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BENTHONIC FORAMINIFERA FROM THE TYPE-LOCALITY OF THE SANDS OF GRIMMERTINGEN (Lower Oligocene of Belgium)

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1. INTRODUCTION

The Sands of Grimmertingen were described for the first time by DUMONT in 1839, when he created his "Système Tongrien". Later on, in 1854, BEYRICH correlated this "Système" with the Sands of Magdeburg, and placed both deposits at the base of the Oligocene, term which was erected by this author. Since that time the stratigraphical position of the Sands of Grimmertingen has been under discussion in Belgium as well as internationally. The boundary between the Eocene and the Oligocene in Belgium is traditionally placed at the base of the Sands of Grimmertingen, although BATJES (1958) and KAASSCHIETER (1961) correlated the Sands of Grimmertingen respectively with the Sands of Asse and the Clay of Asse, which are considered to belong to the Upper Eocene. In their opinion the Horizon of Hoogbutsel would be the boundary between the Oligocene and the Eocene.

Traditionally the Sands of Grimmertingen are correlated with the Latdorfian stage and both units are considered as being the lower part of the Oligocene. Recently CAVELIER (1968) has placed the Sands of Grimmertingen and the Latdorf stage in the Upper Eocene, and the Sannoisian stage at the base of the Oligocene. A more detailed study of this problem can be found in MARTINI & MOORKENS (1969).

2. THE TYPE-LOCALITY OF THE SANDS OF GRIMMERTINGEN

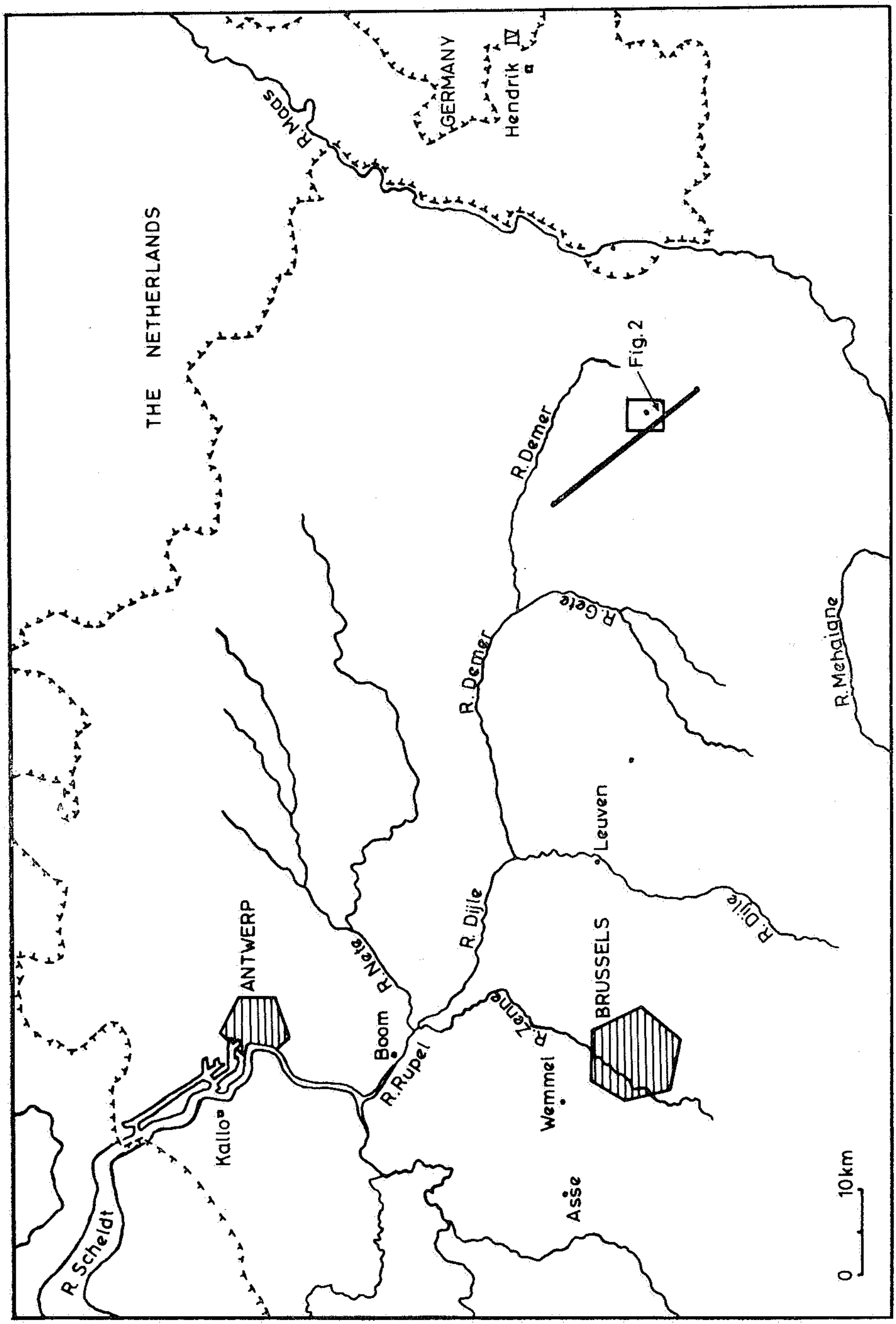
According to DE HEINZELIN & GLIBERT (1957/ the hollow road outcrop at Grimmertingen is to be considered as the type-locality of the Sands of Grimmertingen. This member is indicated by the symbol Tg1c on the Geological Map of Belgium.

Grimmertingen lies about 6 km NW of Tongeren in the Eastern part of Belgium (textfig. 1). The localisation of the hollow road outcrop is indicated at textfig. 2. Recently a small quarry, which is now abandoned, was opened next to the crossing of the hollow road. It belongs to Mr. A. POESMANS, GUIGHOVEN, who benevolently gave us the permission to study the section of this outcrop, and to carry out a boring in the quarry.

3. LITHOLOGIC DESCRIPTION OF THE OUTCROP SECTION AND THE BORING (textfig. 3)

A description of the profile was already given by GLIBERT & DE HEINZELIN (1954, point 101 and profile, fig. 10, p. 305) and by GULINCK (1968). The outcrop section was described and sampled every 50 cm on September 10th, 1968. Under approximately 1 m of Quaternary loam, we observe 3 m of graygreen coarse sand, showing the facies of the Sands of Neerrepen. The upper part of the Sands of Neerrepen shows tubular structures ("fleurettes bifides et trifides", GLIBERT & DE HEINZELIN, 1954) of unknown origin, cross bedding, mud balls and fine claylayers.

Between + 3 m and + 2,80 m, a hard red sandlayer shows an accumulation of rolled mollusc shells, mostly belonging to *Ostrea ventilabrum* and fishteeth, which are possibly reworked from Eocene deposits. The thickness



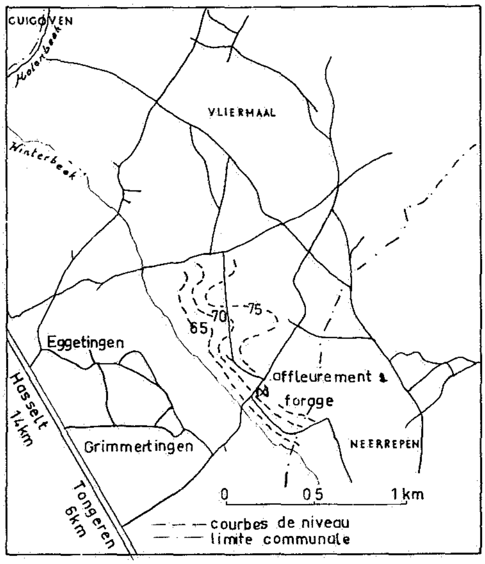
Textfig. 1: Situation map.

of this "hardground" (GLIBERT & DE HEINZELIN, 1954) varies between 0 m and 1 m. The facies of the underlying Sands of Grimmertingen is a fine glauconiferous and micaceous green-brown sand containing many mollusc shells (*Ostrea ventilabrum*), sometimes in layers.

Our reference level (0 m) is the bottom of the road next to the quarry and lies at + 66 m above Ostend sealevel. The measurements of

TABLE 1: *Distribution and composition of the foraminiferal rauna of the Sands of Grimmertingen.*

species \ level	Gm											Gmb																
	11	10	9	8	7	6	5	4	3	2	1	0,10	0,20	4	5	6	7	8	9	10	1	13	1	1	18	1	1	27
Ammodiscus glabratus											r																	
Ammodiscus incertus								r		r	r	r	r									r						r
Glomospira charoides	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
? *Aschemonella* sp.											r																	
Spiroplectammina carinata											r																	
Trochammina sp.											r																	
? *Eggerella* sp.				r			r				r																	
Quinqueloculina sp. cf. *Q. seminula*											r	r																
Nodosaria latejugata											r																	
Dentalina sp. cf. *D. ewaldi*														r														
Dentalina ludwigi											r			r														
Dentalina pauperata											r	r																
Dentalina semilaevis											r																	
Dentalina sp. cf. *D. soluta*											r																	
Lagena hispida												r																
Lagena isabella											r																	
Lagena semiornata											r																	
Lagena striata											r																	
Lagena sulcata											r	r		r														
Lenticulina sp.	f										a	a	r	r	r													
Marginulina sp. cf. *M. hosiusi*												r																
Globulina gibba											f	f	r	r	r													
Globulina sp. cf. *G. laeviglobosa*														r														
Guttulina irregularis											f	f		r														
Guttulina lactea											r																	
Guttulina problema											f	r																
Glandulina sp. cf. *G. aequalis*												r		r														
Glandulina laevigata											f	r		r														
Bolivina fastigia											r		r															
Angulogerina gracilis germanica											f	f																
Angulogerina gracilis tenuistriata											a	a	f	r														
Cancris subconicus											a	a	r	r														
Asterigerina bartoniana	r		r								r	r	r															
Asterigerina brandhorstiana											r																	
Cribrononion moorkensi											r			r														
Cribrononion subnodosum											a	f		r														
Nummulites orbignyi																		r										
Bifarina selseyensis											a	f		r														
Eponides pygmaeus												r																
Cibicides dutemplei											a	a	a	a			r	r										
Cibicides lobatulus											f																	
Cibicides lobatulus grimmertingensis											f	f		r														
Cibicides sulzensis											r	r																
Cibicides tenellus								r			a	f	r	f				r										
Loxostomum teretum												r																
Nonion affine				?							a	a	r	f														
Nonion sp. cf. *N. boueanum dingdenensis*	r																											
Nonion graniferum											f	?																
Gyroidina sp. cf. *G. octocamerata*											r																	
Guttulina sp.											r																	
Bolivina sp.																									r			
Dorothia gradata											r																	
Bulimina trigonalis	r										r																	
Heterohelix sp.		r			r	r					r			r	r													
Hedbergella ssp.		r	r		r	r		r	r		r		r															
Praeglobotruncana ssp.											r	r																
Globotruncana ssp.		r			r								r															



Textfig. 2: Type-locality of the Sands of Grimmertingen.

the boring, carried out on October 2th, 1968, are referred to a zerolevel which lies approximately 30 cm higher than our reference level.

The same facies that occurs at the base of the outcrop section, persists in the boring as deep as — 9 m where abruptly the colour of the sediment changes to blue-gray (probably by reduction of iron). Shell fragments have been observed throughout the section of the Sands of Grimmertingen in the outcrop and in the boring.

The level of the groundwater was at the time of the boring at — 3 m. The base of the Sands of Grimmertingen was not reached in this boring.

4. DISCUSSION OF THE RESULTS

4.1. Distribution and composition of the fauna (table 1).

About thirty levels were searched but only four of them have yielded a fairly rich foraminiferal fauna (cf. table 1). The level Gm 1 is the richest of all, in number of species as well as in number of specimens. The levels above and under the interval between Gm 1 and Gmb 4, yielded a poor fauna, mainly containing arenaceous, reworked or poorly preserved benthonic foraminifera. To obtain, even in the Gm 1 level, a rich association, the CCl_4 concentration method was used on large quantities of the samples (500 g till 1 kg per sample).

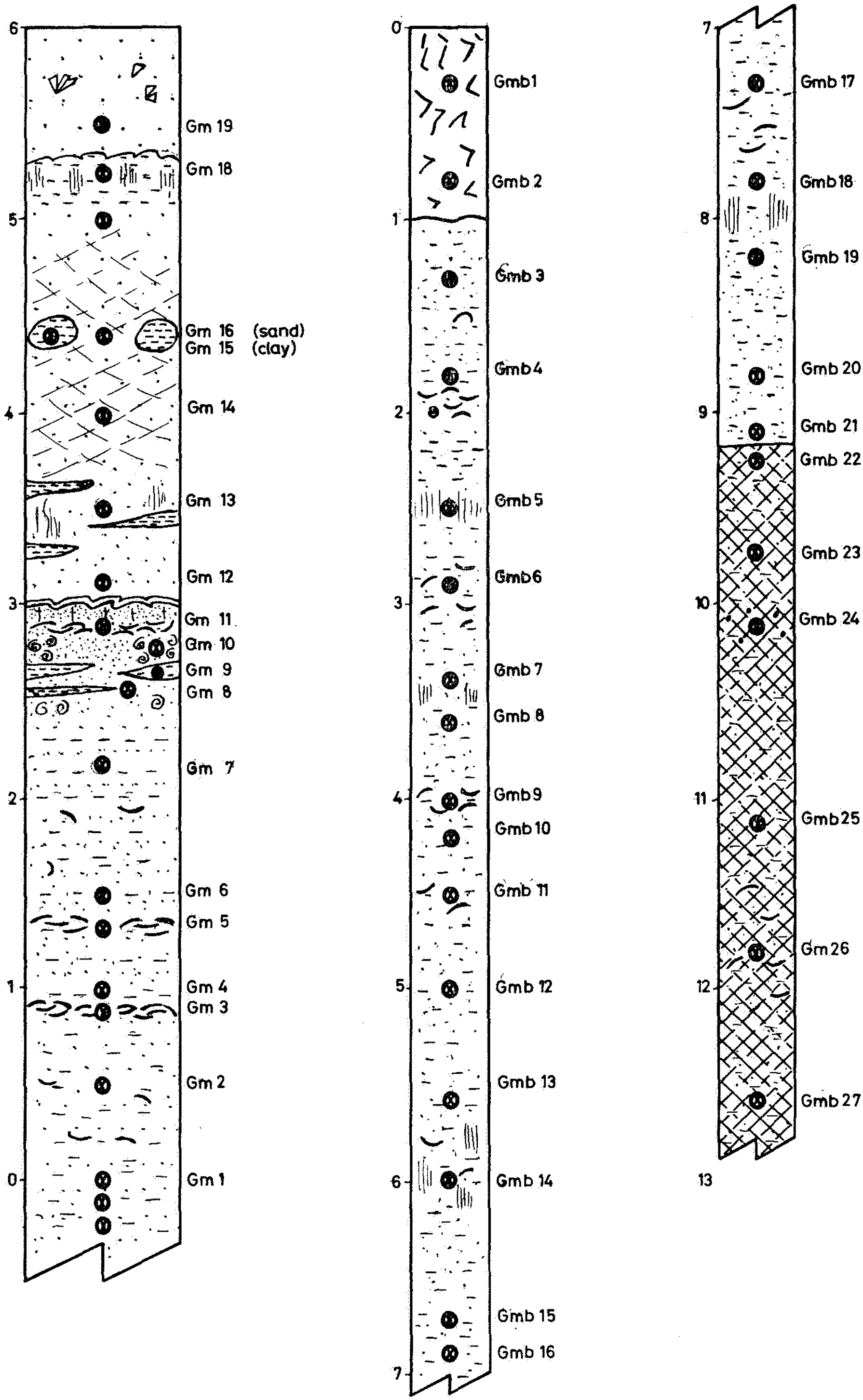
Most frequent species are *Cibicides dutemplei, Cibicides tenellus, Nonion affine, Cribrononion subnodosum, Angulogerina gracilis* var. *tenuistriata, Cancris subconicus, Lenticulina* sp. and *Bifarina selseyensis.* Moreover *Cibicides tenellus* and *Cibisides dutemplei* are the most abundant.

Less frequent are *Globulina gibba, Guttulina irregularis, Angulogerina gracilis* var. *germanica, Cibicides lobatulus, Cibicides lobatulus* var. *grimmertingensis* n. subsp. and *Nonion graniferum.* All other species are very scarce. In the distribution table, "r" means less than 5 specimens, "f" means more than 5 but less than 20 specimens and "a" means more than 20 specimens.

4.2. The foraminiferal fauna of the Sands of Grimmertingen in comparison with those of Oligocene and Eocene strata of Belgium and adjacent areas (table 2).

The Sands of Grimmertingen yielded 46 different benthonic foraminiferal species. As far as this faunal assemblage is considered there exists a very good resemblance with the Lower-Tongeren Beds of the Hendrik IV mineshaft in Brunssum (The Netherlands). In this section, BATJES (1958) has described 21 species which have also been found in our samples, except for *Textularia* sp. cf. *T. gramen, Pullenia bulloides, Gyroidina soldanii, Alabamina wolterstorffi, Rotalia canui* and *Nummulites germanicus.* One species, *Angulogerina gracilis* var. *tenuistriata* was not mentioned in the table of BATJES (1958) but the author supposes that two specimens from the Lower-Tongeren Beds of the mineshaft Hendrik IV and also from Hoeselt (TL 529) could belong to that species (Op. cit. p. 136).

From the 30 species, described by DROOGER (1969) from the interval between 124-131 m of the boring of Kallo, 17 species were



Textfig. 3: Profile and boring at the Grimmertingen type-locality.

	1	2	3	4	5	6	7	8	9	10
Ammodiscus incertus	×									×
Glomospira charoides	×									
Spiroplectaminna carinata	×		×	×	×	×	×	×	×	
Quinqueloculina sp. cf. *Q. seminula*	×	×				×		×	×	×
Nodosaria latejugata	×									
Dentalina sp. cf. *D. ewaldi*	×						×	×	×	
Dentalina ludwigi	×			×			×	×	×	
Dentalina pauperata	×									
Dentalina semilaevis	×									
Dentalina sp. cf. *D. soluta*	×				×	×	×			
Lagena hispida	×									
Lagena isabella	×						×	×		×
Lagena semiornata	×									
Lagena striata	×							×		
Lagena sulcata	×									
Marginulina sp. cf. *M. hosiusi*	×									
Globulina gibba	×		×	×	×	×	×	×	×	×
Globulina sp. cf. *G. laeviglobosa*	×									
Guttulina irregularis	×			×				×	×	×
Guttulina lactea	×			×					×	×
Guttulina problema	×		×	×	×	×	×	×	×	×
Glandulina sp. cf. *G. aequalis*	×		?		×	×	×			
Glandulina laevigata	×			×			×	×	×	×
Bolivina fastigia	×			×		×				
Angulogerina gracilis germanica	×						×			
Angulogerina gracilis tenuistriata	×		×	×		×				
Cancris subconicus	×		×	×				×	×	×
Asterigerina bartoniana	×		?					×	×	×
Asterigerina brandhorstiana	×									
Cribrononion moorkensi	×			×						
Cribrononion subnodosum	×		×					×	×	×
Nummulites orbignyi	×									
Bifarina selseyensis	×							×	×	×
Eponides pygmaeus	×						×			
Cibicides dutemplei	×	×	×	×			×	×	×	×
Cibicides lobatulus	×		×	×		×	×	×	×	×
Cibicides lobatulus grimmertingensis	×		×	×						
Cibicides sulzensis	×				×		×	×	×	×
Cibicides tenellus	×		?					×	×	×
Loxostomum teretum	×							×	×	
Nonion affine	×		×	×	×	×	×	×	×	×
Nonion sp. cf. *N. boueanum dingdenensis*	×		×							
Nonion graniferum	×	×	×	×	×	×			×	×
Gyroidina sp. cf. *G. octocamerata*	×			×				×	×	×

1. Sands of Grimmertingen, type-locality
2. Sands of Grimmertingen, D. A. J. Batjes (1958)
3. Lower Tongeren Beds of Hendrik IV mineshaft of Brunssum (D. A. J. Batjes, 1958)
4. Kallo interval between 124-131 m (C. W. Drooger, 1969)
5. Sands of Berg, Belgium (D. A. J. Batjes, 1958)
6. Nucula Clay, Belgium (id.)
7. Boom Clay, Belgium (id.)
8. Clay of Asse, Belgium (J. P. H. Kaasschieter, 1961)
9. Sands of Wemmel, Belgium (id.)
10. Sands of Lede, Belgium (id.)

Table 2: *The foraminiferal fauna of the Sands of Grimmertingen in comparison with those of Oligocene and Eocene strata of Belgium and adjacent areas.*

found in our samples. Two of them, *Bolivina fastigia* and *Angulogerina gracilis* var. *tenuistriata* are generally considered as typical Oligocene foraminifera and three of them, *Guttulina irregularis*, *Guttulina lactea* and *Gyroidina* sp. cf. *G. octocamerata*, are generally considered as typical Eocene foraminifera. The other species appear in Oligocene as well as in Eocene layers.

Nonion gulincki was not met with in our samples. According to DROOGER (1969) this species is typical for the interval between 124 and 131 m at Kallo.

Cibicides lobatulus var. *grimmertingensis* n. subsp. has been found in the Lower-Tongeren Beds of the Hendrik IV mineshaft (BATJES, 1958, *Cibicides lobatulus* var., pl. 9, fig. 8), in the interval between 124 and 131 m of Kallo (DROOGER, 1969, p. 25), and in our samples (Gm 1, Gm -0,10 m and Gmb 4). Until now *Cribrononion moorkensi* n.sp. has only been found in our samples of Grimmertingen.

The following 10 species are described from Oligocene or younger strata: *Dentalina semilaevis* (Lower Oligocene, LEROY, 1964), *Dentalina* sp. cf. *D. soluta*, *Marginulina* sp. cf. *M. hosiusi* (Miocene of Northsea Basin, LANGER, 1969), *Glandulina* sp. cf. *G. aequalis*, *Bolivina fastigia*, *Angulogerina gracilis* var. *germanica*, *Angulogerina gracilis* var. *tenuistriata*, *Asterigerina brandhorstiana* (Lower Oligocene of Germany), *Eponides pygmaeus* and *Nonion* sp. cf. *N. boueanum* var. *dingdenensis* (German Upper Oligocene, BATJES, 1958).

When we do not consider species of the Polymorphinidae and Lagenidae (very difficult to identify) we have 6 post-Eocene foraminifera, of which only *Angulogerina gracilis* is very common. This species, together with *Bolivina fastigia* and *Asterigerina brandhorstiana*, are considered as being restricted to the Oligocene,

All together, 21 species of our species were described by BATJES (1958) from Middle Oligocene deposits in Belgium (Sands of Berg, Nucula Clay, Clay of Boom), 5 from Upper Oligocene deposits in Belgium (Sands of Voort Chattian stage). This means that about 26 species belong to Oligocene deposits; 10 of them are not described from Eocene or older deposits and only 3 of them have a stratigraphical value.

The following 8 species are described from Eocene or older strata: *Dentalina pauperata*, *Globulina* sp. cf. *G. laeviglobosa* (Paleocene, TEN DAM, 1944), *Guttulina irregularis*, *Guttulina lactea*, *Asterigerina bartoniana*, *Nummulites orbignyi* (Sands of Wemmel, BLONDEAU, 1966), *Bifarina selseyensis* and *Gyroidina* sp. cf. *G. octocamerata*. When we do not consider species of Lagenidae and Polymorphinidae, we have 4 Eocene species of which only *Asterigerina bartoniana* and *Bifarina selseyensis* are common in our material. The meaning of the single specimen of *Nummulites orbignyi* is discussed in the systematic description.

All together, 24 species of our species were described by KAASSCHIETER (1961) from the Asse-Wemmel Formation and from the Middle Eocene of Belgium; 8 species of them are not described from the Oligocene or younger deposits and only 3 of them possess a stratigraphical value.

Summaryzing we can say that among the 46 species described from the Sands of Grimmertingen, 23 are found in Eocene as well as in Oligocene deposits; 10 species are found in Oligocene or younger deposits; of these 10 species 3 are supposed to have stratigraphical value (*Angulogerina gracilis*, *Bolivina fastigia* and *Asterigerina brandhorstiana*); 8 species are found in Eocene or older deposits and of these species, 3 are supposed to have stratigraphical value (*Asterigerina bartoniana*, *Nummulites orbignyi* and *Bifarina selseyensis*).

When we only use the information given by BATJES (1958) and KAASSCHIETER (1961) concerning the foraminifera from the Belgian Middle Oligocene and Upper Eocene, we find 13 species common to both formations, 8 belonging only to Middle Oligocene deposits and 11 to Upper Eocene deposits.

4.3. Presence of other fauna

4.31. Ostracoda

Only two species were met with in our samples. One specimen of *Leguminocythereis striato-*

punctata ROEMER was found in the Gm 1 level. Two specimens of *Haplocytheridea helvetica* LIENENKLAUS were met with in the sample of Gmb 4.

4.32. Bryozoa

In our samples we found many Bryozoans. *Lunulites magnosinuosa* CANU & BASSLER was found in the samples Gm 7 and Gm 10. *Lunulites angusticostata* CANU & BASSLER was found in the level Gm 10. Both species were found by CANU & BASSLER (1931) in the Sands of Grimmertingen. A bryozoan that not yet was found in the Sands of Grimmertingen is *Stichoporina reussi* STOLICZKA. It was met with in the samples Gm 1, Gm 2 and Gmb 4. This species occurs in the Lower Oligocene and Upper Eocene strata of Germany.

4.33. Radiolaria

In the Gm 1 level we found microfossils probably belonging to Radiolaria species. Further identification was not attempted.

4.34. Tintinnida

In a separate study (WILLEMS, in press) the presence of problematic microfossils belonging to the so called *Pseudarcella* group as described by LE CALVEZ (1959) has been discussed.

4.4. Reworked foraminifera

In different levels foraminifera were found which belong to older Tertiary and Secundary strata and which are reworked. Reworked cretaceous planktonic foraminifera are *Heterohelix* sp., *Hedbergella* sp., *Praeglobotruncana* sp., *Globotruncana* sp. and *Dorothia gradata* BERTHELIN. Foraminifera reworked from the older Tertiary (Paleocene and Lower Eocene) are *Guttulina* sp., *Bolivina* sp. and *Bulimina trigonalis* TEN DAM (index fossil for the Upper Paleocene).

5. CONCLUSION

The Sands of Grimmertingen yielded one new species, *Cribrononion moorkensi* n.sp., and one new subspecies, *Cibicides lobatulus* var. *grimmertingensis* n.subsp.

The Sands of Grimmertingen may be correlated with the Lower Tongeren Beds from the Hendrik IV mineshaft of Brunssum (BATJES, 1958). There exists also a close affinity with the interval between 124 and 131 m from the boring of Kallo (DROOGER, 1969). The Sands of Grimmertingen contain a mixture of Eocene and Oligocene species with a slight predominance of Upper Eocene elements. This slight predominance is, in our opinion, not sufficient enough to correlate the Sands of Grimmertingen in Eastern Belgium with the Asse Formation of Western Belgium as was suggested by BATJES (1958) and KAASSCHIETER (1961).

6. SYSTEMATIC DESCRIPTION

Ammodiscus glabratus CUSHMAN & JARVIS
(pl. 1, fig. 1)

Ammodiscus glabratus CUSHMAN & JARVIS, 1928, Contr. Cushm. Lab. Foram. Res., v. 4, pt. 4, nr. 66, p. 86, pl. 19, fig. 6.

Remarks: Two specimens belonging to that species were found in the Gm 1 level. The type level of the species is the Upper Cretaceous; hence our specimens could be reworked.

Ammodiscus incertus (D'ORBIGNY)
(pl. 1, fig. 2)

Operculina incerta D'ORBIGNY, 1839, in DE LA SAGRA, Hist. Phys. Nat. Cuba, Foram., v. 8, p. 49, pl. 6, figs. 16,17.
Ammodiscus incertus (D'ORBIGNY), BRADY, 1884, p. 330, pl. 38, figs. 1-3; TEN DAM, 1944, p. 76, pl. 1, fig. 10; KAASSCHIETER, 1961, p. 136, pl. 1, fig. 16.

Remarks: Our specimens show a wide variation: many specimens are round, other specimens are ellipsoid; very big specimens (more than 200µ) were met with as well as smaller individuals (less than 150µ). Some individuals show very regular whorls, other have whorls which are irregular (younger whorls smaller than older ones).

Glomospira charoides (JONES & PARKER)
(pl. 1, fig. 3)

Trochammina squamata var. *charoides* JONES & PARKER, 1860, Quart. Journ. Geol. Soc., Bd 16, 860, s. 304.

Glomospira charoides (JONES & PARKER), TEN DAM, 1944, p. 77.

Remarks: Specimens of *Glomospira charoides* (JONES & PARKER) are always found in our samples in the fraction smaller than 75µ. Probably all our specimens are reworked, because they are found, together with other reworked species, in all levels, while the not reworked forms occur only in well defined local zones (cf. table 1).

? *Aschemonella* sp.

Remarks: One single broken specimen was found in the Gm 1 level.

Spiroplectammina carinata (D'ORBIGNY)
(pl. 1, fig. 4)

Textularia carinata D'ORBIGNY, 1846, p. 247, pl. 14, figs. 32-34.

Spiroplectammina carinata (D'ORBIGNY), TEN DAM & REINHOLD, 1942, p. 43, pl. 1, figs. 2,3.

Remarks: According to the description of TEN DAM & REINHOLD (1942) our specimens are microspheres.

Trochammina sp.

Remarks: A few specimens belong to that genus but they are very bad preserved. Specific identification was not possible.

? *Eggerella* sp.
(pl. 1, fig. 5)

Remarks: Three specimens, probably belonging to the genus *Eggerella* CUSHMAN, were met with in different levels. They might also be reworked.

Quinqueloculina sp. cf. *Q. seminula* (LINNE)

cf. *Serpula seminulum* LINNE, 1758, Syst. Nat., Ed. 10, t. 1, p. 786.

cf. *Quinqueloculina seminula* (LINNE), TEN DAM & REINHOLD, 1942, p. 42, pl. 1, fig. 6; KAASSCHIETER, 1961, p. 147, pl. 2, figs. 5,6.

Remarks: Identification was done on internal limonitic moulds.

Nodosaria latejugata GUEMBEL
(pl. 1, fig. 6)

Nodosaria latejugata GUEMBEL, 1870, Abh. Bayr. Ak. Wiss., v. 10, p. 619, pl. 1, fig. 32; KAASSCHIETER, 1961, p. 177, pl. 7, fig. 22.

Dentalina sp. cf. *D. ewaldi* (REUSS)
(pl. 1, fig. 7)

cf. *Nodosaria ewaldi* REUSS, 1851, p. 58, pl. 2, fig. 2.

cf. *Dentalina ewaldi* (REUSS), KAASSCHIETER, 1961, p. 175, pl. 7, figs. 15,16.

Remarks: The single found specimen differs from the holotype figured by REUSS (1851) by the more inflated chambers.

Dentalina ludwigi (REUSS)
(pl. 1, fig. 8)

Nodosaria ludwigi REUSS, 1866, Denks. K. Akad. Wiss., Wien, v. 25, p. 135, pl. 2, fig. 23; BATJES, 1958, p. 116, pl. 3, figs. 15,16.

Dentalina ludwigi (REUSS), DROOGER, 1969, p. 21, pl. 1, fig. 9.

Remarks: Because of the asymmetric test we rather identify our material as *Dentalina ludwigi* (REUSS) and not as *Nodosaria ludwigi* REUSS.

Dentalina pauperata D'ORBIGNY
(pl. 1, fig. 9)

Dentalina pauperata D'ORBIGNY, 1846, p. 46, p. 1, figs. 57,58; BORNEMANN, 1855, p. 324, pl. 8, fig. 7.

Dentalina semilaevis HANTKEN
(pl. 1, fig. 10)

Dentalina semilaevis HANTKEN, K. Ungar. Geol. Anst., Mitt. Jahrb., Bd. 4, h. 1, p. 39, pl. 4, fig. 6, pl. 12, fig. 13; LEROY, 1964, p. 23, pl. 15, fig. 32.

Dentalina sp. cf. *D. soluta* REUSS
(pl. 1, fig. 11)

cf. *Dentalina soluta* REUSS, 1851, p. 60, pl. 3, fig. 4.

cf. *Nodosaria soluta* (REUSS), BORNEMANN, 1855, p. 322, pl. 12, fig. 12; BATJES, 1958, p. 114, pl. 3, figs. 17,18.

Remarks: Our single specimen seems to be a juvenile because only two chambers are developed. The suture is not perpendicular on the test as in the juvenile *N. soluta* (REUSS) figured by BATJES (1958). Possibly our specimen is a macrosphere but one specimen is not sufficient to prove this suggestion.

Lagena hispida REUSS
(pl. 1, fig. 12)

Lagena hispida REUSS, 1863, Sitz. Ber. K. Ak. Wiss., Wien, Bd. 46, S. 335, pl. 6, figs. 77-79; TEN DAM & REINHOLD, 1942, p. 69, pl. 3, fig. 12; POZARYSKA, 1957, p. 47, pl. 2, fig. 8, pl. 3, fig. 7.

Lagena isabella (D'ORBIGNY)

Oolina isabella D'ORBIGNY, 1839, Voy. Amér. Mér. For., v. 5, pt. 5, p. 20, pl. 5, figs. 7,8.
Lagena isabella (D'ORBIGNY), POZARYSKA, 1957, p. 48, pl. 1, fig. 4; BATJES, 1958, p. 119, pl. 3, fig. 11; KAASSCHIETER, 1961, p. 178, pl. 7, fig. 25.

Remarks: Our single specimen lacks the smooth area around the aperture that is found in the specimens figured by POZARYSKA (1957), BATJES (1958) and KAASSCHIETER (1961).

Lagena semiornata TERQUEM & TERQUEM

(pl. 1, fig. 13)

Lagena semiornata TERQUEM & TERQUEM, 1886, Bull. Soc. Zool. France, v. 11, p. 330, pl. 11, fig. 2; POZARYSKA, 1957, p. 51, pl. 1, fig. 5.

Remarks: Our single specimen differs from the holotype figured by TERQUEM & TERQUEM (1886) in having a more compressed test and a smaller number of costae. The specimen of POZARYSKA (1957) lacks the spine, has more costae, but nearly the same test as our specimen.

Lagena striata (D'ORBIGNY)

(pl. 1, fig. 14)

Oolina striata D'ORBIGNY, 1839, Voy. Amér. Mér. For., v. 5, pt. 5, p. 21, pl. 5, fig. 12.
Lagena striata (D'ORBIGNY), VAN VOORTHUYSEN, 1951, p. 24, pl. 1, fig. 11; KAASSCHIETER, 1955, p. 63, pl. 5, fig. 3; BATJES, 1958, p. 119, pl. 3, fig. 6; KAASSCHIETER, 1961, p. 179, pl. 7, fig. 26.

Remarks: There exist a very close affinity with *L. striata* (D'ORBIGNY) figured by KAASSCHIETER (1955) and BATJES (1958), the holotype however, is more spherical.

Lagena sulcata (WALKER & JACOB)

(pl. 1, fig. 15)

Serpula sulcata WALKER & JACOB, 1798, Adam's Essays, p. 634, pl. 14, fig. 5.
Lagena sulcata (WALKER & JACOB), VAN VOORTHUYSEN, 1958, p. 9, pl. 2, fig. 19; MARGEREL, 1968, p. 61, pl. 9, fig. 15.

Remarks: Our specimens of *L. sulcata* (WALKER & JACOB) have nearly the same form as our *L. striata* (D'ORBIGNY) specimens but not so many costae. The number of costae of *L. striata* (D'ORBIGNY) and of *L. sulcata* (WALKER & JACOB) in our samples varies between 30 and 45, and between 16 and 22 respectively. All our specimens of *L. sulcata* (WALKER & JACOB) lack the characteristic rings around the neck.

Lenticulina sp.

Remarks: Specimens belonging to the genus *Lenticulina* LAMARCK are very common in our samples. Nearly all specimens show a close affinity to *Lenticulina* sp. figured by BATJES (1958, p. 108, pl. 2, fig. 7). This form is found in the Lower Tongeren Beds of the Hendrik IV mineshaft. One of our specimens (from level −0,10 m) shows a close affinity with *Lenticulina* sp. cf. *L. ellisori* BOWEN figured by KAASSCHIETER (1961, p. 172, pl. 7, fig. 4). Another specimen (from level Gm −0,20 m) closely resembles *Lenticulina* sp. cf. *L. costata* (D'ORBIGNY) figured by KAASSCHIETER (1961, p. 172, pl. 7, fig. 3). Two specimens from level Gm 1 show affinity with *Robulus beyrichi* BORNEMANN figured by BORNEMANN (1955, p. 332, pl. 17, fig. 8).

Marginulina sp. cf. *M. hosiusi* LANGER

(pl. 1, fig. 16)

cf. *Marginulina hosiusi* LANGER, 1969, p. 40, pl. 1, figs. 9-11.

Description: Our single specimen is probably not complete. The oldest part of the test is slightly coiled, the younger part is nearly straight; it has four chambers, which are slightly inflated and wider than high; the chambers possess costae (7-8) that are very raised; the sutures are marked by the interruption of the costae; the aperture is round and sits on a slightly excentric neck; the section of the test is round.

Remarks: Our specimen closely resembles the holotype, however the holotype possesses 8 to 14 costae that are not interrupted.

Globulina gibba D'ORBIGNY

(pl. 1, fig. 17)

Globulina gibba D'ORBIGNY, 1826, Ann. Sci. Nat., v. 7, p. 266, mod. 63; D'ORBIGNY, 1846, p. 199, pl. 13, figs. 7,8; BRADY, 1884, pl. 71, figs. 11,12; BATJES, 1958, p. 121, pl. 4, fig. 8; KAASSCHIETER, 1961, p. 183, pl. 8, figs. 6,7.

Remarks: A few specimens are slightly punctated and may belong to *G. gibba* D'ORBIGNY var. *punctata* D'ORBIGNY.

Globulina sp. cf. *G. laeviglobosa* TEN DAM
(pl. 1, fig. 18)

cf. *Globulina laeviglobosa* TEN DAM, 1944, p. 107, pl. 1, fig. 1.

Remarks: Our specimens are intermediate forms between *G. gibba* D'ORBIGNY and *G. laeviglobosa* TEN DAM. Because of the angular test we rather refer them tentatively to *G. laeviglobosa* TEN DAM.

Guttulina irregularis (D'ORBIGNY)
(pl. 2, fig. 1)

Globulina irregularis D'ORBIGNY, 1846, p. 226, pl. 13, figs. 9,10.

Guttulina irregularis (D'ORBIGNY), KAASSCHIETER, 1955, p. 66, pl. 5, fig. 11; KAASSCHIETER, 1961, p. 182, pl. 8, figs. 2,3; DROOGER, 1969, p. 21, pl. 1, fig. 11.

Guttulina problema (D'ORBIGNY), BATJES, 1958, p. 121, pl. 4, fig. 12.

Remarks: All species differ from the mentioned references by the more triangular est, which is caused by flattening of the basal tpart and by the more elongate chambers.

Guttulina lactea (WALKER & JACOB)
(pl. 1, fig. 19)

Serpula lactea WALKER & JACOB, 1798, Adam's Essays, p. 634, pl. 147, fig. 4.

Guttulina lactea (WALKER & JACOB), KAASSCHIETER, 1961, p. 182, pl. 8, fig. 5.

Guttulina problema (D'ORBIGNY)
(pl. 2, fig. 2)

Polymorphina (*Guttulina*) *problema* D'ORBIGNY, 1846, p. 224, pl. 12, figs. 26-28.

Guttulina problema (D'ORBIGNY), LE CALVEZ, 1950, pl. 3, fig. 11, pl. 1, figs. 7-9; BATJES, 1958, p. 121, pl. 4, figs. 10,11 (not 12); KAASSCHIETER, 1961, p. 181, pl. 7, figs. 30-32, pl. 8, fig. 1.

Remarks: Our specimens resemble very well *G. problema* (D'ORBIGNY) figured by KAASSCHIETER (1961, pl. 7, fig. 31). It is very difficult to distinguish our specimens from *G. lactea* (WALKER & JACOB) which seems to have more elongate chambers. It is possible that some juvenile specimens, here attributed to *G. problema* (D'ORBIGNY) belong to *G. lactea* (WALKER & JACOB).

Glandulina sp. cf. *G. aequalis* REUSS
(pl. 2, fig. 4)

cf. *Glandulina aequalis* REUSS, 1863, Sitz. Ber. K. Ak. Wiss., Wien, v. 48, pl. 3, fig. 38; BRADY, 1884, pl. 61, fig. 32; BATJES, 1958, p. 123, pl. 4, figs. 5,6.

Remarks: The oldest chamber of all our specimens is more pointed than in the typefigure and other references. All our specimens are macrospheres.

Glandulina laevigata (D'ORBIGNY)
(pl. 2, fig. 5)

Nodosaria (*Glandulina*) *laevigata* D'ORBIGNY, 1826, Ann. Sci. Nat., v. 7, p. 252, pl. 10, figs. 1-3.

Glandulina laevigata (D'ORBIGNY), D'ORBIGNY, 1846, p. 29, pl. 1, figs. 4,5; BATJES, 1958, p. 123, pl. 4, fig. 7; KAASSCHIETER, 1961, p. 187, pl. 8, fig. 17; DROOGER, 1969, p. 21, pl. 2, fig. 1.

Remarks: All our specimens are macrospheres.

Bolivina fastigia CUSHMAN
(pl. 2, fig. 7)

Bolivina fastigia CUSHMAN, 1936, Cushm. Lab. For. Res., Sp. Publ. nr. 6, p. 51, pl. 7, fig. 17; BATJES, 1958, p. 131, pl. 5, fig. 12; ELLERMAN, 1960, p. 672, pl. 53, fig. 7; DROOGER, 1969, p. 24, pl. 3, fig. 4.

Remarks: Three specimens of the species were found. The test is more lanceolate than in the holotype figured by CUSHMAN (1936), and in the figures given by BATJES (1958) and ELLERMAN (1960). The specimens resemble very well the figure in DROOGER (1969), but have more chambers and only one strong costa.

Angulogerina gracilis (REUSS)
var. *germanica* CUSHMAN & EDWARDS
(pl. 2, figs. 8,9)

Angulogerina germanica CUSHMAN & EDWARDS, 1938, Cushm. Lab. For. Res., Contr., v. 11, p. 85, pl. 15, figs. 14-16.

Angulogerina gracilis (REUSS) var. *germanica* CUSHMAN & EDWARDS, BATJES, 1958, p. 136, pl. 6, fig. 4.

Angulogerina gracilis (REUSS)
var. *tenuistriata* (REUSS)
(pl. 2, figs. 10-12)

Uvigerina tenuistriata REUSS, 1870, Sitz. Ber. K. Akad. Wiss., Wien, v. 62, p. 485.
Angulogerina gracilis (REUSS) var. *tenuistriata* (REUSS), BATJES, 1958, p. 136, pl. 6, fig. 5; DROOGER, 1969, p. 23, pl. 3, fig. 2.

Remarks: This species is more frequent in our material than *A. gracilis* (REUSS) var. *germanica* CUSHMAN & EDWARDS. It shows a great variation in the shape of the test: some specimens are more than twice as long as wide; others are nearly as long as wide. Our specimens are less angular than those figured by BATJES (1958). Our samples contain forms intermediate between both varieties of the species.

Cancris subconicus (TERQUEM)
(pl. 2, fig. 13)

Rotalina subconica TERQUEM, 1882, Mém. Soc. Géol. France, s. 3, v. 2, p. 51, pl. 4, fig. 5.
Valvulineria subconica (TERQUEM), LE CALVEZ, 1949, p. 26, pl. 5, figs. 87-89.
Cancris subconicus (TERQUEM), KAASSCHIETER, 1961, p. 213, pl. 12, figs. 6-8; DROOGER, 1969, p. 24, pl. 3, fig. 8.
Cancris turgidus CUSHMAN & TODD, 1942, Contr. Cushm. Lab. For. Res., v. 18, p. 92, pl. 24, figs. 3,4; BATJES, 1958, p. 149, pl. 10, fig. 5.

Remarks: Only a few specimens show the characteristic clear area on the last chamber. Our specimens resemble very well *V. subconica* (TERQUEM) figured by LE CALVEZ (1949), and *C. turgidus* CUSHMAN & TODD figured by BATJES (1958). Our specimens differ from these figured by KAASSCHIETER (1961) by their number of chambers, which is 5 to 6. The specimens in KAASSCHIETER (1961) have 7 to 8 chambers.

Asterigerina bartoniana (TEN DAM)
(pl. 3, fig. 1)

Rotalia granulosa TEN DAM, 1944, p. 121, pl. 4, fig. 2.
Asterigerina bartoniana (TEN DAM), BATJES, 1958, p. 158, pl. 10, fig. 1; KAASSCHIETER, 1961, p. 232, pl. 16, figs. 2,3; GRAMANN, 1964, p. 213, pl. 20, fig. 1.

Remarks: Most of our specimens are distinct *A. bartoniana* (TEN DAM). Some of them (specimens from levels Gm 9 and Gm 10) are very poorly preserved. For those specimens an exact identification was not possible.

Asterigerina brandhorstiana GRAMANN
(pl. 3, fig. 2)

Asterigerina brandhorstiana GRAMANN, 1964, p. 216, pl. 20, fig. 2, pl. 21, fig. 4.

Remarks: We found only two specimens belonging to this species. The first specimen has an umbilical side that is more convex than the spiral side. The chambers on the spiral and on the umbilical side are typical, as they are strongly curved. The other specimen has less curved sutures on the umbilical side than in the holotype.

Cribrononion moorkensi n. sp.
(pl. 3, fig. 3)

Etymology: Named in honour of Ir. T. MOORKENS of the Laboratorium voor Paleontologie, Rijksuniversiteit Gent, Belgium.
Holotype: pl. 3, fig. 3; stored at the Laboratorium voor Paleontologie, R.U.G.
Paratypes: 3 other individuals; idem.
Type-locality: Sandpit of Mr. A. POESMANS at Grimmertingen, Belgium (textfig. 2).
Type-level: Sands of Grimmertingen, Lower Oligocene, level Gm 1.
Diagnosis: Little form with sharp keel, curved sutures and central slit in the sutures.
Description: planispiral, involute, periphery round and not lobulated; 8 to 10 chambers in the last whorl; chambers slightly inflated and slowly increasing in size; sutures strongly depressed and curved; in the middle part of each suture a narrow slit is visible; wall smooth and finely perforated; umbilicus narrow and slightly depressed, covered by granular mass; sharp keel; apertural face slightly convex and distinctly subtriangular; aperture at the base of the apertural face; the aperture is a slit or a row of small openings.
Dimensions of the holotype: length 0.24 mm; breadth 0.20 mm; thickness 0.09 mm.

Remarks: We found a fifth cribrononionid specimen that resembles very well *C. moorkensi* n. sp. but that lacks the sharp keel.

Cribrononion subnodosum (ROEMER)
(pl. 3, fig. 4)

Robulina subnodosa ROEMER, 1838, p. 397, pl. 3, fig. 61.

Cribrononion subnodosum (ROEMER), DROOGER, 1969, p. 25, pl. 5, figs. 3,4.
Elphidium subnodosum (ROEMER), TEN DAM & REINHOLD, 1942, p. 72, pl. 5, fig. 9; BATJES, 1958, p. 163, pl. 8, figs. 12,13; KAASSCHIETER, 1961, p. 239, pl. 16, figs. 17,18.

Remarks: Our specimens resemble most these from the Lower Tongeren Beds of the Hendrik IV mineshaft (BATJES, 1958, pl. 8, fig. 13), and the specimens from Kallo (DROOGER, 1969, pl. 5, figs. 3,4). We did not find specimens with areal cribrate openings. The aperture consist in 4 or 5 small openings at the base of the apertural face. Following LOEBLICH Jr. & TAPPAN (1964, p. 632 & 637) the difference between *Elphidium* LAMARCK and *Cribrononion* THALMANN results from the presence or absence of retral processes. All our specimens, and also the specimens of ROEMER (1838), BATJES (1958) and KAASSCHIETER (1961) lack retral processes. Hence they belong to the genus *Cribrononion* THALMANN and can be called *Cribrononion subnodosum* (ROEMER).

Nummulites orbigny (GALEOTTI)
(textfig. 4)

Operculina orbigny GALEOTTI, 1837, Mém. Acad. Roy. Belg., t. 13, S. 54, pl. 3, fig. 13.
Nummulites orbigny (GALEOTTI), BLONDEAU, 1966, p. 915, pl. 28, figs. 3,9, 13, 22, pl. 29, fig. 29.

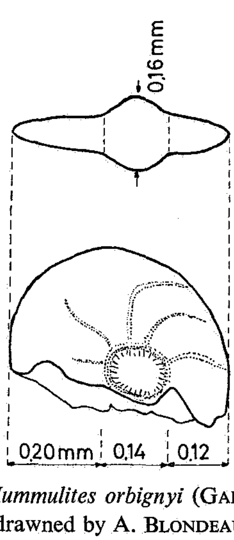
Remarks: A. BLONDEAU (Paris) was so kind to identify our single specimen and gave the following comments, which are translated here: "Little, stunted nummulite, megaspheric, having only one spiral; flattened specimen with an umbilical knob; the six sutures are very fine (0.02 mm) and strongly curved; the rate of increase in size of the subsequent chambers is very great and therefore the umbilical knob does not seem to be in the centre. The specimen has been compared with specimens of the same size and form (A):

N. prestwichianus JONES: has the same form but more flattened and has a less swelled umbilical knob.

N. germanicus BORNEMANN: very convex with steep sutures.

N. concinnus JARZEVA: different sutures, comparable to those in *N. germanicus* BORNEMANN.

Our specimen resembles most *N. orbignyi* (GALEOTTI) by its form and dimensions. It is possible, though improbably that the specimen is reworked."



Textfig. 4 *Nummulites orbignyi* (GALEOTTI) (figure drawned by A. BLONDEAU).

Bifarina selseyensis
(HERON-ALLEN & EARLAND)
(pl. 3, figs. 5,6)

Bigenerina selseyensis HERON-ALLEN & EARLAND, 1909, Journ. Roy. Micr. Soc. London, p. 330, pl. 15, figs. 15-17.
Bifarina selseyensis (HERON-ALLEN & EARLAND), KAASSCHIETER, 1961, p. 200, pl. 10, figs. 8-10.

Remarks: Nearly all individuals show a short glassy spine at the initial end. A few specimens are strongly reticulate, therefore the morphological details of the test are not well visible. Most specimens are distinctly biserial. A few specimens show a tendency to become uniserial.

Eponides pygmaeus (HANTKEN)
(pl. 3, fig. 7)

Pulvinulina pygmaea HANTKEN, 1875, Abh. K. Ungar. Geol. Anst., Mitt. Jahrb., v. 4, pt. 1, p. 78, pl. 10, fig. 8.
Eponides pygmaeus (HANTKEN), BATJES, 1958, p. 146, pl. 7, fig. 11.

Cibicides dutemplei (D'ORBIGNY)
(pl. 4, fig. 2; pl. 5, fig. 4)

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

Cibicides dutemplei (D'ORBIGNY), TEN DAM & REINHOLD, 1942, p. 99, pl. 8, fig. 3; BATJES, 1958, p. 150, pl. 9, figs. 9-11; KAASSCHIETER, 1961, p. 219, pl. 12, fig. 15.

Remarks: The greater part of the *Cibicides* specimens belong to the species *dutemplei* (D'ORBIGNY). There are many typical examples but also forms intermediate between *C. dutemplei* (D'ORBIGNY), *C. lobatulus* (WALKER & JACOB), and *C. tenellus* (REUSS).

Cibicides lobatulus (WALKER & JACOB)
(pl. 4, figs. 1,3)

Nautilus lobatulus WALKER & JACOB, 1798, Adam's Essays, p. 642, pl. 14, fig. 36.

Cibicides lobatulus (WALKER & JACOB), BATJES, 1958, p. 153, pl. 9, fig. 7; KAASSCHIETER, 1961, p. 221, pl. 14, fig. 5.

Remarks: We consider as *C. lobatulus* (WALKER & JACOB) all specimens with lobulated periphery, flattened dorsal side and curved sutures. It is sometimes difficult to distinguish *C. lobatulus* (WALKER & JACOB) from small *C. dutemplei* (D'ORBIGNY) with lobulated periphery, and from lobulated *C. tenellus* (REUSS) having curved sutures and lacking the ventral knob. Forms Intermediate between those three species are very common in our samples.

Cibicides lobatulus (WALKER & JACOB)
var. *grimmertingensis* n. subsp.
(pl. 4, fig. 4)

Cibicides lobatulus (WALKER & JACOB), var., BATJES, 1958, p. 153, pl. 9, fig. 8; DROOGER, 1969, p. 25.

Etymology: Named after Grimmertingen, type-locality of the Sands of Grimmertingen, Belgium.

Holotype: pl. 4, fig. 4; stored at the Laboratorium voor Paleontologie, R.U.G.

Paratypes: about 15 other specimens; idem.

Type-locality: Sandpit of Mr. A. POESMANS at Grimmertingen, Belgium (textfig. 2).

Type level: Sands of Grimmertingen, Lower Oligocene, level Gm 1.

Description: Very small form, periphery round, strongly lobulated, especially in the younger part of the last whorl; wall coarsely perforated; dorsal side flattened with lobulated younger chambers; ventral side convex; sutures straight, radial and depressed in the younger part of the test; 7 to 9 chambers in the last whorl; umbilicus wide and with a deep depression; sharp keel; the aperture is a slit with a lip at the base of the apertural face; sometimes the aperture is reaching almost to the umbilicus; the apertures of the older chambers are still visible on the dorsal side, and form a slit below the base of the last whorl.

Dimensions of the holotype: length 0.29 mm; breadth 0.24 mm; thickness 0.21 mm.

Remarks: BATJES found this form in the Lower Tongeren Beds of shaft Hendrik IV and considered it as a variety of *C. lobatulus* (WALKER & JACOB). DROOGER (1969) mentioned it also from samples of 125,50 and 127 m depth of the Kallo well. In our material it is rather frequent. There exist forms intermediate between *C. lobatulus* (WALKER & JACOB) var. *grimmertingensis* n. subsp. and *C. tenellus* (REUSS) (small and lobulated specimens).

Cibicides sulzensis (HERRMANN)
(pl. 4, fig. 5)

Discorbina sulzensis HERRMANN 1917, Mitt. Geol. L. Anst. Els. Loth., v. 10, pt. 3, p. 290, pl. 3, fig. 2.

Cibicides sulzensis (HERRMANN), BATJES, 1958, p. 149, pl. 9, fig. 5; KAASSCHIETER, 1961, p. 293, pl. 13, fig. 11.

Cibicides tenellus (REUSS)
(pl. 5, figs. 1-3)

Truncalutina tenella REUSS, 1865 Sitz. Ber. K. Akad. Wiss. Wien, v. 50, p. 477, pl. 5, fig. 6.

Cibicides tenellus (REUSS), TEN DAM & REINHOLD, 1942, p. 99, pl. 8, fig. 6, pl. 10, fig. 2; BATJES, 1958, p. 151, pl. 9, figs. 3,4.

Remarks: This species is very variable and some specimens show affinity with *C. ungerianus* (D'ORBIGNY), *C. lobatulus* (WALKER & JACOB), *C. westi* HOWE and *C. dutemplei* (D'ORBIGNY). Most of our *C. tenellus* (REUSS) lack the glassy knob in the umbilicus but otherwise they agree fairly well with the specimens of BATJES (1958). Small specimens, with a flattened dorsal side, glassy knob in the umbilicus and many chambers in the last whorl, are also found. Other specimens, without knob, are more biconvex. Some small specimens have strongly inflated chambers and resemble closely *C. lobatulus* (WALKER & JACOB) var. *grimmertingensis* n. subsp.

Loxostomum teretum CUSHMAN
(pl. 5, fig. 5)

Loxostomum teretum CUSHMAN, 1936, Cushm. Lab. For. Res., Sp. Publ. nr. 6, p. 60, pl. 8, fig. 14; BATJES, 1958, p. 133, pl. 5, fig. 14; KAASSCHIETER, 1961, p. 195, pl. 9, fig. 20.

Nonion affine (REUSS)
(pl. 5, fig. 6)

Nonionina affinis REUSS, 1851, p. 72, pl. 5, fig. 32.
Nonion affine (REUSS), TEN DAM & REINHOLD, 1942, p. 75, pl. 4, fig. 15; BATJES, 1958, p. 140, pl. 6, fig. 2; KAASSCHIETER, 1961, p. 203, pl. 11, figs. 3,4; DROOGER, 1969, p. 22, pl. 2, fig. 6.

Remarks: In the Gm 7 level we found an internal limonitic mould and in the Gmb 27 level we found two internal pyritic moulds. Probably those internal moulds belong to *N. affine* (REUSS).

Nonion sp. cf. *N. boueanum* D'ORBIGNY
var. *dingdenensis* CUSHMAN

cf. *Nonion dingdeni* CUSHMAN, 1936, Cushm. Lab. For. Res., Contr., v. 12, p. 65, pl. 12, fig. 5.
cf. *Nonion boueanum* D'ORBIGNY var. *dingdenensis* CUSHMAN, BATJES, 1958, p. 143, pl. 7, fig. 6.

Remarks: We found the internal limonitic mould of one specimen. It can be discussed as follows: planispiral, 7 chambers in the last whorl, which increase rapidly in size; sutures slightly depressed and curved; keel; umbilicus covered by the last chamber; apertural face oval and slightly convex. Our specimen shows affinity with the specimen figured by BATJES (1958). This specimen however has 10 chambers and a smaller apertural face.

Nonion graniferum (TERQUEM)
(pl. 5, fig. 7)

Nonionina granifera TERQUEM, 1882, Mém. Soc. Géol. France, s. 3, v. 2, p. 42, pl. 2, figs. 8,9.
Nonion graniferum (TERQUEM), LE CALVEZ, 1952, p. 53, pl. 4, figs. 58,59; KAASSCHIETER, 1961, p. 204, pl. 10, fig. 15; DROOGER, 1969, p. 29, pl. 2, fig. 5.

Gyroidina sp. cf. *G. octocamerata*
CUSHMAN & HANNA
(pl. 5, fig. 8)

cf. *Gyroidina soldanii* D'ORBIGNY var. *octocamerata* CUSHMAN & HANNA, 1927, Calif. Ac. Sci. Proc., s. 4, v. 16, p. 223, pl. 14, figs. 16-18.
cf. *Gyroidina octocamerata* CUSHMAN & HANNA, KAASSCHIETER, 1961, p. 212, pl. 13, fig. 2.

Remarks: Our specimens differ from those figured by KAASSCHIETER (1961), by the umbilicus that is covered by a flap completely instead of only partially.

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Note: Controlling of holotypes of some species was done by means of the "Catalogue of Foraminifera" (Ellis & Messina, 1940). Therefore some articles, mentioned in the text, are not mentioned in the list of references.

Batjes, D. A. J. (1958) — Foraminifera of the Oligocene of Belgium. *Verh. Kon. Belg. Inst. Natuurw.*, **143**, pp. 188.

Beyrich, E. (1854) — Ueber die Stellung der Hessischen Tertiärbildungen. *Ber. Verh. Kgl. Preuss. Akad. Wiss. Berlin*, 1854, p. 640-666.

Blondeau, A. (1966) — Les Nummulites de l'Eocène de Belgique. *Bull. Soc. Géol. France, sér.* 7, **8**, p. 908-919.

Bornemann, J. G. (1855) — Die mikroskopische Fauna des Septarienthones von Hemsdorf bei Berlin. *Zschr. Deu. Geol. Ges.*, **7**, p. 307-371.

Brady, H. B. (1884) — Report on the Foraminifera dredged by H.M.S. "Challenger" during the years 1873-1876. *Rep. Voy. Chall., Zool.*, **9**.

Calvez, Y. Le (1949, 1950, 1952) — Révision des Foraminifères lutétiens du Bassin de Paris. Part II (1949): Rotalidae et familles affines; Part III (1950): Polymorphinidae, Buliminidae, Nonionidae; Part IV (1952): Valvulinidae, Peneroplidae, Opthalmidiidae, Lagenidae. *Mém. Expl. Carte géol. dét. France.*

Calvez, Y. Le (1959) — Étude de quelques foraminifères nouveaux du Cuisien franco-belge. *Rev. de Micropal.*, **2**, p. 87-94.

Canu, F. & Bassler, R. S. (1931) — Bryozoaires oligocènes de la Belgique. *Mém. Mus. Roy. Hist. nat. Belg.*, **50**, pp. 23.

Cavelier, C. (1968) — L'Eocène supérieur et la base de l'Oligocène en Europe occidentale. *In*: Colloque sur l'Eocène, Paris, Mai 1968, *Mém. B.R.G.M.*, **58** (1), p. 507-525.

Dam, A. ten (1944) — Die Stratigraphischen Gliederung des Niederländischen Paläozäns und Eozäns nach Foraminiferen (mit Ausnahme von Süd-Limburg). *Med. Geol. St., Ser. C-V*-**3**, pp. 142.

Dam, A. ten & Reinhold, Th. (1942) — Die Stratigraphischen Gliederung des Niederländischen Oligo-Miozäns nach Foraminiferen (mit Ausnahme von Süd-Limburg). *Med. Geol. St., Ser. C-V*-**2**, pp. 106.

Drooger, C. W. (1969) — Microfauna close to the Eocene-Oligocene boundary in the boring at Kallo. *Toelicht. Verh. Geol. Kaart en Mijnk. v. België*, **11**, p. 9-27.

Drooger, C. W., Kaasschieter, J. P. H. & Keij, A. J. (1955) — Microfauna of the Aquitanian-Burdigalian of Southwestern France. *Verh. Kon. Ned. Akad. Wet., afd. Natuurk., Ser.* **1**, pt. 21, pp. 136.

Dumont, A. (1839) — Rapport sur les travaux de la carte géologique pendant l'année 1839. *Bull. Acad. Roy. Belg., 1* (6) (part 2), p. 464-484.

Ellerman, C. (1960) — Foraminiferen aus dem Oligozän des Schachtes Kapellen (Niederrhein) mit variationsstatistik von *Elphidium subnodosum* (Roemer). *Geol. Jb.*, **77**, p. 645-710.

Ellis, F. & Messina, R. A. (1940-1968) — Catalogue of Foraminifera — *Am. Mus. Nat. Hist.*, New York.

Glibert, M. & Heinzelin, J. de (1954) — L'Oligocène inférieur belge. *Volume jubilaire Van Straelen*, p. 281-438, Bruxelles: Hayez.

Gramann, F. (1964) — Die Arten der Foraminiferen-Gattung *Asterigerina* d'Orb. im Tertiär NW Deutschlands. *Paläont. Zeitschr.*, **38**, p. 207-222.

Gulinck, M. (1968) — Colloque sur l'Eocène: Guide des excursions en Belgique, avril 1968. *Serv. Géol. Belg.*, Bruxelles.

Heinzelin, J. de & Glibert, M. (1957) — Terminologie van de Belgische Tertiaire stratigrafische eenheden. *Lex. strat. int.*, **1**, (4a VII).

Kaasschieter, J. P. H. (1961) — Foraminifera of the Eocene of Belgium. *Verh. Kon. Belg. Inst. Natuurw.*, **147**, pp. 271.

Keij, A. J. (1957) — Eocene and Oligocene Ostracoda of Belgium. *Verh. Kon. Belg. Inst. Natuurw.*, **136**, pp. 210.

Langer, W. (1969) — Beitrag zur Kenntniss einiger Foraminiferen aus dem mittleren und oberen Miozän des Nordsee-Beckens. *N. Jb. Geol. Paläont., Abh.*, **133**, p. 27-78.

Leroy, L. W. (1964) — Smaller Foraminifera from the late Tertiary of Southern Okinawa. *Geol. Surv. Prof. Paper*, **452**-*F*, pp. 58.

Loeblich, Jr. A. R. & Tappan, H. (1964) — Sarcodina, chiefly "Thecamoebians" and Foraminifera. In R. C. Moore: *Treatise on Invertebrate Paleontology, Part C*, **2**, pp. 900, Geol. Soc. Am. & Univ. Kansas Press.

Margerel, J. P. (1968) — *Les Foraminifères du Rédonien, Systématique, Répartition stratigraphique, Paléoécologie.* Thèse, pp. 204, Nantes.

Martini, E. & Moorkens, T. (1969) — The type-locality of the Sands of Grimmertingen and calcareous nannoplankton from the Lower Tongrian. *Bull. Soc. belge Géol., Paléont. & Hydrol.*, **78**, p. 111-130.

Orbigny, A. de (1846) — Foraminifères fossiles du Bassin tertiaire de Vienne. *Classics in Paleontology*, **2**, pp. 303.

POZARYSKA, K. (1957) — Lagénidae du Crétacé supérieur de Pologne. *Paleontologica Polonica*, **8**, pp. 190.

REUSS, A. E. (1951) — Ueber die fossilen Foraminiferen und Entomostraceen der Septarienthones der Umgegend von Berlin. *Zschr. Deu. Geol. Ges.*, **3**, p. 49-92.

ROEMER, A. E. (1838) — Die Cephalopoden des Nord-Deutschen tertiären Meeressandes. *N. Jahrb. Min.*, p. 381-392.

VOORTHUYSEN, J. H. VAN (1951) — Recent (and derived Upper Cretacous) Foraminifera of the Netherlands Wadden Sea (tidal flat). *Med. Geol. St.*, nieuw. ser., pp. 23-33.

VOORTHUYSEN, J. H. VAN (1958) — Les Foraminifères Mio-Pliocènes et Quarternaires du Kruisschans, *Mém. Inst. Roy. Sc. Nat. Belg.*, **142**, pp. 34.

WILLEMS, W. (in press) — *Conicarcella tongerenensis* n. sp. de la localité type des Sables de Grimmertingen (Oligocène inférieur de la Belgique). to be published in *Bull. Soc. Belge Géol., Paléont. & Hydrol.*

PLATES

Note: The numbers of the photographs refer to the catalogue of negatives at the "Laboratorium voor Electronenmicroscopie", Rijksuniversiteit Gent, Belgium.

PLATE 1

Fig. 1: *Ammodiscus glabratus* CUSHMAN & JARVIS, Gm 1, ph. 8309 (× 80).
Fig. 2: *Ammodiscus incertus* (D'ORBIGNY), Gm 1, ph. 7400 (× 90).
Fig. 3: *Glomospira charoides* (JONES & PARKER), Gm 1, ph. 8308 (× 240).
Fig. 4: *Spiroplectammina carinata* (D'ORBIGNY), Gm 1, ph. 7401 (× 95).
Fig. 5: ? *Eggerella* sp., Gm 1, ph. 8310 (× 160).
Fig. 6: *Nodosaria latejugata* GUEMBEL, Gm 1, ph. 7371 (× 50).
Fig. 7: *Dentalina* sp. cf. *D. ewaldi* (REUSS), Gmb 4, ph. 7366 (× 100).
Fig. 8: *Dentalina ludwigi* (REUSS), Gmb 4, ph. 7367 (× 50).
Fig. 9: *Dentalina pauperata* D'ORBIGNY, Gm 1, ph. 7368 (× 100).
Fig. 10: *Dentalina semilaevis* HANTKEN, Gm 1, ph. 7369 (× 100).
Fig. 11: *Dentalina* sp. cf. *D. soluta* REUSS, Gm 1, ph. 7370 (× 100).
Fig. 12: *Lagena hispida* REUSS, Gm —0,10 m, ph. 7361 (× 200).
Fig. 13: *Lagena semiornata* TERQUEM & TERQUEM, Gm 1, ph. 7363 (× 200).
Fig. 14: *Lagena striata* (D'ORBIGNY), Gm 1, ph. 7360 (× 200).
Fig. 15: *Lagena sulcata* (WALKER & JACOB), Gm 1, ph. 7365 (× 200).
Fig. 16: *Marginulina* sp. cf. *M. hosiusi* LANGER, Gm —0,10 m, ph. 7372 (× 50).
Fig. 17: *Globulina gibba* D'ORBIGNY, Gm 1, ph. 7410 (× 50).
Fig. 18: *Globulina* sp. cf. *G. laeviglobosa* TEN DAM, Gm 1, ph. 7409 (× 50).
Fig. 19: *Guttulina lactea* (WALKER & JACOB), Gm 1, ph. 7433 (× 90).

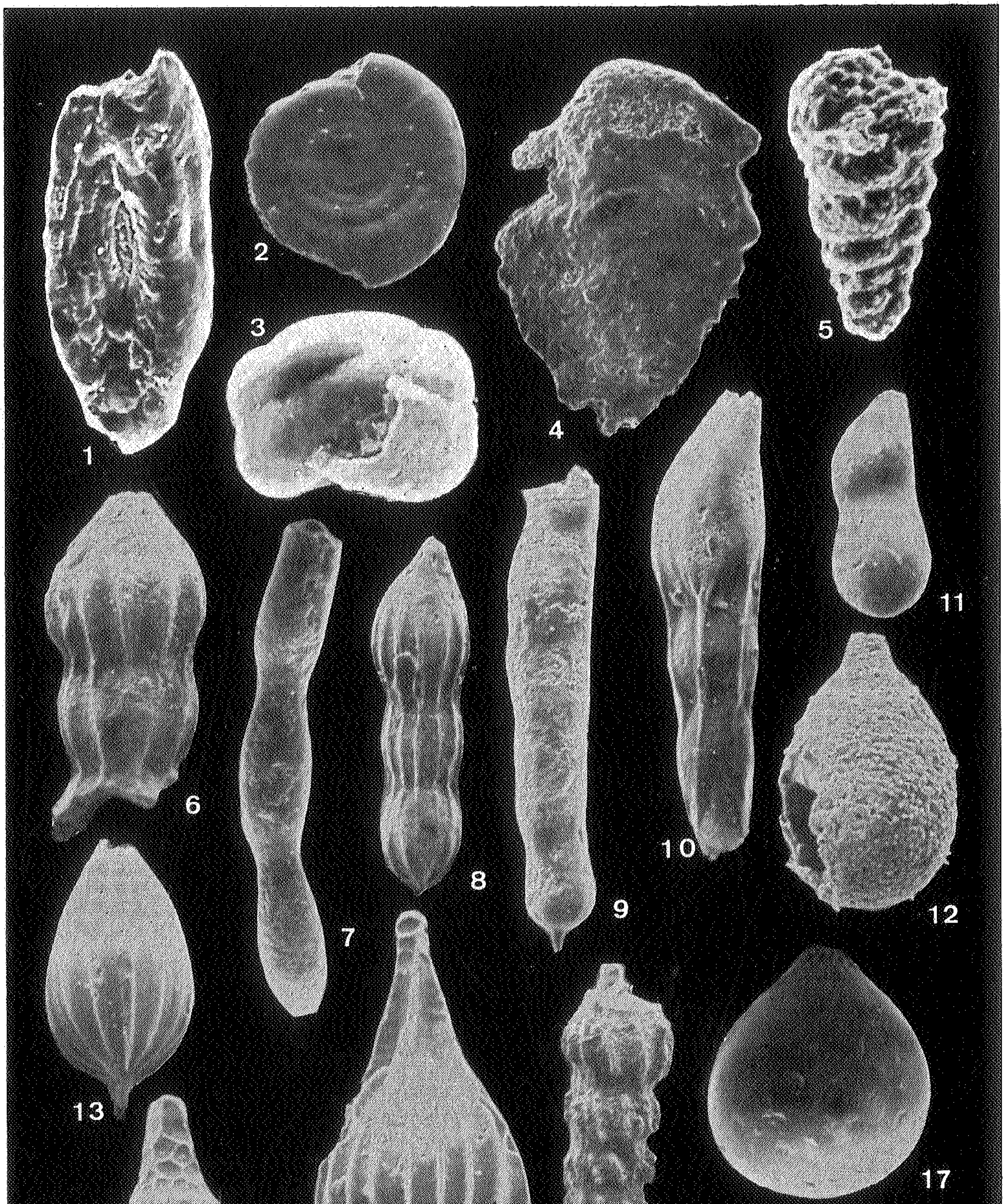
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PLATE 2

Fig. 1: *Guttulina irregularis* (D'ORBIGNY), Gm 1; a, lateral side, ph. 7425 (× 50); b, apertural side, ph. 7415 (× 50); c, lateral side, ph. 7435 (× 40).

Fig. 2: *Guttulina problema* (D'ORBIGNY), Gm 1, a lateral side, ph. 7426 (× 90); b, lateral side, ph. 7434 (× 90).

Fig. 3: *Guttulina* sp., Gm 1, ph. 8306, probably reworked specimen (× 90).

Fig. 4: *Glandulina* sp. cf. *G. aequalis* REUSS, Gmb 4, ph. 7374 (× 100).

Fig. 5: *Glandulina laevigata* (D'ORBIGNY), Gm 1, ph. 7373 (× 100).

Fig. 6: *Bolivina* sp., Gmb 10, ph. 7403, reworked specimen (× 230).

Fig. 7: *Bolivina fastigia* CUSHMAN, Gm 1, ph. 7404 (× 125).

Fig. 8: *Angulogerina gracilis* (REUSS) var. *germanica* CUSHMAN & EDWARDS, Gm 1, ph. 7484 (× 100).

Fig. 9: idem, Gm 1, ph. 7483 (× 100).

Fig. 10: *Angulogerina gracilis* (REUSS) var. *tenuistriata* (REUSS), Gm 1, ph. 8481 (× 100).

Fig. 11: idem, Gm 1, ph. 7475 (× 100).

Fig. 12: idem, Gm 1, ph. 7485 (× 100).

Fig. 13: *Cancris subconicus* (TERQUEM), Gm 1; a, umbilical side, ph. 7428; b, apertural side, ph. 7416; c, spiral side, ph. 7439 (× 100).

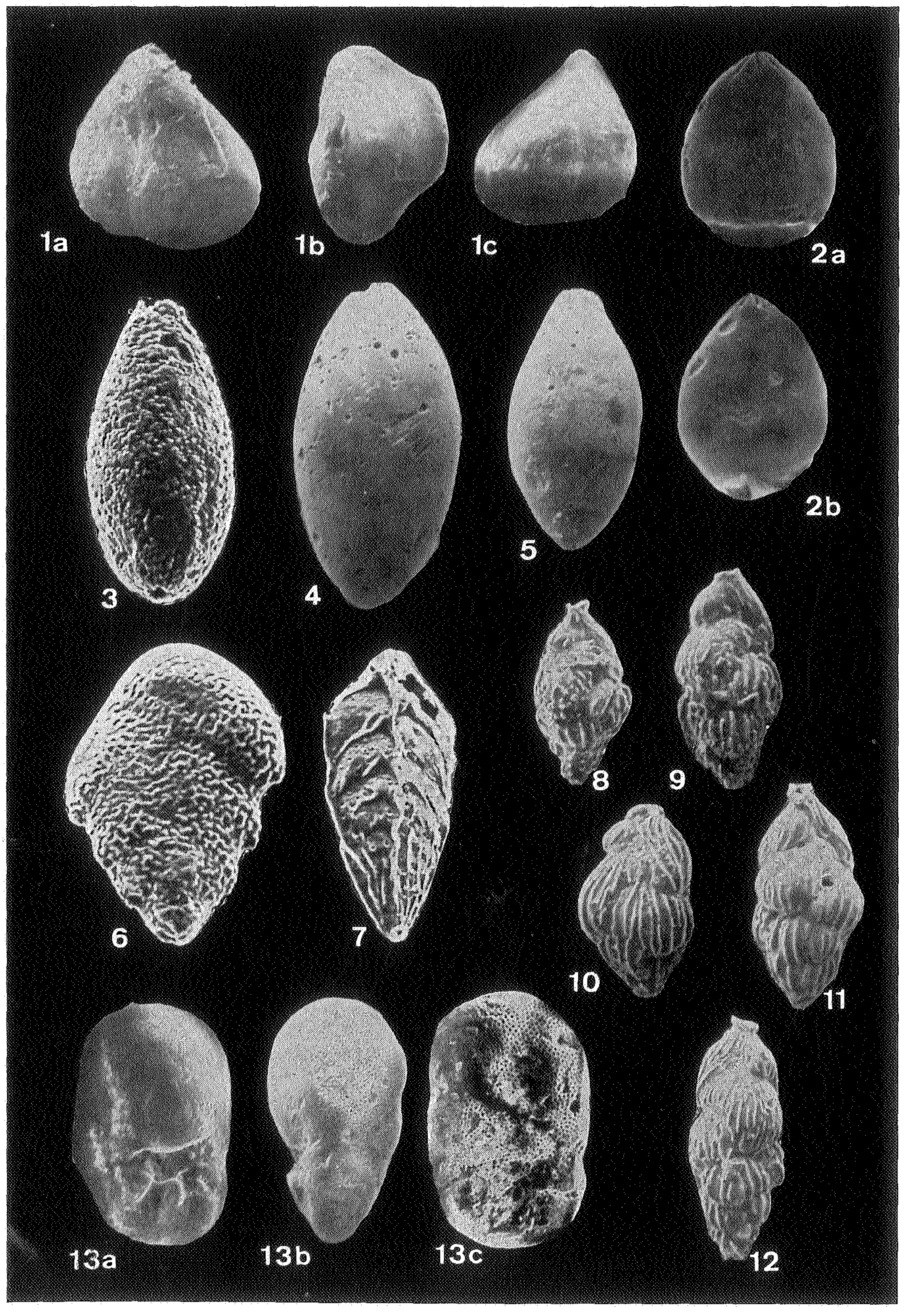
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PLATE 3

Fig. 1: *Asterigerina bartoniana* (TEN DAM), Gm 1; a, umbilical side, ph. 7436; b, apertural side, ph. 7419; c, spiral side, ph. 7431 (× 100).

Fig. 2: *Asterigerina brandhorstiana* GRAMANN, Gm 1; a, umbilical side, ph. 7432; b, apertural side, ph. 7420; c, spiral side, ph. 8305 (× 100).

Fig. 3: *Cribrononion moorkensi* n. sp., holotype, Gm 1; a, spiral side, ph. 7424 (× 200); b, apertural side, ph. 7413 (× 200); c, apertural area 7413 (× 500).

Fig. 4: *Cribrononion subnodosum* (ROEMER), Gm 1; a, spiral side, ph. 7423; b, apertural side, ph. 7414 (× 100).

Fig. 5: *Bifarina selseyensis* (HERON-ALLEN & EARLAND), Gm 1, ph. 7407 (× 100).

Fig. 6: idem, Gm 1, ph. 7408 (× 100).

Fig. 7: *Eponides pygmaeus* (HANTKEN), Gm —0,10 m; a, umbilical side, ph. 7430; b, apertural side ph. 7418; c, spiral side, ph. 7438 (× 100).

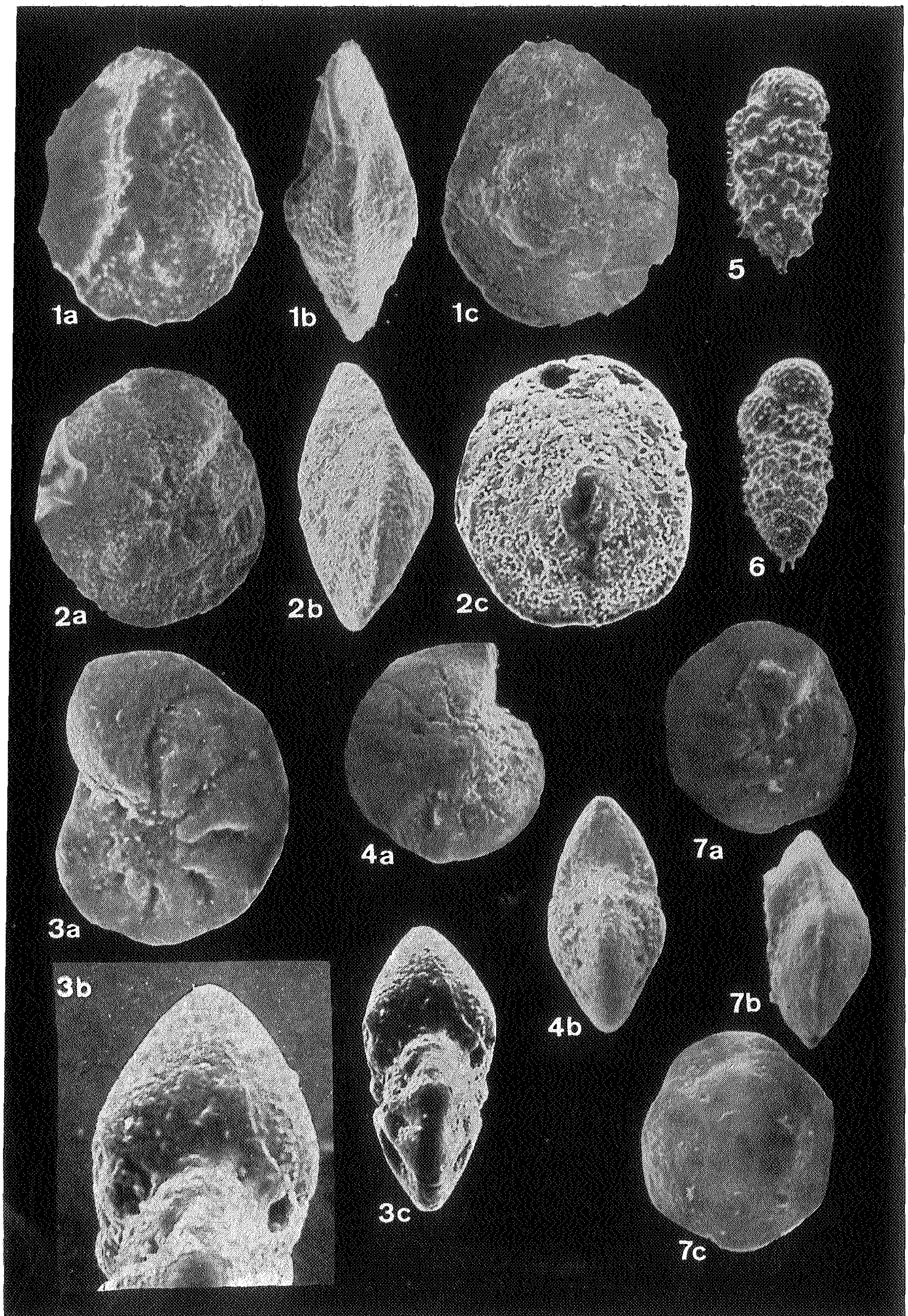
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PLATE 4

Fig. 1: *Cibicides lobatulus* (WALKER & JACOB), Gm 1; a, umbilical side, ph. 7461; b, apertural side, ph. 7445; c, spiral side, ph. 7454 (× 110).

Fig. 2: *Cibicides dutemplei* (D'ORBIGNY), Gm 1; a, spiral side, ph. 7449; apertural side, ph. 7441; c, umbilical side, ph. 7458 (× 50).

Fig. 3: *Cibicides lobatulus* (WALKER & JACOB), Gm 1; a. spiral side, ph. 7456; b, apertural side, ph. 7444; c, umbilical side, ph. 7460 (× 130).

Fig. 4: *Cibicides lobatulus* (WALKER & JACOB) var. *grimmertingensis* n. subsp., holotype, Gm 1; a, spiral side, ph. 7455; b, apertural side, ph. 7443; c & d, umbilical side, ph. 7452 (× 150).

Fig. 5: *Cibicides sulzensis* (HERRMANN), Gm 1; a, umbilical side, ph. 7459 (× 90); b, apertural side, ph. 7440 (× 100); c, spiral side, ph. 7450 (× 100).

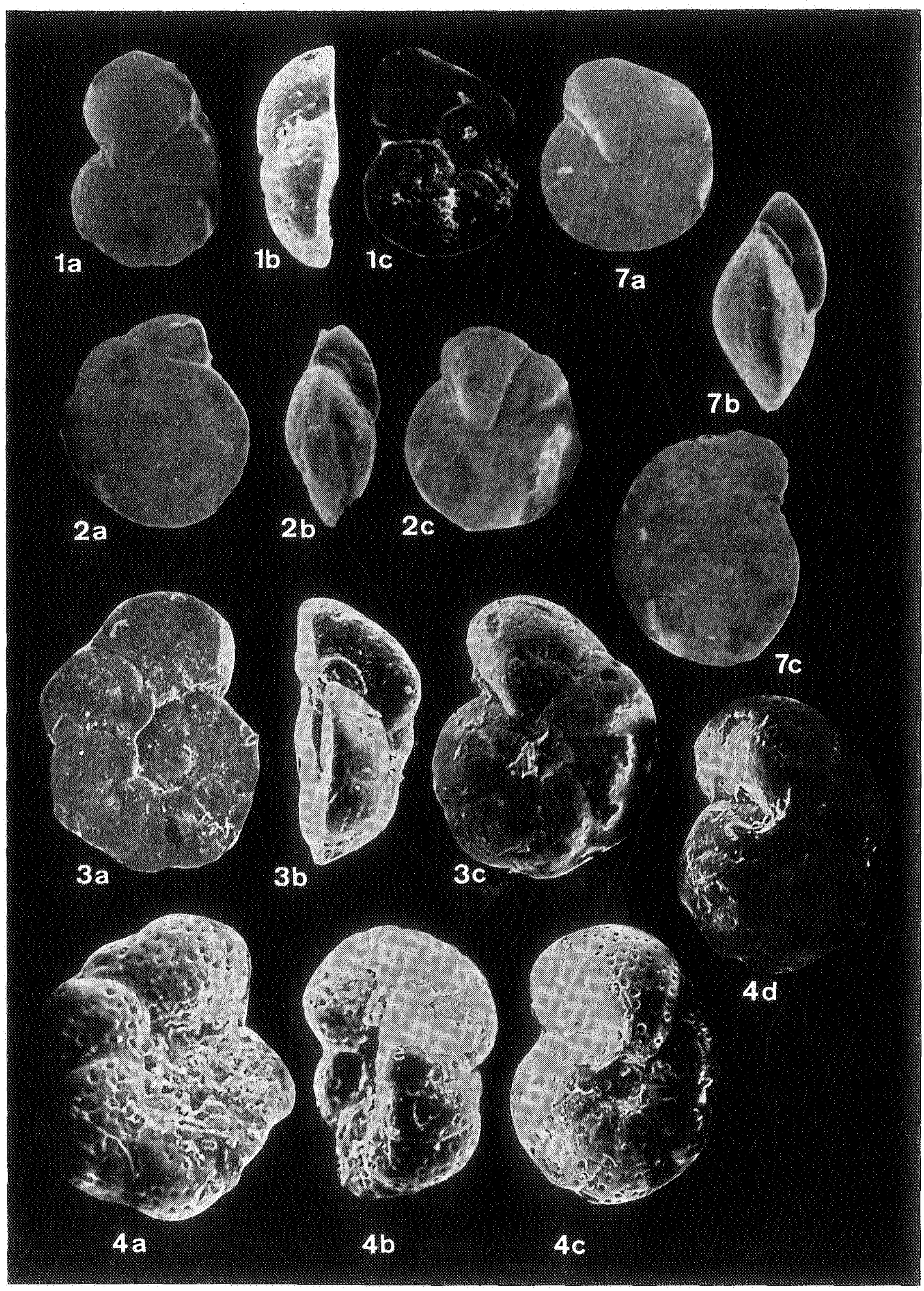
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PLATE 5

Fig. 1: *Cibicides tenellus* (REUSS), Gm 1; a, spiral side, ph. 7447; b, apertural side, ph. 7448; c, umbilical side, ph. 7463 (× 100).

Fig. 2: idem, Gm 1, spiral side, ph. 8307 (× 80).

Fig. 3: idem, Gm 1, apertural side, ph. 7446 (× 110).

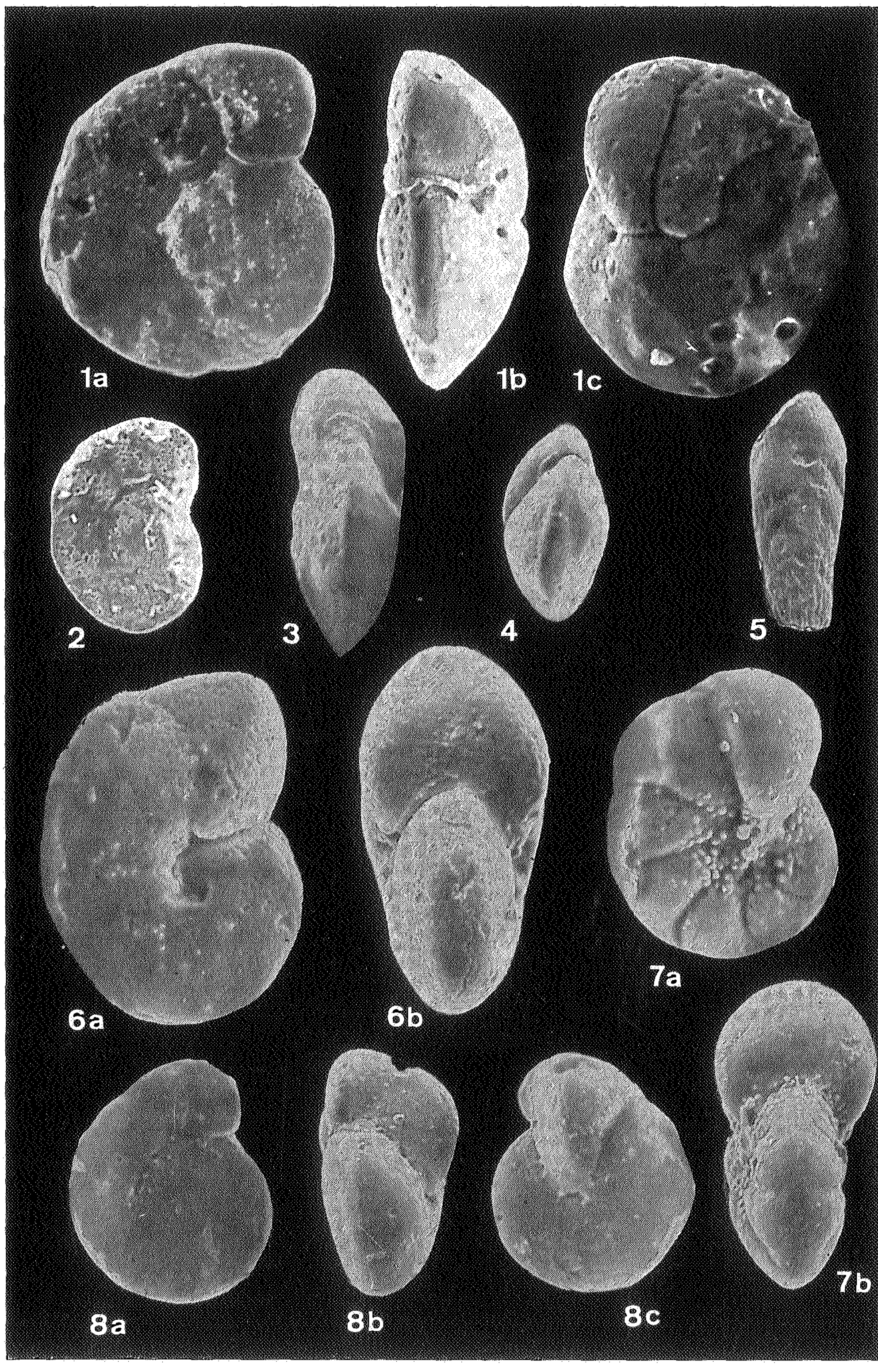
Fig. 4: *Cibicides dutemplei* (D'ORBIGNY), Gm 1, apertural side, ph. 7442 (× 50).

Fig. 5: *Loxostomum teretum* CUSHMAN, Gm —0,10 m, ph. 7402 (× 90).

Fig. 6: *Nonion affine* (REUSS), Gm 1; a, spiral side, ph. 7421; b, apertural side, ph. 7411 (× 90).

Fig. 7: *Nonion graniferum* (TERQUEM), Gm 1; a, spiral side, ph. 7422; b, apertural side, ph. 7412 (× 90).

Fig. 8: *Gyroidina* sp. cf. *G. octocamerata* CUSHMAN & HANNA, Gm 1; a, spiral side, ph. 7429; b, apertural side, ph. 7417; c, umbilical side, ph. 7137 (× 100)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