

NOTE ON THE BIOSTRATIGRAPHY (BENTHIC FORAMINIFERA) AND LITHOSTRATIGRAPHY OF PLIOCENE DEPOSITS AT KALLO (OOST-VLAANDEREN; BELGIUM)

H. Nuyts,
LABORATORIUM VOOR PALEONTOLOGIE, GEOLOGISCH INSTITUUT,
RIJKS UNIVERSITEIT GENT, BELGIUM

Nuyts, H. Note on the biostratigraphy (benthic Foraminifera) and lithostratigraphy of Pliocene deposits at Kallo (Oost-Vlaanderen; Belgium). — Contr. Tert. Quatern. Geol., 27(1): 17-24, 3 figs, 2 pls. Leiden, June 1990.

In a temporary exposure near Kallo, west of Antwerp, Belgium, Pliocene strata (14.65 metres thick) were examined. These lie discordantly over the Putte Member (Boom Clay Formation) of Oligocene age. Between the levels of 17.60 and 8.30 metres, sands of the Kattendijk Formation contain a benthic foraminifer association typical of the BFN 4 Assemblage Zone (*Florilus boueanus-Monspeliensina pseudotepida*). The palaeoecological parameters indicate a shelf sea with normal salinity. The overlying Oorderen Sands Member (Lillo Formation), has a thickness of 5.35 metres. Its foraminiferal content is typical of the BFN 6 Assemblage Zone (*Elphidiella hannai-Cribronion excavatum*). Palaeoecologically, a change into a rather shallow, high-energy environment is to be noted.

Key words — Biostratigraphy, lithostratigraphy, palaeoecology, Foraminifera, Pliocene, Belgium.

Dr H. Nuyts, Laboratorium voor Paleontologie, Geologisch Instituut, Rijksuniversiteit Gent, Krijgslaan 281-S8, B-9000 Gent, Belgium.

CONTENTS

Introduction	p. 17
Historical review	p. 17
Location and description of the section.....	p. 19
Lithostratigraphy.....	p. 20
Biostratigraphy	p. 20
Palaeoecology	p. 22
Acknowledgements.....	p. 24
References	p. 24

INTRODUCTION

Because of large scale excavations in the Antwerp harbour area, regularly new temporary exposures of Neogene sediments can be studied. Between March and April of 1983, a section was sampled in the vicinity of Kallo (province of Oost-Vlaanderen). The main purpose of this investigation was the description of the lithostratigraphic units defined by de Meuter & Laga (1976).

Secondly, an attempt was made to apply the biozonation of Doppert, Laga & de Meuter (1979),

which is based on the benthic Foraminifera. These biozones are usually designated by the symbols BFN 1 to BFN 6, B standing for Belgium, F for Formation and N for Neogene.

A short account of some of the most important studies of the Neogene deposits of the Antwerp area, as well as some remarks on the palaeoecology of the sediments exposed are included.

HISTORICAL REVIEW

In 1862, Reuss studied the Foraminifera of the Antwerp Crag, mentioning 60 species, 13 of which were new. Miller & van den Broeck (1872) considered the deposits studied by Reuss to be of Diestian and Scaldisian age. In 1898, van den Broeck compared the Foraminifera from the Pliocene deposits of the Antwerp area with those of the Belgian Miocene and of the British 'Crag' (Pliocene).

Van Voorthuysen & Pannekoek (1950) published an article on the stratigraphy of Pliocene

sediments in Belgium, the Netherlands and Great Britain. In 1955, Glibert & de Heinzelin listed the Foraminifera of the Late Miocene, which had been identified by van Voorthuysen. Van Voorthuysen (1958) studied the Foraminifera from the Neogene and Quaternary of the Kruisschans locality, near Antwerp.

In 1963 van Voorthuysen described the foraminiferal fauna from the Kattendijk, Luchtbal and Kallo Sands, which had been exposed during the excavations for the "Zesde Havendok" of the Antwerp harbour. De Meuter (1965) described the Foraminifera from Middle Miocene deposits at Terhagen, south of Antwerp, and discussed the palaeoecology of these faunas. Van den Bosch (1965) described the Pliocene lithostratigraphical

units exposed near the "Vierde Havendok". In 1969, van Voorthuysen & Toering reviewed Neogene and Quaternary Foraminifera of the Antwerp region.

Gaemers (1972) and Gaemers & Janssen (1972) discussed the stratigraphy and presented some palaeoecological remarks on sections exposing Pliocene to Holocene deposits near Kallo. Laga (1972) extensively studied the marine Plio-Pleistocene deposits near Antwerp and their foraminiferal faunas. In 1974, Janssen described the lithology and the fossil content (mainly Mollusca) of sediments of Oligocene, Pliocene and Quaternary age, exposed in a temporary excavation near Kallo, while Gaemers (1975a, b) provided a palaeoecological reconstruction of the

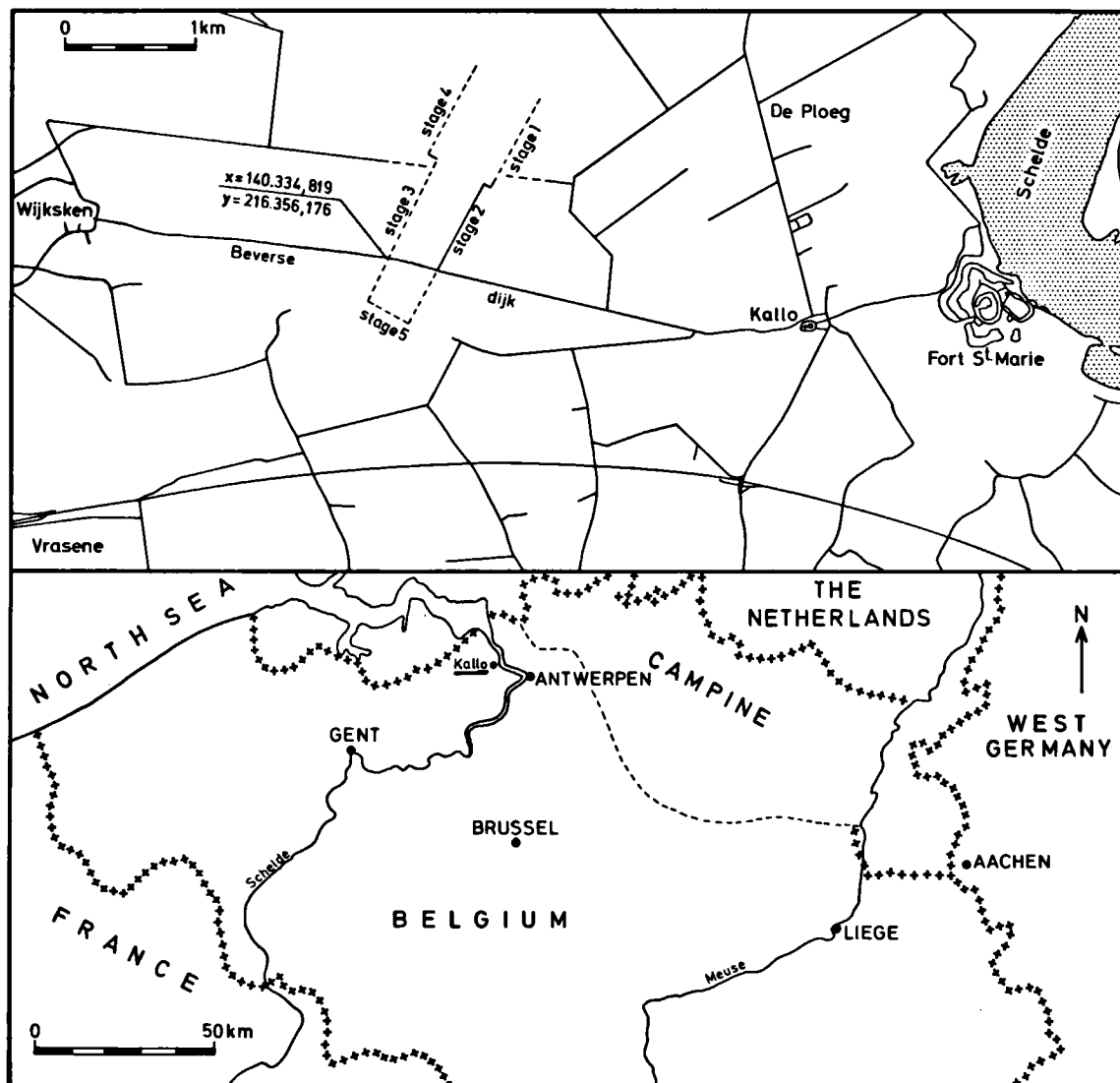


Fig. 1. Location of the exposure at Kallo.

Pliocene strata from the same locality. De Meuter & Laga (1976) published an overview of the lithostratigraphy and the biostratigraphy based on benthic Foraminifera of the Neogene deposits of northern Belgium. A correlation with the Neogene of The Netherlands was established by Doppert, Laga & de Meuter (1979).

De Meuter (1980) dealt with the Miocene foraminiferal fauna of the Antwerp area. Marquet (1984) published an exhaustive account of a molluscan association, found in a part of the Kattendijk Formation, as exposed during excavations for a harbour dock at Kallo.

LOCATION AND DESCRIPTION OF THE SECTION

The village of Kallo in the province of Oost-Vlaanderen, is situated approximately eight kilometres west of Antwerp (Fig. 1). Some three kilometres west of Kallo, excavations were made for the construction of the "Vierde Havendok" (= Fourth Harbour Dock). Five stages were scheduled, each stage comprising the excavation of a trench, in which a concrete dock wall was built. The sampling, in March and April of 1983, was done at the start of the second stage.

A full lithological description of the section is given below, with depths indicated in metres below surface (Fig. 2):

- 0.00- 2.40 m Holocene deposits: sandy clay, peat;
- 2.40- 2.70 m purple to brown sands, with paler spots, small fragments of wood;
- 2.70- 2.80 m brownish sands;
- 2.80- 2.95 m pale beige medium grained sands, with diffuse rusty coloured spots;
- 2.95- 3.40 m alternation of fine laminations of sand and greenish clayey bands;
- 3.40- 3.60 m green clayey medium grained sands and brownish grey medium coarse sands, with shell remains;
- 3.60- 3.70 m brown sands, with large fragments of Mollusca;
- 3.70- 5.20 m greyish brown clayey sands, with many small shell fragments, only few complete Mollusca;
- 5.20- 5.40 m grey clayey sands;
- 5.40- 5.50 m shell layer;
- 5.50- 6.05 m greyish brown fine to medium coarse sands, slightly clayey, rich in shell remains;
- 6.05- 6.20 m shell layer, with a wavy pattern;
- 6.20- 7.70 m brownish fine to medium coarse sands, with fragments of Mollusca;
- 7.70- 8.30 m shell layer, with an undulating base;
- 8.30-11.90 m grey green, glauconite-rich sands, with numerous shells and bioturbations;
- 11.90-12.00 m shell layer, with Brachiopoda, *Pecten*, *Serpula* and bone fragments;
- 12.00-17.40 m greyish green sands, locally bioturbated;
- 17.40-17.60 m greyish green sands, with black phosphatic nodules;
- 17.60-18.20 m clay, bioturbated at the top, infilled with greyish green sands.

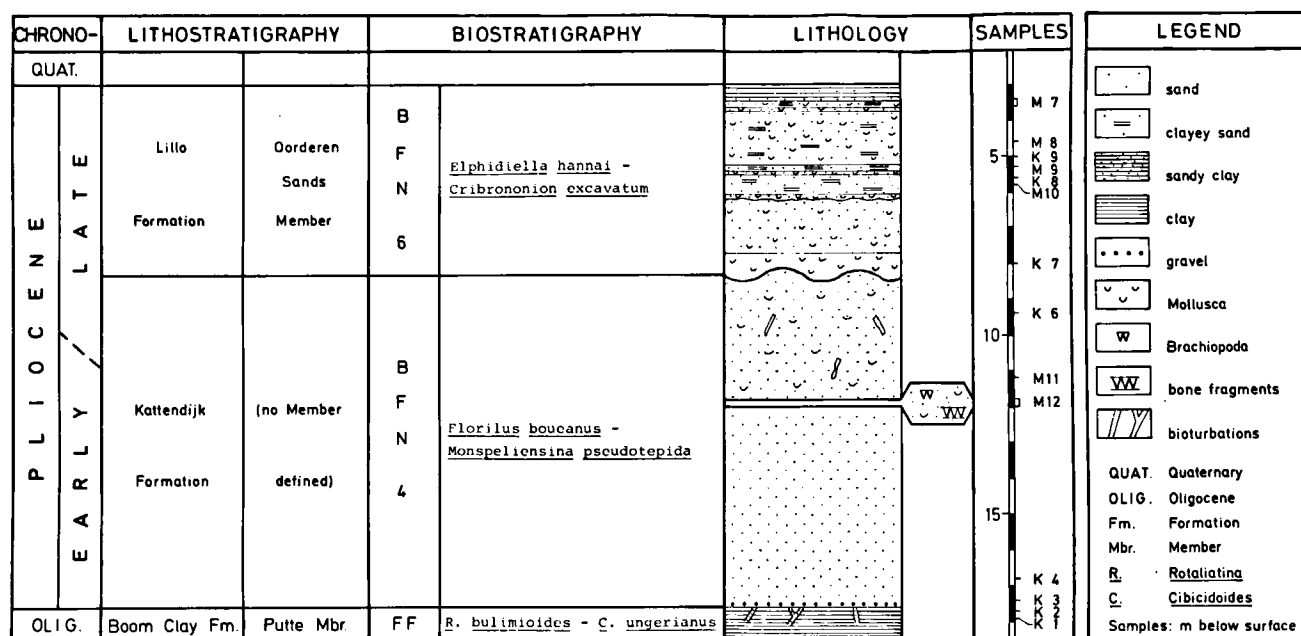


Fig. 2. Stratigraphy and lithology.

LITHOSTRATIGRAPHY

A sedimentary sequence 14.65 metres thick is assigned a Pliocene age (Fig. 2). It discordantly overlies the Putte Member, Boom Clay Formation (Middle Oligocene).

The Kattendijk Formation (Pliocene), with a basal gravel (at 17.40-17.60 m below surface), comprises greyish green sands, and is approximately 9.30 metres thick. It is overlain by the Lillo Formation, which is 5.35 metres thick (between 8.30 and 2.95 m below surface). The Luchtbal Sands Member could not be recognised.

The Oorderen Sands Member rests directly upon the Kattendijk Formation and is marked by a thick shell layer at its base. The Kruisschans Sands Member, the Merksem Sands Member and the Zandvliet Sands Member are also absent at this locality. The top sequence, above the 2.95 m below surface level, is taken to be of Quaternary age.

BIOSTRATIGRAPHY

Twelve samples from the Pliocene strata were studied for their benthic foraminiferal content. From the sediments of the Kattendijk Formation the author extracted an association which is typical of the BFN 4 (*Florilus boueanus-Monspeliensina pseudotepida* Assemblage Zone). Both species are frequent to abundant (up to 18%) in all samples of the Kattendijk Formation. At the base a very large number of specimens belonging to the genus *Bolboforma* (see von Daniels & Spiegler, 1974) occur (Fig. 3). Initially, the exact origin of these cysts was unknown. Recent investigations (Spiegler, 1987) have proved their affinities with the Chrysophyceae, although the precise position within this class is still unknown (Tappan, 1980). In sample K3 (see Fig. 2), representatives of *Bolboforma* make up 82.5% of the total of benthic Foraminifera plus algal cysts. Probably two species can be distinguished, only one of these, *B. costairregularis* (Toering & van Voorthuysen, 1973) has been described before. Reference is made to Nuyts (in prep.) for more details on this topic.

The specific elements of the foraminiferal fauna are *Globulina gibba* d'Orbigny, 1826 forma *paucicrassicosta* van Voorthuysen & Toering, 1969, *Trifarina angulosa* Cushman, 1923, *T. bradyi* Cushman, 1923, *Buccella frigida* (Cushman, 1922), *Epistominella oveyi* (Bhatia, 1955), *Monspeliensina pseudotepida* (van Voorthuysen, 1950), *Cibicides lobatula* (Walker & Jacob, 1798), *Florilus boueanus* (d'Or-

bigny, 1846) and *Heterolepa dutemplei* (d'Orbigny, 1846). No representatives of *Rosalina globularis* d'Orbigny, 1826, a species indicated by Laga (1972) to be also characteristic of the BFN 4 Zone, were observed. The Kattendijk Formation yielded 68 species of benthic Foraminifera. The transition with the underlying Boom Clay Formation is marked by the sudden increase in number of several taxa; for example, with *Cibicides lobatula*, the percentage becomes ten times as high as in the Boom Clay: up to 20% of the total foraminiferal content.

The Oorderen Sands Member yielded a fauna typical of the zone BFN 6 (*Elphidiella hannai-Cribronion excavatum* Assemblage Zone). The association is characterised by *Quinqueloculina seminula* (Linné, 1758), *Buccella frigida* (Cushman, 1922), *Discorbitura cushmani* Margerel, 1968, *Pararotalia serrata* (ten Dam & Reinhold, 1941), *Cribronion excavatum* (Terquem, 1875), *C. haagensis* (van Voorthuysen, 1950), *Elphidiella hannai* (Cushman & Grant, 1927), *Cibicides lobatula* (Walker & Jacob, 1798) and *Cassidulina obtusa* Williamson, 1858. The BFN 5 Peak Zone, which is characterised by the occurrence of high numbers (50 to 60%) of *Cibicides lobatula* is absent at this locality. The boundary with the underlying Kattendijk Formation is marked by a relatively sudden percentage increase of *Buccella frigida* and the genus *Elphidium*, and decreasing numbers of *Florilus boueanus* and *Epistominella oveyi*. In the Oorderen Sands Member 57 benthic foraminiferal species were found.

Plate 1

Florilus boueanus (d'Orbigny, 1846).

Fig. 1. Side view, sample K6, Kattendijk Formation.

Fig. 2. Apertural view, sample K4, Kattendijk Formation.

Cibicides lobatula (Walker & Jacob, 1798).

Fig. 3. Side view, sample K4, Kattendijk Formation.

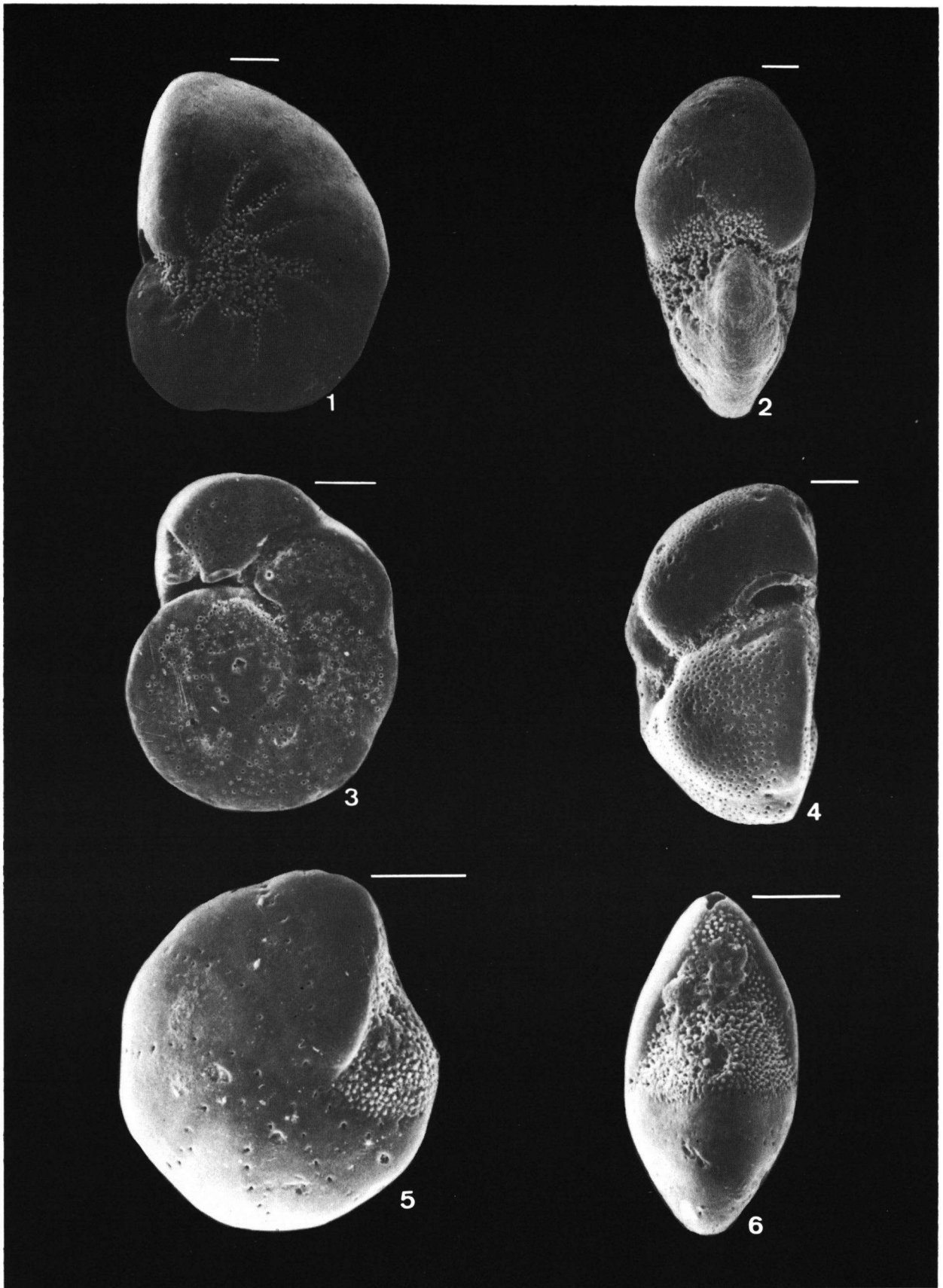
Fig. 4. Apertural view, sample K6, Kattendijk Formation.

Elphidiella hannai (Cushman & Grant, 1927).

Fig. 5. Side view, sample M8, Oorderen Sands Member, Lillo Formation.

Fig. 6. Apertural view, sample K9, Oorderen Sands Member, Lillo Formation.

Scale bars represent 0.100 mm.



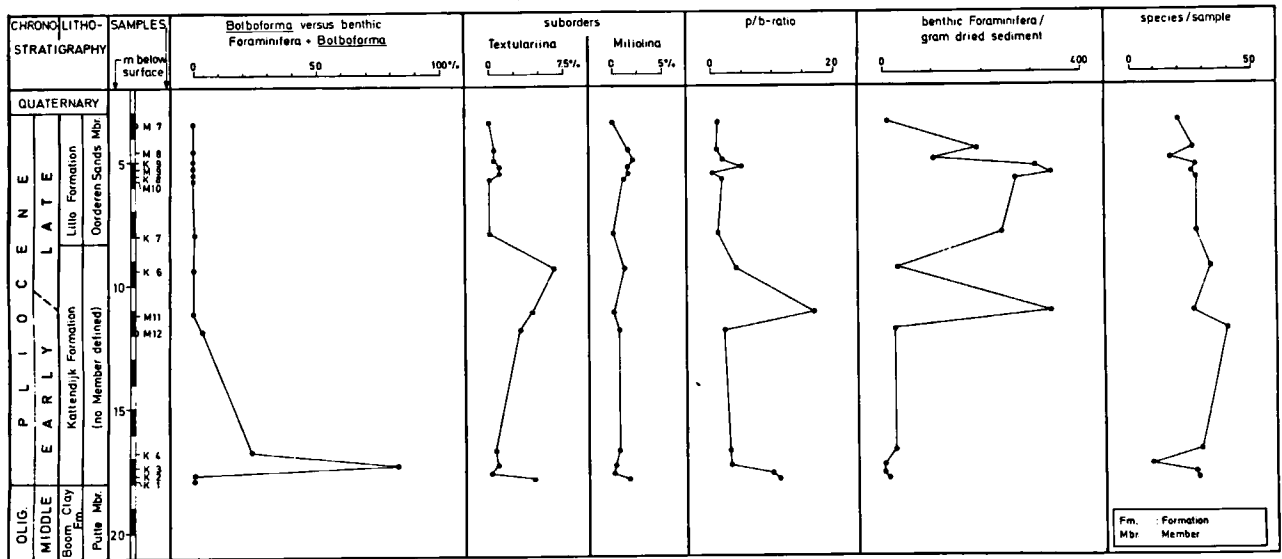


Fig. 3. Palaeoecological parameters and the occurrence of *Bolboforma*.

PALAEOECOLOGY

Five palaeoecological parameters were used (Fig. 3); the dominant taxa, the percentages of the suborders, the ratio of planktonic against benthic Foraminifera (p/b-ratio), the number of specimens per gram of dried sediment and the number of species per sample.

The deposits of the Kattendijk Formation are dominated by the Buliminacea (up to 21%), the Cassidulinidae (maximum 18.5%) and the genus *Cibicides* (23.5% in sample K6). At the top of the formation the Polymorphinidae and Nonionidae show increasing numbers. The high frequencies of Buliminacea, with *Trifarina*, and the Cassidulinidae, with *Cassidulina*, are characteristic of a normal marine habitat, which can, however, vary from a shelf sea to a bathyal environment (Murray, 1973). Also the (limited) occurrence of species such as *Globulina gibba*, and *Rotalia propinqua*, together with the absence of *Elphidium* and the low number of representatives of *Cribronion* suggest a marine environment with a normal salinity. Because *Cibicides lobatula* has an epiphytic mode of life, the high frequency is indicative of an environment with a dense vegetation. Compared with the Murray's triangle diagramme (1973), the proportions of the suborders are atypical. The p/b-ratio and the proportion of the number of species versus the number of specimens are too variable to allow a palaeoecological interpretation. Gaemers (1972) interpreted the main body of the Kattendijk Formation to have

been deposited in a sea with a depth of at least a few tens of metres, not very close to the main land. This is evidenced by the regular occurrence of a species of the articulate brachiopod genus *Terebratula*, found *in situ*.

In the Oorderen Sands Member the most dominant groups are the Discorbidae (up to 24.5%), *Cibicides* (maximum of 44.5%) and *Cribronion* (30.5% in sample M7). The occurrence of numerous specimens of the genus *Cribronion* is typical of a high energy environment, with much displacement of sediment. *Cribronion excavatum* is charac-

Plate 2

Monspeliensina pseudotepida (van Voorthuysen, 1950).

Fig. 1. Side view, sample K6, Kattendijk Formation.

Fig. 2. Side view, sample K9, Oorderen Sands Member, Lillo Formation.

Fig. 3. Apertural view, sample M12, Kattendijk Formation.

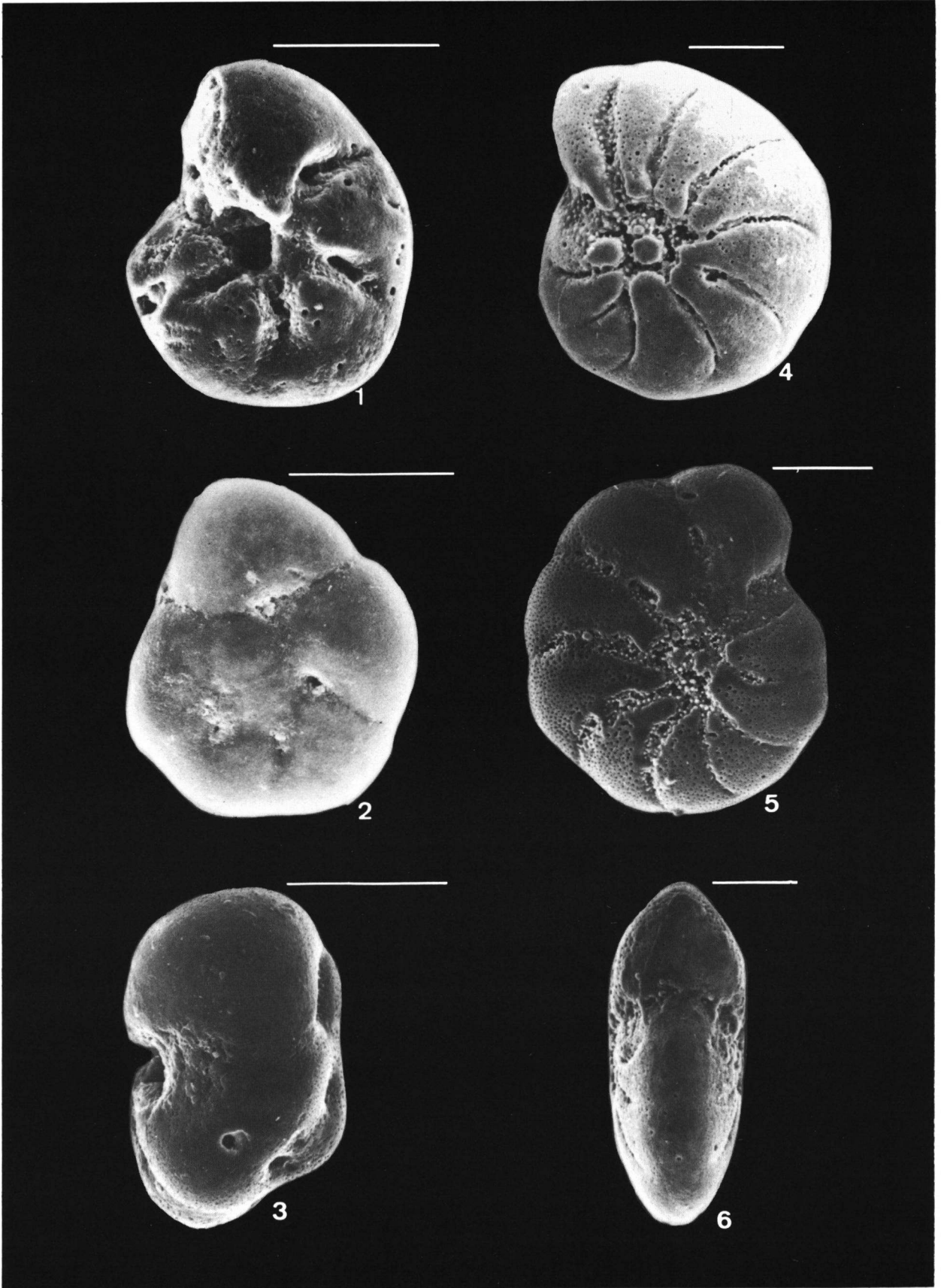
Cribronion excavatum (Terquem, 1875).

Fig. 4. Side view, sample M9, Oorderen Sands Member, Lillo Formation.

Fig. 5. Side view, sample M7, Oorderen Sands Member, Lillo Formation.

Fig. 6. Apertural view, sample K9, Oorderen Sands Member, Lillo Formation.

Scale bars represent 0.100 mm



teristic of an environment with highly variable parameters, such as temperature and salinity (Phleger, 1960). The decreasing number of specimens of the genus *Bolivina* indicates a less deep environment than that prevailing during the deposition of the sediments of the Kattendijk Formation. The sudden increase of *Elphidiella hannai* is also an indication of a shallow, high energy environment.

From the base of the Oorderen Sands Member upwards, the abundance of *Elphidium* suddenly increases, probably due to a change in environment. The genus *Elphidium* is characteristic of a shallow water niche, more precisely of hypersaline tidal zones and lagoons, near the coast line. The occurrence of *Cibicides lobatula* indicates the one-time presence of vegetation. The strong dominance of the suborder Rotaliina is not typical. The rather low p/b-ratio suggests a nearshore environment, as does the low number of species versus the number of specimens. According to King (1983) the absence of *Cibicides grossus* in the Lillo Formation may reflect a predominantly shallow marine facies.

ACKNOWLEDGEMENTS

I am greatly indebted to the late Dr W. Willems (Laboratorium voor Palaeontologie, R. U. Gent) for the initiation in the study of foraminifers). Dr E. Steurbaut (Laboratorium voor Palaeontologie, R. U. Gent) and Lic. Geol. H. Pelckmans assisted in sampling and describing the studied section. I thank Dr N. Ainsworth (Trinity College, Dublin) for correcting the English text. I acknowledge the technical assistance of Mr D. Bavay, Mr T. Temmerman and Mrs N. Reynaert.

REFERENCES

- Bosch, M. van den, 1965. Een interessante ontsluiting bij het 4^e dok te Antwerpen. — Meded. Werkgr. Tert. Kwart. Geol., 2: 62-64, 1 fig.
- Broeck, E. van den, 1898. Petites notes rhizopodiques. — Ann. Soc. Malac. Belgique, 33: 39-50.
- Daniels, C. H. von, & D. Spiegler, 1974. Bolboforma n. gen. (Protozoa ?) — eine neue stratigraphisch wichtige Gattung aus dem Oligozän/Miozän nordwestdeutschlands. — Paläont. Z., 48(1/2): 57-76, 10 pls, 3 figs.
- Doppert, J. W. C., P. G. Laga & F. J. de Meuter, 1979. Correlation of the biostratigraphy of marine Neogene deposits, based on benthonic Foraminifera, established in Belgium and The Netherlands. — Meded. Rijks Geol. Dienst, 31-1: 8 pp., 2 tab., 1 fig., 1 pl.
- Gaemers, P. A. M., 1972. Geologische beschrijving van het profiel van de bouwput voor de nieuwe zeeluis te Kallo (België, prov. Oost Vlaanderen), en een palaeo-ecologische interpretatie van de verschillende afzettingen. — Meded. Werkgr. Tert. Kwart. Geol., 9(1): 23-33.
- Gaemers, P. A. M., 1975a. Enkele paleo-ecologische opmerkingen over de pliocene afzettingen in de tunnelput nabij Kallo, België, provincie Oost Vlaanderen, 1. — Meded. Werkgr. Tert. Kwart. Geol., 12(1): 25-37.
- Gaemers, P. A. M., 1975b. Enkele paleo-ecologische opmerkingen over de pliocene afzettingen in de tunnelput nabij Kallo, België, provincie Oost Vlaanderen, 2. — Meded. Werkgr. Tert. Kwart. Geol., 12(2): 43-49.
- Gaemers, P. A. M., & A. W. Janssen, 1972. Geologische beschrijving van het profiel van de bouwput voor de nieuwe zeeluis te Kallo (België, prov. Oost-Vlaanderen), en een palaeo-ecologische interpretatie van de verschillende afzettingen. — Meded. Werkgr. Tert. Kwart. Geol., 9(1): 23-33, 2 figs.
- Glibert, M., & J. de Heinzelin de Braucourt, 1955. La faune et l'âge Miocène supérieur des Sables de Deurne. — Bull. Inst. r. Sc. Nat. Belg., 31(71): 1-27; 31(72): 1-12.
- Janssen, A. W., 1974. Het profiel van de bouwput onder het eerste kanaaldok nabij Kallo, provincie Oost Vlaanderen, België. — Meded. Werkgr. Tert. Kwart. Geol., 11: 173-185, 3 figs.
- King, C., 1983. Cainozoic micropalaeontological biostratigraphy of the North Sea. — Rep. Inst. Geol. Sci., 82/7: ii + 40 pp., 7 figs, 6 pls.
- Laga, P. G., 1972. Stratigrafie van de mariene plio-pleistocene afzettingen uit de omgeving van Antwerpen met een bijzondere studie van de foraminiferen, 1. Biostratigrafie-paleoecologie-chronostratigrafie; 2. Systematische beschrijving van de foraminiferen. Leuven (Ph. D. thesis Kath. Univ. Leuven), 252 pp. (1); 299 pp. (2) (unpubl.).
- Marquet, R., 1984. A remarkable molluscan fauna from the Kattendijk Formation (Lower Pliocene) at Kallo (Oost-Vlaanderen, Belgium). — Bull. Belg. Ver. Geol., 93(4): 335-345.
- Meuter, F. de, 1965. Etude paléo-écologique des foraminifères des Sables d'Edegem (Miocène Moyen) à Terhaegen (prov. d'Anvers). — Bull. Soc. belge Géol., 74: 53-59.
- Meuter, F. de, 1980. Benthonic Foraminifera from the Miocene of Belgium. — Aardk. Meded., 1: 77-170, 8 pls.
- Meuter, F. J. de, & P. G. Laga, 1976. Lithostratigraphy and biostratigraphy based on benthonic Foraminifera of the Neogene deposits of northern Belgium. — Bull. Soc. belge Géol., 85(4): 133-152, 3 tabs, 1 pl.
- Miller, H. J., & E. van den Broeck, 1872. Les foraminifères vivants et fossiles de la Belgique. — Ann. Soc. Malacol. Belg., 7: 15-46, 2 tabs.
- Murray, J. W., 1973. Distribution and ecology of living benthic foraminiferids. London (Heinemann Educational Books), 274 pp.
- Nuyts, H., in prep. The genus Bolboforma (Chrysophyceae) in Neogene deposits of Belgium and The Netherlands. — Phleger, F. B., 1960. Ecology and distribution of recent Foraminifera. Baltimore (The Johns Hopkins Press), 297 pp.
- Reuss, A. E., 1862. Les foraminifères du Crag d'Anvers. — Bull. Acad. r. Sc. Belgique, (2)15: 137-162, 3 pls.
- Spiegler, D., 1987. Encapsulated Bolboforma (Algae, Chrysophyta) from Late Miocene deposits in the North Atlantic. — Meded. Werkgr. Tert. Kwart. Geol., 24(1-2): 157-166, 3 pls.

- Tappan, H., 1980. The paleobiology of plant protists. San Francisco (W.H. Freeman), xxi + 1028 pp.
- Voorthuysen, J. H. van, 1958. Les foraminifères mio-pliocènes et quaternaires du Kruisschans. — Mém. Inst. r. Sc. Nat. Belgique, 142: 1-34, 10 pls.
- Voorthuysen, J. H. van, 1963. De foraminiferen van drie monsters van het Zesde Havendok, Antwerpen. — Bull. Soc. belge Géol., 8(6): 225-229. *In*: Symposium sur la stratigraphie du Néogène Nordique, Gand, 1961.
- Voorthuysen, J. H. van, & A. J. Pannekoek, 1950. La distribution verticale quantitative des foraminifères du Diestien, du Scaldisien et du Poederlien au Kruisschans près d'Anvers. — Bull. Soc. belge Géol., 59: 204-212.
- Voorthuysen, J. H. van, & K. Toering, 1969. Distribution quantitative des foraminifères neogènes et quaternaires aux environs d'Anvers. — Meded. Rijks Geol. Dienst, (n.s.)20: 93-123, 8 pls.

Manuscript received 31 October 1989, revised version accepted 21 February 1990