ISSN 0378-0902

MINISTERE DES AFFAIRES ECONOMIQUES MINISTERIE VAN ECONOMISCHE ZAKEN

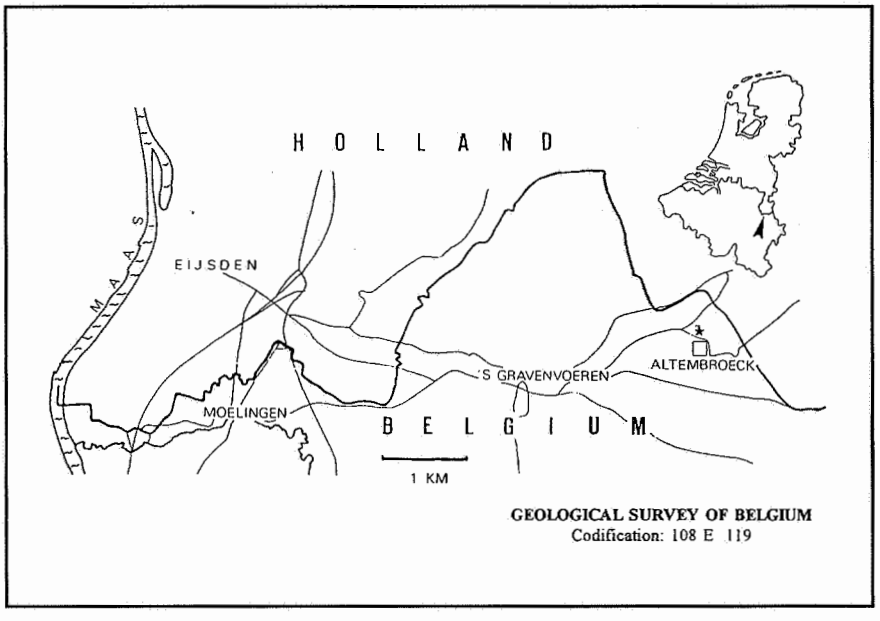
ADMINISTRATION DES MINES
ADMINISTRATIE VAN HET MIJNWEZEN

PRELIMINARY REPORT OF FIELD WORK AT ALTEMBROECK (NE BELGIUM, EARLY MAASTRICHTIAN)

by

THE WORKING GROUP BEUTENAKEN/VIJLEN MEMBERS

1995



PROFESSIONAL PAPER 1995/1 - N. 276

MINISTERE DES AFFAIRES ECONOMIQUES - MINISTERIE VAN ECONOMISCHE ZAKEN
ADMINISTRATION DES MINES - ADMINISTRATIE VAN HET MIJNWEZEN
SERVICE GEOLOGIQUE DE BELGIQUE - BELGISCHE GEOLOGISCHE DIENST
PROFESSIONAL PAPER 1995/1 , N.276, 20 p., 3 fig.

PRELIMINARY REPORT OF FIELD WORK AT ALTEMBROECK (NE BELGIUM, EARLY MAASTRICHTIAN)

by

THE WORKING GROUP BEUTENAKEN/VIJLEN MEMBERS [1]

1995

John W.M. JAGT[2], Mart DECKERS[3], Annie V. DHONDT[4],
Rudi W. DORTANGS[5], P.J. (Sjeuf) FELDER[6], Werner M. FELDER[7],
Manfred JÄGER[8], Norbert KEUTGEN[9], Marcel KUYPERS[10],
Ger MICHELS[11], Jef REYNDERS[12], Eric SIMON[13],
Raymond VAN DER HAM[14], Paul VAN KNIPPENBERG[15]
& Renée VAN NEER[16]

Edition
Imprimerie du Ministère des Affaires Economiques
Rue de Mot, 24-26 - 1040 Bruxelles
Avril 1995

Comité éditorial : L. Dejonghe, P. Laga, R. Paepe
Service Géologique de Belgique
Rue Jenner, 13 - 1040 Bruxelles

Uitgeverij
Drukkerij van het Ministerie van Economische Zaken
De Motstraat, 24-26 - 1040 Brussel
April 1995

Commissie van uitgevers : L. Dejonghe, P. Laga, R. Paepe
Belgische Geologische Dienst
Jennerstraat, 13 - 1040 Brussel

ABSTRACT.

- Rich collections of macro- and microfossils collected during recent field work at a section exposing strata assigned to the Vijlen Member of the Gulpen Formation, of early Maastrichtian age, at Altemb-roeck (municipality of 's Gravenvoeren [Fouron-le-Comte], province of Limburg, Belgium) are briefly described and the resultant biozonation discussed. Belemnites suggest a correlation of part of the Altembroeck section with the middle sumensis Zone (late Early Maastrichtian) of the NW German standard section at Kronsmoor. Benthic foraminifera/ ostracods, galeritid echinoids and serpulids corroborate such an age assignment. Detailed descriptions of the various faunal elements recognised are deferred to another occasion.

KEYWORDS.

- Vijlen Member (Gulpen Formation), early Maastrichtian, Belgium, biostratigraphy.

1. Contribution no. 1 of the 'Vijlen Werkgroep'.
2. Dienst KCO, Natuurhistorisch Museum Maastricht, Postbus 882, NL-6200 AW Maastricht,
   The Netherlands.
3. Boterbloemstraat 26, NL-5953 GJ Reuver, The Netherlands.
4. Koninklijk Belgisch Instituut voor Natuurwetenschappen, Paleontologie, Vautierstraat 29, B-1040 Brussel, Belgium.
5. Hoofdstraat 36, NL-6436 CG Amstenrade, The Netherlands.
6. Université de Liège, Place du Vingt Août 7, B-4000 Liège, Belgium.
7. Rijks Geologische Dienst, Postbus 126, NL-6400 AC Heerlen, The Netherlands.
8. Rohrbach-Zement, D-72359 Dotternhausen, Germany.
9. Schildstraße 17, D-52062 Aachen, Germany.
10. Raevenstraat 27, NL-6014 BA Ittervoort, The Netherlands.
11. Da Costastraat 14, NL-5922 TB Venlo, The Netherlands.
12. Huidevetterstraat 18, B-3530 Houthalen, Belgium.
13. Koninklijk Belgisch Instituut voor Natuurwetenschappen, Paleontologie, Vautierstraat 29, B-1040 Brussel, Belgium.
14. Piet Heinstraat 6, NL-2628 RK Delft, The Netherlands.
15. Gelrestraat 10, NL-5995 XH Kessel, The Netherlands.
16. Fazantstraat 25, NL-6135 EE Sittard, The Netherlands.

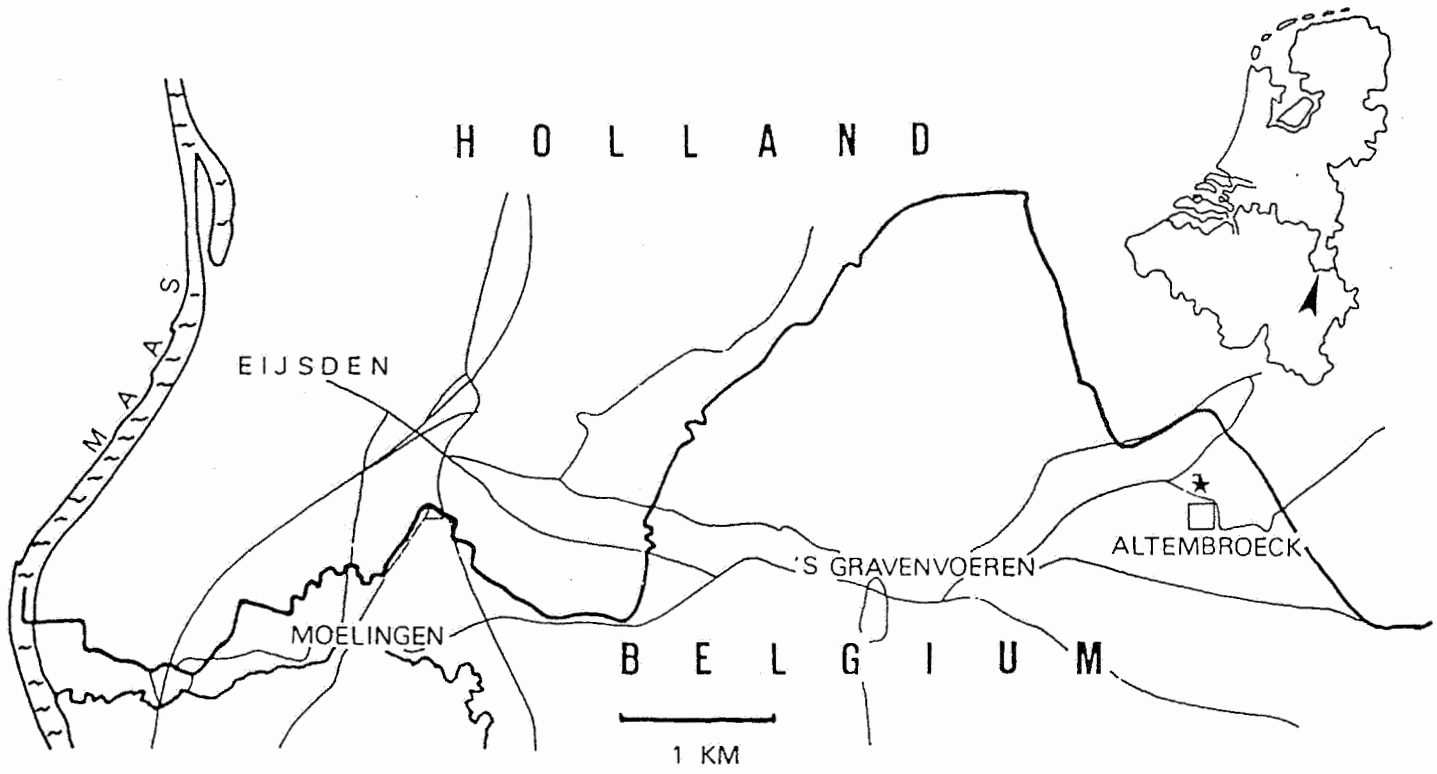


Figure 1. - Locality map showing location of Altembroeck section (star) near Altembroeck castle, 's Gravenvoeren (Voer, Belgium).

1.- INTRODUCTION

It is widely known that the refined lithostratigraphical subdivision (W.M. FELDER, 1975) of the Upper Cretaceous-Lower Palaeocene strata outcropping in the type area of the Maastrichtian Stage is not matched by a comparably detailed biozonation. In fact, only recently has it proved possible to determine the stratigraphical age of the Beutenaken Member and the lower part of the Vijlen Member (Gulpen Formation), on the basis of calcareous nannofossils (VERBEEK, 1983) and belemnites (KEUTGEN & VAN DER TUUK, 1991) (but see also SLIMANI, 1994). However, many uncertainties remain, despite the fact that quite a number of problems have lately been resolved by combining bioclast and benthic foraminifera/ostracod assemblages, in particular those of the Vijlen Member in its type area (P.J. FELDER & BLESS, 1994). In view of the fact that bioclast assemblages cannot be used to determine the stratigraphical age of the strata involved and that benthic foraminifera and ostracods can be used locally only, it was decided in the spring of 1992 to select a number of key sections between Maastricht, Liège and Aachen.
These key sections should expose the uppermost part of the late Campanian Zeven Wegen and Beutenaken Members and the lower/middle part of the Vijlen Member, and preferably yield age-diagnostic macrofossils such as belemnites and ammonites. A number of these sections are found in disused quarries and field work carried out between November 1992 and October 1993 at the Altembroeck section east of 's Gravenvoeren (Figure 1) exposed the entire section once again, with the exception of its lowermost part. It is planned in the near future to drill a well so as to reach the top of the underlying Vaals Formation of early Campanian age. Preliminary correlations based on bioclast assemblages (P.J. FELDER, in prep.) indicate that the base of the Altembroeck section as exposed during the field work is situated c. 8 metres above the top of the underlying Vaals Formation.
It is planned to have similar field work sessions of the so-called 'Vijlen Groep' at the other key localities, and to present interim reports from time to time. Eventually all data will be brought together in a final report which will discuss in detail all fossil groups used for biozonation and illustrate typical representatives of all groups studied.
Below data on selected macro- and microfossil groups are presented; it should be borne in mind that these are of a preliminary nature, that not all of the extensive samples collected have been processed yet, and that analyses of calcareous nannoplankton and dinoflagellate assemblages are under way.

2.- LITHOSTRATIGRAPHY (W.M. FELDER & REYNDERS)

The Altembroeck section ('s Gravenvoeren [Fouron-le-Comte], province of Limburg [Voer], northeast Belgium) is situated in a disused quarry; it is exposure 62C-159 of the Netherlands Rijks Geologische Dienst/Geologisch Bureau [Kartering], sheet 62C, co-ordinates 183.500/303.410. Illustrated in Figure 2 is the lithological log, with an indication of belemnite levels (Bm) and glauconitic levels (Gc), and four sample series (two spot samples every 25 cm and two 50 cm-interval samples).

3.- BIOCLASTS (P.J. FELDER)

Samples A1-A24 (Figure 2) were analysed for bioclast (1-2.4 mm) content along the lines discussed by P.J. FELDER (1981). The results are illustrated in Figure 3.
The upward increase in percentage of Mollusca and the decrease in percentage of Echinodermata probably reflect a shallowing trend in the depositional environment. The belemnite peaks

(samples A21 and A23) bear evidence of high-energy conditions during deposition (storm layers) and are thus additional proof for the above supposition.
The results may be correlated with the outcome of analyses carried out on borehole 108W359, at the Kinkeberg at 's Gravenvoeren, situated c. 2 km west of the Altembroeck section. The changes in percentages of Mollusca and Echinodermata as seen at Altembroeck occur also in this borehole. The obvious increase in Mollusca and decrease in Echinodermata (well visible in sample A11) is found in the borehole at a depth of 16 m, e.g. 3.5 m below the top of the Vijlen Member there. The belemnite peaks in samples A21 and A23, found in the Altembroeck section at 5 m above sample A11, have not been recognised in the Kinkeberg borehole. However, in this borehole a belemnite peak between 26 and 27 m depth, at the base of the Vijlen Member, has been encountered. This peak at the base of this member marks the onset of chalk sedimentation there.
The correlation of the Altembroeck section with borehole 108W359 indicates that the base of the former (see Figure 2) is situated less than 10 m above the base of the Vijlen Member in the area.

4.- BENTHIC FORAMINIFERA AND OSTRACODS

Samples A1 to A24 (see Figure 2) have been analysed, the results showing that:

- Bolivinoides australis Edgell, 1954 is mainly confined to the A3-4 and A13-22 intervals, the average number of pustulae on the last-formed chambers not revealing any major changes, being c. 5.4 for both intervals. This figure compares well with the three Bolivinoides clusters as described by P.J. FELDER & BLESS (1994) for their intervals 1-3 (? inclusive of lower part of 4). Sample A9 yielded two specimens of B. australis.

Eponides beisseli Schijfsma, 1946 (as well as specimens of the ostracod genus Bairdia McCoy, 1844) occur in almost all samples. This is typical of intervals 1-3 of P.J. FELDER & BLESS (1994; ? inclusive of lower part of 4) as well.

Nonionella troostae (Visser, 1950) has not been recognised, which appears to preclude correlation with intervals 4-6 (just upper part of 4?) of P.J. FELDER & BLESS (1994).

Neoflabellina permutata Koch, 1977 has been recognised in sample A13, and in intervals 1-2 of P.J. FELDER & BLESS (1994).

The ostracod species Bythoceratina laevis (Marsson, 1880) occurs in samples A1, A6 and A9, and is typical of intervals 1-2 of P.J. FELDER & BLESS (1994), not occurring above, but returning in the Lixhe 1 Member of the Gulpen Formation.

In summary: the Bolivinoides interval A3-A4 probably corresponds with the upper sumensis Zone of Aachen-Vaalserstraße of KEUTGEN & VAN DER TUUK (1991), interval A13-A22 possibly with upper sumensis Zone of Aachen-Hans- Böckler-Allee of KEUTGEN & VAN DER TUUK (1991).

5.- GASTROPODS (VAN KNIPPENBERG & JAGT)

Most gastropods are preserved as (fragmentary) internal or composite moulds and have suffered more or less from sediment compaction, making identification difficult, if not impossible. Despite this drawback the following taxa have been identified so far:

pleurotomariid sp. 1 (Bm2, Gc1 - 30 cm)
pleurotomariid sp. 2 (Bm1)
fissurellid (Bm1)
Calliomphalus sp. 1 (Bm2, between Gc1 and Bm4, Bm4)

Calliomphalus sp. 2 (Bm2)
? nododelphinulid (Bm1)
Xenophora onusta auctt. (Bm1, Bm2)
? Helicaulax sp. (Bm2)
? Perissoptera sp. (Bm2)
aporrhaid (Bm1, Bm2, Gc1)
? fasciolariid (Bm1, Bm2)
Tudicla quadricarinata (Müller, 1859) (Bm2)
Tudicla cf. carinata sensu ABDEL-GAWAD, 1986 (Bm2, Bm4)
? fusid (Bm2, Bm4)
ringiculid (? Oligoptycha sp.; compare KUTSCHER, 1984, sp. 24) (Bm1, Bm2)
scaphandrid (Bm2)

Poor preservation precludes a detailed comparison with more or less coeval or younger Maastrichtian gastropod faunas from elsewhere (see e.g. KUTSCHER, 1984; BLANK, 1985; ABDEL-GAWAD, 1986).

6.- BIVALVES (DHONDT)

The following species have been identified so far, material from bulk samples not included:

Barbatia sp. (Bm4)
cucullaeid (Bm2)
Pseudoptera coerulescens (Nilsson, 1827) (Bm1, Bm2, Bm3, Bm4)
Endocostea gr. baltica (J. Böhm, 1907) (Bm1, Bm2, Bm4)
Platyceramus sp. (Bm1, Bm2, Bm4)
Selenoceramus cf. inflexus (Beyenburg, 1936) (Bm1)
Selenoceramus cf. sornayi Dhondt, 1993 (Bm1)
Inoceramus cf. planus Münster in Goldfuss, 1835 (Bm2)
Entolium membranaceum (Nilsson, 1827) (Bm2, Bm3, between Gc1 and Bm4, Bm4)
Syncyclonema nilsoni (Goldfuss, 1835) (Bm2)
Microchlamys pulchella (Nilsson, 1827) (Bm0, Bm1, Bm2, Gc1)
Mimachlamys cretosa (Defrance in Brongniart, 1822) (Bm2, between Gc1 and Bm4, Bm4)
Merklinia variabilis (von Hagenow, 1842) (between Gc1 and Bm4)
Neithea sexcostata (Woodward, 1833) (Bm1, Gc1, between Gc1 and Bm4, Bm4)
Neithea striatocostata (Münster in Goldfuss, 1835) (Bm1)
Spondylus fimbriatus ? Goldfuss, 1835 (between Gc1 and Bm4)
Pseudolimea sp. (Bm1, Bm3)
Limatula sp. (between Gc1 and Bm4)
Pycnodonte vesicularis (Lamarck, 1806) (Bm0, Bm1, Bm2, Bm3, Gc1, between Gc1 and Bm4, Bm4).
Hyotissa semiplana (J. de C. Sowerby, 1825) (Bm1, Bm2, Gc1, between Gc1 and Bm4, Bm4)
cardiid (Bm2)
Pholadomya esmarkii (Nilsson, 1827) (Bm1, Bm2)

None of the species listed above give very clear stratigraphical indications, but this is partly due to the fact that Maastrichtian inoceramids have only rarely been studied. Most bivalves are facies dependent. The taxa recognised here are mainly known from most Upper Cretaceous white chalk facies, i.e. from the Turonian to Maastrichtian.
The only taxa with a more restricted stratigraphical distribution according to previous publications (WOODS, 1905; GIERS, 1964; TROEGER, 1989; DHONDT, 1993) are Pseudoptera coerulescens (Campanian-Upper Maastrichtian), Endocostea gr. baltica (Upper Santonian-Maastrichtian), Selenoceramus inflexus (uppermost Santonian-uppermost Campanian), S. sornayi (mid-Campanian-? Maastrichtian), and Inoceramus planus (Lower Campanian-? Maastrichtian). These distributions can only be taken as indicative.

7.- **BELEMNITES** (KEUTGEN)

Belemnite guards are amongst the commonest macrofossils, especially at the Bm0, Bm1, Bm2, Bm3 and Bm4 levels. A sample of 95 specimens from unit Bm2 has been analysed, with the following result:

- Belemnella (Pachybelemnella) sumensis Jeletzky, 1949

mean values (abbreviations follow SCHULZ, 1979):
SW = 2.2 mm (n = 76)
WA = 15.0° (n = 80)
FA = 22.4° (n = 77)
WQs = 2.4 (n = 44)
Lsn = 56.0 mm (n = 81)
AV = 8.7% (n = 81)
AL = -6.3% (n = 81)

The value of 2.4 for WQs as well as those for Lsn and AV/AL show these specimens to be assignable to B. sumensis. Especially the AV/AL values indicate them to be early forms of this species. When compared with Kronsmoor (NW Germany) (see SCHULZ, 1979), it appears that a mean in excess of 8% for AV does not occur but in the middle sumensis Zone there. The majority of the Altembroeck Bm2- level belemnites thus points to a lower/middle sumensis Zone age, probably middle sumensis Zone sensu SCHULZ (1979).

- Belemnella (Belemnella) cf. praearkhangelskii Naidin, 1964 sensu Schulz, 1979

mean values:
SW = 1.1 mm (n = 9)
WA = 13.3° (n = 9)
FA = 27.2° (n = 9)
WQs = 3.2 (n = 8)
Lsn = 70.2 mm (n = 10)
AV = 18.2% (n = 10)
AL = 0.2% (n = 10)

Ten guards fall outside the range of variation of the Belemnella sumensis populations as described by KEUTGEN & VAN DER TUUK (1991) from the lower to middle sumensis Zone of the Bovenste Bosch quarry and from the upper sumensis Zone of Aachen-Vaalserstraße, -Schurzelterstraße and -Hans-Böckler-Allee. They also fall outside the range of variation of B.

sumensis from Kronsmoor and Hemmoor as described by SCHULZ (1979), but correspond well with SCHULZ's B. cf. praearkhangelskii as recorded from the middle sumensis Zone and are therefore assigned to this taxon. This assignment provides additional evidence for a correlation of the Bm2-level with the middle sumensis Zone sensu SCHULZ (1979).

- Belemnitella pulchra Schulz, 1982

Four guards are referred to this species, comprising a complete specimen, 2 rostrum cavum fragments and a rostrum solidum fragment. One of the rostrum cavum fragments has been split and the internal features measured (SW = 5.5 mm; WA = 20°; FA = 28°). For B. pulchra the FA is unusually low. The pronounced ornament of the guard's surface and the characteristically developed lateral depressions of this small belemnitellid, however, favour an assignment to this species. The other three specimens are referred here for the same reasons.
On the basis of these data, the Bm2 level is here correlated with the middle sumensis Zone sensu SCHULZ (1979). This assignment differs considerably from the belemnite zonation indicated by ROBASZYNSKI et al. (1985, fig. 13) for the Altembroeck section.
The belemnite faunas from the other Bm levels will be analysed in the near future.

8.- AMMONITES (JAGT)

With the exception of baculitids, ammonites are rare in the entire section, with most specimens originating from the Bm1 and Bm2 levels. The following species have been identified:

? Hypophylloceras sp. (Bm2)
Pachydiscus (Pachydiscus) sp. (Bm2)
Diplomoceras cylindraceum (Defrance, 1816) (Bm2)
Baculites knorrianus Desmarest, 1817 (Bm1, Bm2, Bm4)
Baculites sp. (Bm2)
Hoploscaphites constrictus (J. Sowerby, 1817) (Bm1, Bm2, Gc2 + 6-12 cm, Gc + 10 cm)
Hoploscaphites tenuistriatus (Kner, 1848) (Bm1)
Acanthoscaphites tridens (Kner, 1848) (Bm1, Bm2)
scaphitid aptychi (compare BIRKELUND, 1993, pl. 17, figs 2-4) (Bm1, between Gc2 and Bm4, Bm4)
Aptychus leptophyllus Sharpe, 1857 (see also BIRKELUND, 1993, pl. 17, fig. 1) (Gc1 + 0.15 m)

Ammonite ranges have recently been documented in terms of micromorphic brachiopod and belemnite zonations in the white chalk facies of Denmark (BIRKELUND, 1993) and it is with that detailed study that the present Altembroeck records are compared.
Baculites knorrianus, the largest baculitid species known in the area (a fragmentary phragmocone of over 0.6 m is known from level Bm2) has been shown to be of lanceolata to pseudobtusa Zone age in the western Ukraine (CHRISTENSEN, 1987; KENNEDY & SUMMESBERGER, 1987), and to span the Lower/Upper Maastrichtian boundary in Denmark (BIRKELUND, 1993). Other records include specimens from the Lower Maastrichtian of Germany, Belgium (KENNEDY, 1993) and Russia.
In Denmark, Hoploscaphites tenuistriatus ranges from the late Early Maastrichtian to early Late Maastrichtian (SURLYK's 1972 brachiopod zones 7 and 8); the species has a similar range in NW Germany; the type material is probably from the lanceolata to pseudobtusa Zones (KENNEDY & SUMMESBERGER, 1987).
BIRKELUND (1993, p. 56) indicated the documented range of Acanthoscaphites tridens to be

the lanceolata, pseudobtusa and obtusa Zones of the early Early Maastrichtian, and recorded a single specimen from possibly the lowermost sumensis Zone. The present records show the species to range well into the sumensis Zone.

9.- NAUTILOIDS (JAGT)

Nautiloids are much commoner than ammonites and comprise at least two species, one apparently assignable to the nautilid genus Eutrephoceras Hyatt, 1894 (Bm1, Bm2, Gc2 - 30 cm, between Gc2 and Bm4, Bm4) the other representing the type of the cymatoceratid genus Epicymatoceras Kummel, 1956, E. vaelsense (Binckhorst, 1861) (Bm1, Bm2, Gc2 - 30 cm, between Gc2 and Bm4, Bm4) previously recorded from the Maastrichtian of Germany and Belgium (KUMMEL, 1964). A single specimen from the Bm1 level may be compared to the genus Cymatoceras Hyatt, 1884.

SCHÖNFELD (1985) recorded Epicymatoceras vaelsense from the late Santonian (Marsupites/granulata Zone) of NW Germany.

10.- SERPULIDS (JÄGER)

So far, only small samples of the levels Bm2, Bm3, Bm4 and Gc1 have been analysed, with the following results:

Cycloserpula lombricus (Defrance, 1827) (Bm2)
Dorsoserpula (Pegmaticula) wegneri wegneri (Jäger, 1983)
(Bm2, Gc1)
Pentaditrupa subtorquata (Münster in Goldfuss, 1831) (Bm2)
Nogrobs (Tetraditrupa) canteriata (von Hagenow, 1840)
(Bm2, Bm3)
Pyrgopolon (Septenaria) macropus (J. de C. Sowerby, 1829)
(Bm1, Bm2, Bm4)
Pyrgopolon (Pyrgopolon) vittata (Regenhardt, 1961) (Bm2)
Pyrgopolon (Pyrgopolon) sp. (Bm2)
Conorca trochiformis (von Hagenow, 1840) (Bm2)
Neomicrorbis crenatostriatus var. crenatostriatus (Münster in Goldfuss, 1831) (Bm2)
Neomicrorbis crenatostriatus var. hagenowii Jäger, 1983
(Bm2)
Neomicrorbis crenatostriatus var. subrugosus (Münster in
Goldfuss, 1831) (Bm2)

The above data are of a preliminary nature, and additional material from the various bulk samples will probably refine this picture. However, it is possible to draw a few conclusions based on the present material: Of importance, stratigraphically speaking, amongst these species are Nogrobs (T.) canteriata, whose occurrence excludes the lanceolata and pseudobtusa Zones, and morphological features displayed by Conorca trochiformis, which favour an age assignment of approximately cimbrica Zone. Other species, many of them long ranging (see JÄGER, 1983), provide less reliable stratigraphic data.

11.- CIRRIPEDES (JAGT)

Valves of five species have been recognised:

Cretiscalpellum glabrum (F.A. Roemer, 1841) (Bm2, Gc1)
Virgiscalpellum aff. darwinianum (Bosquet, 1854)(Bm2, Gc1)
Arcoscalpellum fossula (Darwin, 1851) (Bm2)
A. aff. gracile (Bosquet, 1854) (Bm2)
Pycnolepas sp. (Gc1)

With the exception of the last-named, all these species are long ranging (WITHERS, 1935) and are known from most members of the Gulpen and Maastricht Formations in the type area of the Maastrichtian Stage. The single carina of Pycnolepas probably represents the first early Maastrichtian record of that genus (compare WITHERS, 1935).

12.- DECAPOD CRUSTACEANS (JAGT)

Collected were only poorly preserved remains (exuviae), which appear to be assignable to nephropid (Bm1, Bm2) and ctenochelid (Bm1, Bm2, Gc1, Bm4) lobsters. The former are known from the Vijlen Member (s. lat.) at Haccourt, Liège (FELDMANN et al., 1990). Two isolated cheliped fingers (Gc1) are reminiscent of calappid crabs, but at present cannot be identified to species. Of note is the occurrence of faecal pellets of probable crustacean origin (Bm2).

13.- BRACHIOPODS (SIMON)

It was noted during processing of several bulk samples that micromorphic species are common, but these have not yet been identified (see below). The list below comprises larger species only:

Crania craniolaris (Linné, 1758) (Gc1)
Cretirhynchia limbata (von Schlottheim, 1813) (Bm1, Bm2, Bm3, Gc1, between Gc1 and Bm4)
Cretirhynchia undulata (Pusch, 1837) (Bm1, Gc1)
Cretirhynchia woodwardi (Davidson, 1852) (Bm2)
Cretirhynchia cf. tenuicostata (von Hanstein, 1879) (Bm3)
Cretirhynchia magna Pettitt, 1950 (Bm0, Bm2)
Cretithynchia aff. norvicensis Pettitt, 1950 (Bm1, Gc1, ? between Gc1 and Bm4)
Cretirhynchia gr. exsculpta Pettitt, 1950 (Bm2)
Neoliothyrina obesa Sahni, 1925 (Bm0, Bm1, Bm2, Bm3, Gc1, Bm4, Gc2)
Neoliothyrina sp. ? (Gc1)
Carneithyris subcardinalis (Sahni, 1925) (Bm0, Bm1, Bm2, Bm3, Gc1, between Gc1 and Bm4, Bm4)
Terebratulina chrysalis (von Schlottheim, 1813) (Gc1)
Terebratulina rigida (J. de C. Sowerby, 1829) (Bm3, Gc1)
Magas chitoniformis (von Schlottheim, 1813) (Bm1, Bm2, Bm3, Gc1, between Gc1 and Bm4, Bm4)

In general, macromorphic brachiopod species do not constitute reliable stratigraphic indicators; only N. obesa is confined to the Lower Maastrichtian. The Altembroeck brachiopod assemblage as such is reasonably similar to that of the Porosphaera Beds at Trimingham (Norfolk, UK; especially C. magna), to that found on Rügen (Germany; especially N. obesa), and, to a lesser extent, to that of Ciply (Belgium), all three being of early Maastrichtian age. A sample from level Bm2 has been analysed for micromorphic taxa; it has yielded the following species:

Terebratulina subtilis Steinich, 1965
Gisilina gisii (Roemer, 1841)
Magas chitoniformis (von Schlottheim, 1813)
Leptothyrellopsis polonicus Bitner & Pisera, 1979
Carneithyris subcardinalis (Sahni, 1925) juv.

As long as the stratigraphic ranges of the various micromorphic species in Belgium and The Netherlands are poorly known, it will prove impossible to correlate these sections in detail with other European localities (Norfolk, northwest and northeast Germany, Denmark [see SURLYK, 1970] and Poland). However, on present brachiopod evidence a middle Early Maastrichtian age is suggested for the Altembroeck section and its faunas.

14.- ECHINOIDS (JAGT, DECKERS, DORTANGS, KUYPERS, MICHELS, VAN DER HAM, VAN KNIPPENBERG & VAN NEER)

So far the following species have been identified, but it should be noted that material from bulk samples has not yet been included:

Cidaroida (primary spines) (Gc1, Bm2)
Echinothuriidae (spines) (Gc1, Bm2)
Salenia sp. (Bm2)
Gauthieria pseudoradiata (Schlüter, 1881) (Gc1)
Rachiosoma corollare (Leske, 1778) sensu Cotteau, 1865
(primary spine) (Bm2)
'Phymosoma rutoti' (Lambert, 1898) (Gc1)
Galerites stadensis Lambert, 1911 (sensu Schulz, 1985)
(Bm1, Bm1 + 0.2 m, Bm2 - 0.5/0.75 m, Bm2, Bm2 + 0.5 m, between Bm2 and Gc1, Bm3, between Bm3 and Gc1, Gc1 + c. 0.75 m, Gc2 - c. 0.4 m, Gc2 (plus 2 specimens non in situ, probably from uppermost 3 metres of section)
Echinogalerus belgicus (Lambert, 1898) (non in situ)
Cardiaster gr. granulosus (Goldfuss, 1829) (Bm1, Bm2, Gc1, plus one specimen non in situ)
Echinocorys ex gr. duponti Lambert, 1903/limburgica Lambert, 1903 (Bm1, Bm2, Bm2 + 0.2 m, Bm2 + 0.3 m, Bm2 + 2.2, Bm3, Gc1 - 0.45 m, between Gc1 and Bm4)
Echinocorys sp. (Bm3)
Hemiaster (Bolbaster) sp. (Gc1)
Diplodetus duponti (Lambert, 1911) (Gc1, Bm4)

Discussion -- The echinothuriid spines are undoubtedly conspecific with material referred to as Hygrosoma bruennichi (Ravn, 1928) by VAN DER HAM & VAN BIRGELEN (1992) for their middle unit of the Vijlen Member at Aachen-Schneeberg.

Of Salenia sp. but a single specimen is available; its apical disc is mostly obscured by matrix, the outlines of only two ocular plates and a genital plate are visible. The structure of these as well as the general outline and size suggest it cannot be assigned to Salenia anthophora J.

Müller, 1846 (VAN DER HAM & VAN BIRGELEN, 1992). The poor state of preservation precludes further discussion at the moment.

The single spine of R. corollare compares well with material from Aachen-Schneeberg (VAN DER HAM & VAN BIRGELEN, 1992), where this species is known from their middle and upper division of the Vijlen Member (s. lat.).

Spines generally referred to in the literature as 'Phymosoma rutoti' obviously belong to a phymosomatid, and possibly to G. pseudoradiata. 'Phymosoma rutoti' is based on isolated spines, but two recently collected tests with spines attached from the upper part of the Maastricht Formation (late Maastrichtian) will hopefully resolve some of the problems involved (JAGT, in prep.).

SCHULZ (1985, p. 54) recorded Galerites stadensis (see also VAN DER HAM & VAN BIRGELEN, 1992) from the upper sumensis Zone onwards (ranging to the uppermost Maastrichtian), and described the transition of G. abbreviatus Lamarck, 1816 (middle lanceolata up to middle sumensis Zones) to this species. The fact that most of our specimens show the typical inturned peristomial rim which appears to characterise this species according to SCHULZ (1985) makes us assign our material to G. stadensis. However, it cannot be ruled out that transitional forms with G. abbreviatus do occur in our material.

A single specimen of Echinogalerus belgicus is in the van Birgelen Collection; it was found loose, but may have come from level Bm1 or Bm2. This species occurs commonly at Aachen-Schneeberg at the Wahlwiller Horizon (= base of Lixhe Member, Gulpen Formation, late Maastrichtian), from where VAN DER HAM & VAN BIRGELEN (1992) described it.

With regard to representatives of the genus Echinocorys the following can be stated: after much deliberation we have decided to consider all material (except for a single specimen from unit Bm3) to belong to a single, variable species. However, it should be pointed out that a number of specimens match various types which in the literature have been referred to as E. duponti, E. limburgica (both LAMBERT, 1903) and E. ciplyensis (LAMBERT, 1898). HANCOCK et al. (1993, p. 139) recorded Echinocorys arnaudi Seunes, 1888 (= E. ciplyensis Lambert, 1898) from Tercis, and noted that such forms occur commonly in the sumensis Zone at Trimingham, Norfolk. Specimens similar to some of the Altembroeck material are well known from the Vijlen Member (s. lat.) at Haccourt and Lixhe (Liège), where they are frequent.

The only species of Hemiaster thus far recorded from the Vijlen Member (s. lat.) is H. (Bolbaster) aquisgranensis Schlüter, 1899 (= H. rutoti Lambert, 1911); the single specimen available from Altembroeck is certainly not a juvenile of that species, on account of its tuberculation, but appears to be an intermediate between the exclusively late Maastrichtian H. (B.) prunella (Lamarck, 1816) and H. (B.) koninckanus d'Orbigny, 1855.

VAN DER HAM & VAN BIRGELEN (1992) described a comparable echinoid fauna from the vicinity of Aachen-Schneeberg, and pointed out (p. 141) that the Vijlen Member (s. lat.) of Aachen-Schneeberg could be subdivided into three units on the basis of echinoid faunas: a lower unit characterised by presence of Cardiaster granulosus and absence of Diplodetus duponti, a middle unit without C. granulosus but with small specimens of D. duponti (up to c. 37 mm test length), and an upper unit with C. granulosus and large specimens (> c. 45 mm up) of D. duponti. This division would correspond with the belemnite zonation (KEUTGEN & VAN DER TUUK, 1991) as follows:

- lower unit = lower part of upper sumensis Zone
- middle unit = upper part of upper sumensis Zone/cimbrica Zone
- upper unit = ? junior Zone

The Altembroeck units Gc1 and Bm4 have yielded small individuals of D. duponti, and would thus correspond to VAN DER HAM & VAN BIRGELEN's middle unit, were it not for the occurrence of a single specimen of C. granulosus from unit Gc1.

15.- CRINOIDS, OPHIUROIDS AND ASTEROIDS (JAGT)

Amongst the comparatively rare crinoid remains the following species/groups have been recognised:

Nielsenicrinus agassizii (von Hagenow, 1840) (Gc1)
Bourgueticrinidae (Bm2, Gc1)
Comatulida (Bm2)

RASMUSSEN (1961) assumed N. agassizii to be restricted to the Lower Maastrichtian, but the careful records of SCHMID (1975; see also SCHULZ et al., 1984) show this species to span the Lower/Upper Maastrichtian boundary in northern Germany. The other crinoids are not age diagnostic.

Ophiuroids comprise four species, the commonest of which is an apparently undescribed taxon (Ophiomusium n. sp. ?; Bm2 and Gc1), well known from the 'Vijlen' Member of Haccourt (Liège; JAGT, in prep.). A single lateral arm plate of Ophiura ? hagenowi Rasmussen (range: late Campanian-late Maastrichtian) has been collected from Gc1, two arm plates of an ophiacanthid (Ophiacantha sp.) are known from the same unit (Gc1) and a single vertebra of Asteronyx ? ornatus Rasmussen, 1950 (range: late Campanian-late Maastrichtian) was collected from Bm2.

The following asteroid species are known: Chomataster acules Spencer, 1913 (Gc1), Crateraster n. sp. (Gc1, Bm2) and Lophidiaster pygmaeus Spencer, 1913 (Bm2). The first-named first appears in the lower Upper Campanian and becomes extinct during the late Danian. L. pygmaeus is common in Maastrichtian strata, but there are also late Campanian records from NE Belgium (JAGT, in prep.). The apparently undescribed species of the genus Crateraster Spencer, 1913 is well known from the 'Vijlen' Member (s. lat.) at Haccourt (Liège).

16.- SELACHIANS (REYNDERS)

With the exception of samples of units Bm2 and Gc1 of 60 and 180 kg, respectively, all selachian remains were collected during excavation. Samples were broken down, washed to mesh width of 0.3 mm and cleaned with 40% acetic acid during 20-25 minutes. This process was halted firstly by washing the sample in clean water and secondly by immersing it in a basic solution for two hours. The teeth were handpicked from the residues under a microscope.

The following species have been identified (units in brackets):

Squatina sp. (Bm2, Gc1)
Heterodontus sp. (Bm2)
Centrophoroides appendiculatus (Agassiz, 1843) (Bm2)
Centroscymnus schmidi Herman, 1982 (Bm2, Gc1)
Eoetmopterus supracretaceus Müller & Schöllmann, 1989 (Bm2)
? Palaeohypotodus bronni (Agassiz, 1843) (Bm2)
Archaeolamna kopingensis kopingensis (Davis, 1890)
(Bm4 - 30 cm)
Anomotodon plicatus Arambourg, 1952 (Bm1, Bm2)
Pseudocorax affinis (Münster in Goldfuss, 1843)
(Bm1, Bm2, Bm3, Gc1, Gc1 + 0.25 m)
Scyliorhinus germanicus Herman, 1982 (Bm2)
Scyliorhinus sp. (Bm2, Gc1)

Of the above species, only P. affinis and C. schmidi are indicative of a Maastrichtian age, but both species occur in the Lower and Upper Maastrichtian (HERMAN, 1977, 1982; SIVERSON,1993).
Teeth of enchodontid teleosts are available from Bm1, Bm2, Bm3 and Gc1.

17.- REPTILES

A fragmentary dentary with 3 teeth preserved bears a certain resemblance to material referred to the mosasaur Prognathodon solvayi Dollo, 1889 from the early Maastrichtian (obtusa Zone) Phosphatic Chalk of Ciply (Mons Basin, southern Belgium), described in detail by LINGHAM-SOLIAR & NOLF (1990).

18.-ACKNOWLEDGEMENTS

We extend our best thanks to the proprietor of Altembroeck castle for allowing us access to the section exposed there, and to Marcel VAN BIRGELEN (Voerendaal-Ubachsberg) and HUGO KOHNEN (Venlo-Blerick) for assistance in various ways.

19.- REFERENCES

ABDEL-GAWAD, G.I., 1986. Maastrichtian non-cephalopod mollusks (Scaphopoda, Gastropoda and Bivalvia) of the Middle Vistula Valley, Central Poland. Acta geol. pol., 36: 69-224.

BIRKELUND, T., 1993. Ammonites from the Maastrichtian White Chalk of Denmark. Bull. geol. Soc. Denmark, 40: 33-81.

BLANK, M.Ja., 1985. Novye pozdnemelovye plevrotomariidy donbassa i kryma. Paleont. Sbornik, 22: 22-25.

CHRISTENSEN, W.K., 1987. Belemnella (Pachybelemnella) inflata (Arkhangelsky) from Nagoryany, USSR. Beitr. Paläont. Österr., 13: 79-84.

DHONDT, A.V., 1993. Upper Cretaceous bivalves from Tercis, Landes, SW France. Bull. Inst. r. Sci. nat. Belg., Sci. Terre, 63: 211-259.

FELDER, P.J., 1981. Mesofossielen in de kalkafzettingen uit het Krijt van Limburg. Publ. Natuurhist. Gen. Limburg, 31: 1-35.

FELDER, P.J. & BLESS, M.J.M., 1994. The Vijlen Chalk (early Early to early Late Maastrichtian) in its type area around Vijlen and Mamelis (southern Limburg, The Netherlands). Ann. Soc. géol. Belg., 116(1) (1993): 61-85.

FELDER, W.M., 1975. Lithostratigrafie van het Boven-Krijt en het Dano-Montien in Zuid-Limburg en het aangrenzende gebied. In: Zagwijn, W.H. & van Staalduinen, C.J. (eds). Toelichting bij geologische overzichtskaarten van Nederland: 63-75. Rijks Geologische Dienst, Haarlem.

FELDMANN, R.M., JAGT, J.W.M. & TSHUDY, D.M., 1990. Late Maastrichtian isopod and decapod Crustacea from Haccourt (Liège), northeastern Belgium. Meded. Rijks Geol. Dienst, 44: 23-35.

GIERS, R., 1964. Die Großfauna der Mukronatenkreide (unteres Obercampan) im östlichen Münsterland. Fortschr. Geol. Rheinl. u. Westf., 7: 213-294.

HANCOCK, J.M., PEAKE, N.B., BURNETT, J., DHONDT, A.V., KENNEDY, W.J. & STOKES, R.B., 1993. High Cretaceous biostratigraphy at Tercis, south-west France. Bull. Inst. r. Sci. nat. Belg., Sci. Terre, 63: 133-148.

HERMAN, J., 1977. Les sélaciens des terrains néocrétacés & paléocènes de Belgique & des contrées limitrophes. Eléments d'une biostratigraphie intercontinentale. Mém. Expl. Cartes géol. min. Belg., 15: 1-450.

HERMAN, J., 1982. Die Selachier-Zähne aus der Maastricht-Stufe von Hemmoor, Niederelbe (NW-Deutschland). Geol. Jb., A 61: 129-159.

JÄGER, M., 1983. Serpulidae (Polychaeta sedentaria) aus der norddeutschen höheren Oberkreide - Systematik, Stratigraphie, Ökologie. Geol. Jb., A 68: 3-219.

KENNEDY, W.J., 1993. Campanian and Maastrichtian ammonites from the Mons Basin and adjacent areas (Belgium). Bull. Inst. r. Sci. nat. Belg., Sci. Terre, 63: 99-131.

KENNEDY, W.J. & SUMMESBERGER, H., 1987. Lower Maastrichtian Ammonites from Nagoryany (Ukrainian SSR). Beitr. Paläont. Österr., 13: 25-78.

KEUTGEN, N. & VAN DER TUUK, L.A., 1991. Belemnites from the Lower Maastrichtian of Limburg, Aachen and Liège. Meded. Rijks Geol. Dienst, 44 (1990): 1-39.

KUMMEL, B., 1964. Nautiloidea-Nautilida. In: Moore, R.C. (ed.). Treatise on Invertebrate Paleontology, Part K, Mollusca 3, Cephalopoda-General features. Endoceratoidea-Actinoceratoidea-Nautiloidea-Bactritoidea: K383-K456. Boulder, Geological Society of America/ Lawrence, University of Kansas Press.

KUTSCHER, M., 1984. Die Scaphopoden und Gastropoden der Rügener Schreibkreide (Oberes Unter-Maastricht). Freiberger Forsch., C 395: 54-68.

LAMBERT, J., 1898. Note sur les Échinides de la Craie de Ciply. Bull. Soc. belge Géol., Paléont., Hydrol., 11: 141-190.

LAMBERT, J., 1903. Description des échinides crétacés de la Belgique principalement de ceux conservés au Musée royal de Bruxelles. I. Etude monographique sur le Genre Echinocorys. Mém. Mus. r. Hist. nat. Belg., 2: 1-151.

LINGHAM-SOLIAR, T. & NOLF, D., 1990. The mosasaur Prognathodon (Reptilia, Mosasauridae) from the Upper Cretaceous of Belgium. Bull. Inst. r. Sci. nat. Belg., Sci. Terre, 59 (1989): 137-190.

RASMUSSEN, H.W., 1961. A monograph on the Cretaceous Crinoidea. Biol. Skr. Dan. Vidensk. Selsk., 12: 1-428.

ROBASZYNSKI, F., BLESS, M.J.M., FELDER, P.J., FOUCHER, J.-C., LEGOUX, O., MANIVIT, H., MEESSEN, J.P.M.T. & VAN DER TUUK, L.A., 1985. The Campanian-Maastrichtian boundary in the chalky facies close to the type-Maastrichtian area. Bull. Centres Rech. Explor.-Prod. Elf-Aquitaine, 9: 1-113.

SCHÖNFELD, J., 1985. Zur Lithologie, Biostratigraphie und Fossilführung des Ober-Santon Mergels von Westerwiehe (Ostwestfalen). Geol. Paläont. Westf., 5: 7-50.

SCHMID, F., 1975. Crinoiden-Stielglieder aus dem Maastricht Nordwestdeutschlands und ihre biostratigraphische Auswertung. Mitt. geol.-paläont. Inst. Univ. Hamburg, 44: 235-248.

SCHULZ, M.-G., 1979. Morphometrisch-variationsstatistische Untersuchungen zur Phylogenie der Belemniten-Gattung Belemnella im Untermaastricht NW-Europas. Geol. Jb., A 47: 3-157.

SCHULZ, M.-G., 1985. Die Evolution der Echiniden-Gattung Galerites im Campan und Maastricht Norddeutschlands. Geol. Jb., A 80: 3-93.

SCHULZ, M.G., ERNST, G., ERNST, H. & SCHMID, F., 1984. Coniacian to Maastrichtian stage boundaries in the standard section for the Upper Cretaceous white chalk of NW Germany (Lägerdorf-Kronsmoor-Hemmoor): Definitions and proposals. Bull. geol. Soc. Denmark, 33: 203-215.

SIVERSON, M., 1993. Maastrichtian squaloid sharks from southern Sweden. Palaeontology, 36: 1-19.

SLIMANI, H., 1994. Les dinokystes des craies du Campanien au Danien à Halembaye, Turnhout (Belgique) et à Beutenaken (Pays-Bas). Mém. Expl. Cartes géol. min. Belg., 37: 1-173.

SURLYK, F., 197O. Die Stratigraphie des Maastricht von Dänemark und Norddeutschland aufgrund von Brachiopoden. Newsl. Stratigr., 1: 7-16.

TROEGER, K.A., 1989. Problems of Upper Cretaceous Inoceramid Biostratigraphy and Palaeobiogeography in Europe and Western Asia. In: Wiedmann, J. (ed.). Cretaceous of the Western Tethys, 911-930. Schweizerbart (Stuttgart).

VAN DER HAM, R. & VAN BIRGELEN, M., 1992. Zeeëgels uit het Maastrichtien van de Schneeberg en omgeving (Aken, Duitsland). Natuurhist. Maandbl., 81: 139-153.

VERBEEK, J.W., 1983. The calcareous nannofossils from the Campanian and Maastrichtian rocks of southern Limburg (The Netherlands) and the adjacent Belgian area. In: Birkelund, T., Bromley, R.G., Christensen, W.K., Håkansson, E. & Surlyk, F. (eds). Abstracts Symposium on Cretaceous Stage Boundaries, Copenhagen, October 18-21, 1983: 197-200.

WITHERS, T., 1935. Catalogue of fossil Cirripedia in the Department of Geology. Vol. II. Cretaceous, xiii + 535 pp. Trustees of the British Museum (Natural History), London.

WOODS, H., 1904-1913. A monograph of the Cretaceous Lamellibranchiata of England, 2. Monogr. Palaeontogr. Soc. Lond., 1904-1913: 1-473.

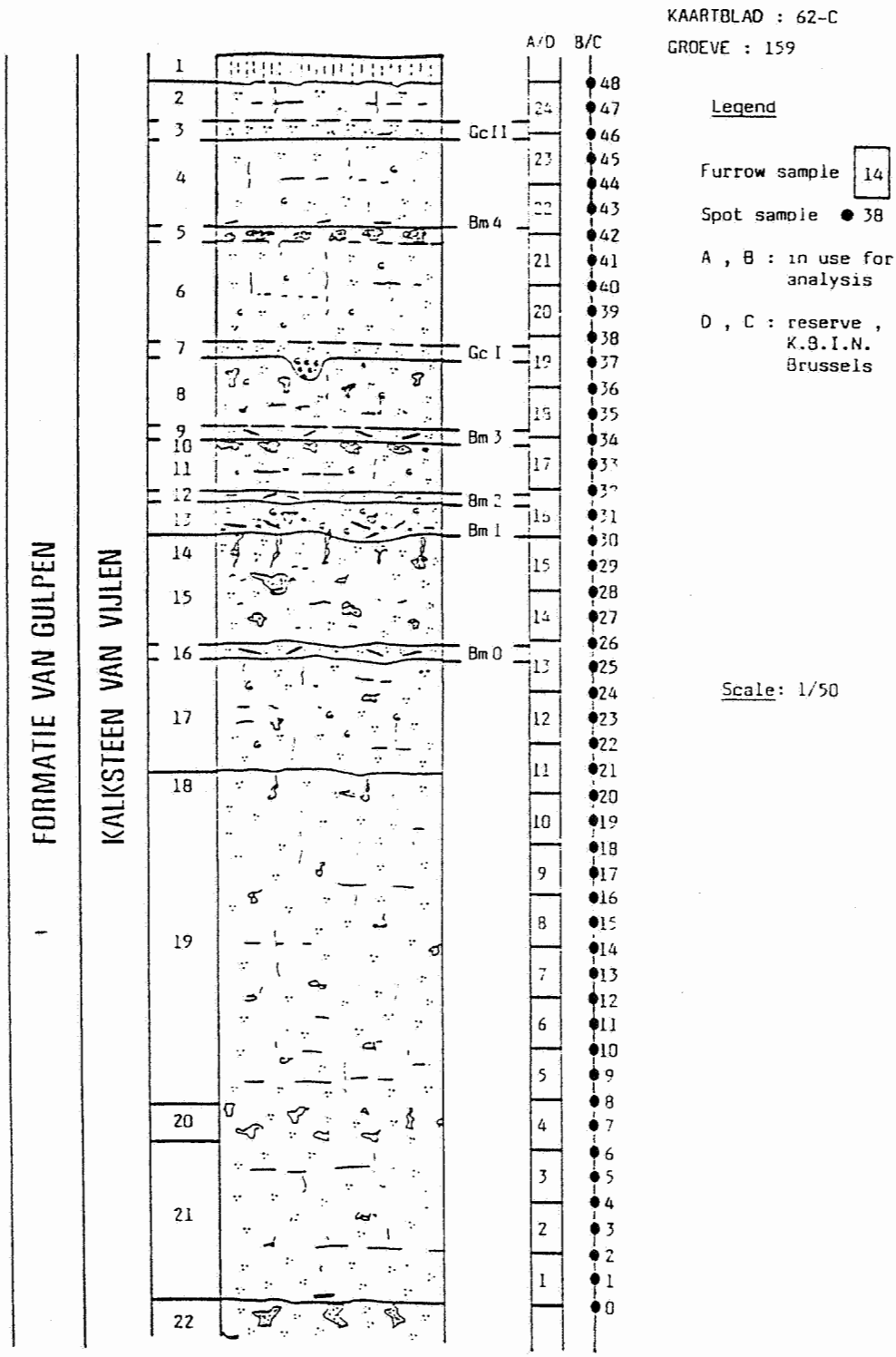


Figure 2. - Log of the section exposed (Gulpen Formation, Vijlen Member) at Altembroeck, showing lithologic units, Bm and Gc levels, as well as position of both kinds of samples (see text). After sampling, the part below levels Bm1/Bm0 was covered.

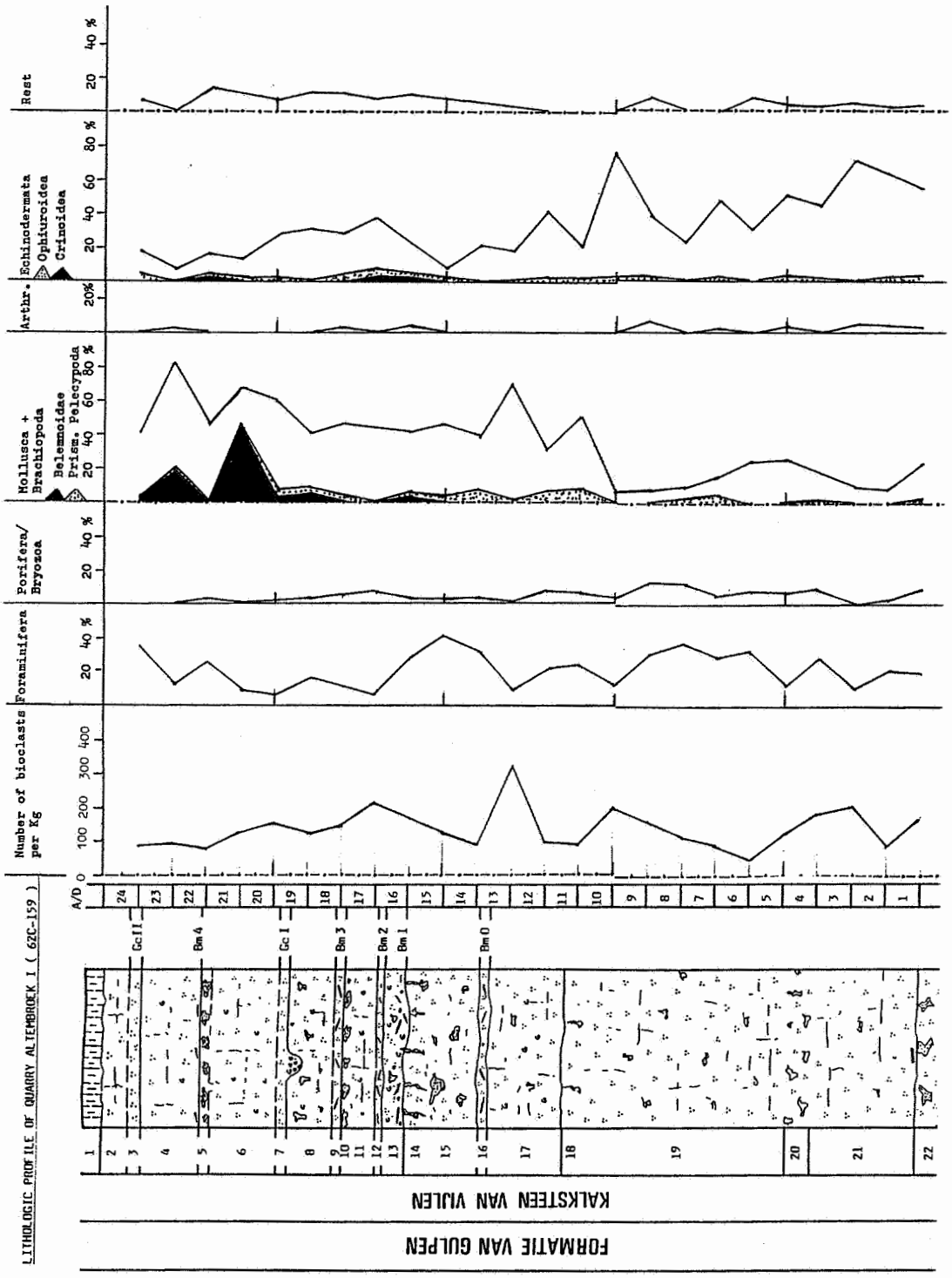


Figure 3. - Bioclast assemblages (subdivided into various groups; see P.J. FELDER, 1981), worked out on the basis of sample series A/D (see Figure 1).