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# Late Cretaceous Ammonite Faunas of the Maastrichtian Type Area

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6 Text-Figures

*Campanian*
*Maastrichtian*
*Ammonoidea*
*Stratigraphy*
*Palaeobiogeography*

## Contents



## Oberkretazische Ammonitenfaunen aus der Typus-Region der Maastricht-Stufe

### Zusammenfassung

Alle bis jetzt bekannten Ammoniten-Arten aus dem Campanium und Maastrichtium der erweiterten Typusregion der Maastricht-Stufe (südöstliche Niederlande, nordöstliches Belgien und Aachen [Deutschland] werden mit ihren stratigraphischen Reichweiten aufgelistet. Die paläobiogeographische Bedeutung dieser Faunen wird kurz diskutiert, auch unter Berücksichtigung sonstiger Makrofossilgruppen (z.B. Coleoiden, Echinodermen, Cirripedier). Aus dem Intervall 6 der Vijlen-Kreide (Gulpen-Formation) der Umgebung von Haccourt – Lixhe (Lüttich, Belgien) wird *Pachydiscus (P.) neubergicus* (VON HAUER, 1858) zum ersten Mal beschrieben sowie ein einziges Fragment, das gefühlsmäßig zu *P. (P.) armenicus* ATABEKIAN & AKOPIAN, 1969 gestellt wird.

### Abstract

All ammonoid species known to date from the Campanian–Maastrichtian of the extended type area of the Maastrichtian Stage (southeast Netherlands, northeast Belgium, and Aachen area [Germany]) are listed, and their stratigraphic ranges indicated. The palaeobiogeographic implications of these faunas are briefly discussed, with reference to other macrofossil groups (e.g. coleoid cephalopods, echinoderms, cirripedes) as well. From Interval 6 of the Vijlen Member (Gulpen Formation) as exposed in the Haccourt – Lixhe area (Liège, Belgium), *Pachydiscus (P.) neubergicus* (VON HAUER, 1858) is recorded for the first time, as well as a single fragmentary specimen tentatively identified as *P. (P.) armenicus* ATABEKIAN & AKOPIAN, 1969.

## 1. Introduction

KENNEDY's (1986c, 1987, 1993b) recent revision of ammonites from the type Maastrichtian (Text-Fig. 1) has greatly improved our knowledge of these faunas. However, at that time the stratigraphic ranges of most taxa were still comparatively poorly known. In recent years, additional taxa have been added and data on stratigraphic distribution refined, by continuing field work and screening of private collections, particularly those made in the 1950s and 1960s which document localities no longer accessible. Although the refined lithostratigraphic subdivision of the Campanian–Maastrichtian strata is still not matched by a comparably detailed biozonation, much progress has been booked lately. For instance, ecozonal subdivisions based on bioclasts, benthic foraminifers and

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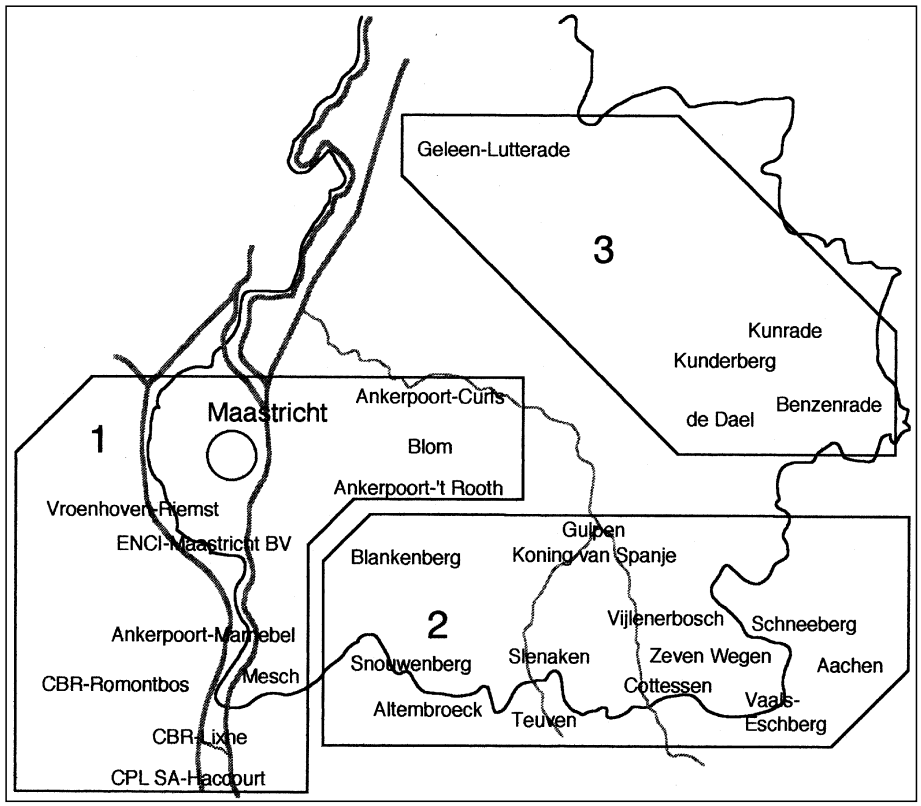



Text-Fig. 1.
Map of southern Limburg (the Netherlands) and contiguous areas in Belgium (provinces of Liège and Limburg) and Germany (Aachen area), showing localities mentioned in the text.
Areas for which ammonite ranges are indicated in Text-Figs. 3–5 are boxed.

ostracods have been shown to allow precise correlations over large distances in the area. In addition, we have a much better understanding of (pre-)K/T boundary phenomena (see BRINKHUIS & SMIT [1996]), and a sequence-stratigraphic interpretation of the type Maastrichtian (SCHIØLER et al., 1997) as well as a preliminary strontium isotope stratigraphy (VONHOF & SMIT, 1996; VONHOF, work in progress) are now available.

Generally speaking, ammonites are rare in the extended type area of the Maastrichtian Stage, with the exception of local acmes in baculitid and scaphitid distribution. Making matters worse is the fact that ammonites are either absent from, or (extremely) poorly preserved in, the non-indurated portions (e.g. friable, coarse-grained biocalcarenites, or white chalk facies) of the sequence. Only under special conditions (e.g. silicification, rapid burial, xenomorphism) have ammonites been preserved in such strata. Naturally, such occurrences may considerably influence the stratigraphic ranges of the various species (see e.g. JAGT & KUYPERS [1994]). On the basis of recently collected material, as well as on specimens in private collections which document outcrops and/or exposures no longer accessible, these ranges may now be refined.

The palaeobiogeographic and stratigraphic implications of these ammonite faunas are briefly discussed in the present paper, also with reference to other macrofossil groups such as coleoid cephalopods, echinoderms, and cirripedes (see e.g. JAGT & COLLINS [1989, 1999]).

Lastly, from Interval 6 (sensu FELDER & BLESS [1994]; FELDER [1997]) of the Vijlen Member (Gulpen Formation), as exposed at the CPL SA and CBR-Lixhe quarries (Haccourt – Lixhe, Liège), *Pachydiscus (P.) neubergicus* (VON HAUER, 1858) is recorded. The first appearance of this species has been taken at Tercis (Landes, SW France) to provisionally define the base of the Maastrichtian (see ODIN [1996]). From the same unit at the CPL SA quarry (Haccourt), a single fragmentary pachydiscid is tentatively assigned to *P. (P.) armenicus* ATABEKIAN & AKOPIAN, 1969.

## 2. Ammonite Faunas and Palaeobiogeographic Implications

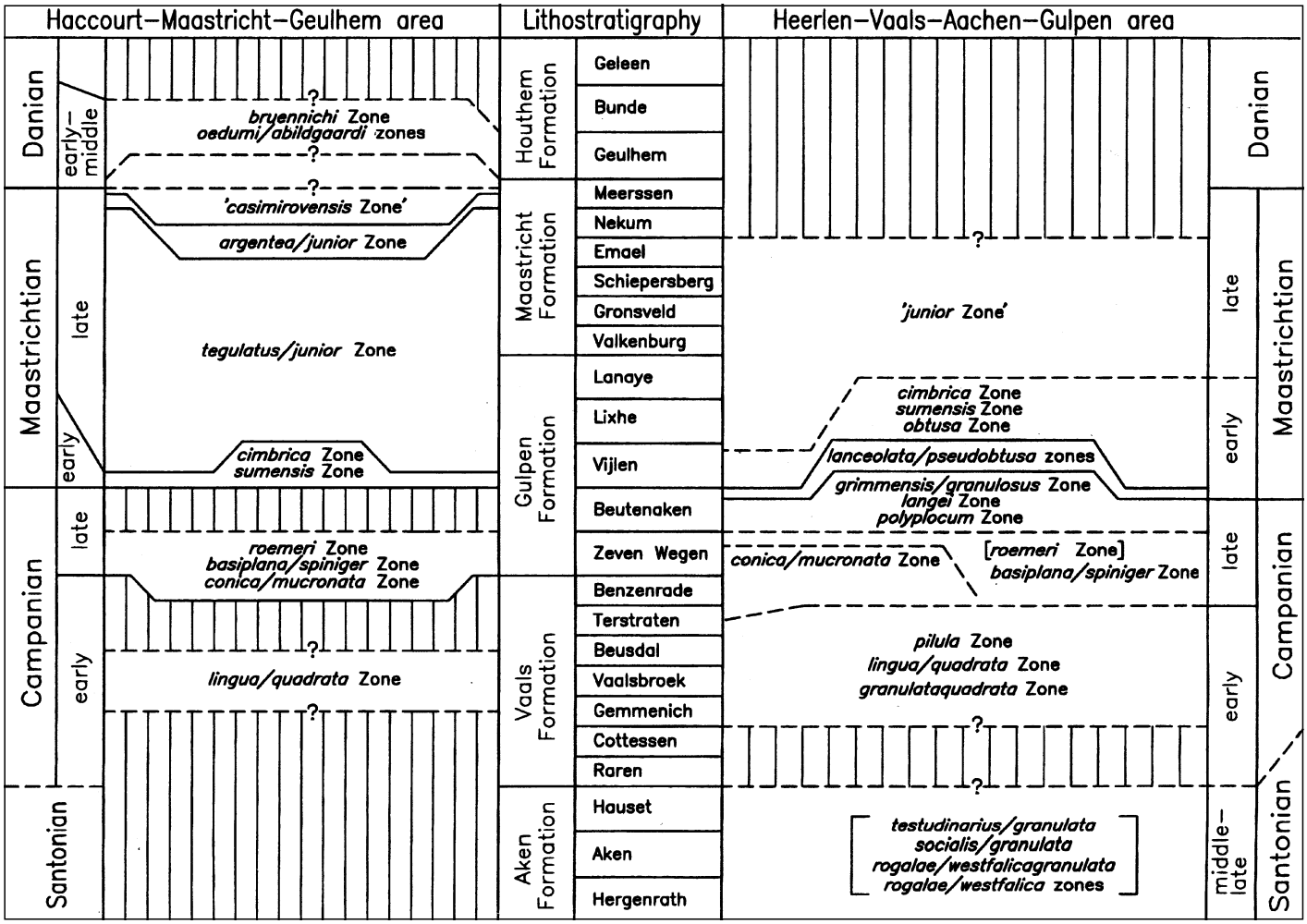
Below all ammonoid taxa known to date from the study area are listed, their palaeobiogeographic implications briefly discussed and their stratigraphic ranges plotted (Text-Figs. 3–5). Text-Fig. 2 illustrates the biozonation and correlation of strata exposed in the area with the Upper Cretaceous white chalk standard section for NW Germany.

### 2.1. Vaals Formation

In the type area near Vaals-Vaalserberg (see Text-Fig. 1), this formation comprises six members, with a total thickness of some 150 m. However, outside this area the boundaries between these members cannot be recognised, which complicates correlations. It means that stratigraphic ranges of ammonites from the Vaals Formation are less firm (see Text-Fig. 4) than those from the Gulpen and Maastricht formations. For instance, material contained in the collections of the Institut royal des Sciences naturelles de Belgique (Brussels), the Rheinisch-Westfälische Technische Hochschule (Aachen), and the Rheinische Friedrich-Wilhelms Universität (Bonn), as revised by KENNEDY & JAGT (1995, 1998), cannot be assigned with certainty to any of these members. A seventh unit, the Benzenrade Member, has recently been added. In part(?) this is the sandy equivalent of the white chalk of the Zeven Wegen Member (Gulpen Formation, see below).

In places, e.g. at Vaals-Eschberg, ammonites are silicified and well preserved, but mostly more or less deformed and fragmentary composite moulds are available from the Vaals Formation.

Widely taken as a marker for the base of the Campanian Stage in ammonite terms is the first appearance of the placenticeratid *Placenticeras bidorsatum* (ROEMER, 1841). There are records from the lower Lower Campanian of Aquitaine (France) and NW Germany (Münster Basin, Niedersachsen) (KENNEDY, 1986b; KENNEDY & KAPLAN, 1995; LOMMERZHEIM, 1995). A single fragment, tentatively identified as *P.* cf. *bidorsatum* (see KENNEDY & JAGT [1995]) and collected loose near Teuven (NE Belgium), is the only record of this species from the study area. However, it cannot be placed in position relative to the material collected from the environs of Vaals nor to that from the Haccourt – Lixhe area.

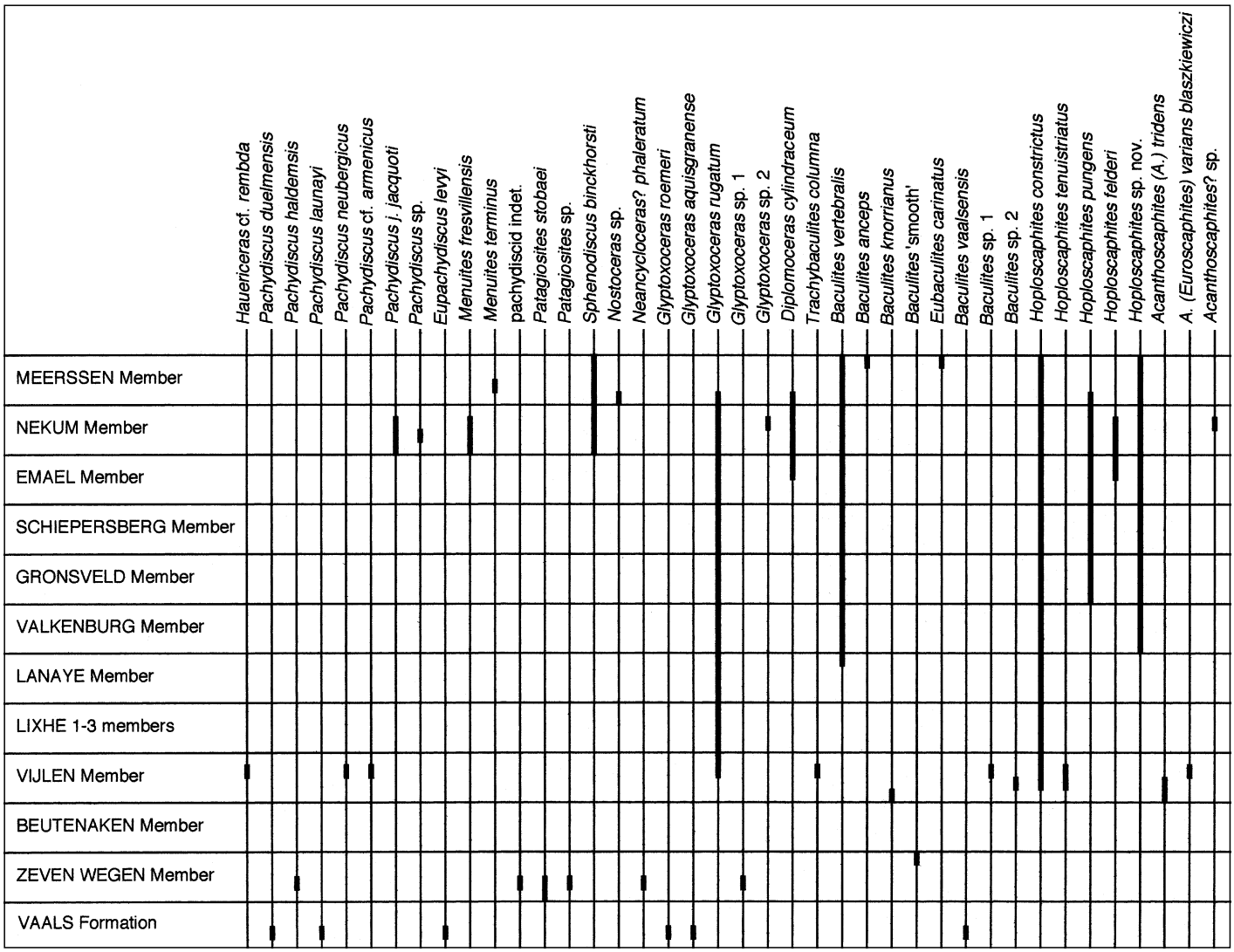



Text-Fig. 2.
Biozonation and correlation of strata exposed in the (extended) type area of the Maastrichtian Stage with the Upper Cretaceous white chalk standard section for NW Germany (after JAGT, 1999a).

The other Vaals Formation placenticeratid is *Hoplitoplacenticeras (H.) marroti* (COQUAND, 1859). The first direct dating of the *H. marroti* Zone, as used in Aquitaine, came from an analysis of associated nannoplankton assemblages; KENNEDY et al. (1992) recorded *H. marroti* from the lower Upper Campanian (subzone CC18B) of Nalzen (Ariège). In Aquitaine, typical *H. marroti* is confined to unit P3; it occurs at a comparable level at Ressec (France). Other possible records include Coesfeld (Münster Basin), Portugal, Israel, central Asia, Madagascar, Texas, and Wyoming (KENNEDY, 1986b; COBBAN & KENNEDY, 1992b; KENNEDY et al., 1992; JAGT et al., 1995a; LOMMERZHEIM, 1995). The most recent records from southern Limburg include a few specimens in the W.M. FELDER Collection (Natuurhistorisch Museum Maastricht) from the upper portion of the Vaals Formation as exposed at the Koning van Spanje, near Gulpen (Text-Fig. 1). All specimens from the study area are thus known from that part of the Vaals Formation which correlates with the Benzenrade and (lower) Zeven Wegen members.

Well represented in the Vaals Formation are pachydiscids, including *Pachydiscus (P.) duelmensis* (SCHLÜTER, 1872), a typically early (though not earliest) Early Campanian species in Aquitaine, and the Münster Basin (KENNEDY, 1986b; KENNEDY & KAPLAN, 1995; WIPPICH, 1995). This occurrence corroborates the faunal exchange between the study area and the Münster Basin, previously postulated on other macrofaunal evidence (echinoids, decapod crustaceans). The second species, *Pachydiscus (P.) launayi* DE GROSSOUVRE, 1894, is known from the Lower Campanian of northern Aquitaine, Madagascar, the ?Münster Basin, the Campine area (Belgium) and possibly in the Gams area, Austria (KENNEDY, 1986b; LOMMERZHEIM, 1995; WIPPICH, 1995; KENNEDY & JAGT, 1998; SUMMESBERGER et al., 1999). The third pachydiscid, *Eupachydiscus levyi* (DE GROSSOUVRE, 1894), is equally widely distributed with records from southern France, northern Spain, the Münster Basin, the Campine area, Poland, and Hungary ((BŁASZKIEWICZ, 1980; THOMEL, 1988; GISCHLER et al., 1994; WIPPICH, 1995; BODROGI et al., 1998; KENNEDY & JAGT, 1998).

From the upper portion of the Vaals Formation as exposed in temporary outcrops in the Zeven Wegen/Vijlenerbosch – Cottessen area (Text-Fig. 1), which correlates with part of the Zeven Wegen Member (Gulpen Formation), JAGT et al. (1995a) recorded *Pachydiscus (P.) subrobustus* SEUNES, 1892. With the exception of KENNEDY & CHRISTENSEN's (1997) record of *P.* cf. *subrobustus* from the uppermost Lower/lower Upper Campanian of southern Sweden, this species has been shown to be confined to the Upper Campanian of Ariège and Tercis (Landes, France), the Gschliefgraben (Austria), Poland, Pontus (Turkey), the Münster Basin, the Ukraine (Donbass), and ?southern Belgium (see KENNEDY & SUMMESBERGER, 1984; HANCOCK & KENNEDY, 1993; KENNEDY, 1993a; KENNEDY & BILOTTE, 1995; KAPLAN et al., 1996).



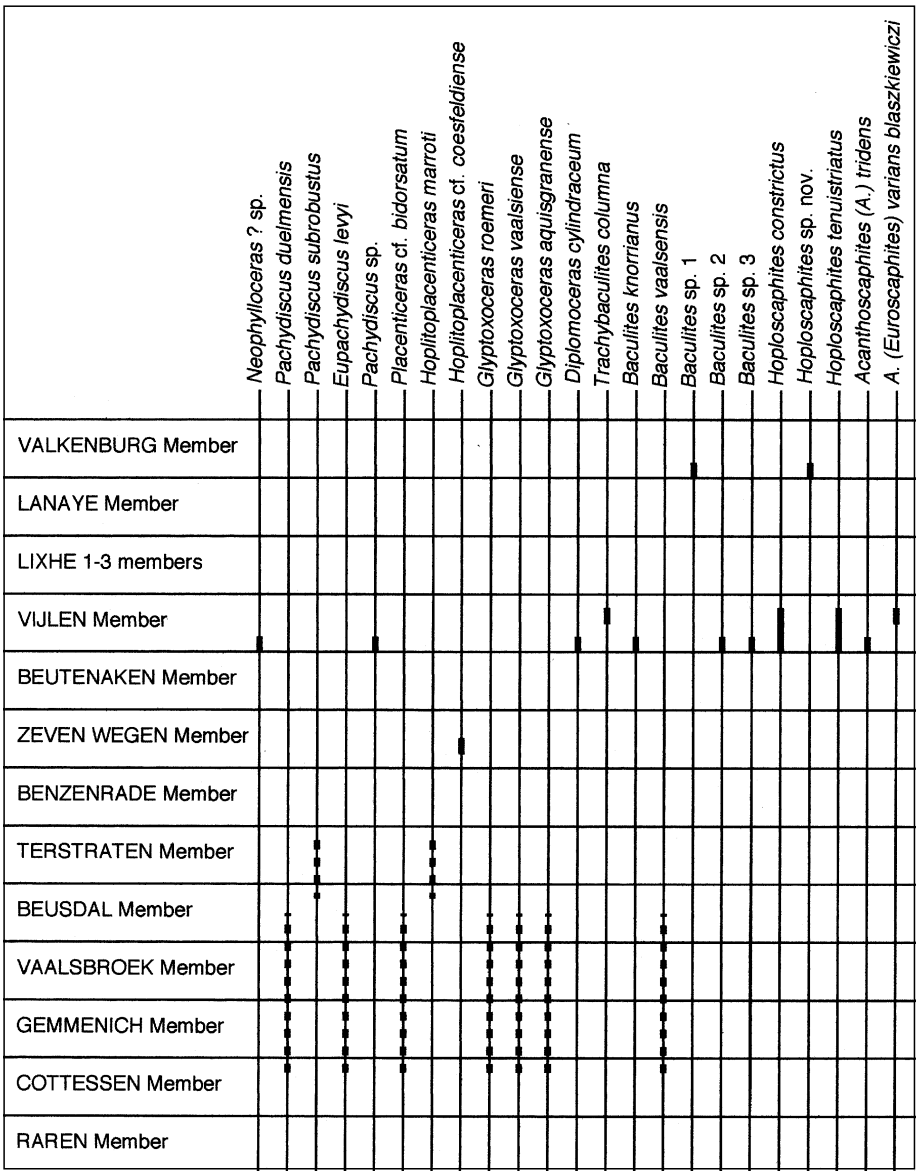

Text-Fig. 3.
Ammonite ranges in Area 1 (see Text-Fig. 1), including the following main localities: CPL SA-Haccourt, CBR-Lixhe, CBR-Romontbos, Ankerpoort-Marnebel, ENCI-Maastricht BV, Ankerpoort–'t Rooth, Blom, and Ankerpoort-Curfs.

Correlative strata in the former Maurits colliery (Geleen-Lutterade) have yielded *Pachydiscus (P.) colligatus* (BINKHORST, 1861), as revised by KENNEDY (1987). This species ranges from the uppermost Lower to (?upper) Upper Campanian, with records from Charente-Maritime, Brabant (Belgium), ?southeast Spain, ?Madagascar, ?Tercis (Landes), and southern Sweden (KENNEDY, 1986b; HANCOCK & KENNEDY, 1993; KENNEDY & CHRISTENSEN, 1997; MARTINEZ, 1997; WARD & ORR, 1997; KENNEDY & JAGT, 1998).

Important for trans-Atlantic correlations is the scaphitid *Scaphites (S.) hippocrepis* (DEKAY, 1828) II/III sensu COBBAN, 1969. In the Western Interior of the United States, three successive forms serve as zonal markers in the Lower Campanian (COBBAN, 1969). These are widely distributed in Montana, Wyoming, South Dakota, Colorado, Utah, New Mexico, Texas, ?Alabama, Georgia, New Jersey, Maryland, and Delaware (KENNEDY & COBBAN, 1993b; KENNEDY et al., 1995, 1997a, b). Other records include northern Spain, NE Belgium, Aquitaine, Alpes Maritimes, Hampshire, Sussex, Israel, NW Germany, and southern Sweden (COBBAN & KENNEDY, 1992b; GISCHLER et al., 1994; KENNEDY & JAGT, 1995; WIPPICH, 1995; WIESE et al., 1996; KENNEDY & CHRISTENSEN, 1997). In the Hannover area (NW Germany), the species characterises the upper Lower Campanian (NIEBUHR et al., 1997). Late forms of *S.* gr. *hippocrepis* (see e.g. COBBAN & KENNEDY [1992a]) have been recorded from the Ozan Formation of Texas, and are of middle Campanian age. These may in fact represent precursors of *Scaphites pumilis* STEPHENSON, 1941 (= *Hoploscaphites pumilis*, in KENNEDY & COBBAN, 1993a) from the Upper Campanian of Texas, Arkansas, Haute Garonne, and Tercis (Landes).

Equally important in correlations with the eastern United States (Atlantic seaboard) is the baculitid *Baculites vaalsensis* KENNEDY & JAGT, 1995, which in New Jersey is associated with *S. hippocrepis* III. At Hedding (New Jersey; see KENNEDY et al. [1995, 1997b]), it occurs in the Merchantville Formation, which has elements in common with central and Trans-Pecos Texas. It is also known from northern Aquitaine (KENNEDY, 1986b).

Of the three diplomoceratid species known from the Vaals Formation, *Glyptoxoceras vaalsiense* (HOLZAPFEL, 1887) appears to be an endemic form. *Glyptoxoceras aquisgranense* (SCHLÜTER, 1872) occurs in the Aachen – Vaals area and at Haccourt (Liège) (KENNEDY & JAGT, 1995), and has also been recorded from the Münster Basin (KENNEDY & KAPLAN, 1995). Slightly younger are well-preserved conspecific specimens from Nalzen (Ariège) as described by KENNEDY et al. (1992). The third species, *G. roemeri* (GEINITZ,




Text-Fig. 4.
Ammonite ranges in Area 2 (see Text-Fig. 1), including the following main localities: Snouwenberg, Altembroeck, Teuven, Gulpen (Koning van Spanje), Vijlenerbosch, Zeven Wegen, Vaals-Eschberg, Aachen, and Schneeberg.

1849), has been recorded from NE Belgium, the Aachen – Vaals area, and from the "Senonian" of Mangyshlak (Transcaspia) (KENNEDY & JAGT, 1995).

Outcrops of the Benzenrade Member in the Benzenrade area (de Dael, Ubachsberg – Voerendaal; see Text-Fig. 1) have yielded large specimens of the puzosiid *Patagiosites stobaei* (NILSSON, 1827), as revised by KAPLAN et al. (1996), KENNEDY & KAPLAN (1997) and KENNEDY & CHRISTENSEN (1997), from the upper Lower to lower Upper Campanian of NW Germany, southern Sweden, southern Belgium (Mons Basin), and Donbass (KENNEDY, 1993a). Correlation of the Benzenrade Member with the lower Zeven Wegen Member (Gulpen Formation, see below) as exposed in the Haccourt – Lixhe area depends on this ammonite species, as well as on coleoid cephalopods, benthic foraminifers and ostracods.

In summary, current ammonite data show the Vaals Formation to range from the lower Lower Campanian (*lingua/quadrata* Zone, sensu germanico) to lower Upper Campanian (correlatives of *basiplana/stobaei* Zone of NIEBUHR et al., 1997). This is corroborated by coleoid cephalopods, with *Gonioteuthis q. quadrata* (DE BLAINVILLE, 1827), *Belemnitella praecursor* STOLLEY, 1897, and *B. mucronata* (VON SCHLOTHEIM, 1813) having been recorded. Cirripedes from the so-called smectite facies of the Vaals Formation in the Haccourt – Lixhe area are close to species recorded from the Middle Campanian of Mississippi and Alabama, as discussed by JAGT & COLLINS (1989) and COLLINS & JAGT (1999).

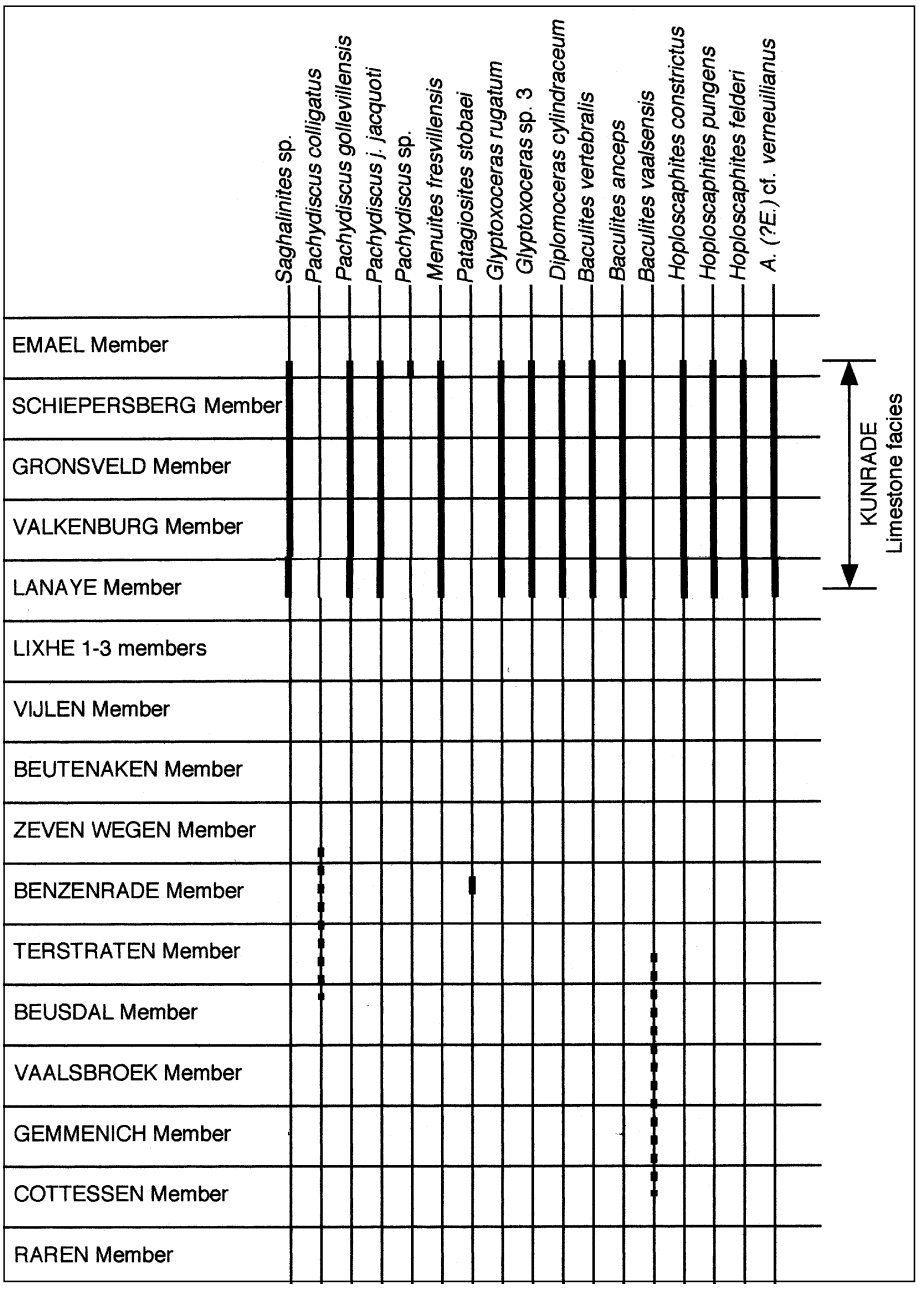
## 2.2. Gulpen Formation

### Zeven Wegen Member

From the type area (Vijlenerbosch, Zeven Wegen) of this unit, a single fragment of a placenticeratid is known, referred with a query by KENNEDY (1987) to *Hoplitoplacenticeras (H.) coesfeldiense* (SCHLÜTER, 1867). This taxon is known from the (lower) Upper Campanian of the Münster Basin, ?southern Sweden, northern Aquitaine, Austria, European Russia, and central Asia (KAPLAN et al., 1996; KENNEDY & CHRISTENSEN, 1997; KENNEDY & KAPLAN, 1997; KENNEDY & SUMMESBERGER, 2001).

Pachydiscids are rare in the Zeven Wegen Member, in comparison to the underlying Vaals Formation. *Pachydiscus (P.) haldemsis* (SCHLÜTER, 1867) has recently been recorded from this member at the CBR-Lixhe quarry (KENNEDY & JAGT, 1998). The same unit, at the nearby CPL SA quarry has yielded an indeterminate microconch pachydiscid. *Pachydiscus haldemsis* is known to date from the Upper Campanian in Aquitaine, NW Germany (Münster Basin), Poland, southern Sweden, the Gschliefgraben and Gams area (Austria), Norfolk (England), Donbass, Kopet Dag, Turkmenia, ?northern Ireland, and ?Texas (KENNEDY & SUMMESBERGER, 1984; COBBAN & KENNEDY, 1994; KENNEDY & CHRISTENSEN, 1997; KENNEDY & KAPLAN, 1997; SUMMESBERGER et al., 1999).

Scaphitids are equally rare, and often poorly preserved; so far *Scaphites (S.) gibbus* SCHLÜTER, 1872, and *Trachyscaphites spiniger spiniger* (SCHLÜTER, 1872) have been recorded. The former species is typically late Early to early Late Campanian well dated, with records from southern Belgium, northern Aquitaine, Angoumé (Landes), northern Germany (Münster Basin, Hannover area), Poland, Donbass, Transcaspia, northern Spain, and the Ukraine (BŁASZKIEWICZ, 1980; KENNEDY, 1986b; WIPPICH, 1995; KAPLAN et al., 1996; WIESE et al., 1996; KENNEDY & KAPLAN, 1997). In the study area, *S. gibbus* is known from the CBR-Lixhe quarry and from a temporary outcrop in the Zeven Wegen (Vijlenerbosch) area (JAGT et al., 1995a; KENNEDY & JAGT, 1998). *Trachyscaphites spiniger* is a typically early Late Cam-




Text-Fig. 5.
Ammonite ranges in Area 3 (see Text-Fig. 1), including former collieries (e.g. Geleen-Lutterade) and the main localities Kunderberg, Kunrade, de Dael, and Benzenrade.

panian species, with records from the Mons Basin(?), Aquitaine, northern Germany, southern Sweden, Poland, European Russia, Armenia, Kopet Dag (Turkmenistan), Texas, and Alabama. Subspecies are known from Israel, Texas, Montana, South Dakota, Wyoming, Colorado, Alabama, and Utah (COBBAN & SCOTT, 1964; BŁASZKIEWICZ, 1980; KENNEDY, 1986b; COBBAN & KENNEDY, 1992a; KENNEDY, 1993a; KENNEDY et al., 1997a; KENNEDY & CHRISTENSEN, 1997; KENNEDY & KAPLAN, 1997). In the Hannover area, *T. spiniger* defines a zone in the lower Upper Campanian, with echinoid and coleoid cephalopod control (NIEBUHR, 1996; NIEBUHR et al., 1997). In the study area, there are records of *T. spiniger* from Vijlenerbosch (KENNEDY, 1987), Malensbos and from the CPL SA and CBR-Lixhe quarries (KENNEDY & JAGT, 1998), all from the lower half of the Zeven Wegen Member.

Puzosiids from this member are *Patagiosites stobaei* and *Patagiosites* sp.; the latter appears close to *P. griffithi* (SHARPE, 1855) from the Upper Campanian of northern Ireland and southeast England (Norfolk), but material available is too poorly preserved to be certain (KENNEDY & JAGT, 1998).

Ranging throughout this unit in the Haccourt – Lixhe area are baculitids but preservation is such that they will have to remain indeterminate. From the chalkstone underlying the Froidmont Horizon (= base of overlying Vijlen Member) at Bois Moreau (Roclenge-sur-Geer, Liège), better preserved baculitids appear to be conspecific with *Baculites* sp. smooth (sensu COBBAN, 1962; see also COBBAN et al. [1992]) from the Pierre Shale of eastern Wyoming. KENNEDY (1993a) recorded this form from the basal Craie d'Obourg of Obourg (Mons Basin), noting that it was an otherwise exclusively North American species which characterises a zone between the *Baculites asperiformis* Zone below and the *B. perplexus* Zone above in the Middle Campanian (see HANCOCK, 1991; COBBAN, 1993).

The diplomoceratid *Glyptoxoceras* sp. 1 as shown in Text-Fig. 3 is based on poorly preserved material, which was assigned with a query to *G. rugatum* (FORBES, 1846) by KENNEDY & JAGT (1998), but is probably distinct. More important for correlation is *Neancyloceras*? *phaleratum* (GRIEPENKERL, 1889), which is also from the lower Upper Campanian (*phaleratum* Zone of Polish authors) of the Gschliefgraben (Austria), northern Germany, Poland, and ?Sweden (BŁASZKIEWICZ, 1980; KENNEDY & SUMMESBERGER, 1984).

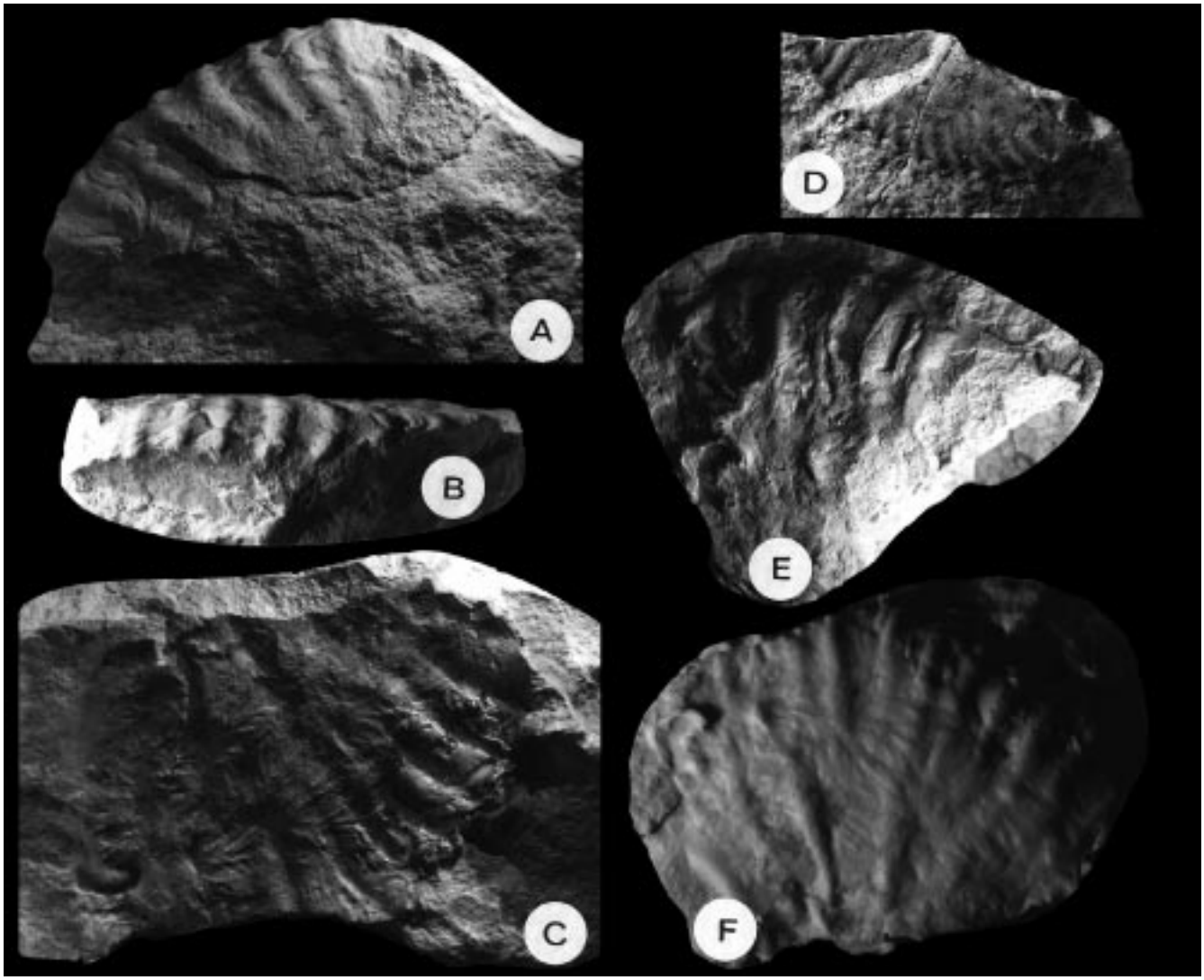
**Beutenaken Member**

This unit has not yielded any ammonites yet, but this may simply be a matter of lack of good exposures in the study area. On coleoid evidence, this member has recently been shown to range from the upper Upper Campanian to the lowermost Maastrichtian age (KEUTGEN & JAGT, 1999), being roughly equivalent to the *polyplocum* and *lanceolata* zones of European authors.

**Vijlen Member**

Outcrops of this unit in the study area have been shown to range from the lower Lower to the lower Upper Maastrichtian, with six zones or intervals recognised (FELDER & BLESS, 1994; KEUTGEN, 1996).

The only phylloceratid from the study area on record to date is a fragmentary specimen from Altembroeck, which JAGT et al. (1995b) listed as *Neophylloceras*? sp.




Text-Fig. 6.
A–C, E–F: *Pachydiscus (P.) neubergicus* (VON HAUER, 1858).
A–B: Natuurhistorisch Museum Maastricht collections, NHMM JJ 7220.
CBR-Lixhe quarry (Lixhe, Liège), Gulpen Formation, Vijlen Member, base + c. 2 m; ×1.4.
C, E–F: Natuurhistorisch Museum Maastricht collections, NHMM 1997094/a–b (leg. G. CREMERS).
CBR-Lixhe quarry (Lixhe, Liège), Gulpen Formation, Vijlen Member, base + c. 4.75 m.
F: Silicone rubber cast; ×1.1.
C, E: External and internal mould, respectively; ×1.4 .
D: *Pachydiscus (P.)* cf. *armenicus* ATABEKIAN & AKOPIAN, 1969.
CPL SA quarry (Haccourt, Liège), Gulpen Formation, Vijlen Member, base + 0–5 m, Natuurhistorisch Museum Maastricht collections, NHMM PNG1 (N. KEUTGEN Colln); ×1.

The same locality has yielded an indeterminate pachydiscid. More important for correlation are two other pachydiscids from Interval 6, here assigned to *Pachydiscus (P.) neubergicus* (VON HAUER, 1858) and *P. (P.)* cf. *armenicus* ATABEKIAN & AKOPIAN, 1969. Of the former species, two crushed fragmentary composite moulds of phragmocones are now available (Text-Fig. 6A–C, E–F). Although rather poorly preserved, these fragments are closely comparable in ornament and sutural details to material from the Bay of Biscay sections (WARD & KENNEDY, 1993), and to the lectotype in particular (KENNEDY & SUMMESBERGER, 1986). Of the latter form only a single, poorly preserved composite mould of a phragmocone is available (Text-Fig. 6D). It differs from the specimens here referred to *P. neubergicus* in apparently having more numerous umbilical bullae (at least 3 in the preserved fragment) and ventral ribs.

*Pachydiscus neubergicus* is currently known from the Bay of Biscay sections, ?southeast Spain, northern Germany, ?southern Belgium (Mons Basin), Denmark, Tercis (Landes), Austria, Poland, Bulgaria, the ?Czech Republic, New Jersey, the Ukraine, European Russia, Baluchistan, Nigeria, Zululand, Madagascar, the United Arab Emirates/Oman, southern India, and ?Sakhalin (BŁASZKIEWICZ, 1980; KENNEDY & SUMMESBERGER, 1987; VAŠIČEK, 1988; KENNEDY & HENDERSON, 1992a; BIRKELUND, 1993; HANCOCK & KENNEDY, 1993; KENNEDY, 1993a; YAZIKOVA, 1994; IVANOV, 1995; KENNEDY, 1995; KENNEDY et al., 1995; MARTINEZ, 1997; WARD & ORR, 1997; KENNEDY, in FATMI & KENNEDY, 1999). Its first appearance has been proposed as defining the base of the Maastrichtian stage (ODIN, 1996); its known range is lower Lower to lower Upper Maastrichtian. At Bjala (Bulgaria), *P. neubergicus* appears to range up to 12 metres below zone CC25b/c (NC22) (RÖGL et al., 1995).

*Pachydiscus armenicus* is known from the type area (Armenia, Azizbek region), the Bay of Biscay sections, Tercis (Landes), Bulgaria, Pyrénées-Atlantiques, and ?Kam-

chatka/Sakhalin (see YAZIKOVA [1994] as *P. gollevillensis*), ranging from the Lower to upper Upper Maastrichtian (HANCOCK & KENNEDY, 1993; WARD & KENNEDY, 1993; IVANOV, 1995).

Desmoceratids are extremely rare, with but a single specimen of *Hauericeras* cf. *rembda* (FORBES, 1846) on record (KENNEDY & JAGT, 1998). This species, originally recorded from south India (KENNEDY & HENDERSON, 1992a), is confined in the Bay of Biscay sections (France, Spain) to a narrow interval in the Lower Maastrichtian (WARD & KENNEDY, 1993), while elsewhere it is of (early) Late Maastrichtian age.

Scaphitids are well represented in the Vijlen Member, both in number of species as well as in number of individuals. *Hoploscaphites constrictus* (J. SOWERBY, 1817) ranges throughout this unit, being fairly common in Interval 6 as exposed at the CPL SA and CBR-Lixhe quarries, and in fact continues to right below the K/T boundary in the area (see below). This species occurs through most of the Maastrichtian Stage, with records from the Bay of Biscay sections, Petites Pyrénées, Tercis (Landes), Cotentin Peninsula, Germany, Denmark, southern Sweden, Poland, Austria, the Czech Republic, Bulgaria, the Ukraine, Donbass, Transcaspia, Carpathians, Kazakhstan, Kopet Dag (BIRKELUND, 1993; HANCOCK & KENNEDY, 1993; WARD & KENNEDY, 1993; KENNEDY & CHRISTENSEN, 1997).

*Hoploscaphites tenuistriatus* (KNER, 1848) is a much rarer species, currently known from Interval 6(?) at Mesch (KENNEDY, 1986c, 1987) and lower in the Vijlen Member at Altembroeck, the only definite records. Elsewhere, this apparently short-ranging form has been described from Denmark, the Ukraine, Poland, the ?Czech Republic, southern Russia, and northern Germany (KENNEDY & SUMMESBERGER, 1986; VAŠIČEK, 1988; BIRKELUND, 1993).

The third scaphitid is *Jeletzkytes dorfi* LANDMAN & WAAGE, 1993, originally described from the Fox Hills Formation in Wyoming and South Dakota (LANDMAN & WAAGE, 1993). A few specimens from Interval 6 of the Vijlen Member at the CPL SA quarry were assigned to this species by JAGT & KENNEDY (1994), who on the basis of this record proposed an approximate correlation between the base of the *Belemnitella junior* Zone of NW Europe and that of the *Hoploscaphites birkelundi* Zone of the US Western Interior.

Equally important for supraregional correlations are *Acanthoscaphites (A.) tridens* (KNER, 1848) and *A. (Euroscaphites) varians blaszkiewiczi* JAGT, KENNEDY & MACHALSKI, 1999. The former is confined to the Lower Maastrichtian, and ranges from the *lanceolata* to the (upper) *sumensis* zones. In the study area, the most precisely dated specimens are from the middle *sumensis* Zone of Altembroeck (JAGT et al., 1995b; KEUTGEN, 1997). A recent find of *A. tridens* at the ENCI-Maastricht BV quarry cannot be assigned to belemnite zone yet, but may either be of *sumensis* or *cimbrica* zone age. Other records of this species are from the Ukraine, central Poland, northern Germany, Denmark, Donbass and elsewhere in southern European Russia (BŁASZKIEWICZ, 1980; KENNEDY & SUMMESBERGER, 1987; BIRKELUND, 1993). The latter form is now known from Intervals 5 and 6 of the Aachen area and of the CPL SA and CBR-Lixhe quarries, which means that this subspecies ranges from the upper Lower to the lower Upper Maastrichtian. A similar range has been documented for Denmark and northern Germany (BIRKELUND, 1993; JAGT et al., 1999).

Of baculitids, two species in particular are of prime importance stratigraphically speaking. *Trachybaculites columna* (MORTON, 1834), which in the study area appears to be confined to Interval 6 of the Vijlen Member at the CPL SA and CBR-Lixhe quarries and at Snouwenberg, is otherwise known only from South Dakota, Alabama, Mississippi, Texas, and California (COBBAN & KENNEDY, 1992c, 1995), of Late Maastrichtian age. *Baculites knorrianus* (DESMAREST, 1817), as revised by KENNEDY & SUMMESBERGER (1987), is a distinctive species currently known from the Lower to lower Upper Maastrichtian with records from the Mons Basin (Belgium), the Ukraine, Denmark, northern Germany, the ?Czech Republic, southern Sweden, and Poland (VAŠIČEK, 1988; KENNEDY, 1993a; BIRKELUND, 1993; KENNEDY & CHRISTENSEN, 1997). In the study area, it appears confined to the *sumensis* Zone of Altembroeck (JAGT et al., 1995b).

Other baculitids were recorded from the Vijlen Member at Vijlenerbosch and Cottessen by KENNEDY (1987): *Baculites* sp. 2, similar to *B. knorrianus*, and *Baculites* sp. 3, respectively. In view of their poor preservation, these will have to remain indeterminate.

Of the diplomoceratid *Glyptoxoceras rugatum*, as revised by KENNEDY & HENDERSON (1992b) and HENDERSON et al. (1992), a single specimen is known from Interval 6 at the CBR-Lixhe quarry (KENNEDY & JAGT, 1998). However, in the study area the species is best known from the Maastricht Formation (see below). Records elsewhere include the Lower and Upper Maastrichtian of south India, Brazil, ?Chile, western Australia, Pyrénées-Atlantiques, Bay of Biscay sections, ?Tercis (Landes) (HANCOCK & KENNEDY, 1993; WARD & KENNEDY, 1993).

#### Lixhe 1–3 Members

These units, best exposed in the Haccourt – Lixhe area, have not yielded any ammonites yet, but this is in part due to collection failure. On coleoid evidence, an early Late Maastrichtian age (*Belemnitella junior* Zone) can be assigned to these members.

#### Lanaye Member

To date, only poorly preserved, generally phosphatised baculitids are known from this unit (see also Valkenburg Member below).

In summary, current ammonite data show the Gulpen Formation to range from the lower Upper Campanian (*phaleratum* Zone of Polish authors) to the lower Upper Maastrichtian (*Belemnitella junior* Zone in coleoid terms). This is corroborated by coleoid cephalopods, with *Belemnitella mucronata*, *Bt. woodi* CHRISTENSEN, 1995, *Bt. minor* I–II sensu CHRISTENSEN, 1995, *Bt. najdini* KONGIEL, 1962, *Belemnella (B.) lanceolata* (VON SCHLOTHEIM, 1813), *Bn. (Pachybelemnella) obtusa* SCHULZ, 1979, *Bn. (P.) sumensis* JELETZKY, 1949, *Bn. (P.) cimbrica* BIRKELUND, 1957, *Bt. junior* NOWAK, 1913 and *Bt. pulchra* SCHULZ, 1982 having been recorded. Correlations of the lower Zeven Wegen and Vijlen members with localities elsewhere in NW Europe as based on these biota, are corroborated by certain species of echinoid, crinoid and asteroid.

### 2.3. Maastricht Formation

#### Kunrade Limestone Facies

Although data presented by FELDER & BLESS (1989) have generally been accepted, detailed correlations between the typical "tuffaceous chalk facies" of the Maastricht Formation in the Maastricht – Geulhem/Valkenburg area and the Kunrade Limestone facies in the Benzenrade/Kunrade area are still problematic. FELDER & BLESS (1989) equated the Kunrade Limestone facies with the (upper) Lanaye Member (Gulpen Formation) up to the basal Emael Member (Maastricht Formation), mostly on bioclast

evidence. Classic localities such as Kunderberg/Kunrade and Schunck have been referred to their ecozones IV and V, which equate with foraminifer zones F and J–H, respectively. According to FELDER & BLESS (1989) the top of the Kunrade Limestone facies in its type area correlates with the top of foraminifer zone H at the ENCI-Maastricht BV quarry, i.e. the base of the Emael Member. However, ammonite and crinoid distribution (see JAGT & KUYPERS [1994] and JAGT [1999b], respectively) suggest matters may be less straightforward than anticipated by FELDER & BLESS (1989).

It appears that most material as described by DE GROSSOUVRE (1908), and revised by KENNEDY (1987), stemmed from the upper portion of the Kunrade Limestone facies, as exposed in the Kunrade/Kunderberg area. The Motorway RW76 exposure near Benzenrade is lower in the section; ammonite records for this part of the sequence are based on material contained in the H. VLIEKS Collection (Simpelveld-Molsberg). Of note is that in particular this lower portion has yielded numerous silicified specimens, which naturally have an impact on the species' distribution and range in the area.

The tetragonitid *Saghalinites* sp. is known only from Kunrade; there are no records from the "tuffaceous chalk" facies in the Maastricht – Geulhem/Valkenburg area. It may be conspecific with BIRKELUND's (1993) *Saghalinites* n. sp. from the Upper Maastrichtian of Denmark.

At least three, possibly four, species of pachydiscid are known from the Kunrade facies:

*Pachydiscus (P.) gollevillensis* (D' ORBIGNY, 1850) appears confined to this facies, despite the fact that KENNEDY (1987) listed material from Geulhem; this has probably been mislabelled. This species is now known to range from the upper Lower to the Upper Maastrichtian, with records from Cotentin (Manche), Lleida (Spain), ?southeast Spain, Poland, northern Germany, Austria, Armenia, northern Caucasus, the Crimea, Bulgaria, the Bithynian peninsula, Turkey, and Madagascar (KENNEDY, 1986a; WARD & KENNEDY, 1993; IVANOV, 1995; MARTINEZ, 1997).

The second species, *Pachydiscus (P.) jacquoti* (SEUNES, 1890), also is best known from the Kunrade facies, although a few specimens are known from the Nekum Member as exposed in the Eben Emael/Maastricht – Geulhem area (JAGT, 1995). Its known range is upper Lower to Upper Maastrichtian, with records from Cotentin (Manche), Pyrénées-Atlantiques, Tercis (Landes), Armenia, Madagascar, ?British Columbia, the Bay of Biscay sections, Bulgaria, and south India (KENNEDY, 1986a, 1987; KENNEDY & HANCOCK, 1993; HANCOCK & KENNEDY, 1993; WARD & KENNEDY, 1993; IVANOV, 1995).

The commonest pachydiscid in the Kunrade facies is *Menuites fresvillensis* (SEUNES, 1890); this species also occurs in the Nekum Member of the Eben Emael – Maastricht area, and possibly also at Valkenburg aan de Geul (KENNEDY, 1987; JAGT, 1995). A single specimen from the uppermost Meerssen Member (top of section IVf-6) at the Ankerpoort-Curfs quarry (Geulhem) is perhaps better referred to *M. terminus* (see below; MACHALSKI & JAGT, 1998). The known range of *M. fresvillensis* is Lower to Upper (not uppermost) Maastrichtian, with records from Cotentin (Manche), Pyrénées-Atlantiques, Haute Garonne, the Bay of Biscay sections, South Africa, Yugoslavia, Armenia, southern India, Madagascar, western Australia, Chile and ?Brazil (HENDERSON & MCNAMARA, 1985; KENNEDY, 1986a, 1987; KENNEDY et al., 1986; KENNEDY & HANCOCK, 1993; WARD & KENNEDY, 1993).

Of a possible fourth pachydiscid species, *Pachydiscus (P.)* sp., first noted by JAGT (1995), a single undistorted, silicified phragmocone from Kunderberg is available. A second specimen, preserved as external mould in a flint nodule, is known from the lower Nekum Member at the Blom quarry (Berg en Terblijt; Text-Fig. 1). This material appears to be close to *P. (P.) noetlingi* KENNEDY in FATMI & KENNEDY (1999) from the Upper Maastrichtian of Baluchistan.

Of diplomoceratids three species are known from the Kunrade facies, viz. *Diplomoceras cylindraceum* and *Glyptoxoceras rugatum* (= *G.* cf. *subcompressum* and *G.* cf. *circulare* of KENNEDY, 1987). The third species, recorded by KENNEDY (1987) as *Glyptoxoceras* sp. (= *G.* sp. 3, herein), must remain indeterminate.

The commonest ammonites in the Kunrade area are baculitids, of which *B. vertebralis* predominates. Its known range is Lower to uppermost Maastrichtian, with records from the Bay of Biscay sections, Cotentin (Manche), Petites Pyrénées (Haute Garonne), southern Sweden, northern Germany, Denmark, Poland, southern Russia and Tunisia (BIRKELUND, 1993; WARD & KENNEDY, 1993). The other species, *B. anceps* LAMARCK, 1822, is much rarer. From the study area, KENNEDY (1987) recorded material from Geulhem, Kunrade, and the "Maastricht area". Its known range is Lower to uppermost Maastrichtian, with records from Cotentin (Manche), the Bay of Biscay sections, Denmark, Russia and ?northern Spain (WARD & KENNEDY, 1993).

Scaphitids are well represented in the Kunrade facies; the following species are known to date: *Hoploscaphites felderi* KENNEDY, 1987, of which still no body chambers are known, is fairly common. Material listed by KENNEDY (1987) as coming from the Meerssen Member is actually from the basal Nekum Member; I have never seen specimens that could be referred to this taxon from the Meerssen Member. In the "tuffaceous chalk" facies of the Maastricht – Eben Emael area, *H. felderi* is now known from the middle Emael Member to the upper Nekum Member (JAGT, 1995).

*Hoploscaphites pungens* (BINKHORST, 1861), long thought to be restricted to the Kunrade facies, is now known to range from the basal Gronsveld (see below) to the basal Meerssen members in the Maastricht – Eben Emael area, being quite common in the upper Nekum Member (JAGT, 1995).

Of the third scaphitid, *Acanthoscaphites (?Euroscaphites) verneuilianus* (D' ORBIGNY, 1841), originally described from the Upper Maastrichtian of Cotentin (Manche), a single poorly preserved phragmocone from Kunrade is available (KENNEDY, 1987), which may be conspecific.

The proper placement of the fourth species is problematic as well. KENNEDY (1987) recorded, under the name of *Acanthoscaphites* sp., a form from the Kunrade area which finds a match in material from the upper Nekum Member of the Eben Emael area (JAGT, 1995). This may prove close to the *Hoploscaphites constrictus* stock; it is not conspecific with *Acanthoscaphites* sp. of KENNEDY & CHRISTENSEN (1997) from the Upper Maastrichtian of southern Sweden. Comparable specimens are now known to occur in the upper Lower Maastrichtian of Rügen.

**Valkenburg Member**

With the exception of KENNEDY's (1987) *Baculites* sp. (here referred to as *Baculites* sp. 1), found as phosphatised internal moulds from the basal portion of this member at Blankenberg, this unit is extremely poor in ammonites.

This taxon, which may well prove to be conspecific with material from the underlying Lanaye Member (see above), is possibly just a morph of *B. vertebralis* LAMARCK, 1801, well known from the upper Maastricht Formation (see below).

**Gronsveld Member**

During recent years, this member has been well exposed at the ENCI-Maastricht BV quarry, and large collections of macrobiota, inclusive of ammonites, are now available. Of the scaphitid *Hoploscaphites pungens*, originally described from the Kunrade Limestone facies (see above), silicified material is known from the basal part of this unit (JAGT & KUYPERS, 1994). Associated are silicified specimens of *Baculites vertebralis*, which preserve connecting rings.

Of the diplomoceratid *Diplomoceras cylindraceum* (DEFRANCE, 1816) the earliest representatives in the Maastricht area are known from the basal Gronsveld Member. This species is widely distributed from the Upper Campanian to the uppermost Maastrichtian, with records from the Bay of Biscay sections, Pyrénées Atlantiques, Tercis (Landes), Cotentin (Manche), Italy, southern Belgium, Germany, Denmark, Poland, Austria, the Ukraine, Bulgaria, Arctic Siberia, Zululand, Madagascar, south India, western Australia, Antarctic, Chile, Argentina, ?Brazil, California, British Columbia, Alaska, Japan, ?Greenland, ?New Zealand, and Baluchistan (BŁASZKIEWICZ, 1980; HANCOCK & KENNEDY, 1993; WARD & KENNEDY, 1993; MACHALSKI, 1996b; KENNEDY in FATMI & KENNEDY, 1999). HENDERSON et al. (1992) stressed the worldwide distribution of this species in spite of its shell shape and life orientation, and suggested it to have had a long larval stage. Those authors synonymised a number of other specific names given to material from the southern hemisphere.

**Schiepersberg Member**

This member has not yielded any ammonites yet, but this is in part due to collection failure. On coleoid evidence, an early Late Maastrichtian age (*Belemnitella junior* Zone) can be assigned to this unit.

**Emael Member**

In recent years, *Diplomoceras cylindraceum* has proved to be quite common in the middle Emael Member (above the Lava Horizon), as exposed at the CBR-Romontbos quarry (Text-Fig. 1), in composite mould preservation. Not particularly rare in the indurated portions directly below the Lava Horizon is *Baculites vertebralis*, which is associated by much rarer phragmocones of *Hoploscaphites felderi* at the same locality. So far, the CBR-Romontbos quarry is the only outcrop in the study area that has yielded ammonites from this member.

**Nekum Member**

The richest ammonite assemblage recorded to date from this member is from the upper part of the unit, preserved in discontinuous tabular flints at the CBR-Romontbos quarry (JAGT, 1995). The following species have been listed:

- the pachydiscid *Menuites fresvillensis*, which is also known from the lower Nekum Member (directly above the Laumont Horizon) in the Maastricht area;
- *Sphenodiscus binckhorsti* J. BÖHM, 1898, which is currently known to range from the base of the Nekum Member to the uppermost Meerssen Member (top section IVf-6, directly below the Berg en Terblijt Horizon), and to be absent from the Kunrade Limestone facies. The species has also been recorded from the Upper Maastrichtian of central Poland and Bulgaria (BŁASZKIEWICZ, 1980). KENNEDY & HENDERSON (1992a) noted that the widely distributed, (near) smooth sphenodiscids (e.g., *S. lobatus* (TUOMEY, 1856), *S. siva* (FORBES, 1846) and the present taxon might actually represent but a single form;
- *Diplomoceras cylindraceum*;
- *Glyptoxoceras* sp. (= *G.* sp. 2, herein), characterised by constrictions; not known from elsewhere;
- *Baculites vertebralis*, including the largest and best preserved specimens in the study area;
- *Hoploscaphites constrictus*, which is apparently quite rare in this unit, in comparison with its common occurrence in the Vijlen and Meerssen members;
- *H. felderi* and *H. pungens*, in approximately equal numbers.

**Meerssen Member**

*Menuites terminus* (WARD & KENNEDY, 1993) appears to be the only pachydiscid to occur in the Meerssen Member. To date, three specimens are known, one from the Blom quarry (Berg en Terblijt) preserving part of the body chamber, a fragmentary phragmocone from the St Pietersberg (ENCI-Maastricht BV quarry), and a partial phragmocone from the top of section IVf-6 at the Ankerpoort-Curfs quarry (Geulhem; Ellie Magnée Collection). The last-named specimen was originally thought to be assignable to *M. fresvillensis*, but now seems best referred to *M. terminus*. In the Bay of Biscay sections, *M. terminus* is a short-ranging species in the uppermost Maastrichtian; it is also known from Denmark, Azerbijan, central Poland, and Bulgaria (BIRKELUND, 1993; IVANOV, 1995; MACHALSKI & JAGT, 1998). Should *Pachydiscus sersensis* ATABEKIAN & AKOPIAN, 1969 prove conspecific after all, the geographic range may be extended to Armenia. Professor Ashot ATABEKIAN (pers. comm., September 1999) tells me that he has a topotype specimen of *P. sersensis*; now that Dr Marcin MACHALSKI (pers. comm., September 1999) has just collected the inner whorls of one of the specimens from central Poland assigned to *M. terminus* (see MACHALSKI & JAGT, 1998), this discussion may be taken up again.

Of the sphenodiscid *Sphenodiscus binckhorsti*, numerous specimens have been collected during recent years from the top of section IVf-6 at the Ankerpoort-Curfs quarry (Geulhem). Correlative strata at the Blom and ENCI-Maastricht BV quarries have also yielded specimens, but at those localities the species is much rarer. The M. BLOM Collection (Berg en Terblijt) includes a specimen from the base of the Meerssen Member, as exposed at the Blom quarry.

From the same level at that locality, M. BLOM has collected a specimen of *D. cylindraceum*; this is the highest record of this species in the Maastrichtian type area. Two additional species, a single specimen each, are known from the basal Meerssen Member, one referred to *Glyptoxoceras* sp. (possibly *G. rugatum*), the other identified as *Nostoceras* sp. by VAN DER TUUK & ZIJLSTRA (1979). Both are from the Blom quarry. KENNEDY (1987) compared the latter to *N. colubriformis* STEPHENSON, 1941 (see KENNEDY & COBBAN, 1993a) from the Maastrichtian of Texas and Arkansas, and to *Turrilites saundersorum* STEPHENSON, 1941, from the basal Palaeocene of Texas and derived from the underlying Maastrichtian Kemp Clay.

Of the three baculitids recorded from the present unit, *B. vertebralis* is the commonest, occurring locally in large numbers at the top of section IVf-6 (e.g. Ankerpoort-Curfs quarry). Records in the literature of *B. anceps* from the up-

per Maastricht Formation may also be placed here, although no recent find of this species is known from that locality. The third species is the rarest, *Eubaculites carinatus* (MORTON, 1834). In the Maastrichtian type area, BINKHORST VAN DEN BINKHORST (1861) recorded it (as *B. anceps*) from "St Pierre et dans les environs de Fauquemont", ( suggesting that he had more than one specimen, although a single fragment survives (see KENNEDY, 1987). KENNEDY (1986c, 1987) took this to mean provenance from either the Nekum or Meerssen members; in view of the state of preservation I am inclined to follow him. Unfortunately, no additional material is known. *Eubaculites carinatus* is a widely distributed and long-ranging species, with records from the Lower to upper Upper Maastrichtian of Austria, Petites Pyrénées, Zululand, Madagascar, south India, western Australia, Argentina, central Chile, Mozambique, the Bay of Biscay sections, Pyrénées Atlantiques, Haute Garonne, northern Spain, California, and ?Angola (WARD & KENNEDY, 1993; KLINGER & KENNEDY, 1993; KENNEDY et al., 1995). HENDERSON et al. (1992) stressed its worldwide distribution, with the exception of high-latitude locations; the Dutch occurrence is the only one in northern Europe. In the United States, the species occurs in the Owl Creek and Prairie Bluff formations of Missouri, Mississippi, Tennessee, Texas, New Jersey, Mississippi, Alabama (Atlantic Seaboard) (see KENNEDY & COBBAN, 1993c, 1996).

Of note is the occurrence in the top of section IVf-7 (Meerssen Member) at the Ankerpoort-Curfs quarry of baculitids, some of which preserve apertural features, well above the K/T boundary defined on calcareous nannofossil, dinoflagellate and benthic foraminiferal evidence. In showing a tabulate venter and strong flank ribs, this material is reminiscent of representatives of the genus *Eubaculites* (see KLINGER & KENNEDY, 1993). This material will be described in detail elsewhere.

Three scaphitids are currently known from the Meerssen Member, of which *Hoploscaphites constrictus* is the commonest. Stout specimens with coarse ornament and ventrolateral tubercles extending to (near) the aperture (forma *crassus* of authors) are best known from the top of the unit (IVf-6). MACHALSKI (1996a) noted that the name *crassus* should be used with caution, as originally it was introduced to refer to especially thick-set conchs. In populations, e.g. from the upper Upper Maastrichtian of central Poland, these however occur associated with more slender varieties of the same species. Within the Meerssen Member, *H. constrictus* is commoner in the upper part (IVf-5, -6), being much rarer, and mostly also poorly preserved, in the bryozoan- and coral-dominated lower and middle portions of the unit.

Very rare, and currently known from a single specimen only collected from the basal Meerssen Member at the ENCI-Maastricht BV quarry, is *H. pungens*. This appears to be the highest occurrence of this endemic species. Equally rare is *Hoploscaphites* sp. nov. (gr. *waagei/angmartussutensis* BIRKELUND, 1965). This apparently new species (see KENNEDY & JAGT, 1998) appears closely related to a group known from the Maastrichtian of Greenland, and would thus testify to a marine communication via the North Atlantic region (KENNEDY et al., 1998) in the Late Maastrichtian. Two specimens are known, one from the basal Valkenburg Member at Blankenberg, the other from the top of section IVf-6 (Meerssen Member) at the Ankerpoort-Curfs quarry, thus ranging throughout the Maastricht Formation.

In summary, current ammonite data show the Maastricht Formation to be of early Late to late Late Maastrichtian age, with the upper part corresponding to the *terminus* Zone of WARD & KENNEDY (1993). This is corroborated by coleoid cephalopods, with *Belemnitella junior* and *Belemnella (Neobelemnella)* gr. *kazimiroviensis* (SKOŁOZDRÓWNA, 1932) having been recorded.

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