterigerina gürichi,* in the sandy deposits in between 273 and 385 m of the boring Kühlerhof (near Erkelenz) in western Germany. In these deposits *Asterigerina* is accompanied by a distinct Voort sand association with *Frondicularia oblonga, Nonion roemeri, Elphidium subnodosum* and other species.

The Oligocene representatives of *Asterigerina gürichi* (8), are evidently most commonly found in sandy deposits of the later Oligocene. In these sediments the species is either accompanied by a Boom clay or by a Voort sand assemblage, which phenomenon may be merely due to different environments.

The lower part of the Kühlerhof sediments between 273 and 385 were interpreted by Miss INDANS as Middle Oligocene; those above 340 m as Upper Oligocene. Recognition of rock-stratigraphic units would be preferable. The deposits between 273 and 385 m have to be correlated with the sand of Voort. Those between 385 and ± 425 m are considered more or less sandy equivalents of the Boom clay, while the *Nummulites* specimens at 450-470 m probably indicate the presence of an equivalent of the Lower Tongeren beds.

Some of the species of the Voort sand and of the German Upper Oligocene were also found in the horizon of Houthalen. Their occurrence in that member is discussed below.

THE HORIZON OF HOUTHALEN

(Table 4)

One sample of the type locality of the horizon of Houthalen could be investigated. The given depth range of the sample (80,25-80,79 m) covers the whole vertical extent of the horizon, from the top of the Voort sand upwards to the base of the overlying dark sands with lignite and fish teeth, which were interpreted by GLIBERT (1945) as possible Anversian.

A reliable evaluation of the microfauna of this horizon is therefore impossible. The basal layer may contribute Foraminifera that had been reworked from the sand of Voort.

Thirteen species were found, all of which were rare. Three of them are characteristic Voort sand species : *Lenticulina (Vaginulinopsis) gladia, Frondicularia oblonga* and *Elphidium subnodosum.*

Most of the other ten species are known either from the Voort sand (*Lenticulina* spp., *Guttulina problema, Pyrulina fusiformis, Nonion boueanum, Cibicides dutemplei, Asterigerina gürichi*) or they have been found in the German Upper Oligocene (*Pseudopolymorphina soldanii* (CUSHMAN and OZAWA, 1930), *Sigmomorphina regularis, Virgulina schreibersiana* (CUSHMAN, 1937).

Only one of the species, *Rotalia beccarii,* has not been found in the Voort sand or in the German Upper Oligocene (except for one, probably reworked, *Rotalia beccarii* specimen in the boring Lillo).

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(8) In Bavaria *Asterigerina gürichi* was found in sandy and marly deposits referred to as Chattian (HAGN, 1955). These Chattian sediments overlie the zone of *Asterigerina praeplanorbis* HAGN, which zone was interpreted by HAGN as Upper Rupelian.

Glibert (1945, 1952), on the basis of the mollusc contents of the horizon of Houthalen, considered the deposit to be of Middle Miocene age. If the Foraminifera are not reworked we would consider the horizon of Houthalen to represent the upper part of the sand of Voort, which probably is of Late Oligocene age.

THE MIOCENE OF ANTWERP AND DINGDEN

(Table 4)

The microfaunal assemblages of the sand of Antwerp [Burcht, Heist 26 m and Antwerp (poor microfauna)] and of the Dingden beds show very close resemblance, which fact had already been noted by Reuss in 1861. Both the Antwerp sand and the Dingden beds are usually regarded as of Middle Miocene age, on the basis of the mollusc associations.

Some sixty species were encountered, more than twenty of which were not found in our material of older deposits. In the following list of most frequent species, those appearing for the first time in our column are marked with an asterisk *.

Spiroplectammina carinata, **Martinottiella communis*, *Bulimina elongata*, **Bolivina dilatata*, *Nonion affine*, **Nonion perfossum*, *Nonion boueanum*, *Cibicides ungerianus*, *Hanzawaia boueana*, *Asterigerina gürichi* and *Elphidium inflatum*.

Less frequent but nevertheless important are :

**Bigenerina nodosaria*, **Siphotextularia labiata*, *Globulina gibba*, **Bulimina dingdenensis*, **Virgulina* (*Virgulinella*) *pertusa*, **Bulimina floridana* var. *imporcata*, **Uvigerina rugulosa*, *Trifarina bradyi*, **Nonion pompilioides*, **Nonionella limba*, *Cancris auriculus*, *Cibicides dutemplei*, *Cibicides lobatulus*, *Ceratobulimina contraria* var., *Globigerina* spp., *Elphidium hiltermanni*.

As a whole the assemblages are rich in *Textulariidae*, *Buliminidae*, *Nonionidae*, *Anomalinidae*, *Asterigerina* and *Elphidiidae*.

There are no distinct relations between these assemblages and the associations described from European Miocene deposits farther southward.

The peculiar *Virgulina* (*Virgulinella*) *pertusa* as yet is only known from the Antwerp and Dingden beds and from Miocene deposits of North Africa. Other species of the subgenus *Virgulinella* have been recorded from several north-American Miocene formations [Choctawatchee, Shoal River formations and Oak Grove sand of Florida, Choptank, St.-Mary's and Calvert formations, Maryland (Cushman, 1937)] and from the Pliocene « Formation VI » of West-Java [*Virgulinella lunata*, Yabe and Asano, 1937, Tokohu Imp. Univ. Sci. Repts., Sendai, Japan, ser. 2 (geol.), vol. 19, no. 1, p. 121].

Asterigerina gürichi (commonly *A. gürichi* var. *staeschei*) that is frequent in the Antwerp and Dingden samples, has been reported from the so-called Redonian deposits of northwestern France (Roger and Freneix, 1946), which are usually considered of Late Miocene or Early Pliocene age.

The other enumerated species do not allow for any correlation toward the south. Some of them are as yet only known from the northwest-European basin. The others have either a longer vertical range or their specific relations are indistinct.

TABLE 1. — **Distribution chart of Foraminifera**

	FORAMINIFERA												
	Spiroplectammina carinata	*Textularia* cf. *T. gramen*	*Lenticulina* spp.	*Guttulina problema*	*Globulina gibba*	*Pyrulina fusiformis*	*Glandulina aequalis*	*Pullenia bulloides*	*Nonion affine*	*Nonion granosum*	*Nonion boueanum*	*Gyroidina soldanii*	*Cancris turgidus*
Middle Miocene	+	.	.	+	+	+	+	+	+	+	+	+	.
Upper Oligocene	+	.	.	+	+	+	+	+	+	+		+	+
Rupel formation	+	.	+	+	+	+	+	+	+	+	.	+	.
Upper Tongeren beds	.	.	.	.	.	.	.	.	.	.	.	.	.
Lower Tongeren beds :													
SG 198, Grimmertingen	.	.	r	.	r	.	.	.	.	.	.	.	.
TL 529, Hoeselt	.	.	r	.	r	r	.	.	.	.	.	.	?
Hendrik IV :													
190-191 m	.	.	.	.	.	.	.	.	.	.	.	.	.
191-192 m	.	.	r	r	r	r	.	.	r	.	r	.	r
192-193 m	.	.	.	.	.	.	.	.	.	.	.	.	.
193-194 m	.	r	C	.	r	r	.	.	.	.	r	.	r
194-195 m	r	r	r	.	r	.	.	.	.	r	.	.	r
195-196 m	r	r	r	r	r	r	?	.	.	.	.	.	.
196-197 m	r	.	r	r	r	r	.	.	.	.	.	.	.
197-198 m	r	.	r	.	r	r	.	.	.	.	.	.	.
198-199 m	r	.	C	r	r	.	.	.	.	.	.	.	.
199-200 m	r	.	r	.	r	.	.	r	.	.	.	.	.
200-201 m	r	.	r	.	r	r	.	.	.	.	.	.	.
201-202 m	r	.	C	r	r	r	.	.	r	.	.	.	.
202-203 m	.	.	r	r	.	.	.	.	.	.	.	.	.
203-204 m	r	.	r	r	.	.	.	r	r	.	.	.	.
205-206 m	r	.	.	.	.	.	.	.	.	r	.	.	.
206-207 m	.	.	r	.	.	.	.	.	.	.	.	.	.
209-210 m	.	.	r	r	r	.	.	.	r	.	.	r	.
Lattorf (FRANKE, 1925)	+	?	+	+	+	+	.	+	+	.	.	+	+
Eocene	+	?	+	+	+	+	+	+	+	+	+	+	+

and Ostracoda in the Lower Tongeren beds.

								OSTRACODA											
Cibicides dutemplei	*Cibicides lobatulus*	*Alabamina wolterstorffi*	*Asterigerina bartoniana*	*Globigerina* spp.	*Elphidium subnodosum*	*Rotalia canui*	*Nummulites germanicus*	*Cytherella* sp.	*Haplocytheridea heizelensis*	*Haplocytheridea perforata*	*Krithe bartonensis*	*Pterygocythereis cornuta*	*Pterygocythereis fimbriata*	*Trachyleberidea aranea*	*Echinocythereis scabra*	*Leguminocythereis striatopunctata*	*Cytheretta concinna*	*Cytheretta rhenana stigmosa*	*Cytheropteron gulincki*
+	+	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
+	+	·	·	·	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·
+	+	·	·	·	·	+	·	·	·	·	?	·	+	·	+	·	+	+	·
+	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	r	·	r	·	·	·	·	·	·	·	·	·	·	r	·	·	·
r	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
r	·	·	C	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C	·	·	A	·	r	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	r	·	·	·	·	·	·	·	·	·	·	·	·
A	r	·	C	·	r	r	C	·	·	·	·	·	·	·	·	r	·	·	·
C	r	·	C	r	r	r	A	·	r	·	r	·	r	r	·	r	·	·	·
C	r	·	r	·	r	r	C	·	·	·	r	·	·	·	·	r	·	·	·
C	·	r	·	·	r	·	r	·	r	r	r	·	·	r	r	r	r	r	r
C	·	·	r	·	r	·	r	·	·	·	·	·	·	·	r	·	·	·	·
C	r	·	·	·	r	·	·	r	r	·	·	·	r	·	·	·	·	·	·
A	·	r	·	·	·	·	·	·	·	·	r	·	·	·	·	·	·	·	·
C	r	·	·	·	r	·	·	·	·	·	r	r	·	·	·	·	·	·	·
C	·	·	·	r	r	·	·	·	·	·	·	·	r	·	·	·	·	·	·
r	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C	·	·	·	·	r	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C	·	·	·	·	r	·	·	·	·	·	·	·	·	·	·	·	·	·	·
r	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
+	·	+	·	·	+	+	+	·	·	·	·	·	·	·	·	·	·	·	·
+	+	+	·	·	+	+	+	·	+	+	+	+	+	+	+	+	+	·	+

TABLE 2. — **Distribution chart of Foraminifera in the**

	Spiroplectammina carinata	*Quinqueloculina seminula*	*Quinqueloculina juleana*	*Quinqueloculina impressa*	*Quinqueloculina parisiensis*	*Scutuloris oblongus*	*Triloculina tricarinata*	*Spirolina* sp.	*Lenticulina* spp.	*Saracenella böttcheri*	*Nodosaria soluta*	*Guttulina problema*	*Globulina gibba*	*Pyrulina fusiformis*
Middle Miocene	+	.	.	.	.	.	.	.	.	.	.	+	+	+
Upper Oligocene	+	+	+	.	.	.	.	.	.	.	.	+	+	+
Boom clay	+	.	+	+	.	.	.	.	.	+	+	+	+	+
Nucula-clay :														
Boring 39, BZ 559	r	.	.	.	.	.	.	.	r	r	r	.	.	r
Boring 38, BZ 557	.	.	.	.	.	.	.	.	r	r	.	.	.	.
Boring 35, BZ 553	r	.	.	.	.	.	.	.	r	r	r	r	.	r
Boring 35, BZ 552	r	r	r	.	.	r	.	.	r	.	.	r	.	r
Boring 28, BZ 536	r	.	.	.	.	.	.	.	r	.	.	.	r	.
Boring 28, BZ 535	r	.	.	.	.	.	.	.	r	.	r	r	.	r
Boring 27, BZ 534	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bilzen-Katteberg, TK 526	A	.	.	.	.	.	.	.	C	C	C	r	.	C
Bilzen-Katteberg, TK 525	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bilzen-Katteberg, TK 524	r	r	.	.	.	r	r	r	.	.	.	.	.	r
Bilzen-Katteberg, TK 523	r	r	.	.	.	.	.	.	.	.	.	.	.	.
Bilzen-Katteberg, TK 522	r	r	.	.	.	r	.	r	.	.	.	.	.	r
Boring 21, BZ 513	C	.	.	.	.	.	.	.	r	.	.	r	.	r
Boring 16, BZ 504	C	.	.	.	.	.	.	.	.	r	.	r	.	.
Boring 16, BZ 503	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Boring 7, BZ 495	r	.	.	.	.	.	.	.	.	.	.	.	.	.
Boring 6, BZ 493	r	.	.	.	.	r	.	.	r	r	.	.	r	r
Boring 6, BZ 492	.	.	.	.	.	r	.	.	.	.	.	.	.	r
Boring 6, BZ 491	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Boring 6, BZ 490	r	.	.	.	.	.	.	.	.	r	.	.	.	r
Boring 5, BZ 488	C	.	.	.	.	.	.	.	r	r	r	r	r	r
Boring 5, BZ 487	r	.	.	.	.	r	r	.	.	.	.	.	.	.
Boring 5, BZ 486	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Boring 5, BZ 485	.	.	.	.	.	.	.	.	r	r	.	r	.	r
Kleine-Spouwen, TE 428	r	.	.	.	.	.	.	.	r	r	.	r	.	.
Kleine-Spouwen, TE 224	C	.	.	.	.	.	.	.	r	r	r	r	.	r

Upper Tongeren beds, Berg sand and Nucula-clay.

Glandulina aequalis	*Buliminella carteri*	*Bulimina elongata*	*Bolivina beyrichi*	*Bolivina fastigia*	*Angulogerina gracilis*	*Pullenia quinqueloba*	*Nonion affine*	*Nonion granosum*	*Nonionella lobsannensis*	*Discorbis globularis*	*Discorbis* sp.	*Gyroidina soldanii*	*Cibicides sulzensis*	*Cibicides dutemplei*	*Cibicides lobatulus*	*Globigerina* spp.	*Rotalia kiliani*	*Rotalia propingua*	*Rotalia canui*
.	.	+	.	.	.	+	+	+	.	+	.	+	.	+	+	.	.	.	.
.	.	.	.	+	+	.	+	+	.	+	.	+	.	+	+	.	.	+	+
+	.	.	+	.	+	+	+	.	.	.	.	+	+	+	+	.	.	.	.
.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	r	.	.	.	.	r	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	C
.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	r	.	.	.
.	.	.	r	.	.	.	r	C	.	.	.	.	.	.	.	.	.	r	.
.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.
.	r	.	.	.	r	r	.	**V**	r	r	r	.	.	.	.	.	.	.	**V**
.	.	.	.	.	.	r	r	C	.	r	.	.	.	.	.	.	.	.	C
.	.	.	.	r	.	.	r	C	.	r	.	.	.	.	r	.	.	.	**A**
r	.	.	.	.	.	.	C	r	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	r	C	.	.	.	.	.	.	.	r	.	.	.	r
.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	r	C	.	r	r	.	.	.	.	.	.	.	**A**
.	.	.	.	.	.	.	.	**A**	.	r	.	.	.	.	.	.	.	.	**A**
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TABLE 2. — Distribution chart of Foraminifera in the Upper

	Spiroplectammina carinata	*Quinqueloculina seminula*	*Quinqueloculina juleana*	*Quinqueloculina impressa*	*Quinqueloculina parisiensis*	*Scutuloris oblongus*	*Triloculina tricarinata*	*Spirolina* sp.	*Lenticulina* spp.	*Saracenella böttcheri*	*Nodosaria soluta*	*Guttulina problema*	*Globulina gibba*	*Pyrulina fusiformis*
R1b/R1c, Boring 5, BZ 489	r	.	.	.	.	.	.	.	r	.	.	r	.	r
Berg sand :														
Boring 18, BZ 510	.	.	.	.	.	.	.	.	r	.	.	.	.	r
Boring 18, BZ 509	.	.	.	.	.	.	.	.	.	.	.	.	r	.
Boring 18, BZ 508	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Boring 18, BZ 507	r	.	.	.	.	.	.	.	.	.	.	.	r	r
Boring 16, BZ 505	r	.	.	.	.	.	.	.	r	.	.	r	.	r
Kleine-Spouwen, TE 427	r	.	.	.	.	.	.	.	r	r	r	.	.	r
Upper Tongeren beds :														
Oude-Biezen member :														
Tongeren, TA 579	.	r	r	.	.	C	.	.	.	.	.	.	.	.
Boring 31, BZ 546	.	.	.	.	r	r	.	.	.	.	.	.	.	.
Boring 30, BZ 545	.	.	.	.	.	r	.	.	.	.	.	.	.	.
Boring 29, BZ 544	.	r	.	.	.	r	.	.	.	.	.	.	.	.
Boring 29, BZ 543	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Boring 29, BZ 542	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Boring 29, BZ 541	.	.	.	.	r	C	.	.	.	.	.	.	.	.
Boring 29, BZ 540	.	r	.	.	.	.	.	.	.	.	.	.	.	.
Boring 26, BZ 521	.	.	.	.	A	.	.	.	.	.	.	.	.	.
Boring 26, BZ 520	.	.	.	.	r	r	.	.	.	.	.	.	.	.
Boring 26, BZ 519	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Boring 26, BZ 518	.	.	.	r	r	r	.	.	.	.	.	.	.	.
Henis clay :														
Boring 34, BZ 551	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oude-Biezen, TG 228	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tongeren, TB 216	.	.	.	.	r	r	.	r	.	.	.	.	.	.
Tongeren, TB 215	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lower Tongeren beds	+	.	.	.	.	.	.	.	.	.	.	+	+	+

Tongeren beds, Berg sand and Nucula-clay (continued).

Glandulina aequalis	*Buliminella carteri*	*Bulimina elongata*	*Bolivina beyrichi*	*Bolivina fastigia*	*Angulogerina gracilis*	*Pullenia quinqueloba*	*Nonion affine*	*Nonion granosum*	*Nonionella lobsannensis*	*Discorbis globularis*	*Discorbis* sp.	*Gyroidina soldanii*	*Cibicides sulzensis*	*Cibicides dutemplei*	*Cibicides lobatulus*	*Globigerina* spp.	*Rotalia kiliani*	*Rotalia propingua*	*Rotalia canui*
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TABLE 3. — **Distribution chart of Foraminifera in**

	Haplophragmoides latidorsatus	*Spiroplectammina carinata*	*Karreriella siphonella*	*Cyclammina placenta*	*Quinqueloculina ludwigi*	*Quinqueloculina juleana*	*Quinqueloculina impressa*	*Spiroloculina canaliculata*	*Sigmoilina tenuis*	*Pyrgo bulloides*	*Lenticulina* spp.	*Frondicularia seminuda*	*Saracenella böttcheri*	*Nodosaria soluta*	*Nodosaria intermittens*	*Nodosaria ludwigi*	*Nodosaria spinescens*	*Nodosaria emaciata*	*Nodosaria ewaldi*	*Lagena isabella*	*Lagena tenuis*	*Siphonodosaria hirsuta*	*Guttulina problema*	*Globulina gibba*	*Pyrulina fusiformis*	*Glandulina aequalis*	*Glandulina laevigata*	*Sigmomorphina regularis*
Middle Miocene	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	+	.	+	.
Upper Oligocene	.	+	.	.	.	+	+	.	+	.	.	.	.	.	+	.	.	+	.	+	.	.	+	+	+	.	.	+
Septaria- clay :																												
Hermsdorf 10445	.	**V**	**A**	.	.	.	.	.	r	.	r	r	.	r	.	.	r	C	r	.	.	r	.	r	.	.	.	.
Hermsdorf 13438	.	**V**	**A**	.	.	.	r	r	r	.	r	r	.	r	.	.	.	C	r	r	.	r	r	C	.	.	.	.
Pietzpuhl 10447	.	**A**	C	.	.	.	r	r	r		C	.	r	.	.	.	r	r	C	r	r	r	.	r	.	r	.	.
Boom clay :																												
HB 665, Loksbergen	.	C	**A**	.	.	.	.	.	.	.	r	r	.	r	.	.	r	C	r	.	.	.	r	.	r	.	.	r
JF 608, Kemzeke-Hol	.	.	.	.	.	.	.	.	.	.	C	.	.	r	r	.	.	.	.	r	.	.	C	C	r	.	.	.
JF 609, Kemzeke-Hol	.	.	.	.	.	.	.	.	.	.	**A**	.	.	r	r	.	r	r	r	.	.	C	r	r	.	.	.	.
JK 628, Kruibeke	r	C	r	.	.	r	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
JN 653, Kontich	r	**A**	.	**A**	.	.	r	.	.	.	r	.	.	r	.	.	C	r	r	.	.	C	r	r	.	.	.	.
MA 648, Boom	.	**V**	C	.	.	.	r	.	.	.	r	.	.	r	.	.	.	.	.	.	.	.	r	r	.	.	.	.
MA 649, Boom	.	**V**	C	.	.	.	r	.	.	.	C	.	.	r	r	.	.	r	r	.	r	.	C	r	.	.	.	.
MA 650, Boom	.	**V**	C	.	.	.	r	.	.	.	r	.	.	r	r	r	.	.	r	.	.	.	r	r	r	.	.	.
MA 651, Boom	.	**A**	C	.	.	.	.	.	.	.	r	.	.	.	r	.	.	r	.	.	.	.	r	r	.	.	.	.
MA 652, Boom	.	**A**	**A**	.	.	.	r	.	.	.	C	.	.	r	r	r	.	.	.	.	.	.	r	C	r	.	.	.
AA 657-660, Schriek	.	+	+	.	.	.	+	.	.	.	+	+	+	+	+	+	+	+	+	.	.	+	.	.	.	.	.	.
AE 661-664, Herselt	.	+	+	+	.	.	+	.	+	.	+	.	.	+	+	.	.	+	.	.	.	.	.	.	+	+	.	.
JA 352-355, Tielrode	.	+	+	+	.	.	+	.	.	.	+	.	.	+	+	?	.	.	.	.	.	.	+	+	.	.	+	.
JB 356-366, Niel	.	+	+	+	+	.	+	+	.	.	+	.	+	+	+	+	.	+	+	+	.	+	+	+	+	.	.	.
JC 584-591, Sint-Niklaas	.	+	+	.	.	.	.	.	.	.	+	+	.	+	+	+	.	.	.	+	.	.	+	+	+	.	+	.
JD 594, Elversele	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.
JE 605-607, Kemzeke-Hol	.	+	.	+	.	.	.	.	.	.	+	.	.	+	+	+	.	.	.	+	+	.	+	+	.	.	.	.
JG 610-612, Tielrode	.	+	+	.	.	.	.	.	.	.	+	.	.	+	.	.	+	.	.	.	.	.	+	+	+	.	+	.
JH 613-618, Tielrode	.	+	+	.	.	.	.	.	.	.	+	.	+	+	+	+	.	+	+	.	+	.	+	+	.	.	.	.
JJ 619-627, Steendorp	.	+	+	+	.	.	+	.	.	.	+	.	+	+	+	.	.	+	.	.	.	.	+	+	+	.	.	.
JL 629-631, Wilrijk	+	+	+	+	.	.	+	.	.	.	+	.	.	+	.	.	+	+	.	.	.	+	.	+	.	.	.	.
JM 642-647, Schelle	.	+	+	.	+	.	.	.	.	.	+	.	.	+	+	+	.	.	.	.	.	.	+	+	+	.	+	.
MA 367-383, Boom	.	+	+	+	.	.	+	.	.	.	+	.	+	+	+	+	+	+	.	.	+	+	+	+	+	.	+	.
ME 633-641, Rumst	.	+	+	.	.	.	.	.	.	.	+	.	+	+	+	+	+	+	.	.	.	+	+	+	+	.	+	.
OA 595-604, Stekene	.	+	+	.	.	.	.	.	.	.	+	.	.	+	+	+	.	+	.	.	+	.	+	+	+	.	+	.
VA 654-656, Lier	.	+	+	+	.	.	+	.	.	.	+	.	.	+	.	+	.	+	.	.	.	.	+	+	+	.	.	.
NLD 459-460, Winterswijk	.	+	+	+	?	.	+	.	.	.	+	.	+	+	.	.	.	+	.	.	.	.	+	+	+	+	.	.
NLD 669-673, Kuiperberg	.	+	+	.	.	.	+	.	.	.	+	.	.	+	+	.	+	+	+	.	.	+	+	+	+	.	.	.
Nucula-clay and Berg sand	.	+	.	.	.	+	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	+	+	+	+	.	.
Upper Tongeren beds	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lower Tongeren beds	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	?	.	.

the Boom clay and the German Septaria-clay.

Turrilina alsatica	*Bulimina alsatica*	*Bolivina beyrichi*	*Bolivina beyrichi* var. *melettica*	*Loxostomum teretum*	*Loxostomum minutissimum*	*Angulogerina gracilis*	*Robertina declivis*	*Cassidulina carapitana*	*Cassidulina subglobosa* var.	*Pleurostomella alternans*	*Allomorphina* sp.	*Chilostomella cylindroides*	*Pullenia bulloides*	*Pullenia quinqueloba*	*Sphaeroidina bulloides*	*Nonion affine*	*Nonion buxovillanum*	*Nonion granosum*	*Nonionella lobsannensis*	*Discorbis globularis*	*Eponides pygmeus*	*Eponides umbonatus*	*Valvulineria petrolei*	*Gyroidina soldanii*	*Rotaliatina bulimoides*	*Cibicides sulzensis*	*Cibicides dutemplei*	*Cibicides ungerianus*	*Cibicides lobatulus*	*Almaena osnabrugensis*	*Epistomina elegans*	*Alabamina tangentialis*	*Alabamina perlata*	*Pseudoparrella oveyi*	*Ceratobulimina contraria*	*Globigerina* spp.	*Globigerinella micra*	*Gümbelina gracillima*
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.	.	A	.	.	.	V	.	.	.	.	.	r	C	C	A	C	.	.	.	.	.	r	r	r	C	.	.	A	C	.	r	r	r	.	.	r	.	.
.	.	r	.	.	.	V	.	.	.	.	.	.	A	.	A	A	.	.	.	.	.	A	.	V	V	.	r	V	r	.	r	C	r	.	A	C	.	.
A	r	C	.	C	r	V	.	.	A	r	.	r	A	r	A	A	.	r	C	r	.	r	A	A	r	.	C	C	r	.	r	A	C	.	.	A	?	?
.	.	r	.	.	.	A	.	.	r	.	.	.	r	r	r	C	.	.	.	.	.	.	.	r	C	.	r	V	.	.	.	.	r	.	.	r	.	.
V	.	.	.	.	.	r	.	.	r	.	.	.	V	.	V	V	r	.	.	.	.	A	.	V	r	A	.	C	r	.	.	.	C	.	.	r	.	.
r	r	C	V	.	.	.	.	.	.	.	r	.	C	.	.	r	.	.	.	.	.	.	r	A	.	r	.	.	r	.	V	.	.	C	.	C	.	.
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.	.	.	V	.	.	.	.	.	A	.	.	.	C	r	.	C	.	.	.	.	.	r	.	A	C	.	r	C	r	.	.	.	.	.	.	r	.	.
.	.	.	.	.	.	C	.	C	.	.	.	.	.	r	C	.	.	.	.	.	.	C	.	C	.	V	r	.	r	.	r	.	r	.	r	A	.	.
.	.	r	.	.	.	V	r	.	.	.	.	.	.	r	V	r	.	.	.	.	r	C	r	A	.	V	A	.	r	.	.	.	r	.	r	A	.	.
.	.	C	.	.	.	V	.	.	.	.	.	.	.	r	A	C	.	.	.	.	.	C	.	C	.	V	C	.	r	.	.	.	.	.	C	C	.	.
.	.	C	.	.	.	.	.	r	.	.	.	.	.	.	C	C	.	.	.	.	.	C	.	C	.	A	A	.	r	.	.	.	.	.	C	A	.	.
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+	.	+	.	.	.	+	.	.	.	.	.	.	+	+	+	+	+	.	.	.	+	+	+	+	.	+	+	.	.	.	+	.	+	.	+	+	.	.
.	.	.	.	.	.	+	.	.	+	.	.	+	+	.	+	+	.	.	.	.	.	+	.	+	+	+	+	+	.	.	+	+	+	.	.	+	.	.
+	.	.	.	.	.	+	.	+	.	.	.	+	+	.	+	+	.	.	.	.	.	+	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.
.	.	+	.	.	.	+	.	+	.	.	.	+	+	+	+	+	.	.	.	.	+	+	.	+	.	+	+	.	+	.	+	.	+	.	+	+	.	.
+	.	.	.	.	.	+	.	+	.	.	.	+	+	.	+	+	.	.	.	.	+	+	.	+	.	+	+	.	.	.	.	.	+	.	+	+	.	.
.	.	+	.	.	.	+	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.
+	.	+	.	.	.	+	.	.	+	.	.	.	+	+	+	+	+	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	+	+	.	+	.	.
.	.	+	.	.	.	.	.	+	.	.	.	+	+	.	+	+	+	.	.	.	+	+	+	+	.	+	+	.	.	.	+	+	.	.	+	+	.	.
.	+	+	.	.	.	+	+	+	.	.	.	+	+	.	+	+	+	.	.	.	+	+	+	+	.	+	+	.	.	.	+	.	+	.	+	+	.	.
+	.	+	+	.	.	+	.	+	+	.	.	+	+	+	+	+	+	.	.	.	+	+	+	+	+	+	+	.	.	.	+	+	+	.	+	+	.	.
.	.	.	+	.	.	.	.	.	+	.	.	.	+	.	+	+	.	.	.	.	.	.	.	+	+	+	.	+	+	.	.	+	.	.	.	+	.	.
.	.	+	.	.	.	+	.	+	.	.	.	+	+	+	+	+	.	.	.	.	+	+	+	+	.	+	+	.	+	.	+	.	.	.	+	+	.	.
.	.	+	+	.	.	+	.	+	.	.	.	.	+	+	+	+	.	.	.	.	.	+	+	+	.	+	+	.	+	.	+	.	+	.	+	+	.	.
+	+	+	+	.	.	+	.	.	.	.	+	.	+	.	+	+	+	.	.	.	.	+	+	+	.	+	+	.	.	.	+	.	+	.	+	+	.	.
+	.	+	+	.	.	+	.	+	.	.	.	.	+	.	+	+	+	.	.	.	.	+	+	+	.	+	+	.	+	.	+	.	+	.	+	+	.	.
.	.	+	.	.	.	+	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	+	+	+	+	+	.	.	.	+	+	.	+	+	.	.
.	+	.	.	.	.	+	.	.	+	.	.	+	+	.	+	+	.	.	.	.	.	+	.	+	+	.	+	+	+	.	+	+	+	.	.	.	.	.
+	.	.	.	.	.	+	.	+	.	.	.	.	+	+	+	+	+	.	.	.	.	+	.	+	.	+	+	.	.	+	.	+	+	.	+	+	.	.
.	.	+	.	.	.	+	.	.	.	.	.	.	.	+	.	+	.	+	+	+	.	.	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.
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TABLE 4. — **Distribution chart of Foraminifera in the German Upper Oligocene,**

	Spiroplectammina carinata	*Textularia speyeri*	*Bigenerina nodosaria*	*Siphotextularia labiata*	*Martinottiella communis*	*Quinqueloculina seminula*	*Quinqueloculina juleana*	*Quinqueloculina impressa*	*Sigmoilina tenuis*	*Lenticulina* spp.	*Lenticulina (Planularia) auricula*	*Lenticulina (Vaginulinopsis) gladia*	*Marginulina hirsuta*	*Frondicularia oblonga*	*Frondicularia nysti*	*Vaginulina obtusicosta*	*Nodosaria intermittens*	*Nodosaria vertebralis*	*Nodosaria koninckii*
Middle Miocene :																			
Dingden 456	V	.	C	r	A	.	.	.	r	r	.	.	.	.	.	.	.	.	r
Boring Heist, 26 m	r	.	r	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Antwerp	r	.	.	.	.	.	.	.	.	r	.	.	.	.	r	.	.	.	r
Burcht	C	.	.	C	r	.	.	.	.	r	.	.	r	.		r	.	.	.
Horizon of Houthalen, I, 80,25-80,79 m ...	.	.	.	.	.	.	.	.	.	r	.	r	.	r	.	.	.	.	.
Sand of Voort :																			
Houthalen, shaft I, 81-84 m	.	.	.	.	.	.	.	.	.	r	.	r	.	r	.	.	.	.	.
Houthalen, shaft I, 98-100,50 m	.	.	.	.	.	.	.	.	.	r	.	r	.	.	.	.	.	.	.
Houthalen, shaft II, 84-88 m	.	.	.	.	.	.	.	.	.	r	.	r	.	r	.	.	.	.	.
Deepboring Lillo, 81	r	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 83	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 84	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 88	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.
Deepboring Lillo, 89	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.
Deepboring Lillo, 90	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 91	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 92	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 94	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 98	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 99	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 104	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 105	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 107	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 113	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Deepboring Lambroek, 23	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lambroek, 27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lambroek, 29	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lambroek, 33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lambroek, 37	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
German Upper Oligocene :																			
Astrup 17538	C	r	.	.	.	r	.	.	r	r	.	r	.	r	.	.	r	r	.
Kassel 12667	r	.	.	.	.	r	r	r	.	r	r	r	.	r	.	.	r	r	.
Kassel 11315	r	.	.	.	.	r	.	.	.	r	.	.	.	r	.	.	r	.	.
Boom and Septaria-clay	+	.	.	.	.	.	+	+	+	.	?	.	.	?	.	.	+	.	.
Nucula-clay and Berg sand	+	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Upper Tongeren beds	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.
Lower Tongeren beds	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

sand of Voort, horizon of Houthalen and Miocene of Antwerp and Dingden.

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+	.	+	+	r	r	r	r	.	.	.	.	r	.	.	.	.	r	.	r	.	.	.	.	r	.	r	.	.	r	r	r	r	r	r	*Guttulina problema*
+	.	+	+	r	r	r	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	C	r	r	r	*Globulina gibba*
+	.	+	+	r	r	r	.	.	.	r	r	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	r	r	r	r	r	r	r	r	*Pyrulina fusiformis*
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TABLE 4. — **Distribution chart of Foraminifera in the German Upper Oligocene, sand of**

	Uvigerina tenuipustulata	*Uvigerina rugulosa*	*Angulogerina gracilis*	*Trifarina bradyi*	*Cassidulina subglobosa* var.	*Pullenia bulloides*	*Pullenia quinqueloba*	*Sphaeroidina bulloides*	*Nonion affine*	*Nonion perfossum*	*Nonion pompilioides*	*Nonion granosum*	*Nonion roemeri*	*Nonion boueanum*	*Nonionella limba*	*Patellina corrugata*	*Discorbis globularis*	*Valvulineria petrolei*	*Gyroidina soldanii*
Middle Miocene :																			
Dingden 456	.	r	.	.	.	r	r	r	**A**	**A**	C	.	.	**A**	.	.	.	r	.
Boring Heist, 26 m	r	r	.	C	.	r	r	.	C	r	r	r	.	C	.	.	r	.	.
Antwerp	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Burcht	.	C	.	C	.	.	r	r	.	r	C	r	.	**V**	C	.	.	.	.
Horizon of Houthalen, shaftI, 80,25-80,79 m ...	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Sand of Voort :																			
Houthalen, shaft I, 81-84 m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Houthalen, shaft I, 98-100,50 m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Houthalen, shaft II, 84-88 m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 81	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Deepboring Lillo, 83	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Deepboring Lillo, 84	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.
Deepboring Lillo, 88	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Deepboring Lillo, 89	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Deepboring Lillo, 90	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Deepboring Lillo, 91	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Deepboring Lillo, 92	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 94	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 98	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.
Deepboring Lillo, 99	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.
Deepboring Lillo, 104	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lillo, 105	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Deepboring Lillo, 107	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Deepboring Lillo, 113	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Deepboring Lambroek, 23	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lambroek, 27	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Deepboring Lambroek, 29	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lambroek, 33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Deepboring Lambroek, 37	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
German Upper Oligocene :																			
Astrup 17538	.	.	C	?	r	r	.	r	r	.	.	r	r	.	.	.	r	.	r
Kassel 12667	.	.	**A**	.	.	r	.	r	C	.	.	r	r	r	.	r	r	.	.
Kassel 11315	.	.	C	.	.	.	.	r	r	.	.	C	r	r	.	.	.	.	.
Boom and Septaria-clay	.	.	+	.	+	+	+	+	+	.	.	+	.	.	.	.	+	+	+
Nucula-clay and Berg sand	.	.	+	.	.	.	+	.	+	.	.	+	.	.	.	.	+	.	+
Upper Tongeren beds	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.
Lower Tongeren beds	.	.	.	.	.	+	.	.	+	.	.	+	.	+	.	.	.	.	+

Voort, horizon of Houthalen and Miocene of Antwerp and Dingden (continued).

Cancris auriculus	*Cancris turgidus*	*Cibicides dutemplei*	*Cibicides tenellus*	*Cibicides ungerianus*	*Cibicides lobatulus*	*Hanzawaia boueana*	*Almaena osnabrugensis*	*Epistomina elegans*	*Alabamina tangentialis*	*Asterigerina gürichi*	*Ceratobulimina contraria*	*Stomatorbina concentrica*	*Globigerina* spp.	*Elphidium subnodosum*	*Elphidium minutum*	*Elphidium inflatum*	*Elphidium ungeri*	*Elphidium hiltermanni*	*Planorbulina difformis*	*Gypsina globulus*	*Rotalia beccarii*	*Rotalia propingua*	*Rotalia trochus*	*Rotalia canui*
C	.	C	.	**A**	C	**A**	.	.	r	**V**	?	.	r	.	.	**V**	.	C	.	.	.	.	.	.
r	.	C	r	r	r	C	.	.	r	**A**	.	.	C	.	.	r	.	.	.	.	.	.	.	.
r	.	r	.	.	.	.	.	.	.	r	?	.	.	.	.	.	.	.	.	.	.	.	.	.
C	.	r	r	.	C	C	.	r	.	**V**	?	.	C	.	.	.	r	r	.	.	.	.	.	.
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r	r	C	**V**	.	C	.	.	.	.	.	.	r	r	C	.	.	.	r	r	r	.	.	r	.
r	r	C	**V**	r	C	C	r	.	.	r	.	.	r	r	.	.	.	r	.	.	.	C	r	C
.	r	**A**	C	r	r	.	C	.	.	.	.	.	r	C	.	.	.	r	.	.	.	r	.	.
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CHAPTER V

TIME-STRATIGRAPHIC INTERPRETATION

After the detailed discussion of the rock-units, field observations and microfaunal associations, some time-stratigraphic interpretation of these data might be expected.

The sharp distinction in the preceding paragraphs between rock-stratigraphic and time-stratigraphic units was introduced during the early stages of our investigation, not merely on theoretical grounds, but especially because some errors in the generally accepted stratigraphy were suspected.

When reviewing now the available data, we unfortunately cannot get much farther than our early suspicion. Although the older time-stratigraphy is doubtful in several points, no changes can be proposed with definite proof. As a result our interpretation must as yet be tentative.

The main difficulties which cause that neither the older interpretation can be disproved nor the new one substantiated, are of two categories. Primarily we lack a sufficient number of reliable lithologic data from the subsoil of northern Belgium. And further, the faunal differences between major rock-units are entirely based on differences between associations, which are in turn no doubt closely connected with environmental changes. No reliable evolutionary series within some species or species group, independent of the sedimentary environment, have as yet been thoroughly described. No such group was apparent in the microfauna, but future detailed research of single species throughout the column, may yield a better basis for correlation of time-stratigraphic units.

In the commonly accepted time-stratigraphic interpretation the type deposits of the various Tongeren members are united in the Tongrian stage, those of the Rupel formation in the Rupelian, while the sand of Voort is placed in the Chattian, which stage was based on the Kasseler Meeressand in Germany. Parallel with this Tongrian-Rupelian-Chattian series are used the terms Early (Lower), Middle and Late (Upper) Oligocene.

With minor fluctuations and occasional criticism this interpretation has been adhered to since the days of Dumont and Beyrich. In the succession of stages the superposition of the strata in the type areas has been fully taken into account, but difficulties arose in other areas where the sequence appeared different. The usual confusion of rock- and time-units hampered the distinction of lithologic boundaries and time-levels as different things.

Richly fossiliferous deposits of each of the three units could be recognized by their faunal contents, their distinctness being in our opinion mainly based on environmental differences. This is true of the Mollusca as well as of the Foraminifera and Ostracoda. Actually the Rupel fauna belonged mainly to an open-sea environment with mud deposition, whereas those of the Tongeren and Chattian deposits point to near-shore conditions with for the former distinct brackish influences.

Reviewing the available data, the following details may be put forward.

There is considerable difference between the sequence of Oligocene rock-units in western Belgium and those in the eastern part of the country (see fig. 1).

East of the Hageland, which is taken as boundary area between west and east, they show the classical sequence. The marine sand of Grimmertingen and the sand of Neerrepen, a shore deposit, constitute the Lower Tongeren beds, which in general have a thickness of 30 m. They are covered by about 10 m of the brackish and fluviatile Upper Tongeren beds with at some places a freshwater deposit, the horizon of Hoogbutsel, in between. As to the Rupel formation the typical Berg sand with *Glycymeris obovatus* (Lamarck) and in many places with the Rupel basal gravel, rests unconformably on the Tongeren formation. To the east the Berg sand is covered by about 5 m of Nucula-clay (R1c). Up to 10 m of sand (R1d-R2b) locally separate the Nucula-clay from the overlying Boom clay, which is fairly sandy in eastern Belgium. To the west the Nucula-clay joins the Boom clay. The thickness of the Boom clay diminishes from 80 to 10 m in southeastern direction. This clay in turn is covered by up to 50 m of Voort sand. In most places there is a gradual transition between both members, but locally the Voort sand is separated from the Boom clay by a basal gravel.

In western Belgium there are only a few very doubtful records of Lower Tongeren beds; mostly they were found to be absent. Upper Tongeren deposits are completely wanting in this area, where in most places about 20 m of uncharacteristic sand are considered to represent the Berg sand. This sand covers the Late Eocene Asse sand. The contact Asse sand — Berg sand is very vague. In many borings no definite boundary could be drawn in the unfossili-ferous sandy complex in between distinct Asse clay and equally distinct Boom clay, in which complex both the Asse and Berg sands might be theoretically present. The Rupel basal gravel is mostly absent.

The characteristic Boom clay of western Belgium is not or slightly sandy. It reaches 91 m thickness in the deepboring Woensdrecht and it is unconformably overlain by the Miocene Antwerp sand, while the Voort sand is lacking.

Towards the north, into the Netherlands (mainly in the provinces of Utrecht, Gelderland and Limburg and in the eastern part of Noordbrabant), Upper Oligocene sandy deposits were found on top of the Boom clay and underlying the Miocene, but no Tongeren deposits have been recorded. In Dutch South-Limburg the Oligocene again has a stratigraphy closely resembling that in eastern Belgium.

The greatest differences between both parts of Belgium are in the beds under the Boom clay. For rock-stratigraphic correlation, which often was considered identical with the time-stratigraphic one, the base of the Rupel formation (and Rupelian) was put on the level of the basal gravel. If this gravel was absent, the base either was identified with a vague boundary in the Asse — Berg sand complex or it was put in some relation with the base of the Boom clay and the top of the Asse clay. If present the gravel was taken as formation and time-stratigraphic boundary. As to the correctness of the latter usage some doubt may be expressed. It must be avowed that the origin of the gravel is obscure, but it is difficult to see it as a synchronous deposit in all the Belgian area, when the accompanying deposits are so much different from east to west.

A fundamental point in the time-stratigraphic correlation is the conception of the Belgian sedimentation area. The geographically restricted occurrences of the fluviatile, brackish and shallow water deposits of the Tongeren beds in eastern Belgium and Dutch South-Limburg, make it clear that the coast-line at that time was not far away, probably running a direction approximately ENE-WSW. The oblique cutting out of these deposits to the west by later erosion, indicates that this coast-line continued at least some way farther in this direction, so that the present most southern Oligocene sediments in western Belgium were deposited further off-shore. This general trend of the coast-line also follows from the decreasing sandyness of the Boom clay in western and northwestern direction. Probably the Oligocene depositional basin was open to the north and northwest and bordered by the elevations of Weald-Artois and the Ardennes region in the south and southeast.

Two different lines of thought are possible now. Either the absence of the Tongeren beds in western Belgium is considered due to pre-Rupelian erosion (FOURMARIER, 1934) or non-deposition, or their time-stratigraphic equivalents are present, disguised among other units. Most earlier authors adhered to the first explanation. This would need differential vertical movements of the area for which there are no obvious indications in the sediments or in the fauna. The second supposition would fit in better with our idea of the sedimentation area, though it must be admitted that definite proof is lacking. In our opinion there would have been fewer gaps in the sedimentation in western Belgium than there were in the coastal area of the Tongeren region.

So if the time-stratigraphic equivalents of the Tongeren beds are represented in the western area, where must we look for them ? In our opinion the sand (and possibly part of the clay) of Asse is likely to be of the same age as the Lower Tongeren beds. Their geographic areas more or less join, their lithologic differences are slight and often obscure and finally it has been pointed out in a previous chapter that the microfauna of the equivalent of the Grimmertingen sand in the shaft Hendrik IV very closely resembles that of the Asse deposits, much closer than it does that of the other Oligocene units.

Although it can of course not be asserted that the Lower Tongeren beds and the Asse sand (? and clay) are of exactly the same age, the time-stratigraphic overlap of Lower Tongeren beds and Asse sand (? and clay) is very probable.

The same opinion has been repeatedly defended by VELGE towards the end of the nineteenth century (G. VELGE, 1880, 1882, 1895, 1896, cited in FORIR, 1901). VELGE based his view on field observations. As early as 1839, 1849 and 1851, DUMONT in his descriptions of the Tongrian also regarded the sand of Asse as belonging to this stratigraphic unit.

Since the Asse deposits are probably fairly well correlated with the Barton beds, type deposits of the Bartonian, it has become a delicate question to draw a boundary between Bartonian and Tongrian or between Eocene and Oligocene.

It was mentioned already that the microfauna of the typical Lattorf beds also shows good resemblance with those of the Lower Tongeren beds and the Asse clay. As a consequence the Lattorfian as a time-stratigraphic unit may have the same dubious value as the Tongrian.

Dealing with deposits in Germany the Neuengammer Gassand in the northwestern part of that country, which is usually interpreted as Early Oligocene, needs some consideration. It contains a poor microfauna, which consists of a few Middle Oligocene (i.e. Septaria-clay) Foraminifera species together with scarce small specimens of *Nummulites germanicus* (STAESCHE and HILTERMANN, 1940, SCHAD, 1947). These *Nummulites* caused the Early Oligocene determination of the sand. The Neuengammer Gassand overlies Upper Eocene sandy deposits with a rich microfauna, of which *Nummulites germanicus* is a characteristic species. It is covered by Septaria-clay.

In our opinion the Neuengammer Gassand is more likely an equivalent of the Berg sand of western Belgium, than it is of the Lower Tongeren and Lattorf beds. The existence of a few *N. germanicus* specimens in the Neuengammer Gassand might well have lasted some time after the deposition of the Lower Tongeren and Lattorf beds, or the individuals may have been re-deposited.

Of course there is no reason to suppose that a sharp faunal break occurred at the Eocene-Oligocene boundary. The confusing resemblance of variously as Late Eocene and Early

Oligocene classified deposits, and even type deposits, could be expected. Although we wish to maintain that in Belgium the Asse deposits and Lower Tongeren beds are at least partly of the same age, we have to await more field data and a thorough analysis of some single species (groups) for a more definite settling of the chronological question around the Eocene-Oligocene boundary.

The Upper Tongeren beds have only local importance. Both their stratigraphic and geographic position under, and at the landward side of the sand of Berg, as well as their microfauna, show that these lagoonal-brackish deposits are best considered as lateral equivalents of some part of the lower Rupel formation in western Belgium.

It is most likely that their time-equivalents in that area are incorporated in the so-called Berg sand that underlies the Boom clay. The maximally 8 m of Berg sand of the type area are probably contemporary with no more than part of the 20 m of the western Belgian sand.

Among others a similar opinion was already held by Beyrich (1854, 1856) and by Ortlieb and Dolfuss (1873, cited in Forir, 1901). Ortlieb and Dolfuss considered the Upper Tongeren beds, the Berg sand and the Nucula-clay in Limburg as probable equivalents of the Boom clay in western Belgium.

Most Dutch authors, among which recently Albrecht and Valk (1943) and Muller (1943) also regarded the Cerithium-clay, which is the Netherlands' equivalent of the Upper Tongeren beds, as part of the Rupel formation.

These ideas never became common opinion in Belgium. Most Belgian authors strongly emphasized the superposition of strata in different areas and the differences in mollusc contents.

As we remarked already, the basal gravel of the Berg sand is usually interpreted as a time-stratigraphic marker, which corresponds to a transgression. This may be correct in eastern Belgium. In the western part of the country the gravel has only little importance, and furthermore it is neither certain that there is but a single layer nor that it was continuous throughout Belgium. Its rarity in that area would be selfevident, since the source of pebbles probably was more remote than in the eastern region, where the characteristic Rupel basal gravel was deposited. In our opinion this eastern gravel is younger than the western gravel occurrences, whether it corresponds to a transgression or not.

During the greater part of Oligocene time the characteristic Boom clay was deposited in the west, whilst more sandy deposits, such as sandy clays and clayey or even pure sand, were laid down in Belgian and Dutch Limburg. Characteristic sandy members in the east are the R1d-R2b sand and the Lintfort member.

No doubt the Nucula-clay in Limburg is another near-shore equivalent of the lower part of the Boom clay of western Belgium. The differences in the faunas of Berg sand and Nucula-clay with those of the Boom clay are clearly due to the different depositional environments.

Toward the end of Oligocene time the sand supply from the southeast and east gradually increased. It resulted in the deposition of the Voort sand, which reaches far northwards over the Boom clay. In western Belgium relations are unknown because of later erosion, but it is thought probable that the Boom clay sedimentation in this region lasted somewhat after the start of the Voort sand deposition in the east. The microfaunal resemblance of the Voort sand and the Chattian type deposits of Germany has already been pointed out.

Both western Belgian Boom clay and eastern Belgian Voort sand are said to be unconformably overlain by Middle Miocene deposits, viz Antwerp sand and Houthalen beds respectively. According to current opinion Lower Miocene deposits are wanting in Belgium.

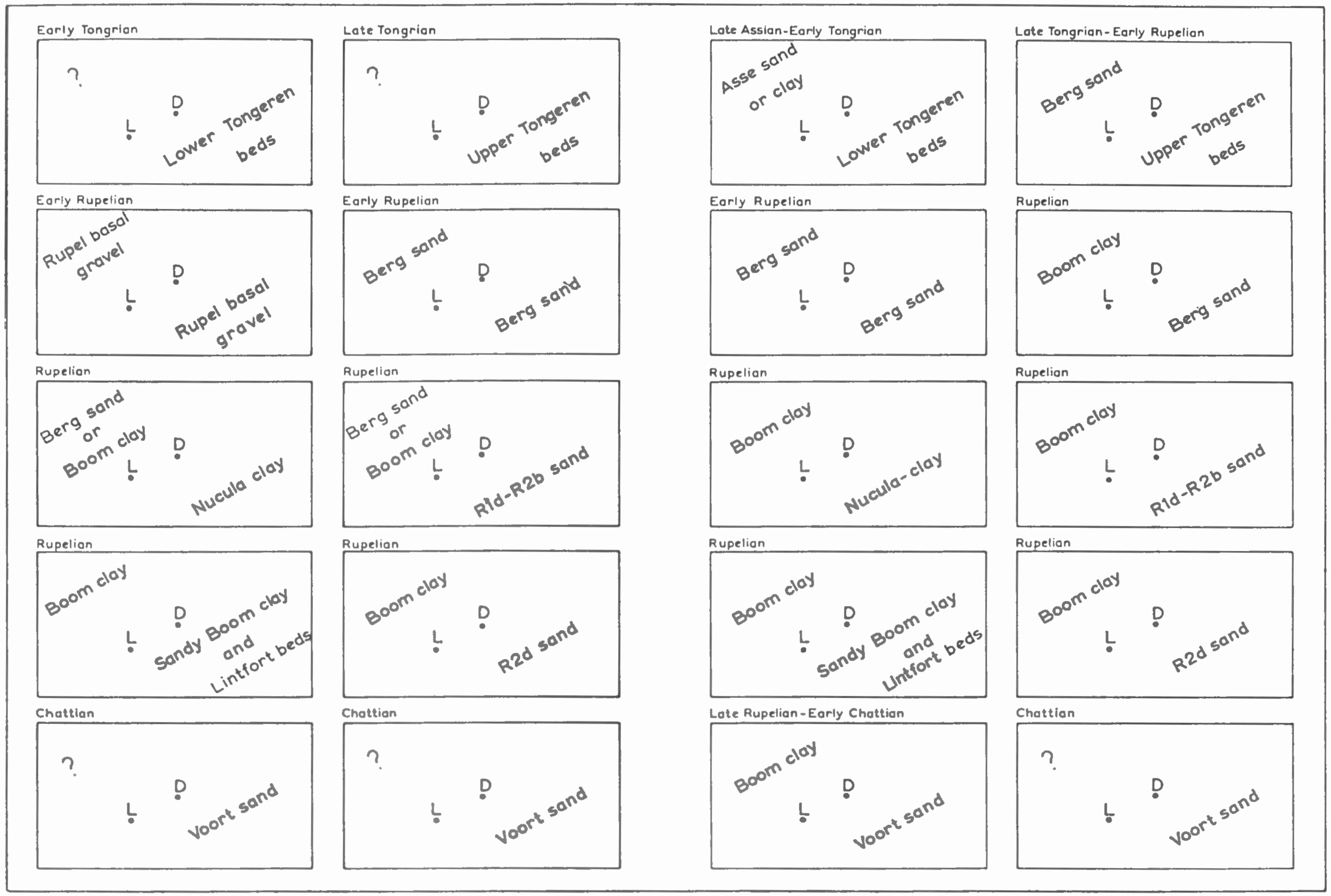

FIG. 11. — Lithologic units in western and eastern Belgium at successive time-levels of the Oligocene according to the current opinion (left) and as interpreted in this paper (right). D = Diest, L = Leuven.

No distinct sandy equivalent of the sand of Voort has been observed under the Antwerp sand in western Belgium, but Upper Oligocene sands are found farther north in the Netherlands (Noordbrabant, Utrecht, Gelderland, Limburg). The Antwerp sand contains fragmented septaria at the base, which have been derived from the Boom clay (Tavernier, 1954).

Summarizing, it is considered unlikely that the sequence Tongrian-Rupelian-Chattian, as based on the respective type deposits, is a clear-cut subdivision of Oligocene time. On the basis of the supposition that the off-shore sedimentation was more continuous than it was in the marginal areas, time overlaps of the various type deposits must be admitted. The Rupelian Boom clay which constitutes the bulk of the Oligocene off-shore sediments is evidently synchronous not only with the marginal Rupelian deposits, but also with part of those of the Tongrian and possibly also with part of those of the Chattian. In our opinion the Tongrian overlaps the late Bartonian and the early Rupelian, while the Chattian may have similar relations to the late Rupelian.

Our ideas are once more confronted with the current opinion in the small sketches below (fig. 11), in which the lithologic units in both Belgian areas are given at successive time-levels of the Oligocene.

CHAPTER VI

SYSTEMATIC DESCRIPTION OF THE FORAMINIFERA

Altogether some 140 species were recognized in our material. Variants have been treated under the corresponding species. Data on the stratigraphic distribution are given under each species and also in a number of charts (see introduction of chapter IV).

The cited references are only those which have been used for the determinations. For comparison were available the collections of Marks (Vienna-basin) and Kaasschieter (Aquitaine basin), both stored in Utrecht, and those of ten Dam and Reinhold (Eocene-Miocene of the Netherlands), stored in the Geologische Stichting at Haarlem. Furthermore, many data were obtained from the contemporaneous investigation of the Belgian Eocene Foraminifera by Mr. Kaasschieter.

The taxonomic units have been arranged according to the recent classification of Sigal (1952, in Piveteau, Traité de Paléontologie, vol. 1), which is considered more up to date than that of Cushman (1950, Foraminifera, their classification and economic use, 4th revised edition).

The greater part of the material is stored in the collections of the Mineralogical-Geological Institute of the State University of Utrecht. Only the Hermsdorf and Pietzpuhl specimens are deposited in the collections of the Amt für Bodenforschung, Hannover. The Geological Survey at Haarlem obtained some specimens of most of the Hendrik IV species.

SUPERFAMILY **LITUOLIDEA**

FAMILY **HAPLOPHRAGMIIDAE**

Genus HAPLOPHRAGMOIDES CUSHMAN, 1910

Haplophragmoides latidorsatus (BORNEMANN)

Pl. I, fig. 1

Nonionina latidorsata BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 339, pl. 16, fig. 4.
Haplophragmium deforme ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 197, pl. 8, fig. 1.

Remarks. — The species was found only in a few Boom clay samples, in which it is rare to rather common.

Although our material is scarce and of bad preservation, *Haplophragmium deforme* is considered conspecifie with *Nonionina latidorsata*. Our material consists of coarsely arenaceous individuals and pyrite moulds. As stated by ANDREAE, the specimens are often irregularly coiled. The greater part of our specimens has a more rounded periphery than the specimen figured by BORNEMANN.

The generic placement of this species is tentative. Sections of some of our better specimens made the presence of simple walls a more likely characteristic than that of a labyrinthic interior.

Distribution.

Boom clay : JK 628, JL 630, JN 653.

FAMILY **TEXTULARIIDAE**

Genus SPIROPLECTAMMINA CUSHMAN, 1927

Spiroplectammina carinata (D'ORBIGNY)

Pl. I, figs. 2, 3

Textularia carinata D'ORBIGNY, 1846, For. Foss. Vienne, p. 247, pl. 14, figs. 32-34.
Textilaria carinata (D'ORBIGNY), REUSS, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 157.
Textularia lacera REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 84, pl. 6, figs. 52, 53.
Textularia attenuata REUSS, 1851, id., vol. 3, p. 84, pl. 6, fig. 54.
Spiroplectammina carinata (D'ORBIGNY), TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 42, pl. 1, figs. 2, 3.

Remarks. — Characteristic *S. carinata* is rhomboid in apertural view and has a median ridge, more or less inflated chambers with broad, depressed sutures in between, and a wide carina that is more or less dentate to spinose. In our abundant material of the species there is complete gradation to a type (pl. I, fig. 3) without carina and with less limbate to not-limbate, straight sutures. This type is identical with *Textularia deperdita* D'ORBIGNY (1846, For. Foss. Vienne, p. 224, pl. 14, figs. 23-25) or *Textilaria pectinata* REUSS (1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 157, pl. 4, figs. 12, 13).

S. carinata occurs throughout our Oligo-Miocene column. It is very frequent in the Boom clay, common in some Nucula-clay samples and frequent in some samples from the Miocene. In general the *carinata*-type predominates; only in the Antwerp sand at Burcht and at Heist-op-den-Berg *S. carinata* var. *deperdita* is dominant. In Astrup 17538 and Kassel 12667 the specimens lack the rhomboid end view and the distinct median ridge; they are closest to the variety.

Distribution.

Middle Miocene : Antwerp, Burcht, Heist 26 m, Dingden 456.
Voort sand : Lillo 81, 83, 84, 91.
German Upper Oligocene : Astrup 17538, Kassel 11315, 126667.
Boom clay : AA, AE, HB, JA-JE, JG-JN, MA, ME, OA, VA, Kuiperberg, Winterswijk.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.
Nucula-clay : TE, TK, BZ (see table 2).
Berg sand : TE 427, BZ 505, 507.
Lower Tongeren beds : Hendrik IV, 194-202 m, 203-204 m, 205-206 m.

Genus TEXTULARIA DEFRANCE, 1824

Textularia cf. T. gramen D'ORBIGNY

Pl. I, fig. 11

Remarks. — A few specimens from the Lower Tongeren beds of Dutch South-Limburg are tentatively assigned to this species, which was originally described from the Miocene of the Vienna basin (D'ORBIGNY, 1846, For. Foss. Vienne, p. 248, pl. 15, figs. 4, 6). In the litterature *T. gramen* is recorded from Tertiary to recent.

Distribution.

Lower Tongeren beds : Hendrik IV, 193-196 m.

Textularia speyeri (REUSS)

Plecanium speyeri, REUSS, 1865, Sitz.ber. K. Ak. Wiss. Wien, vol. 50, p. 449, pl. 1, fig. 3.

Remarks. — Some fragments in Astrup 17538, which have biserial chambers, coarsely arenaceous wall and very indistinct sutures may belong to this species. The upper end is truncated with a long narrow aperture in a slight reentrant at the inner margin of the chamber.

The species was originally described from the German Upper Oligocene.

Distribution.

German Upper Oligocene : Astrup 17538.

Genus BIGENERINA D'ORBIGNY, 1826

Bigenerina nodosaria D'ORBIGNY

Pl. I. fig. 12

Bigenerina nodosaria D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 261, pl. 11, figs. 9-12; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 37.
Bigenerina agglutinans D'ORBIGNY, 1846, For. Foss. Vienne, p. 238, pl. 14, figs. 8-10; HOSIUS, 1893, Verh. Naturh. Ver. Rheinl.-Westf., vol. 50, p. 115.

Remarks. — Altogether we had some ten specimens from Dingden and Heist-op-den-Berg. Only part of them reach a uniserial stage of maximally two chambers. HOSIUS recorded from Dingden this species as very variable in the relative proportion of biscrial and uniserial parts.

Distribution.

Middle Miocene : Heist 26 m, Dingden 456.

Genus SIPHOTEXTULARIA FINLAY, 1939

Siphotextularia labiata (REUSS)

Pl. I, fig. 5

Textilaria labiata REUSS, 1861, Sitz.ber. K. Ak. Wiss. Wien, vol. 42, p. 362, pl. 2, fig. 17.
Plecanium labiatum (REUSS), REUSS, 1863, Bull. Ac. Roy. Sci., etc., Belgique, ser. 2, vol. 15, p. 139.

Remarks. — The type of this species came from the Miocene sand of Antwerp. Our specimens agree well with the original description and figure.

Distribution.

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

FAMILY VERNEUILINIDAE

SUBFAMILY EGGERELLINAE

Genus KARRERIELLA CUSHMAN, 1933

Karreriella siphonella (REUSS)

Pl. I, figs. 6-8

Gaudryina siphonella REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 78, pl. 5, figs. 40-42.
Karreriella siphonella (REUSS), CUSHMAN, 1937, Cushm. Lab. For. Res., spec. publ. 8, p. 125, pl. 14, figs. 17-32.
Textularia chilostoma REUSS, 1852, Zschr. Deu. Geol. Ges., vol. 4, p. 18, textfigs. *a*, *b*.
Gaudryina chilostoma (REUSS), REUSS, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 120, pl. 1, fig. 5.
Karreriella chilostoma (REUSS), CUSHMAN, 1937, Cushm. Lab. For. Res., spec. publ. 8, p. 126, pl. 15, figs. 1-8.
Gaudryina globulifera REUSS, 1852, Zschr. Deu. Geol. Ges., vol. 4, p. 18, textfigs. *a*, *b*.
Gaudryina chilostoma (REUSS) var. *globulifera* REUSS, ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 200, pl. 7, figs. 8, 9.
Gaudryina siphonella (REUSS) var. *asiphonia* ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 200, pl. 7, fig. 7.
Dorothia asiphonia (ANDREAE), CUSHMAN, 1937, Cushm. Lab. For. Res., spec. publ. 8, p. 90, pl. 9, figs. 22, 23.

Remarks. — The species is rare to abundant in many Boom clay samples. It shows a wide variation, that covers all three species described by REUSS from the German Septaria-clay (*K. siphonella, K. chilostoma, K. globulifera*). CUSHMAN (1937) already remarked that the records of both *K. siphonella* and *K. chilostoma* are almost the same and that the relationship of the two may be « even more close than has been thought ». *K. globulifera* was already made a synonym of *K. chilostoma* by REUSS himself in one of his later papers (1866).

In our opinion CUSHMAN's figures clearly show the intergradation between *K. siphonella* and *K. chilostoma*. In the latter variant the biserial, textularian part makes up nearly the entire test; in characteristic *siphonella*-forms the multi-triserial part is more prominent, while the biserial chambers are in a looser arrangement. Specimens of the *siphonella*-type, in which the aperture lacks neck and lip, and moreover, is situated at the base of the final chamber, are identical with *K. siphonella* var. *asiphonia* (ANDREAE).

The greater part of the Belgian *Karreriella* individuals ar of the *chilostoma*-type.

Distribution.

Boom clay : AA, AE, HB, JA-JD, JG-JJ, JL, JM, MA, ME, OA, VA, Kuiperberg, Winterswijk.

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

Genus MARTINOTTIELLA CUSHMAN, 1933

Martinottiella communis (D'ORBIGNY)

Pl. I, fig. 4

Clavulina communis D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 268; D'ORBIGNY, 1846, For. Foss. Vienne, p. 196, pl. 12, figs. 1, 2.

Listerella communis (D'ORBIGNY), CUSHMAN, 1937, Cushm. Lab. For. Res., spec. publ. 8, p. 148, pl. 17, figs. 4-9; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 45, pl. 1, fig. 9.

Remarks. — Distinct specimens of *M. communis* were found in most of our samples from the Miocene.

One Boom clay pit (Loksbergen, HB 665) yielded a number of stout *Martinottiella* individuals. They are much thicker than our Miocene specimens and have but few uniserial chambers (pl. I, fig. 10).

Distribution.

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

Family LITUOLIDAE

Subfamily LITUOLINAE

Genus CYCLAMMINA Brady, 1876

Cyclammina placenta (Reuss)

Pl. I, fig. 9

Nonionina placenta Reuss, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 72, pl. 5, fig. 33.

Haplophragmium placenta (Reuss), Andreae, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 197, pl. 7, fig. 6.

Cyclammina placenta (Reuss), Weber, 1939, Bad. Geol. Abh., vol. 10, pt. 1-2, p. 11, textfig. 1; ten Dam and Reinhold, 1942, Med. Geol. St., ser. C-V, no. 2, p. 41, pl. 1, fig. 1, textfig. 1.

Remarks. — Specimens of this species, orginally described from Hermsdorf and Freienwalde, were found rather common to rare in several Boom clay samples. Some are pyrite-moulds that agree very well with the original description of the species, which is based on « aus Brauneisenstein oder gelblichen Kalkmergel bestehenden Steinkerne ». The other specimens are roughly arenaceous. In most individuals the sutures are indistinguishable. Some thin sections were made, which showed the internal labyrintic structure very vaguely. Consequently, we had to rely mainly upon the evidence presented by Weber and by ten Dam and Reinhold for our generic determination.

Distribution.

Boom clay : AE, JA, JB, JE, JJ, JL, JN, MA, VA, Winterswijk.

Superfamily MILIOLIDEA

Family MILIOLIDAE

Genus QUINQUELOCULINA d'Orbigny 1826

Quinqueloculina seminula (Linné)

Pl. I, fig. 15

Serpula seminulum Linné, 1758, Syst. Nat., ed. 10, vol. 1, p. 786.

Quinqueloculina seminula (Linné), Bhatia, 1955, Journ. Pal., vol. 29, p. 674, pl. 67, fig. 8; Kaasschieter, 1955, Verh. Kon. Ned. Ak. Wet., Nat., ser. 1, vol. 21, no. 2, p. 56, pl. 2, fig. 3; Gullentops, 1956, Mém. Inst. Géol. Univ. Louvain, vol. 20, p. 9, pl. 1, fig. 1.

Remarks. — A number of specimens without special characteristics are assigned to this ubiquitous species. They occur in several of our lithologic units. A rather wide variation is shown, which includes quinqueloculine and triloculine specimens. The latter, which make up the minor part of our material, resemble *Triloculina consobrina* (d'Orbigny) as described by Kaasschieter (1955, op. cit., p. 60, pl. 4, fig. 6) from the Aquitaine basin and *T. tongriensis* Gullentops (1956, op. cit., p. 15, pl. 1, fig. 12), originally described from sand of Oude-Biezen near Borgloon.

The aperture is provided with a simple or bifid tooth, which, however, is lacking in part of the individuals.

Distribution.

German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Nucula-clay : TK 522-524, BZ 552.
Oude-Biezen member : TA 579, BZ 540, 544.

Quinqueloculina ludwigi Reuss

Pl. I, fig. 14

Quinqueloculina ludwigi Reuss, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 126, pl. 1, fig. 12.

Remarks. — All *Quinqueloculina seminula*-like individuals from the Boom clay have a more or less extended apertural neck. Apart from the less depressed sutures they resemble fairly well Reuss's *Q. ludwigi*, originally described from the Septaria-clay of Alsfeld (Germany).

Distribution.

Boom clay : JB 364, JM 642, 643, ?Winterswijk NLD 465.

Quinqueloculina juleana d'Orbigny

Pl. I, fig. 16

Quinqueloculina juleana d'Orbigny, 1846, For. Foss. Vienne, p. 298, pl. 20, figs. 1-3; Bhatia, 1955, Journ. Pal., vol. 29, p. 672, pl. 66, fig. 9, textfig. 3.

Remarks. — For a small number of angular *Quinqueloculina* specimens, a wealth of specific names appeared available. The name *Q. juleana* was chosen in conformance with Bhatia's determination. Only in the Boom clay a single smooth specimen was found which agrees with the type. All other individuals have a more or less roughened exterior of indistinct character. They might be classified as *Q. rugosa* d'Orbigny (1852, Prodr. Pal. Strat., vol. 3, p. 195, Fornasini, 1905, Mem. R. Acc. Sci. Ist. Bologna, ser. 6, vol. 2, p. 66, pl. 3, fig. 13). This roughened character may be an original feature of the specimens. We observed that the same is true of Marks's individuals of *Q. rugosa* from the Vienna basin. Hence, Marks may be right in considering *Q. rugosa* and *Q. juleana* conspecific, but Bhatia's remark then is correct that *Q. juleana* (or *Q. contorta* d'Orbigny) is the older name.

Distribution.

German Upper Oligocene : Kassel 12667.
Boom clay : JK 628.
Nucula-clay : BZ 552.
Oude-Biezen member : TA 579.

Quinqueloculina impressa Reuss

Pl. I, fig. 13

Quinqueloculina impressa Reuss, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 87, pl. 7, fig. 59; Reuss, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 124.

Quinqueloculina cognata Bornemann, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 349, pl. 19, fig. 7.

Quinqueloculina impressa Reuss var. *cognata* Bornemann, Bhatia, 1955, Journ. Pal., vol. 29, p. 671, pl. 67, fig. 10.

Remarks. — A number of distinct specimens was found at Pietzpuhl and also in the Boom clay, in which the species is rare in several samples. A few indistinct specimens were met with in one sample from Kassel and in the Oude-Biezen member. The species, originally described from the Septaria-clay of Hermsdorf, is characterized by the depressed sutures and the more or less subangular shape of the chambers. As was recognized by REUSS (1866) and BHATIA, *Q. cognata* BORNEMANN is merely a variant of this species.

Distribution.

German Upper Oligocene : Kassel 12667.
Boom clay : AA, AE, JA, JB, JJ, JL, JN, MA, VA, Kuiperberg, Winterswijk.
Septaria-clay : Hermsdorf 13438, Pietzpuhl 10447.
Oude-Biezen member : BZ 518.

Quinqueloculina parisiensis D'ORBIGNY

Pl. II, fig. 4

Quinqueloculina parisiensis D'ORBIGNY, 1850, Prod. Pal. Strat., vol. 2, p. 409; TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 181, pl. 19, fig. 21; FORNASINI, 1905, Mém. R. Acc. Sci. Ist. Bologna, ser. 6, vol. 2, p. 7, pl. 2, fig. 9; YOLANDE LE CALVEZ, 1947, For. Lut. Paris, pt. 1, p. 12.

Remarks. — *Quinqueloculina parisiensis,* originally described from the « Parisien (=Lutetian) inférieur » of Grignon in the Paris basin, was found in several samples of the Upper Tongeren beds. It is common in BZ 521.

Especially in this sample the assemblage shows a wide variation. *Sigmoilina*-like specimens are connected by intermediates with characteristic individuals of *Q. parisiensis,* which agree with those found by Mr. KAASSCHIETER in topotype material of Grignon and in the Upper Eocene of Belgium (personal communication). The ornamentation of both the quinqueloculine and the sigmoiline specimens consists of longitudinal striae with single rows of small pits in between.

Specimens with two or even more rows of pits in between the striae and specimens without striae and with scattered pits were found as well. The former resemble *Q. disticha* (TERQUEM, 1882, op. cit., p. 183, pl. 20, fig. 7), the latter are identical with *Q. pertusa* TERQUEM (1882, op. cit., p. 183, pl. 20, fig. 5) both from the Eocene of the Paris basin.

Our specimens either have a simple aperture with or without a tooth, or their aperture is cribrate.

The individuals with cribrate aperture resemble *Miliola saxora* (LAMARCK) (*Miliolites saxora* LAMARCK, 1804, Ann. Mus. Hist. Nat., Paris, vol. 5, p. 352; 1807, id., vol. 9, pl. 17, fig. 2) from the Eocene of the Paris basin and *Miliola pseudoprisca* GULLENTOPS from the Oude-Biezen member of Borgloon (1956, Mém. Inst. Géol. Univ. Louvain, vol. 20, p. 13, pl. 1, fig. 8). Our material does not allow for a certain statement on the relations of these species with *Q. parisiensis.*

BHATIA (1955) recorded *Q. pertusa* from the Oligocene Brockenhurst beds of Isle of Wight, which is the only other record of this species group from the Oligocene of northwestern Europe.

Q. gregaria ANDREAE (1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 278, pl. 12, fig. 10) from Oligocene « Cyrenenmergel » of Alsace may be a related species. It differs from our specimens in the absence of pits in between the longitudinal costae.

Distribution.

Oude-Biezen member : BZ 518-521, 541, 546.
Henis clay : TB 216.

Quinqueloculina spp.

Remarks. — Several *Quinqueloculina* specimens with different features could not be determined with sufficient certainty. Most of them are from the Boom clay. They are short and rather big, partly with strongly inflated chambers; some specimens are more or less triloculine. Well-preserved specimens show a broad apertural lip. The specimens might be determined as *Triloculina valvularis* REUSS, *T. enoplostoma* REUSS (1851, Zschr. Deu. Geol. Ges., vol. 3, p. 85, pl. 7, fig. 56; p. 86, pl. 7, fig. 57 respectively) and *T. circularis* BORNEMANN (1855, id., vol. 7, p. 349, pl. 19, fig. 4), alle three from the Septaria-clay of Hermsdorf. *Q. lamellidens* from the Septaria-clay of Offenbach (REUSS, 1863, Sitz.ber. K. Ak. Wiss. Wien, vol. 48, p. 41, pl. 1, fig. 7) is another Oligocene type, which is more elongate than our specimens.

Two short, damaged triloculine specimens from Bilzen (TK) and Lillo are somewhat reminiscent of our Boom clay specimens.

Sample Hermsdorf 10445 contained two big specimens, which resemble *Q. ermani* BORNEMANN (1855, Zschr. Deu. Geol. Ges., vol. 7, p. 351, pl. 19, fig. 6), originally described from Hermsdorf.

Distribution.

Voort sand : Lillo 104.
Boom clay : AE 664, JK 628, Winterswijk NLD 459, 460.
Septaria-clay : Hermsdorf 10445.
Nucula-clay : TK 523.

Genus SCUTULORIS LOEBLICH and TAPPAN, 1953

Scutuloris oblongus (MONTAGU)

Pl. II, fig. 1

Vermiculum oblongum MONTAGU, 1803, Test. Brit., p. 522, pl. 14, fig. 9.
Miliolinella oblonga (MONTAGU), BHATIA, 1955, Journ. Pal., vol. 29, p. 671, pl. 67, fig. 17.

Remarks. — A number of small specimens agree well with *M. oblonga* as interpreted by BHATIA. The species occurs in the Upper Tongeren beds and in the Nucula-clay.

All individuals are quinqueloculine. Most of them show a more or less broad plate in the aperture. Individuals lacking such a plate occur as well. They resemble *Quinqueloculina simplex* TERQUEM as figured by GULLENTOPS (1956, Mém. Inst. Géol. Univ. Louvain, vol. 20, p. 11, pl. 1, fig. 5) from the Oude-Biezen member near Borgloon.

Some of the Oude-Biezen specimens and one Nucula-clay individual are ornamented with longitudinal costae or striae.

Very oblique individuals resemble *Quinqueloculina obliqua* REUSS (1867, Sitz.ber. K. Ak. Wiss. Wien, vol. 55, p. 75, pl. 2, figs. 6, 7) from the Miocene of Poland and the Vienna basin, which species is evidently very close to *S. oblongus*.

Distribution.

Nucula-clay : TK 522, 524, BZ 487, 492, 493, 552.
Oude-Biezen member : TA 579, BZ 518, 520, 541, 544, 545, 546.
Henis clay : TB 216.

Genus SPIROLOCULINA D'ORBIGNY, 1826

Spiroloculina canaliculata D'ORBIGNY
Pl. II, fig. 3

Spiroloculina canaliculata D'ORBIGNY, 1846, For. Foss. Vienne, p. 269, pl. 16, figs. 10-12; CUSHMAN and TODD, 1944, Cushm. Lab. For. Res., spec. publ. 11, p. 22, pl. 4, figs. 1-11.
Spiroloculina limbata, BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 348, pl. 19, fig. 1.

Remarks. — A few distinct specimens were found in the samples from Pietzpuhl and Hermsdorf. The Boom clay samples yielded a single damaged specimen at Niel and another one in the boring Heist-op-den-Berg.

Distribution.

Boom clay : JB 362, Heist 36 m.
Septaria-clay : Hermsdorf 13438, Pietzpuhl 10447.

Genus SIGMOILINA SCHLUMBERGER, 1887

Sigmoilina tenuis (CZJZEK)

Quinqueloculina tenuis CZJZEK, 1847, Haid. Naturw. Abh., vol. 2, pt. 1, p. 149, pl. 13, figs. 31-34; REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 87, pl. 7, fig. 60; REUSS, 1864, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 126.
Sigmoilina tenuis (CZJZEK), CUSHMAN, 1929, Cushm. Lab. For. Res. Contr., vol. 22, p. 32, pl. 5, figs. 13-15; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 39, pl. 5, fig. 7.

Remarks. — The specimens of *S. tenuis* are often damaged in such a way that the final chambers are lacking. Only in Hermsdorf 13438 do we have more than one specimen; the other samples yielded only one individual per sample. The Hermsdorf specimens show some variation; quinqueloculine small specimens and individuals that have sigmoiline later chambers occur together.

In the Boom clay of Herselt (AE) a number of different *Sigmoilina* specimens was found. These specimens, one of which is figured (pl. II, fig. 5), resemble *Sigmoilina miocenica* CUSHMAN (1946, Cushm. Lab. For. Res. Contr., vol. 22, p. 33, pl. 5, figs. 19-22) from the Miocene Choctawatchee marl of Florida. The smaller Herselt individuals show a relatively thick quinqueloculine portion as compared with the entire test. The bigger specimens are more flattened.

Distribution.

Middle Miocene : Dingden 456.
German Upper Oligocene : Astrup 17538.
Boom clay : AE 664.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

Genus TRILOCULINA D'ORBIGNY, 1826

Triloculina tricarinata D'ORBIGNY

Pl. II, fig. 2

Triloculina tricarinata D'ORBIGNY, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 299, no. 7, Modèle no. 94; CUSHMAN, 1929, U.S. Nat. Mus., Bull. 104, pt. 6, p. 56, pl. 13, fig. 3; KAASSCHIETER, 1955, Verh. Kon. Ned. Ak. Wet., Nat., ser. 1, vol. 21, no. 2, p. 59, pl. 3, fig. 2.

Remarks. — Two complete specimens and a fragment are referred to this species. The angles of the chambers are rather bluntly rounded, just as in the specimens figured by KAASSCHIETER. The aperture has a distinct bifid tooth. The sutures are depressed.

Distribution.

Nucula-clay : TK 524, BZ 487.

Genus PYRGO DEFRANCE, 1824

Pyrgo bulloides (D'ORBIGNY)

Biloculina bulloides D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 297, pl. 16, figs. 1-4.
Pyrgo bulloides (D'ORBIGNY), MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 41.

Remarks. — Two specimens referable to this species, were found in the Boom clay of Kruibeke.

Distribution.

Boom clay : JK 628.

FAMILY **PENEROPLIDAE**

SUBFAMILY **SPIROLININAE**

Genus SPIROLINA LAMARCK, 1804

Spirolina sp.

Pl. II, fig. 6

Remarks. — Because of the simple aperture in the centre of the apertural face our few minute individuals are considered to represent the coiled part of some *Spirolina* species. With the exception of one of them, the specimens are striated.

Possibly they are juveniles of *Spirolina cylindracea* LAMARCK (1804, Ann. Mus. Hist. Nat. Paris, vol. 5, p. 244; 1806, id., vol. 8, pl. 62, fig. 15), originally described from the Eocene of Grignon and recorded by GULLENTOPS (1956, Mém. Inst. Géol. Univ. Louvain, vol. 20, p. 16, pl. 1, fig. 13) from the Oude-Biezen member at Borgloon.

Distribution.

Nucula-clay : TK 522, 524.
Henis-clay : TB 216.

Superfamily LAGENIDEA

Family LAGENIDAE

Subfamily LENTICULININAE

Genus LENTICULINA Lamarck, 1804

Lenticulina spp.

Pl. II, figs. 7, 9-11, 13-15

Lenticulina is used as generic name for all coiled lagenid forms (see also Bartenstein, 1948, Senckenbergiana, vol. 29, pp. 41-65) in a similar way as several authors use the name *Cristellaria*. *Robulus*, *Lenticulina*, *Planularia*, *Vaginulinopsis*, *Darbyella* and *Saracenaria* are treated as subgenera.

A great number of *Lenticulina* (*Robulus*) specimens, together with a few individuals of *Lenticulina* (*Lenticulina*), *Lenticulina* (*Planularia*) and *Lenticulina* (*Darbyella*) was found in samples from most stratigraphic units. Among them we encountered many of the forms which had been described by earlier authors as distinct species and varieties, either from the same deposits or from equivalent strata elsewhere. There is wide variation connecting many of these types, which variation severely hampers the separation of species in our material. Because of this intergradation, our *Lenticulina* material will be treated per stratigraphic unit and not in species order. It will not be tried to give Linnean names.

Samples from the Lower Tongeren beds of shaft Hendrik IV, and of Grimmertingen and Hoeselt, yielded a number of thick *Lenticulina* (*Robulus*) specimens, that reach up to 2,2 mm in diameter (pl. II, fig. 7). Their sutures are strongly curved backward and often slightly raised. The individuals are never uncoiling. The umbilical region in nearly all specimens is provided with a flat glassy area. Smaller individuals have the same features.

No *Lenticulina* individuals were observed in the samples from the brackish Upper Tongeren beds.

The Berg sand yielded only very few small *Lenticulina* specimens. They resemble those found in the Nucula-clay.

Samples from the Nucula-clay are poor in *Lenticulina*. The maximum number of specimens per sample is fifteen. Most of them are small. They show less variation than the individuals in the Boom clay.

Among the larger individuals the type shown in pl. II, fig. 10 and fig. 14 is the most common. Varietal forms of this figured type connect it with a few *Lenticulina* (*Planularia*) specimens, with a single *Lenticulina* (*Darbyella*) individual and with a few other types, the latter of which were also found in the Boom clay. Ornamentation is always absent or faint, some individuals are uncoiling.

The few *Planularia* specimens (up to 2,5 mm) are somewhat larger and less rapidly uncoiling than the specimen figured from the Boom clay (pl. II, fig. 11). In one specimen some of the sutures are raised.

Among the smaller Nucula-clay individuals of *Lenticulina* some resemble the bigger specimen from the Boom clay figured in pl. II, fig. 9.

Numerous *Lenticulina* individuals have been found in the Boom clay. Most samples from that clay contain only two or three specimens, but few of them contain each as many as sixty specimens, which are mostly small ones, however. Up to ten fairly big individuals may be present in one sample. Most of them are *Lenticulina* (*Robulus*) but *Lenticulina* (*Lenticulina*) was also encountered. Especially the « rich » samples show very wide variation. This variation covers most of the 58 species and varieties of « *Cristellaria* » described by Reuss (1866) from the German Septaria-clay.

The Boom clay *Lenticulina* individuals are usually not ornamented or slightly so. A small part of them has raised, thick sutures, a peripheral carina or a thick peripheral margin. Neither knobs nor peripheral spines were observed. Many individuals resemble the types figured from the Nucula-clay (pl. II, figs. 10,14). Variants of this type have depressed sutures between the last formed, more inflated chambers. Such specimens are intermediate to the type of a few *Lenticulina* individuals with inflated chambers and correspondingly depressed sutures. These individuals may be uncoiling.

Another characteristic, rather frequently encountered Boom clay *Lenticulina* has a protruding aperture, thickened often raised sutures in the depressions in between the inflated chambers, and a rounded to carinate periphery along the dorsal margin of the elongate test (pl. II, figs. 13, 15). Intermediates between these specimens and the type of *Lenticulina* figured from the Nucula-clay occur in several samples.

Other forms such as that figured in pl. II, fig. 9, and less common specimens similar to the one figured from the Lower Tongeren beds, occur as well.

A few rather big specimens with raised, thickened sutures resemble the *Lenticulina* specimens that accompany *Lenticulina* (*Vaginulinopsis*) *gladia* in the Upper Oligocene of Kassel.

A distinct *Planularia* type from the Boom clay is figured in pl. II, fig. 11. Other, less elongate specimens were equally met with. They occasionally have a slight carina.

Finally a number of more or less uncoiling *Lenticulina* specimens, which are more triangular in transverse section occur scattered in some Boom clay samples.

In the Hermsdorf and Pietzpuhl Septaria-clay few *Lenticulina* specimens were found. They resemble the Boom clay ones.

In the samples of the deposits on top of the Boom clay, *Lenticulina* becomes relatively scarce. The sand of Voort yielded only few *Lenticulina* specimens, chiefly in the deepboring Lillo and in the samples from Houthalen. Most of them are very small or damaged. The few larger specimens are more or less different from one another. They usually show raised, thickened sutures but smooth specimens occur as well. When preserved, the radiate aperture shows an enlarged median slit. One *Lenticulina* (*Darbyella*) was observed in sample Lambroek 23.

In the Upper Oligocene of Kassel and Astrup most coiled lagenids belong to distinct species, such as *Lenticulina* (*Vaginulinopsis*) *gladia*, *Lenticulina* (*Planularia*) *auricula* and *Frondicularia oblonga*, which will be treated separately. Young individuals of these species are indistinguishable from *Lenticulina* (*Lenticulina*) and *Lenticulina* (*Robulus*) types.

The horizon of Houthalen yielded only one well-preserved *Lenticulina* (*Lenticulina*) specimen. Apart from the thickened sutures and the apertural features it resembles the *Lenticulina* (*Robulus*) form in our pl. II, fig. 10, from the Nucula-clay.

In the Miocene of Dingden, of Antwerp and of Burcht, but few *Lenticulina* specimens were found. For the greater part they resemble the not-elongate, smooth *Lenticulina* (*Robulus*) specimens of the Nucula-clay and Boom clay. Some of them have straight sutures, a glassy area in the umbilical region and a carina.

Subgenus PLANULARIA DEFRANCE, 1824

Lenticulina (Planularia) auricula (ROEMER)
Pl. II, fig. 12

Planularia auricula ROEMER, 1838, N. Jhrb., Min., etc., p. 383, pl. 3, fig. 12.
Cristellaria auricula (ROEMER), REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 235, pl. 3, fig. 38; REUSS, 1865, id., vol. 50, p. 464.

Remarks. — Two specimens referable to this species were found at Kassel, where they occur together with other big *Lagenidae* such as *Frondicularia oblonga* and *Lenticulina (Vaginulinopsis) gladia.*

Some carinate *Lenticulina* specimens in the Boom clay may be immature individuals of the present species.

Distribution.

German Upper Oligocene : Kassel 12667.
Boom clay : ?JM 642.

Subgenus VAGINULINOPSIS SILVESTRI, 1904

Lenticulina (Vaginulinopsis) gladia (PHILIPPI)
Pl. II, fig. 8

Marginulina gladius PHILIPPI, 1843, Beitr. Kenntn. Tert.verst. Nordwestl. Deutschl., pp. 40, 84, pl. 1, fig. 37; HOSIUS, 1894, Jahresber. Naturw. Ver. Osnabrück, no. 10, p. 113.
Cristellaria gladius (PHILIPPI), REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 232, pl. 2, fig. 31, pl. 3, figs. 32, 33; REUSS, 1865, id., vol. 50, p. 462, pl. 2, figs. 14-17.

Remarks. — The species was originally described from the Upper Oligocene of Freden, north of Kassel (Germany). REUSS and HOSIUS found it at several other Upper Oligocene localities in northwestern Germany.

In our material it occurs at Kassel, at Astrup, in the sand of Voort and in the horizon of Houthalen. The specimens are often accompanied by other big *Lagenidae* such as *Frondicularia oblonga* and *Lenticulina auricula.* Together with *L. gladia* we found in sample Kassel 12667 several individuals of the subgenera *Lenticulina* and *Robulus,* among which there are types such as described by REUSS (1856, 1865) as *Cristellaria arcuata.* The relations of *L. gladia* to these smaller forms are uncertain.

At Houthalen two big straight *Vaginulina* individuals were found together with *L. gladia.* They resemble *Vaginulina ligata* REUSS from the Upper Oligocene of Harleshausen in NW Germany (REUSS, 1865, op. cit., p. 457, pl. 1, fig. 1).

Distribution.

Horizon of Houthalen : Houthalen I, 80,25-80,79 m.
Sand of Voort : Lillo 88, 89, Houthalen I, 81-84 m, 98-100,50 m, II, 84-88 m.
German Upper Oligocene : Astrup 17538, Kassel 12667.

Genus FRONDICULARIA DEFRANCE, 1824

Frondicularia oblonga (ROEMER)

Pl. III, figs. 1-3

Frondiculina oblonga ROEMER, 1838, N. Jhrb. Min., etc., p. 382, pl. 3, figs. 4, 6.

Flabellina oblonga (ROEMER), REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 226, pl. 1, figs. 11-16, pl. 2, figs. 17-19; REUSS, 1865, id., vol. 50, p. 458, pl. 2, figs. 1-4, pl. 5, fig. 1; HOSIUS, 1894, Jahresber. Naturw. Ver. Osnabrück, no. 10, p. 108.

Frondiculina ovata ROEMER, 1838, N. Jhrb. Min., etc., p. 382, pl. 3, fig. 5.

Frondiculina obliqua ROEMER, 1838, id., p. 382, pl. 3, fig. 7.

Frondiculina cuneata ROEMER, 1838, id., p. 383, pl. 3, fig. 10.

Flabellina cuneata (ROEMER), REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 231, pl. 2, fig. 29; REUSS, 1865, id., vol. 50, p. 460, pl. 2, fig. 8.

Frondiculina striata ROEMER, 1838, N. Jhrb. Min., etc., p. 382, pl. 3, fig. 9.

Flabellina striata (ROEMER), REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 230, pl. 2, figs. 25-28.

Remarks. — *Frondicularia oblonga* and the other species in the above list of synonyms were all originally described by ROEMER from the Upper Oligocene of northwestern Germany. Later on REUSS (1856, 1865) and HOSIUS (1894) reported them again from the same deposits.

We found distinct specimens of *F. oblonga* in the German Upper Oligocene, in the sand of Voort and in the horizon of Houthalen. Some juvenile individuals of *Frondicularia* from the Boom clay possibly also belong to the present species.

In our material the species shows wide variation. Similar variation in big *Lagenidae*, among which *F. oblonga*, from Upper Oligocene deposits in northwestern Germany, has recently been illustrated by BARTENSTEIN (1950, Senckenbergiana, vol. 31, pp. 339-345, pl. 1-3).

Specimens identical with the type figures of *F. oblonga* are considered to represent the microspheric generation of the species. They show a coiled *Lenticulina*-like early portion of the test, in which the sutures may be raised and ornamented. The broad and flattened later portion, which forms the greater part of the test of big individuals (up to 6 mm) is usually smooth. In some specimens it shows very faint longitudinal striae. The peripheral borders are rounded or truncated. The width of the later-formed portion of the test is variable. *F. oblonga* and *F. ovata* are broader types and *F. obliqua* a narrower type of the same species.

F. cuneata and *F. striata* are considered to represent the macrospheric generation of *F. oblonga*. *F. striata* is a broader variant with less costae. Both *F. cuneata* and *F. striata* are not coiled in the early portion of the test. The number of costae varies from 12 tot 30. In some specimens only the first chamber is costate, the remainder of the test being smooth. A single completely smooth, macrospheric specimen was found as well. Macrospheric individuals are usually not as broad as the microspheric ones.

F. speyeri REUSS (1865, op. cit., p. 458, pl. 4, fig. 8) from the Upper Oligocene of Niederkaufungen near Kassel, which possesses a basal spine, is possibly another macrospheric variant of *F. oblonga*. It was not met with in our material.

Frondicularia hosiusi REUSS (1861, Sitz.ber. K. Ak. Wiss. Wien, vol. 42, p. 365, pl. 1, figs. 8, 9) from the Miocene of Dingden, may be yet another macrospheric type of *F. oblonga*. It resembles rather well some of our macrospheric *F. oblonga* specimens from the horizon of Houthalen, which have but few costae.

In Kassel and Astrup microspheric specimens are dominant, whilst in the horizon of Houthalen relations are reversed. In the samples from Kassel, Astrup and from the horizon of Houthalen seven to fifteen specimens per sample were met with. In the sand of Voort maximally two specimens per sample were found, microsperic as well as macrospheric.

Although some intergradation was found to exist in the ornamentation of microspheric and macrospheric individuals, the possibility that *F. oblonga* and *F. cuneata* are distinct species cannot be entirely ruled out from our too poor material.

The possibility that *Lenticulina* (*Vaginulinopsis*) *gladia* and *F. oblonga* are in a varietal relation to one another can neither be excluded. *Flabellina ensiformis* (ROEMER) as figured by REUSS (1856, op. cit., p. 229, pl. 2, figs. 23, 24), though not found in our material, and *F. obliqua* may be intermediate types in between distinct *F. oblonga* and *L. gladia*.

A small number of *Lenticulina* specimens in the sample Kassel 12667 are considered juvenile microspheric specimens of *F. oblonga*.

Distribution.

Horizon of Houthalen : Houthalen I, 80,25-80,79 m.
Voort sand : Lillo 113, Houthalen I, 81-84 m, II, 84-88 m.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Boom clay : ?JC, ?JG, ?JM, ?VA.

Frondicularia nysti REUSS
Pl. III, fig. 4

Frondicularia nysti REUSS, 1863, Bull. Ac. Roy. Sci., etc., Belgique, ser. 2, vol. 15, p. 148, pl. 2, fig. 20.

Remarks. — Two specimens from the sand of Antwerp, from which the species was originally described, are in good agreement with the type description and figure. Both individuals are macrospheric. They somewhat resemble elongate microspheric specimens of *F. oblonga*.

Distribution.

Middle Miocene : Antwerp.

Frondicularia seminuda REUSS
Pl. III, fig. 8

Frondicularia seminuda REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 65, pl. 3, figs. 15, 16; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 66, pl. 4, fig. 8, pl. 9, fig. 11.

Remarks. — Distinct specimens were found in our material from Hermsdorf, from which locality the species was originally described by REUSS. Some more specimens were encountered in Boom clay sample HB 665 from Loksbergen. Two broad, fan-shaped specimens with few longitudinal costae from the Boom clay at Schriek (AA) are thought to be variants of *F. seminuda*. A single elongate smooth specimen from St.-Niklaas (JC) may be yet another variant of this species.

Distribution.

Boom clay : AA 657, HB 665, JC 584.
Septaria-clay : Hermsdorf 10445, 13438.

Genus VAGINULINA D'ORBIGNY, 1826

Vaginulina obtusicosta TEN DAM and REINHOLD

Pl. III, fig. 10

Vaginulina striatula TEN DAM and REINHOLD (not ROEMER), 1942, Med. Geol. St., ser. C-V, no. 2, p. 65, pl. 4, fig. 10, pl. 9, fig. 12.
Vaginulina obtusicosta TEN DAM and REINHOLD, 1947, Journ. Pal., vol. 21, p. 186.

Remarks. — Three juvenile specimens of *Vaginulina obtusicosta* were found in the sand of Antwerp. They were compared with the type of the species that was originally described from the Middle Miocene of the Netherlands. The largest of our individuals consists of four chambers.

Distribution.

Middle Miocene : Burcht.

Genus MARGINULINA D'ORBIGNY, 1826

Marginulina hirsuta D'ORBIGNY

Marginulina hirsuta D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 259; D'ORBIGNY, 1846, For. Foss. Vienne, p. 69, pl. 3, figs. 17, 18; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 44, pl. 5, fig. 13.

Remarks. — A single distinct specimen was found in the Miocene of Burcht. It has an eccentric aperture on a somewhat inflated last chamber.

It is considered questionable whether *Marginulina dingdeni* TEN DAM and REINHOLD (1942, Med. Geol. St., ser. C-V, no. 2, p. 56, pl. 3, fig. 7, pl. 9, fig. 3) is sufficiently different from *Marginulina hirsuta* to warrant specific separation.

Distribution.

Middle Miocene : Burcht.

Genus SARACENELLA FRANKE, 1936

Saracenella böttcheri (REUSS)

Pl. III, fig. 14

Cristellaria böttcheri REUSS, 1863, Sitz.ber. K. Ak. Wiss. Wien, vol. 48, p. 49, pl. 3, figs. 38-42; 1866, Denkschr. id., vol. 25, p. 139.
Cristellaria böttgeri ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 223, pl. 9, fig. 26.

Remarks. — Single or but very few *Saracenella*- and *Saracenaria*-like specimens were found in several samples of both Boom and Nucula-clay. Their wide morphologic variation makes a distinction of several species illusionary. Part of the individuals, especially the smaller ones, may be assigned to *Saracenella böttcheri*, originally described from the Septaria-clay of Offenbach. REUSS's original description is accompanied by figures of five specimens, which give a greater certainty to our determination. Just as REUSS' specimens, ours are often hardly triangular, approaching such types as are found in the genera *Marginulina, Vaginulina* and *Astacolus*.

Several stouter specimens are closer to *Saracenaria italica* DEFRANCE (1824, Dictionn. Sci. Nat., vol. 32, p. 176, Atlas pl. 13, fig. 6) than to *Saracenella böttcheri*.

Distribution.

Boom clay : AA, JB, JH, JJ, MA, ME, Winterswijk.
Septaria-clay : Pietzpuhl 10447.
Nucula-clay : TE, TK, BZ (see table 2).
Berg sand : TE 427.

Genus NODOSARIA LAMARCK, 1812

For our material *Dentalina* was considered congeneric with *Nodosaria,* as was also done by REUSS in his later papers on the fauna of the Septaria-clay. Actually the boundary between both genera is not a natural one in most of our species.

Nodosaria soluta (REUSS)

Pl. III, figs. 17, 18

Dentalina soluta REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 60, pl. 3, fig. 4; BORNEMANN, 1855, id., vol. 7, p. 322.
Nodosaria soluta (REUSS), REUSS, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 131, pl. 2, figs. 4-8; BRADY, 1884, Rep. Voy. « Challenger », Zool., vol. 9, p. 503, pl. 62, figs. 13-16.
Nodosaria soluta BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 322, pl. 12, fig. 12.

Remarks. — This is the most common *Nodosaria* species in the Nucula- and Boom clays; mostly it is encountered as fragments. In the Boom clay it is commonly accompanied by *N. intermittens.*

The species was originally described from the Septaria-clay of Hermsdorf.

A few specimens are very finely rugose at the base of the chambers; some others are more completely so.

Distribution.

Boom clay : AA, AE, HB, JA-JC, JE, JF, JG-JJ, JL-JN, MA, ME, OA, VA, Winterswijk, Kuiperberg.
Septaria-clay : Hermsdorf 10445, 13438.
Nucula-clay : TE 224, TK 526, BZ 488, 535, 553, 559.
Berg sand : TE 427.

Nodosaria intermittens ROEMER

Pl. III, fig. 22

Nodosaria intermittens ROEMER, 1838, N. Jhrb. Min., etc., p. 382, pl. 3, fig. 2.
Dentalina intermittens (ROEMER), REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 224, pl. 1, fig. 7; REUSS, 1865, id., vol. 50, p. 455.
Dentalina capitata (BOLL.) in REUSS, 1856, id., vol. 18, p. 223, pl. 1, fig. 4.
Nodosaria capitata BOLL., REUSS, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 134.

Remarks. — The species is rare in many of the Boom clay samples.

In our opinion *Nodosaria intermittens* and *Nodosaria capitata* belong to a single species. REUSS (1866) already put several more of his earlier species in the synonymy of *N. capitata.*

In our material the species is very variable. The individuals are for the greater part arcuate, some are straight. The few specimens from the German Upper Oligocene, from which the species was originally described, are generally somewhat more heavily striated than the Boom clay specimens. The striae on the sutures are absent in some individuals. These are identical with the specimens figured as *N. grandis* by REUSS (1866, op. cit., p. 131, pl. 1, figs. 26-28).

Distribution.

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

Boom clay : AA, AE, JA-JC, JE, JF, JH, JJ, JM, MA, ME, OA, Kuiperberg.

Nodosaria vertebralis (BATSCH)
Pl. III, fig. 19

Nautilus (*Orthoceras*) *vertebralis* BATSCH, 1781, Conchylien des Seesandes, pp. 2, 5, pl. 2, fig. 6.
Dentalina vertebralis (BATSCH), CUSHMAN, 1931, Cushm. Lab. For. Res. Contr., vol. 7, p. 66, pl. 8, figs. 20, 21.
Nodosaria elegans ROEMER, 1838, N. Jhrb. Min., etc., p. 382, pl. 3, fig. 1.
Dentalina münsteri REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 225, pl. 1, fig. 8.

Remarks. — The widely recorded *Nodosaria vertebralis* was found only in the German Upper Oligocene. Two obvious synonyms, originally described from the same deposits, are *N. elegans* and *D. münsteri*.

Distribution.

German Upper Oligocene : Astrup 17538, Kassel 12667.

Nodosaria konincki (REUSS)
Pl. III, fig. 5

Dentalina konincki REUSS, 1861, Sitz.ber. K. Ak. Wiss. Wien, vol. 42, p. 356, pl. 1, fig. 3; REUSS, 1863, Bull. Ac. Roy. Sci., etc., Belgique, ser. 2, vol. 15, p. 146, pl. 1, fig. 19.
Dentalina microptycha REUSS, 1861, Sitz.ber. K. Ak. Wiss. Wien, vol. 42, p. 365, pl. 1, fig. 4.
Dentalina arcuata REUSS, 1861, id., vol. 42, p. 364, pl. 1, fig. 5; HOSIUS, 1892, Verh. Naturh. Ver. Rheinl.-Westf., vol. 49, p. 163; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 58, pl. 4, fig. 6, pl. 9, fig. 7.

Remarks. — The species was originally described from the Miocene of Antwerp. It differs from *N. vertebralis* (BATSCH) in the more dentaline arrangement of the chambers and the more oblique costae in some of our few specimens.

REUSS (1863) and HOSIUS already described the wide variation of this species. REUSS (1863) considered *D. arcuata* and *D. microptycha* as variants of *D. konincki*. Therefore we think it more correct to retain *D. konincki* instead of *D. arcuata*, as was done by HOSIUS and by TEN DAM and REINHOLD.

Distribution.

Middle Miocene : Dingden 456, Antwerp.

Nodosaria ludwigi Reuss

Pl. III, figs. 15, 16

Nodosaria ludwigi Reuss, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 135, pl. 2, fig. 23; Andreae, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 204, pl. 10, fig. 1.

Remarks. — The species is rare in many Boom clay samples.

Some of our specimens (pl. III, fig. 15) are identical with *Nodosaria herrmanni* Andreae (1884, op. cit., p. 205, pl. 10, fig. 2). They are considered to be microspheric individuals of *N. ludwigi*.

Distribution.

Boom clay : AA, ?JA, JB, JC, JE, JH, JM, MA, ME, OA, VA.

Nodosaria spinescens (Reuss)

Pl. III, fig. 13

Dentalina spinescens Reuss, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 62, pl. 3, fig. 10.
Nodosaria spinescens (Reuss), Reuss, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 135.

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

N. spinescens, originally described from the Septaria-clay of Hermsdorf, differs from *N. adolphina* (d'Orbigny) (1846, For. Foss. Vienne, p. 51, pl. 2, figs. 18-20) in the slightly more elongate chambers, which are less constricted. The ornamentation is variable up to nearly wanting. Both straight and arcuate specimens were found.

Occasional well preserved specimens (also among *N. adolphina* in Marks's material of the Vienna basin) have a long neck with faint crenulations at the end, which suggest a radiate aperture. Apertures without these features are more common. Mostly the aperture is indistinct and surrounded by a thick collar, the remainder of a broken-off later chamber.

Distribution.

Boom clay : AA, HB, JF, JG, JL, JN, MA, ME, Kuiperberg.
Septaria-clay : Hermsdorf 10445, Pietzpuhl 10447.

Nodosaria emaciata (Reuss)

Pl. III, figs. 20, 21

Dentalina emaciata Reuss, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 63, pl. 3, fig. 9; Bornemann, 1855, id., vol. 7, p. 324.

Remarks. — A highly variable group of specimens has been put together under this specific name. The test consists of a straight, but more commonly a curved, series of uniformly inflated chambers that are somewhat longer than broad. The initial chamber is elongate to rather globular and often it bears one, or occasionally two, short spines. The sutures are commonly normal to the axis and they are slightly or moderately depressed. One specimen did not lack the aperture, which appeared to be radiate and slightly eccentric (pl. III, fig. 20).

Most specimens are smooth throughout. Others have short costae in the sutural constrictions, which sometimes extend over the entire chambers. In another type of ornamentation there are sharp, tiny costae, which are longitudinal or obliquely twisted and which are often irregularly interrupted (pl. III, fig. 21). Furthermore there are some individuals with a rugose wall.

In addition to *Dentalina emaciata* there are for the smooth form several names available, which have been all based on specimens from the Septaria-clay :

Dentalina dispar Reuss, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 61, pl. 3, fig. 7;
Dentalina benningseni Reuss, 1863, Sitz.ber. K. Ak. Wiss. Wien, vol. 48, p. 44, pl. 2, fig. 14;
Dentalina indifferens Reuss, 1863, id., vol. 48, p. 44, pl. 3, figs. 15, 16;
Nodosaria calomorpha Reuss, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 129, pl. 1, figs. 15-19;
Nodosaria laxa Reuss, 1866, id., vol. 25, p. 132, pl. 1, figs. 2, 3;
Nodosaria subaequalis Reuss, 1870, Sitz.ber. K. Ak. Wiss. Wien, vol. 62, p. 471; von Schlicht, 1870, For. Sept.thon Pietzpuhl, pl. 6, figs. 23, 26;
Nodosaria bicuspidata Reuss, 1870, id., vol. 62, p. 474; von Schlicht, 1870, id., pl. 9, figs. 10, 11, 12, 14, 16.

D. emaciata has been selected. *Dentalina consobrina* d'Orbigny (1846, For. Foss. Vienne, p. 46, pl. 2, figs. 1-3) cannot be used, as was repeatedly done by Reuss, since the chambers become too elongate and the aperture would point to *Siphonodosaria* (accordig to Marks, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 55). The most common interpretation of *Nodosaria (Dentalina) communis* d'Orbigny shows fairly oblique sutures, which feature is exceedingly rare among our specimens.

The partly striated specimens might be referred to as *Dentalina obliquestriata* Reuss (1851, Zschr. Deu. Geol. Ges., vol. 3, p. 63, pl. 3, figs. 11, 12).

Those with costae throughout (pl. III, fig. 21) are identical with the figured specimens of :

Dentalina multilineata Bornemann, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 325, pl. 13, fig. 12;
Nodosaria bactridium Reuss, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 130, pl. 1, figs. 24, 25.

Distribution.

Voort sand : Lambroek 29.
Boom clay : AA, AE, HB, JB, JF, JH, JJ, JL, JN, MA, ME, OA, VA, Kuiperberg, Winterswijk.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

Nodosaria ewaldi Reuss

Nodosaria ewaldi Reuss, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 58, pl. 2, fig. 2; Bornemann, 1855, id., vol. 7, p. 321, pl. 12, fig. 10; Reuss, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 129, pl. 2, fig. 18; Hagn, 1952, Geol. Bav., no. 10, p. 152.

Remarks. — Many names are available for *Nodosaria* specimens with very elongate chambers. One of them is *N. ewaldi*, originally described for specimens from the Septaria-clay of Hermsdorf.

Our material is poor. Fairly distinct specimens occur in the German Septaria-clay samples. In the Belgian and Dutch Boom clay the individuals are still more fragmentary and doubtful. These fragments are bigger than the comparable parts of our German specimens.

Distribution.

Boom clay : AA, HB, JB, JF, JH, JN, Kuiperberg.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

SUBFAMILY LAGENINAE

Genus LAGENA WALKER and JACOB, 1798

Lagena spp.

Monothalamous individuals are scarce in our samples. In addition to three groups dealt with separately below, the following specific names might be applied for them.

Lagena apiculata (REUSS) (*Oolina apiculata* REUSS, 1850, Haid. Naturw. Abh., vol. 4, p. 22, pl. 1, fig. 1), one elongate specimen in Boom clay sample MA 652.

Lagena squammosa (MONTAGU) var. *hexagona* (WILLIAMSON) [*Entosolenia squammosa* (MONTAGU) var. *hexagona* WILLIAMSON, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 20, pl. 2, fig. 23]. Single specimens in Pietzpuhl 10447 and Dingden 456 (pl. III, fig. 9).

Lagena seriatogranulosa REUSS (1870, Sitz.ber. K. Ak. Wiss. Wien, vol. 62, p. 468; VON SCHLICHT, 1870, For. Sept.thon Pietzpuhl, pl. 38, fig. 20). A single specimen from Pietzpuhl (10447), from which locality the species has originally been described.

Lagena (*Entosolenia*) *orbignyana* (SEGUENZA) (*Fissurina orbignyana* SEGUENZA, 1862, For. Monotal. Mioc. Messina, p. 66, pl. 2, figs. 25, 26). Again a single individual. This one from Kassel (11315).

Lagena (*Entosolenia*) *lagenoides* (WILLIAMSON) (*Entosolenia marginata* var. *lagenoides* WILLIAMSON, 1858, Rec. For. Gr. Brit., p. 11, pl. 1, figs. 25, 26). Two specimens in Pietzpuhl sample 10447 (pl. III, fig. 7) and one in sample JG 611 from the Boom clay.

Lagena (*Fissurina*) *laevigata* (REUSS) (*Fissurina laevigata* REUSS, 1850, Denkschr. K. Ak. Wiss. Wien, vol. 1, p. 366, pl. 46, fig. 1). Some specimens from Dingden (456) and Kassel (11315) agree fairly well with REUSS's original type from the Miocene of the Vienna basin. They have a symmetrical slit-like aperture and show no obvious traces of an entosolenian neck (pl. III, fig. 25). Some other specimens from Pietzpuhl 10447 and Boom clay sample JB 359 are within the range of variation indicated in REUSS's later paper on the Foraminifera of the Septaria-clay of Pietzpuhl (1870, Sitz.ber. K. Ak. Wiss. Wien, vol. 62, p. 470; VON SCHLICHT, 1870, For. Sept.thon Pietzpuhl, pl. 4, figs. 16-24, pl. 5, fig. 7-9). They have a *Parafissurina*-like aperture and an internal tube along one side of the test.

Lagena isabella (d'ORBIGNY)

Pl. III, fig. 11

Oolina isabella d'ORBIGNY, 1839, Voy. Amér. Mér., For., vol. 5, pt. 5, p. 20, pl. 5, figs. 7, 8.

Lagena isabella (d'ORBIGNY), REUSS, 1863, Sitz.ber. K. Ak. Wiss. Wien, vol. 46, p. 330, pl. 4, figs. 55, 56; REUSS, 1870, id., vol. 62, p. 467; VON SCHLICHT, 1870, For. Sept.thon Pietzpuhl, p. 10, pl. 3, figs. 13, 14, 19, 20.

Ovulina elegantissima BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 316, pl. 12, fig. 1.

Lagena elegantissima (BORNEMANN), MATTHES, 1939, Palaeontographica, vol. 90, pt. A, p. 58, pl. 3, figs. 13, 14.

Remarks. — We mostly found single specimens in several samples of various formations. Their range of variation is less wide than that of the common interpretation of *Lagena sulcata* (WILLIAMSON), which name is more frequently used for heavily costate *Lagena* individuals.

Distribution.

Middle Miocene : Burcht, Dingden 456.
German Upper Oligocene : Astrup 17538, Kassel 12667.
Boom clay : JB, JC, JE, JF.
Septaria-clay : Hermsdorf 13438, Pietzpuhl 10447.

Lagena striata (d'ORBIGNY)

Pl. III, fig. 6

Oolina striata d'ORBIGNY, 1839, Voy. Amér. Mér., For., p. 21, pl. 5, fig. 12.

Lagena striata (d'ORBIGNY), REUSS, 1863, Bull. Ac. Roy. Sci., etc., Belgique, ser. 2, vol. 15, p. 142, pl. 1, figs. 10, 11; KAASSCHIETER, 1955, Verh. Kon. Ned. Ak. Wet., ser. 1, vol. 21, no. 2, p. 63, pl. 5, fig. 3.

Remarks. — Four big specimens (diameter about 0,33 mm) were found at Burcht in the Miocene sand of Antwerp. They occur together with a number of similar, as big individuals, that are less ornamented. The latter are completely smooth or they have fine costae, that cover the aboral part of the test. These specimens might be referred to as *Lagena vulgaris* WILLIAMSON and *Lagena vulgaris* var. *semistriata* WILLIAMSON as was done by REUSS (1863), who also recognized these types in his description of the Foraminifera from the sand of Antwerp.

Distribution.

Middle Miocene : Burcht.

Lagena tenuis (BORNEMANN)

Pl. III, fig. 23

Ovulina tenuis BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 317, pl. 12, fig. 3, 3'.

Lagena tenuis (BORNEMANN), REUSS, 1863, Sitz.ber. K. Ak. Wiss. Wien, vol. 46, p. 325, pl. 3, figs. 30-39; REUSS, 1863, Bull. Ac. Roy. Sci., etc, Belgique, ser. 2, vol. 15, p. 141, pl. 1, figs. 6-9; REUSS, 1870, Sitz.ber. K. Ak. Wiss. Wien, vol. 62, p. 466; VON SCHLICHT, 1870, For. Sept.thon Pietzpuhl, pp. 7, 8, pl. 2, figs. 12, 13-16, 21-23.

Remarks. — Three distinct individuals of this species were found in the Septaria- and Boom clays. Two specimens from Burcht belong to the same variant as the one that was described and figured by REUSS (1863) from the sand of Antwerp.

Some other, more globular specimens, that are more or less densely and more or less completely covered with fine striae (pl. III, fig. 24), are intermediates towards the types described under *L. striata* and even *L. isabella*. They were found in samples from the Boom clay, from Pietzpuhl and from Burcht and Dingden.

Distribution.

Middle Miocene : Burcht, Dingden 456.

Boom clay : JE, JH, MA, OA.

Septaria-clay : Pietzpuhl 10447.

Subfamily STILOSTOMELLINAE

Genus SIPHONODOSARIA Silvestri, 1924

Siphonodosaria hirsuta (d'Orbigny)

Pl. III, fig. 12

Nodosaria hirsuta d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 252.
Nodogenerina hirsuta (d'Orbigny), Marks, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 56, pl. 7, fig. 7.

Remarks. — Except for some samples, in which it is common, this species is rare in the Boom clay.

The chambers of our specimens are often slightly elongate. The hispid ornamentation is variable. Isolated, worn chambers cannot be distinguished from fragments of rugose *Nodosaria soluta*.

The following species, originally described from the German Septaria-clay, may be conspecific with *S. hirsuta*, when this species is interpreted in a wider sense regarding the ornamentation and shape of the chambers :

Nodosaria conspurcata Reuss, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 59, pl. 3, fig. 3;

Nodosaria schlichti Reuss, 1870, Sitz.ber. K. Ak. Wiss. Wien, vol. 62, p. 472; von Schlicht, 1870, For. Sept.thon Pietzpuhl, pl. 6, figs. 29-31.

Distribution.

Boom clay : AA, AE, JB, JF, JL, JN, MA, ME, Kuiperberg.

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

FAMILY POLYMORPHINIDAE

SUBFAMILY POLYMORPHININAE

Genus GUTTULINA D'ORBIGNY, 1839

Guttulina problema D'ORBIGNY

Pl. IV, figs. 10-12

Guttulina problema D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 266; CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6, p. 19, pl. 2, figs. 1-6, pl. 3, fig. 1.

Guttulina communis D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 266, pl. 12, figs. 1-4.

Guttulina frankei CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6. p. 28, pl. 4, fig. 1.

Remarks. — The species occurs throughout our column in many samples, but it is nearly always rare. Among the numerous specimens from the Nucula- and Boom clay it appeared impossible to distinguish *G. problema* from *G. frankei* [originally described from the Middle Oligocene of Söllingen (Germany)]. Many intermediates between these types were observed. Furthermore several variants are identical with *Guttulina irregularis* (D'ORBIGNY) (*Globulina irregularis* D'ORBIGNY, 1846, For. Foss. Vienne, p. 226, pl. 13, figs. 9, 10).

In the Miocene sand of Antwerp some specimens are referable to *G. austriaca* D'ORBIGNY (1846, op. cit., p. 223, pl. 12, figs. 23-25).

The small specimens in shaft Hendrik IV are accompanied by a few immature *Sigmomorphina* individuals. Possibly they are juveniles of this problematic *Sigmomorphina*.

Distribution.

Middle Miocene : Antwerp, Burcht, Heist 26 m, Dingden 456.
Horizon of Houthalen : Houthalen I, 80,25-80,79 m.
Voort sand : Lambroek 37, Lillo 81, 84, 92, 98, 113, Houthalen I, 81-84 m.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Boom clay : AA, AE, HB, JA-JJ, JM, JN, MA, ME, OA, VA Kuiperberg, Winterswijk.
Septaria-clay : Hermsdorf 13438.
Nucula-clay : TE 224, 428, TK 526, BZ 485, 488, 504, 513, 535, 552, 553.
Berg sand : BZ 505.
Lower Tongeren beds : Hendrik IV, 191-192 m, 195-197 m, 198-199 m, 201-204 m, 209-210 m.

Genus GLOBULINA D'ORBIGNY, 1839

Globulina gibba D'ORBIGNY

Pl. IV, fig. 9

Globulina gibba D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 266, Modèle 63; CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6, p. 60, pl. 16, figs. 1-4.

Globulina inaequalis REUSS, 1850, Denkschr. K. Ak. Wiss. Wien, vol. 1, p. 377, pl. 48, fig. 9; CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6, p. 73, pl. 18, figs. 2-4.

Remarks. — In our rather abundant *Globulina* material (mainly from the Boom clay) it is impossible to separate *G. gibba* and *G. inaequalis*. Both types often occur together and they are connected through many intermediates. Only few of our specimens are as compressed as the individual figured as *G. inaequalis* by REUSS (1850).

In the sand of Antwerp *G. gibba* var. *tuberculata* (*G. tuberculata* D'ORBIGNY, 1846, For. Foss. Vienne, p. 230, pl. 13, figs. 21, 22) and fistulose specimens of *G. gibba* were found.

Distribution.

Middle Miocene : Antwerp, Burcht, Heist 26 m, Dingden 456.
Voort sand : Lambroek 23, Lillo 81, 83, 113.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Boom clay : AA, AE, JA-JJ, JL, JM, JN, MA, ME, OA, VA, Kuiperberg, Winterswijk.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.
Nucula-clay : BZ 488, 493, 536.
Berg sand : BZ 507, 509.
Lower Tongeren beds : SG 198, TL 529, Hendrik IV, 191-192 m, 193-202 m, 209-210 m.

Genus PYRULINA D'ORBIGNY, 1839

Pyrulina fusiformis (ROEMER)

Pl. IV, fig 3

Polymorphina fusiformis ROEMER, 1838, N. Jhrb. Min., etc., p. 386, pl. 3, fig. 37.
Pyrulina fusiformis (ROEMER), CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6, p. 54, pl. 13, figs. 3-8.

Remarks. — The species is fairly common in the Nucula-clay. In samples from several other stratigraphic units it is equally present, but always rare.

The greater part of our *Pyrulina* individuals resembles well the *P. fusiformis* individuals figured by CUSHMAN and OZAWA on pl. 13, figs. 3, 4, 6. Such elongate specimens as the individual on their pl. 13, fig. 5, are relatively rare.

Some of our specimens have more elongate chambers. These individuals agree with the specimens of *P. cylindroides* (ROEMER), figured by CUSHMAN and OZAWA on pl. 14, figs. 1, 2, 3.

Finally there are from the Boom clay and from deposits higher up in the stratigraphic column some big individuals with short chambers. They resemble the *P. fusiformis* specimens figured by CUSHMAN and OZAWA on pl. 13, figs. 7, 8.

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, Lillo 90, Houthalen I, 81-84 m, 98-100,50 m, II, 84-88 m.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Boom clay : AE, HB, JB-JD, JF, JG, JJ, JM, MA, ME, OA, VA, Kuiperberg, Winterswijk.
Nucula-clay : TE, TK, BZ (se table 2).
Berg sand : TE 427, BZ 505, 507, 510.
Lower Tongeren beds : TL 529, Hendrik IV, 191-192 m, 193-194 m, 195-198 m, 200-202 m.

Genus GLANDULINA D'ORBIGNY, 1826

Glandulina aequalis REUSS

Pl. IV, figs. 5, 6

Glandulina aequalis REUSS, 1863, Sitz.ber. K. Ak. Wiss. Wien, vol. 48, p. 48, pl. 3, fig. 28; REUSS, 1867, id., vol. 55, p. 83, pl. 3, fig. 4.

Remarks. — A number of distinct *Glandulina aequalis* specimens (pl. IV, fig. 5) was found in a few Nucula-clay samples. These individuals are macrospheric. They are accompanied by microspheric *Glandulina* specimens (pl. IV, fig. 6) resembling *Psecadium acuminatum* REUSS (not *Glandulina acuminata* COSTA) (REUSS, 1870, Sitz.ber. K. Ak. Wiss. Wien, vol. 62, p. 478; VON SCHLICHT, 1870, For. Sept.thon Pietzpuhl, pl. 25, figs. 1-10) and forms intermediate between *G. aequalis* and *Psecadium acuminatum*.

The few Boom and Septaria-clay specimens are all microspheric. They are provided with a distinct initial spine. Such a spine was not observed in the individuals from the Nucula-clay.

Psecadium acuminatum, renamed *Glandulina ozawai* by CUSHMAN (1931, Cushm. Lab. For. Res. Contr., vol. 7, p. 83) is considered to represent the microspheric generation of *G. aequalis* in our material.

One of the macrospheric specimens has a distinct entosolenian tube.

Distribution.

Boom clay : AE 664, Heist 36 m, Winterswijk.

Septaria-clay : Pietzpuhl 10447.

Nucula-clay : TE 224, 428, BZ 486, 488, 513.

Berg sand : TE 427.

Lower Tongeren beds : ?Hendrik IV, 195-196 m.

Glandulina laevigata (D'ORBIGNY)

Pl. IV, figs. 7, 8

Nodosaria (Glandulina) laevigata D'ORBIGNY, Ann. Sci. Nat., vol. 7, p. 252, pl. 10, figs. 1-3.

Glandulina laevigata (D'ORBIGNY), D'ORBIGNY, 1846, For. Foss. Vienne, p. 29, pl. 1, figs. 4, 5; REUSS, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 136, pl. 2, figs. 29-31; REUSS, 1870, Sitz.ber. id., vol. 62, pp. 477, 478; VON SCHLICHT, 1870, For. Sept.thon Pietzpuhl, pl. 6, figs. 7, 8; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 47.

Glandulina ?laevigata D'ORBIGNY, BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 320, pl. 12, fig. 8.

Remarks. — The species is fairly rare in a number of Boom clay samples and in our sample from Dingden.

It shows wide variation. Forms such as *Glandulina inflata* BORNEMANN (not COSTA, 1853) (1855, Zschr. Deu. Geol. Ges., vol. 7, p. 320, pl. 12, figs. 6,7), *G. elongata* BORNEMANN (1855, id., vol. 7, p. 321, pl. 12, fig. 9), *G. elliptica* REUSS (1863, Sitz.ber. K. Ak. Wiss. Wien, vol. 48, p. 47, pl. 3, figs. 29-31) and *G. obtusissima* REUSS (1863, id., vol. 48, p. 66, pl. 7, figs. 92, 93), all originally described from the German Septaria-clay, were found together with distinct *G. laevigata* and intermediate forms. In his paper on the Pietzpuhl Foraminifera REUSS (1870) already regarded these and other forms as variants of *G. laevigata*.

Distribution.

Middle Miocene : Dingden 456.
Boom clay : AA, AE, JA, JC, JG, JM, MA, ME, OA.

Genus PSEUDOPOLYMORPHINA CUSHMAN and OZAWA, 1928

Pseudopolymorphina obscura (ROEMER)
Pl. IV, fig. 1

Polymorphina obscura ROEMER, 1838, N. Jhrb. Min., etc., p. 385, pl. 3, fig. 23; REUSS, 1865, Sitz.ber. K. Ak. Wiss. Wien, vol. 50, p. 471, pl. 3, figs. 8-10.
Pseudopolymorphina obscura (ROEMER), CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6, p. 104, pl. 27, fig. 2.

Remarks. — A few distinct specimens were found in our samples from the German Upper Oligocene.

Distribution.

German Upper Oligocene : Astrup 17538, Kassel 12667.

Pseudopolymorphina soldanii (D'ORBIGNY)

Polymorphina soldanii D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 265.
Pseudopolymorphina soldanii (D'ORBIGNY), CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6, p. 92, pl. 23, figs. 6-8.

Remarks. — A few more or less distinct *Pseudopolymorphina* specimens from the horizon of Houthalen and the sand of Antwerp resemble *Pseudopolymorphina soldanii* (D'ORBIGNY) as figured by CUSHMAN and OZAWA. They are more slender than our specimens of *P. obscura.*

Distribution.

Middle Miocene : Antwerp, Burcht.
Horizon of Houthalen : Houthalen I, 80,25-80,79 m.

Pseudopolymorphina subnodosa (REUSS)
Pl. IV, fig. 4

Polymorphina subnodosa REUSS, 1861, Sitz.ber. K. Ak. Wiss. Wien, vol. 42, p. 362, pl. 2, fig. 15.
Pseudopolymorphina subnodosa (REUSS), CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6, p. 110, pl. 29, fig. 2.

Remarks. — A few specimens, only two of which are undamaged, distinctly belong to *P. subnodosa.* They are loosely biserial to uniserial; the chambers are somewhat inflated. This species was originally described from the Miocene sand of Antwerp.

Distribution.

Middle Miocene : Antwerp, Burcht.
Horizon of Houthalen : ?Houthalen I, 80,25-80,79 m.

Genus SIGMOMORPHINA CUSHMAN and OZAWA, 1928

Sigmomorphina regularis (ROEMER)
Pl. IV, fig. 2

Polymorphina regularis ROEMER, 1838, N. Jhrb. Min., etc., p. 385, pl. 3, fig. 21; REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 247, pl. 7, figs. 70-73.

Sigmomorphina regularis (ROEMER), CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6, p. 126, pl. 33, fig. 1; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 74, pl. 4, figs. 11-13.

Polymorphina humboldti BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 347, pl. 18, figs. 7-8.

Polymorphina anceps PHILIPPI, 1843, Beitr. Kenntn. Tert. verst. Nordwestl. Deutschl., p. 41, pl. 1, fig. 34; REUSS, 1856, Sitz.ber. K. Ak. Wiss. Wien, vol. 18, p. 246, pl. 6, fig. 68, pl. 7, fig. 69; REUSS, 1865, id., vol. 50, p. 472, pl. 3, figs. 11, 12, pl. 4, figs. 1-3.

Remarks. — Fairly large specimens were found in the German Upper Oligocene and in the horizon of Houthalen, some juvenile ones in the Boom clay.

Distribution.

Horizon of Houthalen : Houthalen I, 80,25-80,79 m.
German Upper Oligocene : Astrup 17538, Kassel 12667.
Boom clay : HB 665.

Genus POLYMORPHINA D'ORBIGNY, 1826

Polymorphina cf. **P. charlottensis** CUSHMAN

Remarks. — In the Miocene of Antwerp two damaged specimens were found, which fairly well resemble the original figures of this species (CUSHMAN, 1925, Cushm. Lab. For. Res. Contr., vol. 1, p. 41, pl. 6, fig. 9; see also CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6, p. 119, pl. 31, figs. 1-6).

Distribution.

Middle Miocene : Antwerp.

SUPERFAMILY **BULIMINIDEA**

FAMILY **BULIMINIDAE**

SUBFAMILY **TURRILININAE**

Genus TURRILINA ANDREAE, 1884

Turrilina alsatica ANDREAE
Pl. IV, fig. 15

Turrilina alsatica ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 212, pl. 8, figs. 18, 19; CUSHMAN and PARKER, 1947, U.S. Geol. Surv., prof. paper 210-D, p. 56, pl. 15, fig. 3.

Remarks. — The species was found in several of the Boom clay samples; it is most common in JF 608 and JJ 626. Some of the specimens have a lip at the base of the aperture.

In the literature *T. alsatica* has so far only been recorded from the European Middle Oligocene.

Distribution.

Boom clay : AA, JA, JC, JE, JF, JJ, ME, OA, Kuiperberg.
Septaria-clay : Pietzpuhl 10447.

Genus BULIMINELLA CUSHMAN, 1911

Buliminella carteri BHATIA
Pl. IV, fig. 14

Buliminella carteri BHATIA, 1955, Journ. Pal., vol. 29, p. 678, pl. 66, fig. 10, textfig. 4.

Remarks. — The species was originally described from the Middle Oligocene Corbula-beds of the Isle of Wight. Only two specimens of this peculiar, small species were found in our Belgian material.

Distribution.

Nucula-clay : TK 524.

SUBFAMILY **BULIMININAE**

Genus BULIMINA D'ORBIGNY, 1826

Bulimina elongata D'ORBIGNY
Pl. IV, figs. 16, 17

Bulimina elongata D'ORBIGNY, 1846, For. Foss. Vienne, p. 187, pl. 11, figs. 19-20; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 80, pl. 5, fig. 11; CUSHMAN and PARKER, 1947, U.S. Geol. Surv., prof. paper 210-D, p. 108, pl. 25, figs. 14-17; MARKS, 1951, Cushm. Found For. Res. Contr., vol. 2, p. 57, pl. 7, fig. 12.

Remarks. — The species is frequent in our samples from the Miocene of Dingden and Burcht. Single distinct specimens were also found in the sand of Voort and in the Oude-Biezen member.

The Dingden material shows wide variation. The length-diameter ratio varies between 3 : 2 and 8 : 3 in well developed specimens. Elongate individuals are more common than short ones. The aperture usually is broader than in the figured elongate specimen. A few specimens from Dingden and Burcht have some very small blunt spines on the initial portion of the test.

Distribution.

Middle Miocene : Burcht, Heist 26 m, Dingden 456.
Oude-Biezen member : BZ 541.

Bulimina alsatica CUSHMAN and PARKER

Pl. IV, fig. 13

Bulimina alsatica CUSHMAN and PARKER, 1937, Cushm. Lab. For. Res. Contr., vol. 13, p. 39, pl. 4, figs. 6, 7; CUSHMAN and PARKER, 1947, U.S. Geol. Surv., prof. paper 210-D, p. 102, pl. 24, figs. 10-11.

Remarks. — The species is very rare in a few Boom clay samples.

The aperture is in most smaller specimens just at the junction of the second and third chambers, which position is not in accordance with that in typical *B. alsatica*. Our material is too scarce to appraise the stated difference between *B. alsatica* and other species of the group of *B. inflata* SEGUENZA.

Distribution.

Boom clay : JF 609, JH 618, ME 635, Heist 30,50 m, Winterswijk NLD 459.
Septaria-clay : Pietzpuhl 10447.

Bulimina striata D'ORBIGNY

Bulimina striata D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 269; CUSHMAN and PARKER, 1947, U.S. Geol. Surv., prof. paper 210-D, p. 119, pl. 28, figs. 1-3; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 58.

Remarks. — Two poorly preserved specimens are referred to this species.

Distribution.

Middle Miocene : Dingden 456.

Bulimina kasselensis nov. sp.

Pl. V, figs. 4-6

Etymology. — Named after the type locality Kassel in Germany.

Description. — Test small, triserial, pyramidal, rounded triangular in transverse section; chambers inflated, gradually increasing in size, those of about four of the later whorls distinctly visible, arranged in vertical series; number and arrangement of the early chambers indistinguishable; sutures depressed, somewhat curved; wall thick, perforate with fine pores and scattered wider and large pores, variously ornamented with blunt spines, which often coalesce to an irregular plate-like structure on or below the middle of the chamber at right angles to the longitudinal axis of the test; aperture small, rounded, at the base of the final chamber, in a wide triangular depression of the apertural face.

Length of holotype 0,26 mm, variation in the type sample 0,18 tot 0,32 mm.

Remarks. — There is but slight variation in the length-greatest width ratio of the test, which ranges from 3 : 2 tot 2 : 1. Wider variation is found in the ornamentation. Many specimens only have widely scattered knobs over the entire surface, whilst in others the above mentioned plate-like structures and well-developed blunt spines, especially in the early part of the test are predominant.

Because of recrystallization of the calcite, especially in the ornamentation it appeared too difficult to retrace the relations between the spines and the long, « tubular » pores. In some cases the pores were seen to pierce the spines, but others in between the ornamentation were thought to be present as well. As a consequence of this uncertainty we refer this species to the genus *Bulimina*, thus refraining from the establishing of a new genus, which would have some features in common with the genus *Tritubulogenerina* CUSHMAN, 1927.

Type locality. — « Brunnen Aushub am Südhang des « Gelben Berges » westlich des Einganges zur Sandgrube », in the surroundings of Kassel (Western Germany).

A sample from this locality, no. 11315, was put at our disposal by Dr. H. HILTERMANN, Amt für Bodenforschung, Hannover.

Type level. — Kasseler Meeressand. The age of this deposit is usually regarded to be Late Oligocene. The stage name Chattian is based on it.

Distribution.

The species is also present in our second sample from Kassel, 12667.
Two individuals were found in the sample from Astrup (17538).

Depository. — Holotype and paratypoids stored in the collections of the Geological Institute of Utrecht (S 4168-4172).

Bulimina dingdenensis nov. sp.
Pl. V, figs. 1-3

Etymology. — Named after the type locality Dingden in Westfalen (Germany).

Description. — Test small to medium sized, triserial, pyramidal, subtriangular in transverse section; chambers, especially the later ones, moderately inflated, rounded triangular, arranged in regular triserial series, the later ones in large specimens more or less remote and less regularly placed, which gives the test a twisted appearance; sutures curved, depressed; wall thick, finely perforate, mainly on the angular parts of the chambers ornamented with spinose projections of variable height with deep depressions in their centre; the projections mostly coalesced resulting in a reticulate pattern; aperture fairly large, semicircular to rounded triangular, at the base of the last-formed chamber, situated in a wide depression of the apertural face.

Length of holotype 0,25 mm, variation in the type sample from 0,23 mm to 0,45 mm.

Remarks. — *B. dingdenensis* differs from *B. kasselensis* in the more triangular shape of the test and in the pitted surface ornamentation.

There is some variation in the length-greatest width ratio of the test, which ranges from about 3 : 2 in short, stout individuals to 3 : 1 in elongate slender specimens.

In some of the smaller specimens there are well-developed blunt spines, on or just below the middle of the chambers. Just as in *B. kasselensis* these spines tend to coalesce to irregular plate-like structures at right angles to the longer axis of the test. However, most of the individual spines have a deep depression in their top with a thin surrounding rim. In most larger specimens these rims are present on the whole surface of the chambers. They are lower and they have coalesced to a distinct reticulation with depressions in between. Whether larger pores, as in *B. kasselensis* are really absent or whether they are obscured by later recrystallization could not be decided. It is considered likely that several of the fine pores are present in each pit, whilst the thickened rims are imperforate. The ornamentation is heaviest and the pits are largest on the angles of the chambers, whence they spread more or less over the remainder of the surface, especially along the base of the chambers.

Type locality. — The incision of a brook just near the « Künigsmühle », east of Dingden in Westfalen (Germany) : our sample Dingden 456.

Type level. — The Dingden beds, from the type locality of which sample 456 is taken. The age of these deposits is generally regarded to be Middle Miocene.

Distribution.

Dingden 456. A single specimen of the species was observed in a sample covering the sand of Voort-Horizon of Houthalen limit in mine-shaft Houthalen II, 80,50-81,52 m.

Depository. — The holotype and the paratypoids are stored in the collections of the Geological Institute of Utrecht (S 4173-4176).

Genus VIRGULINA D'ORBIGNY, 1826

Virgulina schreibersiana CZJZEK

Virgulina schreibersiana CZJZEK, 1847, Haid. Naturw. Abh., p. 147, pl. 13, figs. 18-21; CUSHMAN, 1937, Cushm. Lab. For. Res., spec. publ. 9, p. 13, pl. 2, figs. 11-20.

Remarks. — Three specimens, which may be referred to this species in wide sense, were met with in the Horizon of Houthalen and in the Miocene of Dingden.

Distribution.

Middle Miocene : Dingden 456.
Horizon of Houthalen : Houthalen I, 80,25-80,79 m.

Subgenus VIRGULINELLA CUSHMAN, 1932

Virgulina (Virgulinella) pertusa REUSS

Pl. V, fig. 7

Virgulina pertusa REUSS, 1861, Sitz.ber. K. Ak. Wiss. Wien, vol. 42, p. 362, pl. 2, fig. 16; HOSIUS, 1893, Verh. Naturh. Ver. Rheinl.-Westf., vol. 50, p. 119.

Virgulina (Virgulinella) pertusa REUSS, CUSHMAN, 1937, Cushm. Lab. For. Res., spec. publ. 9, p. 31, pl. 5, figs. 6-9; MARKS, 1952, Geol. Mijnb., new. ser., vol. 14, p. 287, pl. 1, figs. 15, 16.

Virgulinella pertusa (REUSS), TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 82, pl. 5, fig. 10.

Remarks. — This species was originally described from the Crag of Antwerp. REUSS considered these deposits to be of Pliocene age. From REUSS's description of the fauna that accompanies *V. pertusa* it is apparent that this species was derived from the Miocene part (Anversian) of the Antwerp Crag.

Evidently *V. pertusa* is restricted to Miocene deposits, not only in Europe but also in North Africa, Algeria (MARKS, 1952), Egypt (CUSHMAN, 1937).

We have typical specimens in our material from the sand of Antwerp and also in the sample from Dingden. The specimens from Burcht are more elongate than those from Dingden and Heist-op-den-Berg.

Distribution.

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

SUBFAMILY **REUSSELLINAE**

Genus REUSSELLA GALLOWAY, 1933

Reussella spinulosa (REUSS)

Pl. V, fig. 8

Verneuilina spinulosa REUSS, 1850, Denkschr. K. Ak. Wiss. Wien, vol. 1, p. 374, pl. 47, fig. 12; REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 159.

Verneuilina cognata REUSS, 1865, Sitz.ber. K. Ak. Wiss. Wien, vol. 50, p. 448, pl. 1, fig. 1.

Reussella cognata (REUSS), CUSHMAN, 1945, Cushm. Lab. For. Res. Contr., vol. 21, p. 31, pl. 6, fig. 1.

Reussella spinulosa (REUSS), CUSHMAN, 1945, id., p. 33, pl. 6, figs. 8, 9; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 61.

Remarks. — In 1865 REUSS described and figured a new species, *Reussella cognata*, from the Upper Oligocene of Kassel and two other localities. This species is considered to lack marginal spines. Such specimens do occur in our material; but most individuals are provided with distinct spines along the borders. Evidently *R. cognata* is a variant of *R. spinulosa* (REUSS), and moreover it is hardly different from typical representatives of *R. spinulosa* var. *laevigata* CUSHMAN (1945, op. cit., p. 34, pl. 6, fig. 10). These variants are evidently based on rather thick-shelled individuals, which are commonly devoid of spines. This is equally true among the assemblages of *R. spinulosa* from the Miocene of its type region, the Vienna basin, as could be seen in MARKS's material.

Distribution.

German Upper Oligocene : Kassel 11315.

SUBFAMILY **BOLIVININAE**

Genus BOLIVINA D'ORBIGNY, 1839

Bolivina dilatata REUSS

Pl. V, fig. 9

Bolivina dilatata REUSS, 1850, Denkschr. K. Ak. Wiss. Wien, vol. 1, p. 381, pl. 48, fig. 15; CUSHMAN, 1937, Cushm. Lab. For. Res., spec. publ. 9, p. 78, pl. 9, figs. 17-20; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 59.

Remarks. — Our individuals from the Dingden Miocene are elongate variants of this species. Shorter ones, such as occur in MARKS's material of the Vienna basin, are lacking.

Distribution.

Middle Miocene : Dingden 456.

Bolivina beyrichi Reuss

Pl. V, fig. 11

Bolivina beyrichi Reuss, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 83, pl. 6, fig. 5; Cushman, 1937, Cushm. Lab. For. Res., spec. publ. 9, p. 74, pl. 9, figs. 3-6; ten Dam and Reinhold, 1942, Med. Geol. St., ser. C-V, no. 2, p. 83, pl. 5, fig. 13.

Remarks. — Typical representatives of this species have been figured by Cushman (op. cit., pl. 9, fig. 3) from the German Septaria-clay. Such specimens were found in our material from Hermsdorf and Pietzpuhl and in several Boom clay samples, but morphological variation is fairly wide. At the German localities elongate variants occur frequently. They are relatively thicker and the peripheral spines are inconspicuous or occasionally wanting.

The species is rather frequent in our Boom clay material; in the samples it is a rare to common constituent of the fauna. A single fragmentary individual was found in the Nucula-clay. Some other, small, indistinct *Bolivina* specimens occur in the Oude-Biezen member and the Nucula-clay.

Distribution.

Boom clay : AA, HB, JB, JD-JJ, JM, MA, ME, OA, VA, Kuiperberg.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.
Nucula-clay : TK 526.

Bolivina beyrichi Reuss var. melettica Andreae

Pl. V, fig. 10

Bolivina melettica Andreae, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 257, pl. 11, fig. 5; Cushman, 1937, Cushm. Lab. For. Res., spec. publ. 9, p. 75, pl. 9, fig. 9.

Remarks. — This variant of *B. beyrichi* is important in our Belgian material. It is thicker and with less acute periphery than typical *B. beyrichi*. Moreover it is commonly shorter, while marginal spines are generally lacking. The sutures are strongly curved, often with a depressed area near the middle. The wall is mostly opaque and often with fine striae. These features fit in with those of *B. melettica* Andreae from the Middle Oligocene Meletta-beds of Alsace. *B. beyrichi* Reuss var. *bituminosa* Spandel (1909, Offenbacher Ver. Naturk., Ber., no. 43-50, p. 207, pl. 1, fig. 14) from similar beds in the Mainz basin may be a synonym, but Spandel's figure is too poor for a reliable decision.

B. beyrichi var. *melettica* is common to very abundant in a few glauconitic Boom clay samples, in which the species is rare or absennt. It was also found in non-glauconitic samples of the clay. In some samples complete intergradation between both types was observed.

Distribution.

Boom clay : JF 609, JJ 627, JL 631, JN 653, MA 376, ME 638, ME 639, OA 596.

Bolivina fastigia Cushman

Pl. V, fig. 12

Bolivina fastigia Cushman, 1936, Cushm. Lab. For. Res., spec. publ. 6, p. 51, pl. 7, fig. 17;Cushman, 1937, id., spec. publ. 9, p. 76, pl. 9, figs. 12-14;Marks, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 59; Bhatia, 1955, Journ. Pal., vol. 29, p. 681, pl. 66, fig. 15, textfig. 5.

Remarks. — *B. fastigia* was originally described from the German Upper Oligocene (Bünde). Bhatia found the species in great frequencies in the Middle Oligocene Corbula-beds of Wight. Typical representatives in our material from Kassel, Astrup and the Nucula -clay are few. The German specimens are accompanied by a small number of other *Bolivina* specimens, which may partly belong to *B. plicatella* CUSHMAN (1930, Florida St. Geol. Surv., Bull. 4, p. 46, pl. 8, fig. 10). Two indistinct specimens were furthermore found at Burcht in the Miocene sand of Antwerp.

Distribution.

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

Nucula-clay : TK 522.

Bolivina floridana CUSHMAN var. **imporcata** CUSHMAN and RENZ

Pl. V, fig. 13

Bolivina floridana CUSHMAN var. *regularis* (non *B. regularis* NUTTAL) CUSHMAN and RENZ, 1941, Cushm. Lab. For. Res. Contr., vol. 17, p. 17, pl. 3, fig. 7.

Bolivina floridana CUSHMAN var. *imporcata* CUSHMAN and RENZ, 1944, id., Contr., vol. 20, p. 78; DROOGER, 1953, Cushm. Found. For. Res. Contr., vol. 4, p. 130, pl. 21, figs. 7, 8.

Bolivina imporcata CUSHMAN and RENZ, RENZ, 1948, Geol. Soc. Am., Mem. 32, p. 118, pl. 7, fig. 3.

Remarks. — Our specimens are much smaller (up to 0,4 mm) than those from the Aruban Miocene (DROOGER, loc. cit.).

This variety is especially known from the American Miocene.

Distribution.

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

Genus LOXOSTOMUM EHRENBERG, 1854

Loxostomum sinuosum CUSHMAN

Pl. V, fig. 15

Loxostoma sinuosum CUSHMAN, 1936, Cushm. Lab. For. Res., spec. publ. 6, p. 60, pl. 8, fig. 16;CUSHMAN, 1937, id., spec. publ. 9, p. 183, pl. 21, figs. 13-15.

Remarks. — The species was originally described from the « Pliocene, Crag noir » near Antwerp. The confusion about the age of the Crags of Antwerp (Miocene, Pliocene and Pleistocene being present) renders CUSHMAN's age determination of the type specimens indefinite. Our specimens come from the Miocene of Dingden, equivalent of the Belgian sand of Antwerp.

Distribution.

Middle Miocene : Dingden 456.

Loxostomum digitale (D'ORBIGNY)
Pl. V, fig. 14

Polymorphina digitalis D'ORBIGNY, 1846, For. Foss. Vienne, p. 235, pl. 14, figs. 1-4.
Loxostoma digitalis (D'ORBIGNY), CUSHMAN, 1937, Cushm. Lab. For. Res., spec. publ. 9, p. 180, pl. 21, figs. 10-12; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 60.

Remarks. — Our specimens agree with those from the Vienna basin; most of them are less coarsely perforated than the majority of MARKS's specimens.

The species has been recorded from several European Miocene deposits.

Distribution.

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

Loxostomum teretum CUSHMAN
Pl. V, fig. 17

Loxostoma teretum CUSHMAN, 1936, Cushm. Lab. For. Res., spec. publ. 6, p. 60, pl. 8, fig. 14; CUSHMAN, 1937, id., spec. publ. 9, p. 179, pl. 21, figs. 1, 2.

Remarks. — Some distinct specimens of *L. teretum* were found in the Septaria-clay of Pietzpuhl. The species was originally described from the Middle Oligocene of Lobsann, Alsace.

Distribution.

Septaria-clay : Pietzpuhl 10447.

Loxostomum minutissimum (SPANDEL)
Pl. V, fig. 16

Bolivina minutissima SPANDEL, 1909, Offenbacher Ver. Naturk., Ber., no. 43-50, p. 209, pl. 1, fig. 11.

Remarks. — Four specimens, the largest of which reaches a length of 0,35 mm, were found in the sample from Pietzpuhl. They agree well with SPANDEL's original description of *Bolivina minutissima* from the Rupelton of the Mainz basin, both in dimensions and in number of chambers. They also show the arrangement of well developed pores at the base of the chambers that for the rest are very smooth. The test is slightly curved and it has a constant or even decreasing width in its later-formed portion, which is another point of resemblance with SPANDEL's type.

Because of the placing of *Bolivina minutissima* in the genus *Loxostomum*, CUSHMAN's *Loxostoma minutissimum* (1938, Cushm. Lab. For. Res. Contr., vol. 14, p. 45, pl. 7, fig. 19), becomes an objective homonym.

Distribution.

Septaria-clay : Pietzpuhl 10447.

Subfamily UVIGERININAE

Genus UVIGERINA d'Orbigny, 1826

Uvigerina tenuipustulata van Voorthuysen

Pl. V, fig. 20

Uvigerina tenuipustulata van Voorthuysen, 1950, Med. Geol. St., new. ser., no. 4, p. 60, pl. 2, fig. 13, textfig. 2.

Remarks. — The type of this species was derived from the Middle Miocene in a boring at Zaandam (Netherlands).

Distribution.

Middle Miocene : Heist 26 m.

Uvigerina rugulosa Reuss

Pl. V, fig. 19

Uvigerina rugulosa Reuss, 1863, Bull. Ac. Roy. Sci., etc., Belgique, ser. 2, vol. 15, p. 153, pl. 3, fig. 43.

Remarks. — *U. rugulosa* has originally been described from the Miocene sand of Antwerp. We found some specimens (length up to 0,37 mm) in samples of the same member from Burcht and Heist-op-den-Berg.

Three small, indistinct individuals were found at Dingden together with a single bigger specimen. This bigger specimen (0,60 mm) is identical with *Uvigerina acuminata* Hosius (1895, Jahresber. Naturw. Ver. Osnabrück, vol. 10, p. 167), which species was given another new specific name by ten Dam and Reinhold (1941, Geol. Mijnb., new. ser., vol. 3, p. 237, pl. 2, figs. 1-3) : *U. hosiusi*. The latter authors overlooked the fact, that Hosius (1895) himself had already renamed his earlier *U. aculeata* Hosius (1893) which was a homonym of *U. aculeata* d'Orbigny.

The relations of *U. rugulosa* and *U. acuminata* cannot be clarified because of our scarce material of both species.

Distribution.

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

Genus ANGULOGERINA Cushman, 1927

Angulogerina gracilis (Reuss)

Pl. VI, figs. 1-5

Uvigerina gracilis Reuss, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 77, pl. 5, fig. 39; Cushman and Edwards, 1938, Cushm. Lab. For. Res. Contr., vol. 14, p.74, pl. 13, figs. 3-6.

Remarks. — *Uvigerina gracilis* was originally described from the Septaria-clay of Hermsdorf and Freienwalde. Both from Reuss's description and figure and from the figured topotypoids (from Hermsdorf) published later (Cushman and Edwards, op. cit., pl. 13, figs. 3-6), it is apparent that *U. gracilis* is a more or less elongate species with a finely hispid wall, which is often smooth in the later chambers. In our material from Hermsdorf such specimens are common; a number of them are hispid throughout. Especially in the more elongate specimens, the later, more remote chambers have a rounded triangular shape, which is one of our reasons for placing this species in the genus *Angulogerina.*

A. gracilis is an extreme type in our extensive and widely variable *Angulogerina* material. Because of the frequently observed intergradation between the various types there is no clear opportunity to split our material in a number of separate species.

Typical *A. gracilis* (pl. VI, fig. 2) is common in our samples from Hermsdorf and at a few Boom clay localities, among which there are Loksbergen (HB), Boom (MA) and Niel (JB).

Entirely smooth variants (pl. VI, fig. 1) are abundant in the sample from Pietzpuhl (10447). No appropriate name could be found in the literature for this variety, that was also found in the Boom clay, where it is rare, and in samples from Kassel (12667) and Astrup (17538).

In one of our samples from Hermsdorf (13438), where typical *A. gracilis* is dominant, many specimens have very faint, often interrupted, longitudinal striae, especially on the earlier part of the test (pl. VI, fig. 3). This variant was also found in several Boom clay samples. It closely resembles *A. oligocaenica* (ANDREAE), originally described from Septaria-clay from Frankurt am Main.

The most frequent variant in our Boom clay material has elongate, continuous costae on variable parts of the test, mostly on the earlier half only, but occasionally on the entire surface (pl. VI, fig. 5). This variant is no doubt identical with *A. tenuistriata* (REUSS) originally described from the Septaria-clay of Pietzpuhl.

Another species from the German Middle Oligocene (Ratinger Ton near Düsseldorf), the type of which is from the Lower Oligocene of Calbe near Magdeburg, was found in our material, namely *A. germanica* CUSHMAN and EDWARDS (pl. VI, fig. 4). This variant is characterized by the discontinuous to serrate costae.

In our material these five types, which are based on the surface ornamentation, are linked by numerous intermediates. Generally there is an increase in angulogerine appearance in the series from *A. gracilis* via *A. oligocaenica* to *A. germanica* and *A. tenuistriata.* In many of our samples, several (or even all, such as in Pietzpuhl, 10447) of the variants occur together. There is no obvious stratigraphic succession of the types.

Angulogerina gracilis (REUSS) var. **oligocaenica** (ANDREAE)

Pl. VI, fig. 3

Uvigerina oligocaenica ANDREAE, 1894, Ber. Senckenb. Naturf. Ges., p. 50, textfig. 1.
Angulogerina oligocaenica (ANDREAE), CUSHMAN and EDWARDS, 1938, Cushm. Lab. For. Res. Contr., vol. 14, p. 86, pl. 15, figs. 8, 11 (not figs. 9, 10).

Remarks. — The variety is the least common one in our *A. gracilis* material. It is present in a few Boom clay samples and in the Septaria-clay of Hermsdorf (13438) and Pietzpuhl (10447). Two distinct specimens were met with in Nucula-clay samples, namely in TE 224 and TK 524.

In the samples from Astrup (17538) and Kassel (11315 and 12667) some specimens occur in which the greater part of the test is smooth. The earlier portion is provided with longitudinal costae that are somewhat coarser than in the *A. gracilis* var. *oligocaenica* specimens from the Boom clay.

Two of the individuals figured by Cushman and Edwards as *A. oligocaenica* (op. cit., pl. 15, figs. 9, 10) are distinct *A. gracilis* var. *tenuistriata*. The specimen in their figure 11, also on plate 15, is neither a very distinct *A. oligocaenica*. The costae on the earlier portion of this specimen are coarser than in typical *A. gracilis* var. *oligocaenica*.

Angulogerina gracilis (Reuss) var. **germanica** Cushman and Edwards

Pl. VI, fig. 4

Angulogerina germanica Cushman and Edwards, 1938, Cushm. Lab. For. Res. Contr., vol. 14, p. 85, pl. 15, figs. 14-16.

Remarks. — In the Boom clay *A. gracilis* var. *germanica* is less common than *A. gracilis* var. *tenuistriata*, but more frequent than typical *A. gracilis*. The variety was also found in sample Kassel 12667 and in the Septaria-clay from Pietzpuhl (10447).

Angulogerina gracilis (Reuss) var. **tenuistriata** (Reuss)

Pl. VI, fig. 5

Uvigerina tenuistriata Reuss, 1870, Sitz.ber. K. Ak. Wiss. Wien, vol. 62, p. 485, von Schlicht, 1870, For. Sept.thon Pietzpuhl, pl. 22, figs. 34-37.

Angulogerina tenuistriata (Reuss), Cushman and Edwards, 1938, Cushm. Lab. Res. Contr., vol. 14, p. 84, pl. 15, figs. 1-7; Bhatia, 1955, Journ. Pal., vol. 29, p. 682, pl. 66, fig. 18.

Angulogerina oligocaenica Cushman and Edwards (not Andreae), 1938, Cushm. Lab. For. Res. Contr., vol. 14, p. 86, pl. 15, figs. 9, 10 (not figs. 8, 11).

Remarks. — This is the most common variety of *A. gracilis* in our Boom clay and Upper Oligocene material. It was found in two of our samples from the German Septaria-clay, namely in Pietzpuhl 10447 and in Hermsdorf 10445. One distinct individual was found in the Nucula-clay (BZ 488).

Two striated *Angulogerina* specimens from the Lower Tongeren beds of the mine-shaft Hendrik IV and Hoeselt (TL 529) resemble *A. gracilis* var. *tenuistriata*. By the lack of sufficient material, their determination is tentative.

Genus TRIFARINA Cushman, 1923

Trifarina bradyi Cushman

Pl. V, fig. 18

Rhabdogonium tricarinatum Brady (not *Vaginulina tricarinata* d'Orbigny), 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 525, pl. 67, figs. 1-3.

Trifarina bradyi Cushman, 1923, U.S. Nat. Mus., Bull. 104, pt. 4, p. 99, pl. 22, figs. 3-9.

Remarks. — A number of distinct specimens of this species was found in the Miocene Antwerp sand of Burcht and Heist-op-den-Berg. Some damaged *Trifarina* individuals from Astrup may belong to the same species.

Distribution.

Middle Miocene : Burcht, Heist 26 m.

SUBFAMILY ROBERTININAE

Genus ROBERTINA D'ORBIGNY, 1846

Robertina declivis (REUSS)
Pl. VI, fig. 6

Bulimina declivis REUSS, 1863, Sitz.ber. K. Ak. Wiss. Wien, vol. 48, p. 55, pl. 6, fig. 70, pl. 7, fig. 71.
Robertina declivis (REUSS), CUSHMAN and PARKER, 1946, U.S. Geol. Surv., prof. paper 210-D, p. 73, pl. 18, fig. 7.

Remarks. — Two distinct specimens were found in our material of the Boom clay. The species was originally described from the Middle Oligocene Septaria-clay of Offenbach near Frankfurt am Main (Germany).

Distribution.

Boom clay : JH 615, MA 649.

FAMILY CASSIDULINIDAE

Genus CASSIDULINA D'ORBIGNY, 1826

Cassidulina carapitana HEDBERG
Pl. VI, fig. 7

Cassidulina carapitana HEDBERG, 1937, Journ. Pal., vol. 11, p. 680, pl. 92, fig. 6; RENZ, 1948, Geol. Soc. Am., Mem. 32, p. 124, pl. 9, fig. 8; DROOGER, 1953, Cushm. Found. For. Res. Contr., vol. 4, p. 140, pl. 24, fig. 12.

Remarks. — This species is common to rare in numerous Boom clay samples.

No species described from Europe could be found for these lenticulinar *Cassidulina* individuals, characterized by the strong curvature of the sutures in the umbonal area.

Comparison with American specimens of *C. carapitana* (Miocene of Aruba, DROOGER, loc. cit.) showed very close resemblance.

Distribution.

Boom clay : JA-JC, JG-JJ, JM, MA, OA, Kuiperberg.

Cassidulina subglobosa BRADY var.
Pl. VI, fig. 10

Cassidulina oblonga ANDREAE (not REUSS), 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 156, pl. 10, fig. 32.

Remarks. — A small number of specimens resembles *C. subglobosa* BRADY (1884, Rep. Voy. « Challenger », Zool., vol. 9, p. 430, pl. 54, fig. 17) in the number of chambers and in the shape of the aperture. They are different by the moderate compression of the test.

The specimens from Astrup are bigger than those from the Boom and Septaria-clays.

C. oblonga REUSS as figured by ANDREAE (1884) from Oligocene marl of Oberstritten (Alsace) is identical with our Septaria- and Boom clay specimens.

Distribution.

German Upper Oligocene : Astrup 17538.
Boom clay : AE, HB, JE, JF, JJ, JL, JN, Winterswijk.
Septaria-clay : Pietzpuhl 10447.

FAMILY ELLIPSOIDINIDAE

Genus PLEUROSTOMELLA REUSS, 1850

Pleurostomella alternans SCHWAGER

Pleurostomella alternans SCHWAGER, 1866, Novara Exp., Geol., vol. 2, p. 238, pl. 6, figs. 79, 80.

Remarks. — A single distinct macrospheric individual was found in our sample from Pietzpuhl.

Distribution.

Septaria-clay : Pietzpuhl 10447.

FAMILY CHILOSTOMELLIDAE

Genus ALLOMORPHINA REUSS, 1850

Allomorphina sp.

Remarks. — A small number of pyritized *Allomorphina*-moulds was found in two Boom clay samples. Specific determination appeared impossible.

Distribution.

Boom clay : JF 609, ME 640.

Genus CHILOSTOMELLA REUSS, 1850

Chilostomella cylindroides REUSS

Pl. VI, fig. 13

Chilostomella cylindroides REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 80, pl. 6, fig. 43; CUSHMAN, 1926, Cushm. Lab. For. Res. Contr., vol. 1, p. 76, pl. 11, figs. 14, 15.

Remarks. — The species is scarce in several samples of the Boom clay.

For the greater part our individuals are heavily damaged; they are often pyritized, recrystallized or broken. The most ovoidal specimens are more elongate than that of *C. ovoidea* in REUSS's type figure of that species (REUSS, 1850, Denkschr. K. Ak. Wiss. Wien, vol. 1, p. 380, pl. 48, fig. 12).

Distribution.

Boom clay : AE, JA-JC, JG-JK, Winterswijk.
Septaria-clay : Hermsdorf 10445, Pietzpuhl 10447.

Genus PULLENIA PARKER and JONES, 1862

Pullenia bulloides (D'ORBIGNY)

Pl. VI, fig. 9

Nonionina bulloides D'ORBIGNY, 1846, For. Foss. Vienne, p. 107, pl. 5, figs. 9, 10; BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 339, pl. 16, figs. 1-3.

Pullenia bulloides (D'ORBIGNY), ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 206, pl. 9, fig. 23; CUSHMAN and TODD, 1943, Cushm. Lab. For. Res. Contr., vol. 19, p. 13, pl. 2, figs. 15-18; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 69.

Remarks. — The species is rare to very abundant in the Boom clay samples, and less frequent to absent in our samples of the other deposits.

Our specimens show considerable variation. The test is subglobular to slightly compressed with evenly rounded periphery. The periphery is often slightly lobulated, corresponding to the slightly inflated later chambers. There are four to five chambers in the last whorl. The aperture varies between a limited basal opening in the median plane and a large slit extending to the umbilicus of either side.

Compressed five-chambered specimens are distinguishable from *P. quinqueloba* by the more rounded periphery, even when both types occur together. The Upper Oligocene specimens mostly have five chambers in the final coil; in part of them the chambers are slightly inflated.

Distribution.

Middle Miocene : Heist 26 m, Dingden 456.

German Upper Oligocene : Astrup 17538, Kassel 12667.

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

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

Lower Tongeren beds : Hendrik IV, 199-200 m, 203-204 m.

Pullenia quinqueloba (REUSS)

Pl. VI, fig. 8

Nonionina quinqueloba REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 71, pl. 5, fig. 31.

Pullenia quinqueloba (REUSS), CUSHMAN and TODD, 1943, Cushm. Lab. For. Res. Contr., vol. 19, p. 10, pl. 2, fig. 5, pl. 3, fig. 8; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 94, pl. 7, fig. 7.

Pullenia compressiuscula REUSS, 1866, Denkschr. K. Ak. Wiss. Wien, vol. 25, p. 150; ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 206, pl. 9, fig. 22.

Remarks. — The species is rare in several samples, mainly from the Boom clay. It was originally described from the Septaria-clay of Hermsdorf.

P. quinqueloba as figured by BRADY (1884, Rep. Voy. « Challenger », Zool., vol. 9, p. 617, pl. 84, figs. 14, 15), which is probably identical with *P. subcarinata* (D'ORBIGNY) (*Nonionina subcarinata* D'ORBIGNY, 1839, For. Amér. Mér., vol. 5, pt. 5, p. 28, pl. 5, figs. 23,24), differs from our specimens in the less rounded periphery. Only at Burcht a number of specimens were found that are referable to *P. subcarinata*.

Distribution.

Middle Miocene : Burcht, Heist 26 m, Dingden 456.
Boom clay : AA, HB, JB, JE, JJ, JM, JN, MA, VA, Kuiperberg.
Septaria-clay : Hermsdorf 10445, Pietzpuhl 10447.
Nucula-clay : BZ 504, TK 523, 524.

Genus SPHAEROIDINA D'ORBIGNY, 1826

Sphaeroidina bulloides D'ORBIGNY

Pl. VI, fig. 11

Sphaeroidina bulloides D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 267, Modèle 65; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 95, pl. 7, fig. 6; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 70.

Sphaeroidina variabilis REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 88, pl. 7, figs. 61-64; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 95, pl. 7, fig. 5.

Remarks. — This species is rare to very abundant in many Boom clay samples.

Distribution.

Middle Miocene : Burcht, Dingden 456.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Boom clay : AA, AE, HB, JA-JM, MA, ME, OA, VA, Kuiperberg, Winterswijk.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.

FAMILY NONIONIDAE

Genus NONION MONTFORT, 1808

Nonion affine (REUSS)

Pl. VI, fig. 12

Nonionina affinis REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 72, pl. 5, fig. 32.

Nonion affine (REUSS), CUSHMAN, 1939, U.S. Geol. Surv., prof. paper 191, p. 9, pl. 2, fig. 13; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 75, pl. 4, fig. 15.

Nonion umbilicatulum (WALKER and JACOB), BHATIA, 1955, Journ. Pal., vol. 29, p. 678, pl. 66, fig. 2.

Remarks. — *Nonion affine,* originally described from Hermsdorf and Freienwalde, is rare to very abundant in many Boom clay samples. It occurs also in most of the other Oligo-Miocene stratigraphic units.

The Boom and Septaria-clay specimens are characteristic *Nonion affine.* Some of them show slightly inflated chambers and a lobulated periphery. They are intermediate towards the Nucula-clay specimens. These Nucula-clay specimens, which are larger, have inflated chambers; their periphery is lobulated and more broadly rounded than it is characteristic specimens.

BHATIA placed *N. affine* in the synonymy of *N. umbilicatulum* (WALKER and JACOB), but we share CUSHMAN's opinion (1939, op. cit., p. 21) that this specific name had better not be used as long as the features of its type have not been clarified.

Distribution.

Middle Miocene : Heist 26 m, Dingden 456.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Boom clay : AA, AE, HB, JA-JM, MA, ME, OA, VA, Kuiperberg, Winterswijk.
Septaria-clay : Hermsdorf 10445, 13438, Pietzpuhl 10447.
Nucula-clay : TE, TK, BZ (see table 2).
Berg sand : BZ 505, 508.
Lower Tongeren beds : Hendrik IV, 191-192 m, 201-202 m, 203-204 m, 209-210 m.

Nonion perfossum (CLODIUS)
Pl. VI, fig. 16

Nonionina perfossa CLODIUS, 1922, Ver. Freunde Naturg. Mecklenburg, Archiv, p. 144, pl. 1, fig. 19.
Nonion? perfossum (CLODIUS), CUSHMAN, 1939, U.S. Geol. Surv., prof. paper 191, p. 18, pl. 5, fig. 8.

Remarks. — In general outline the specimens of this remarkable species resemble those of *Nonion affine*. Specimens which show the partly depressed sutures most clearly, commonly have a very thick and vitreous wall. The species was originally described from the Upper Miocene of Mecklenburg. It occurs in some of our samples from Miocene deposits.

Distribution.

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

Nonion pompilioides (FICHTEL and MOLL)
Pl. VI, fig. 14

Nautilus pompilioides FICHTEL and MOLL, 1798, Test. Micr., p. 31, pl. 2, figs. *a-c*.
Nonionina soldanii D'ORBIGNY, 1846, For. Foss. Vienne, p. 109, pl. 5, figs. 15, 16.
Nonion soldanii (D'ORBIGNY), TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 76, pl. 5, fig. 1.
Nonion pompilioides (FICHTEL and MOLL), MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 49.

Remarks. — A number of distinct specimens were found in some samples from the Miocene.

Distribution.

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

Nonion buxovillanum (ANDREAE)
Pl. VI, fig. 15

Nonionina buxovillana ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 254, pl. 11, fig. 3.

Remarks. — The species is rare in a number of Boom clay samples. Our specimens agree well with description and figures of ANDREAE's small species from the Meletta-beds of Buchsweiler. In general they are somewhat thicker; a fairly thick specimen has been figured.

Distribution.

Boom clay : AA, JE-JJ, ME, OA, Kuiperberg.

Nonion granosum (D'ORBIGNY)
Pl. VII, figs. 1-3

Nonionina granosa D'ORBIGNY, 1846, For. Foss. Vienne, p. 110, pl. 5, figs. 19, 20.
Nonion granosum (D'ORBIGNY), CUSHMAN, 1939, U.S. Geol. Surv., prof. paper 191, p. 11, pl. 2, figs. 17, 18; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 48.

Remarks. — In our material the number of chambers in the final coil varies from eight to eleven; the sutures are curved to nearly straight, somewhat limbate and slightly depressed to excavated toward the umbilicus; the periphery is broadly to more narrowly rounded; the umbilicus is filled with granular material, which often surrounds one or more small knobs.

Many small specimens of this species, which is hardly separable from various other forms in the literature, occur in the samples from the Tongeren-Kleine-Spouwen region. They agree with MARKS's specimens from the Vienna basin, but are considerably smaller. The species was also found in the higher stratigraphic units, especially in the samples from the German Upper Oligocene.

Distribution.

Middle Miocene : Burcht, Heist 26 m.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.
Septaria-clay : Pietzpuhl 10447.
Nucula-clay : TE, TK, BZ (see table 2).
Berg sand : BZ 507.
Oude-Biezen member : TA 579, BZ 540, 541.
Henis clay : TG 228, BZ 551.
Lower Tongeren beds : Hendrik IV, 194-195 m, 205-206 m.

Nonion roemeri CUSHMAN
Pl. VII, fig. 5

Nonion roemeri CUSHMAN, 1936, Cushm. Lab. For. Res. Contr., vol. 12, p. 65, pl. 12, fig. 3; CUSHMAN, 1939, U.S. Geol. Surv., prof. paper 191, p. 10, pl. 3, fig. 1; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 76, pl. 5, fig. 2.
Nonion granulosum TEN DAM and REINHOLD, 1941, Geol. Mijnb., new. ser., vol. 3, p. 211, fig. 1; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 77, pl. 5, fig. 3, pl. 10, fig. 5.

Remarks. — *Nonion roemeri* was originally described from the Upper Oligocene of Kassel. In our material the species was found only in samples from the sand of Voort and the German Upper Oligocene, in which it is a rare component of the fauna.

Re-study of the specimens in the type slide of *N. granulosum* TEN DAM and REINHOLD (in Haarlem) showed that the rather flat type of this species (which is within the range of variation of our *N. granosum*) is accompanied by thicker specimens tending toward the type of *N. roemeri*.

Our specimens of *N. roemeri* differ from those of *N. granosum* in their greater size and greater relative thickness. The absence of a gradational series may be due to the scarceness of both species in our Upper Oligocene material.

Distribution.

Voort sand : Lambroek 27, Lillo 84, 88-91, 98, 99, 105, 107.
German Upper Oligocene : Astrup 17538, Kassel 11315, 12667.

Nonion boueanum (D'ORBIGNY)

Pl. VII, figs. 6, 7

Nonionina boueana D'ORBIGNY, 1846, For. Foss. Vienne, p. 108, pl. 5, figs. 11, 12.
Nonion boueanum (D'ORBIGNY), CUSHMAN, 1939, U.S. Geol. Surv., prof. paper 191, p. 12, pl. 3, figs. 7, 8; TEN DAM and REINHOLD, 1942, Med. Geol. St., ser. C-V, no. 2, p. 77, pl. 5, fig. 4; MARKS, 1951, Cushm. Found. For. Res. Contr., vol. 2, p. 48, pl. 5, fig. 17.

Remarks. — There are no clear-cut boundaries between the various described species of this ordinary *Nonion*-type, which is fairly well represented in our material. *Nonion boueanum* (D'ORBIGNY) as re-described by MARKS, has nine to fourteen chambers in the final coil. The sutures are more or less limbate, varying from slightly raised to slightly depressed. The umbilicus contains more or less granular material. The periphery is narrowly rounded.

The number of chambers per convolution somewhat increases with size but there is for every size group again considerable variation.

As has already been remarked by MARKS, *N. boueanum* is hardly separable from several other described species. Our Oligocene specimens in general agree fairly well with the above described average type of *N. boueanum*. The most common type among our Miocene individuals (sand of Antwerp, Dingden) has a more rounded periphery, more depressed, less limbate sutures and a few chambers less in the final coil (pl. VII, fig. 6). This type has been named *N. dingdeni* by CUSHMAN (1936, Cushm. Lab. For. Res. Contr., vol. 12, p. 65, pl. 12, fig. 5).

It must be pointed out that there is complete intergradation between these « types » of *N. boueanum* and *N. dingdeni*. In the assemblages there are only differences in dominance. In our Miocene material the *N. boueanum* type was also encountered, while among MARKS's material of *N. boueanum* from its type region and in ours from the Upper Oligocene also the *N. dingdeni* type is represented.

Distribution.

Middle Miocene : Antwerp, Burcht, Heist 26 m, Dingden 456.
Horizon of Houthalen : Houthalen I, 80,25-80,79 m.
Voort sand : Lillo 81, 83, 84, 98, 99, 113.
German Upper Oligocene : Kassel 11315, 12667.
Lower Tongeren beds : Hendrik IV, 191-192 m, 193-194 m.

Genus NONIONELLA CUSHMAN, 1926

Nonionella limba (D'ORBIGNY)

Pl. VII, figs. 8, 9

Nonionina limba D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 294, Modèle no. 11.
Nonion limbum (D'ORBIGNY), CUSHMAN, 1939, U.S. Geol. Surv., prof. paper 191, p. 19, pl. 5, fig. 6.

Remarks. — A number of small specimens from the Miocene Antwerp sand of Burcht are referred to this species. Only the photograph of D'ORBIGNY's modèle is available as a reference. Consequently our determination may be regarded as tentative.

The individuals are more or less asymmetrical, involute, rather flattened, with about nine chambers in the last coil. The periphery is narrowly rounded, occasionally with a very slight keel that is always absent in the later chambers. The most peculiar are very broad and raised sutures that curve strongly backwards. The umbilicus of the more evolute side is often wide and open (pl. VII, fig. 9), but in other specimens (pl. VII, fig. 8) both umbilici are identical and flush, covered with granules. The wall is finely perforate. The aperture is indistinct, somewhere at the base of the last-formed chamber.

Distribution.

Middle Miocene : Burcht.

Nonionella lobsannensis (ANDREAE)
Pl. VII, fig. 4

Pulvinulina lobsannensis ANDREAE, 1884, Abh. Geol. Speckrt. Els.-Loth., vol. 2, pt. 3, p. 218, pl. 8, fig. 16.

Remarks. — A small number of distinct specimens of this minute species were found in samples from Pietzpuhl and Bilzen-Katteberg. The species was originally described from the Septaria-clay of Lobsann (Alsace).

Distribution.

Septaria-clay : Pietzpuhl 10447.
Nucula-clay : TK 524.

SUPERFAMILY ROTALIIDEA

FAMILY DISCORBIDAE

SUBFAMILY PATELLININAE

Genus PATELLINA WILLIAMSON, 1858

Patellina corrugata WILLIAMSON

Patellina corrugata WILLIAMSON, 1858, Rec. For. Gr. Brit., p. 46, pl. 3, figs. 86-89; CUSHMAN, 1930, Cushm. Lab. For. Res. Contr., vol. 6, p. 15, pl. 3, fig. 5.

Remarks. — One specimen.

Distribution.

German Upper Oligocene : Kassel 12667.

SUBFAMILY DISCORBINAE

Genus DISCORBIS LAMARCK, 1804

Discorbis globularis (D'ORBIGNY)

Pl. VIII, fig. 2

Rosalina globularis D'ORBIGNY, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 271, pl. 13, figs. 1-4.
Discorbina globularis (D'ORBIGNY), BRADY, 1884, Rep. Voy. « Challenger », Zool., vol. 9, p. 643, pl. 86, figs. 8, 13.
Discorbis globularis (D'ORBIGNY), CUSHMAN, 1915, U.S. Nat. Mus., Bull. 71, pt. 5, p. 11, pl. 9, fig. 4.

Remarks. — Part of our specimens have irregularly distributed, rounded to elongate elevations in the central part of the ventral surface, which is surrounded by a smooth peripheral area. They closely resemble *D. choctawensis* CUSHMAN and MCGLAMERY (1938, U.S. Geol. Surv., prof. paper 189-D, p. 109, pl. 26, figs. 15, 16) from the Oligocene Byram marl of Alabama, which species was recently also recorded by GULLENTOPS (1956, Mém. Inst. Géol. Univ. Louvain, vol. 20, p. 17, pl. 1, fig. 14) from the Oude-Biezen member of Borgloon. *D. choctawensis* probably is only a variety of *D. globularis* since intermediate types occur.

D. globularis var. *bradyi* CUSHMAN (1915, op. cit., pt. 5, p. 12, pl. 8, fig. 1) is also present in our material.

Distribution.

Middle Miocene : Heist 26 m.
German Upper Oligocene : Astrup 17538, Kassel 12667.
Septaria-clay : Pietzpuhl 10447.
Nucula-clay : TK 522-524, BZ 486, 487, 490-493.
Oude-Biezen member : BZ 521, 540, 541, 544.

Discorbis sp.

Remarks. — A few minute *Discorbis* specimens from the Tongeren region resemble *Valvulineria araucana* (D'ORBIGNY), as figured by BHATIA from Wight (1955, Journ. Pal., vol. 29, p. 683, pl. 67, fig. 1).

Distribution.

Nucula-clay : TK 524, BZ 493.
Oude-Biezen member : BZ 540.
Henis clay : TB 216.