BULLETIN DE L'INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE
BULLETIN VAN HET KONINKLIJK BELGISCH INSTITUUT VOOR NATUURWETENSCHAPPEN,
SCIENCES DE LA TERRE, 65: 127-137, 1995
AARDWETENSCHAPPEN, 65: 127-137, 1995

Santonian macrofauna and nannofossils from northeast Belgium

by John W.M. JAGT, William James KENNEDY, Jacqueline A. BURNETT, Walter Kegel CHRISTENSEN & Annie V. DHONDT

Abstract

From a limited number of mine shafts in the Belgian province of Limburg (Houthalen and Zolder/Voort areas), a small fauna comprising ammonites, belemnites and inoceramid bivalves is described. A nannofossil analysis of samples taken from the ammonites is added. This assemblage is of (late) middle to late Santonian age, and thus roughly corresponds to the 'Craie de Lonzée' (province of Namur, Belgium) and the Aachen Formation of the Aachen-Vaals area (SE Netherlands and Germany).

Key-words: Cephalopoda, Bivalvia, nannofossils, late Cretaceous, biostratigraphy.

Résumé

De quelques charbonnages du Limbourg belge (Houthalen et Zolder-Voort) une faunule d'ammonites, belemnites et inocérames a été étudiée. Les nannofossiles des échantillons d'ammonites ont été identifiés. L'assemblage est d'âge Santonien moyen (supérieur) à supérieur et peut ainsi être comparé à la "Craie de Lonzée" (province de Namur, Belgique) et à la Formation d'Aix-la-Chapelle de la région d'Aix-la-Chapelle - Vaals (SE des Pays-Bas et Allemagne).

Mots-clefs: Céphalopodes, bivalves, nannofossiles, Crétacé supérieur, biostratigraphie.

Introduction

During a revision of the ammonite fauna of the type Maastrichtian (KENNEDY, 1987a), it was noted that the collections of the Institut royal des Sciences naturelles de Belgique at Brussels also comprised ammonite faunules of Santonian age not previously described. These limited faunas were collected during the construction of mine shafts of the former Houthalen and Zolder/Voort collieries (Limburg, NE Belgium) (Text-fig. 1). Labels with the specimens state locality and depth below surface; other than this there are no stratigraphic details. In order to refine the dating it was decided to add data taken from belemnites and inoceramid bivalves from the same shafts and depths and to remove quantities of matrix for nannofossil analysis.

These faunas are of importance mainly in a broader context, in being roughly coeval with the "Glauconie de Lonzée" (CHRISTENSEN, 1994; MALCHUS *et al.*, 1994) of Namur province (Belgium) and (part of) the Aachen Formation as exposed in the Dutch-Belgian-German borderland southwest of Aachen-Vaals (BATTEN *et al.*, 1988).

Material

All specimens are housed in the collections of the Institut royal des Sciences naturelles de Belgique at Brussels and generally bear IG registration numbers. The figured specimens have been transferred and renumbered to form part of type collections.

Systematic descriptions

AMMONOIDEA

Superfamily Hoplitaceae DOUVILLÉ, 1890
Family PLACENTICERATIDAE HYATT, 1900
Genus *Placenticeras* MEEK, 1876

TYPE SPECIES: *Ammonites placenta* DEKAY, 1828, p. 278, by original designation of MEEK (1876, p. 426).

Placenticeras polyopsis (DUJARDIN, 1837)
Pl. 1, Figs. 3-6.

* 1837 *Ammonites polyopsis* DUJARDIN, p. 232, pl. 17, fig. 12.
1983 *Placenticeras polyopsis* (Dujardin, 1837) - KENNEDY & WRIGHT, p. 856, pls 86-88; text-figs. 1-4 (with full synonymy).
1987b *Placenticeras polyopsis* (Dujardin, 1837) - KENNEDY, p. 768 (with additional synonymy).
1994 *Placenticeras polyopsis* (Dujardin) - WIEDMANN *in* GISCHLER *et al.*, p. 238, pl. 43, figs. 10-12.

TYPE: Lectotype, by subsequent designation of KENNEDY & WRIGHT (1983, p. 856), is the original of DUJARDIN

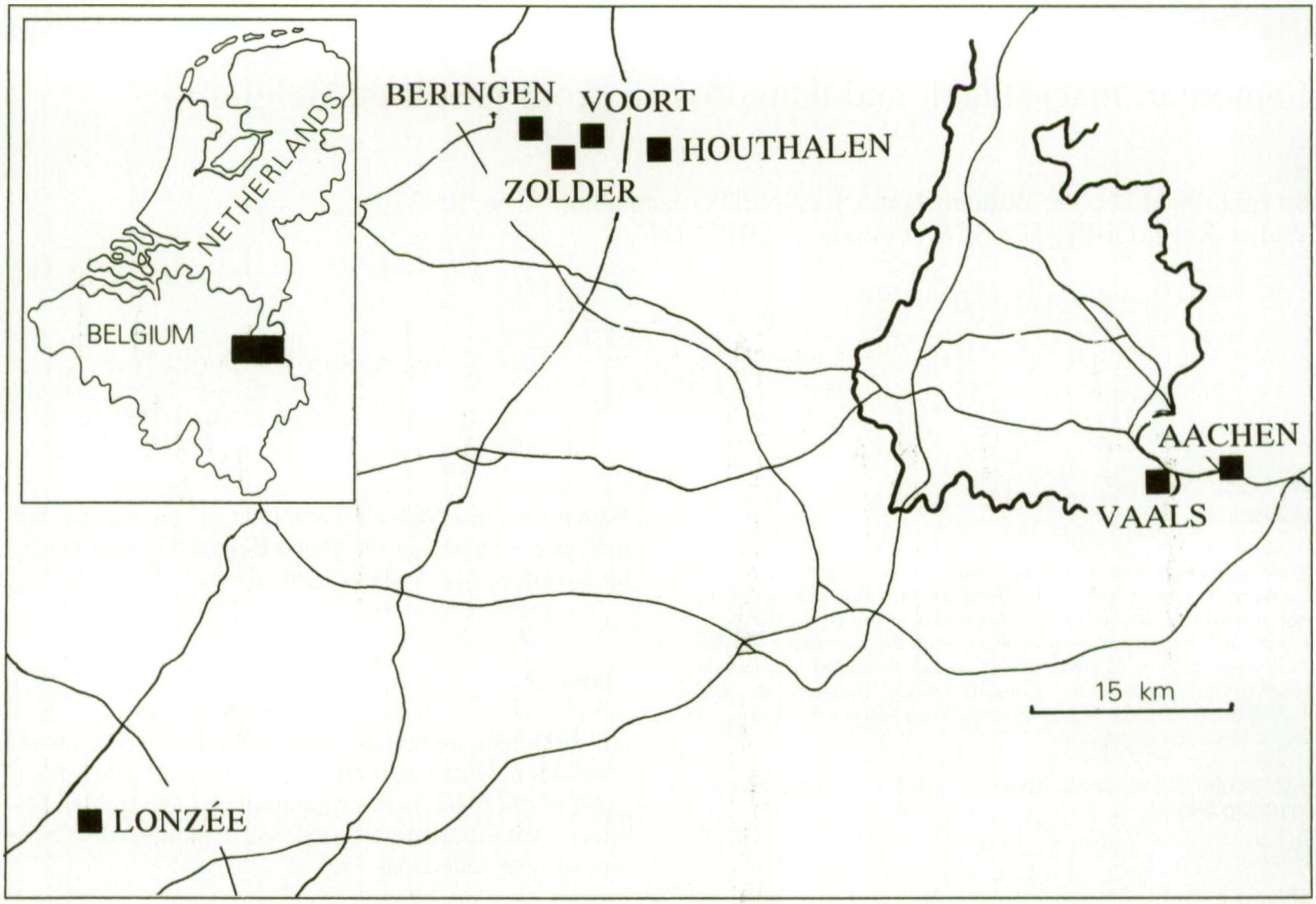

Fig. 1 — Locality map showing locations of mine shafts and exposures/outcrops mentioned in the text.

(1837, pl. 17, fig. 12) from the "Craie tuffau" of Touraine (France); its present whereabouts is unknown.

MATERIAL: IRSNB IG 9780 from the Hervian of the Charbonnage Houthalen, shaft 1, at a depth of 583-585 m; three fragments. IRSNB IG 8914, Charbonnage Zolder (Voort), shaft 2, seven fragments from a depth of 527 m. IRSNB 10378a, b, 10379 (IG 8831), from the same shaft at a depth of 581.45 m. IRSNB IG 8748, from shaft 1 at the same locality at a depth of 582-584.30 m.

DISCUSSION: These fragments are all rather poorly preserved composite moulds, either fragments of juveniles or of body chamber. All show the characteristic strong ornament of the middle growth stages of this species, which is discussed at length by KENNEDY & WRIGHT (1983).

OCCURRENCE: *Placenticeras polyopsis* ranges throughout the Santonian, and is widespread in France (Aquitaine Basin, Corbières, Beausset (Var), and Touraine), northeastern Belgium, Germany and northern Spain.

Superfamily Acanthocerataceae de GROSSOUVRE, 1894
Family COLLIGNONICERATIDAE WRIGHT & WRIGHT, 1951
Subfamily Texanitinae COLLIGNON, 1948
Genus and subgenus *Texanites (Texanites)* SPATH, 1932

TYPE SPECIES: *Ammonites texanus* ROEMER, 1852, p. 31, pl. 3, fig. 1, by original designation of SPATH (1932, p. 379).

Texanites (Texanites) sp.
Pl. 1, Figs. 7, 8.

MATERIAL: A large composite internal mould, and an external mould (IG 8914) of the venter of a larger specimen (Wh *c* 100 mm), Charbonnage Zolder (Voort), shaft 1, at a depth of 583-590 m. IRSNB 10377 (IG 9780), labelled "Campanien (base)", Houthalen (Charbonnages), shaft 1, at a depth of 596.97-598 m.

DESCRIPTION: IRSNB 10377 is a crushed composite mould with a maximum preserved whorl height of 60 mm. There are prominent umbilical bullae (1), clavate inner lateral (2), larger, clavate outer lateral (3), and larger, clavate inner (4) and outer ventrolateral clavi

(5), borne on strong, distant, straight, prorsiradiate ribs. A pronounced groove separates the outer ventrolateral clavi from a strong, slightly undulose siphonal keel.

DISCUSSION: Although only fragmentary, the present material is of interest as the only known representative of the Texanitinae from the area.

Superfamily Scaphitaceae GILL, 1871
Family SCAPHITIDAE GILL, 1871
Subfamily Scaphitinae GILL, 1871
Genus and subgenus *Scaphites* PARKINSON, 1811

TYPE SPECIES: *Scaphites equalis* J. SOWERBY, 1813, p. 53, pl. 18, figs. 1-3, by subsequent designation of MEEK (1876, p. 413).

Scaphites (Scaphites) kieslingswaldensis fischeri RIEDEL, 1931
Pl. 1, Figs. 1, 2.

1931 *Scaphites bärtlingi* RIEDEL, p. 701, pl. 79, figs. 3, 4.
* 1931 *Scaphites fischeri* RIEDEL, p. 704, pl. 79, figs. 5, 6.
1986 *Scaphites fischeri* Riedel, 1931 - KENNEDY, p. 124, fig. 40.
1991 *Scaphites kieslingswaldensis fischeri* Riedel, 1931 - KENNEDY & CHRISTENSEN, p. 222, pl. 2, figs. 1, 2; pl. 5, fig. 2; pl. 6, figs. 2-4, 7; pl. 7, figs. 2, 4.
1993 *Scaphites (Scaphites) kieslingswaldensis fischeri* Riedel, 1931 - KENNEDY & CHRISTENSEN, p. 155, figs. 4f, g, m, n.

TYPE: Lectotype, designated by KENNEDY (1986, p. 124), is the original of RIEDEL (1931, pl. 79, fig. 6).

MATERIAL: From the Charbonnage Houthalen, shaft 1, IRSNB 10383 (IG 9780), a single fragmentary specimen at a depth of 583-585 m.

DISCUSSION: The single available specimen corresponds closely to material from the lowermost Campanian of Broitzem-Braunschweig (Germany) as figured by KENNEDY (1986, fig. 40); it is here recorded for the first time from the Upper Santonian/Lower Campanian of Belgium (see below).

OCCURRENCE: Lower Santonian to Lower Campanian of Germany, Santonian of Denmark and Sweden and Upper Santonian/Lower Campanian of Belgium.

BELEMNOIDEA

The present collection comprises 109 specimens, 15 of which are complete, 26 are fragments of the anterior end, and 68 are fragments of the middle and posterior part of the guard. All are referable to the genus *Gonioteuthis* BAYLE, 1878.

The specimens come from Charbonnage Houthalen, shaft 1, at a depth of 575-598 m; Charbonnage Zolder (Voort), shaft 1, at a depth of 575.8-584.3 m; same colliery, shaft 2, at a depth of 581.45-588 m, and from Charbonnage Beringen, shaft 2, at a depth of 612 m.

The North European palaeobiogeographic province extends from Ireland in the west to the Ural Mountains in the east and includes the Central European and Central Russian Subprovinces. These subprovinces are well defined in the Coniacian-Lower Campanian. The Central European Subprovince is characterised by the genus *Gonioteuthis* and the Central Russian Province by the genus *Belemnitella* d'ORBIGNY, 1840 (CHRISTENSEN, 1976, 1988, 1990). Belgian Limburg is part of the Central European Subprovince as defined on belemnites.

Family BELEMNITELLIDAE PAVLOW, 1914
Genus *Gonioteuthis* BAYLE, 1878

TYPE SPECIES: *Belemnites quadratus* DE BLAINVILLE, 1827.

REMARKS: The evolutionary lineage of *Gonioteuthis* includes seven species and subspecies occurring from the Middle Coniacian to the Lower/Upper Campanian boundary (Text-fig.2). This lineage was studied in great detail by the German authors E. STOLLEY, G. ERNST and M.-G. SCHULZ, in addition to I. JARVIS and W.K. CHRISTENSEN (references in CHRISTENSEN, 1991). Eleven zones have been established on the basis of this lineage (Text-fig. 2), based mainly on the Riedel-Quotient (= length of guard divided by depth of pseudoalveolus; see ERNST, 1964). ERNST & SCHULZ (1974) introduced the term Riedel-Index, which is the depth of the pseudoalveolus as a percentage of the length of the guard. The Schlankheits-Quotient (= Slenderness-Quotient) of ERNST (1964) is the length of the guard divided by the dorsoventral diameter at the alveolar end.

CHRISTENSEN (1991) analysed the growth relationship of guard length *vs* the depth of the pseudoalveolus, and guard length *vs* the dorsoventral diameter at the alveolar end of a large number of samples, representing all species of *Gonioteuthis*, with the exception of *G. praewestfalica*. He showed that the relationship of guard length *vs* depth of pseudoalveolus is generally isometric. The *Gonioteuthis* zonation of ERNST (1964) is therefore valid. On the other hand, the relationship of guard length *vs* dorsoventral diameter at the alveolar end is allometric to strongly allometric in most samples. Juvenile specimens are more slender than adults. It is therefore not valid to calculate the mean Slenderness-Quotient.

DISTRIBUTION: *Gonioteuthis* is known from the upper Middle Coniacian to the Lower/Upper Campanian boundary. The genus had its evolutionary centre in NW Europe and is recorded almost exclusively from the Central European Subprovince.

Gonioteuthis westfalicagranulata (STOLLEY, 1897)
(See CHRISTENSEN, 1975a, b for synonymy).

TYPE: The original of STOLLEY (1897, pl. 2, fig. 16; pl. 3, fig. 6) was designated lectotype and reillustrated by CHRISTENSEN (1975b, pl. 10, fig. 1; text-fig. 2A).

BIOMETRY: Fifteen complete specimens were analysed using univariate statistical methods: these are FI 94-1/1 & 2 (2 specimens), IG 9780, Charbonnage Houthalen, shaft 1, 575-583 m; FI 94-1/13 (2 specimens), IG 8748, Charbonnage Zolder (Voort), shaft 1, 575.8-579.5 m; FI 94-1/9 (2 specimens), IG 8748, Charbonnage Zolder (Voort), shaft 1, 579.5-582 m; FI 94-1/8 (3 specimens), IG 8748, Charbonnage Zolder (Voort), shaft 1, 582-584.3 m; FI 94-1/7 (4 specimens), IG 8831, Charbonnage Zolder (Voort), shaft 2, 581.45 m; and FI 94-1/10 (2 specimens), IG 8831, Charbonnage Zolder (Voort), shaft 2, 588 m.

Univariate analysis

Character	N	$\bar{X}$	SD	CV	OR
L	15	60.1	3.8	6.4	52.0-64.9
RQ	15	9.2	2.4	25.8	6.4-15.0
RI	15	11.4	2.8	24.3	6.7-15.7
SQ	15	6.1	0.8	13.8	5.1- 7.5
L/MLD	13	6.2	1.0	15.6	4.9- 8.5
MLD/LDAE	13	1.1	0.1	5.5	1.0- 1.3

N = number of specimens; $\bar{X}$ = mean value; SD = standard deviation; CV = coefficient of variation; OR = observed range; L = length of guard; RQ = Riedel-Quotient; RI = Riedel-Index; SQ = Slenderness-Quotient; MLD = maximum lateral diameter; LDAE = lateral diameter at alveolar end.

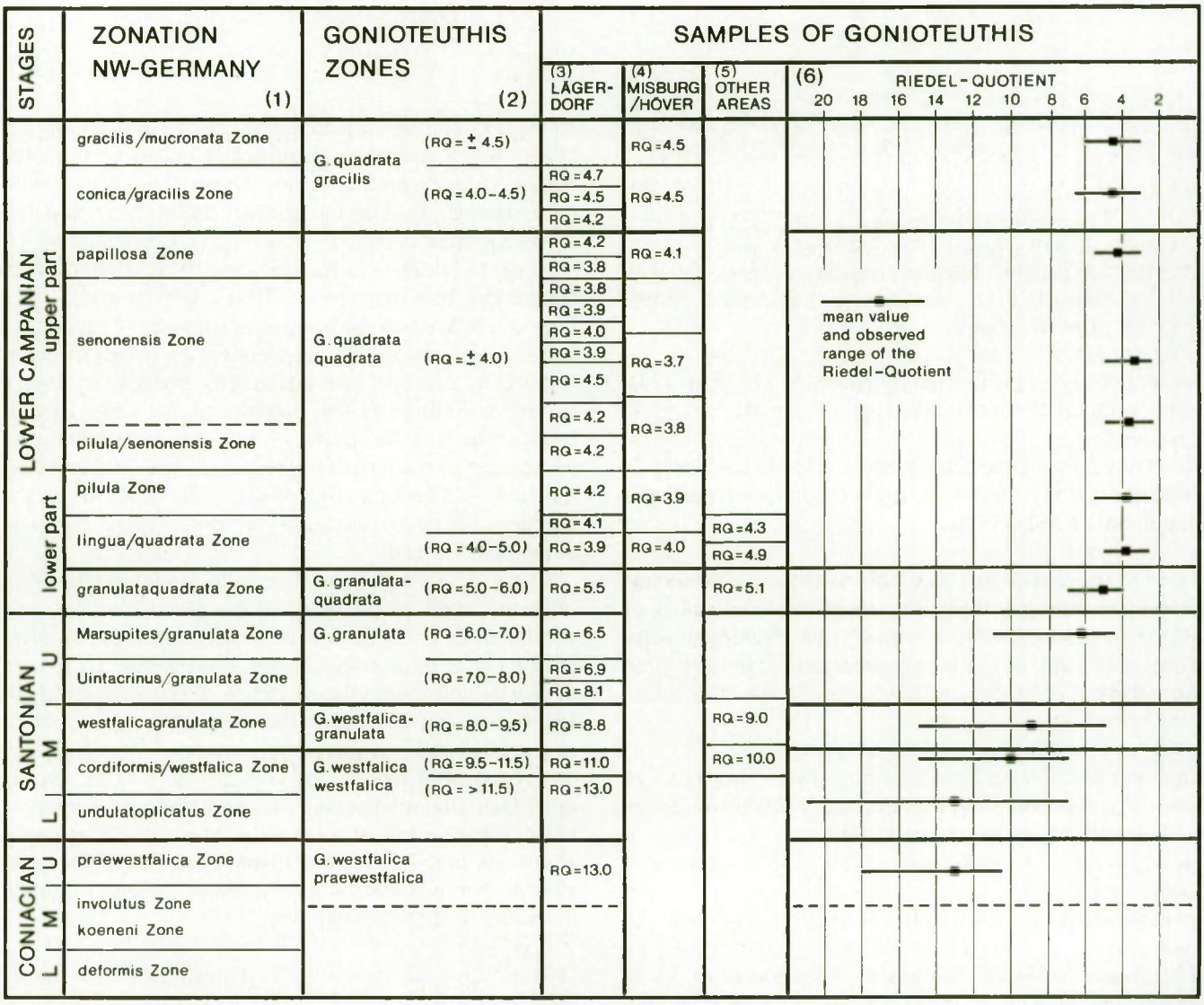

Fig. 2 — Zonation of the Coniacian-Lower Campanian of NW Germany (Braunschweig-Hannover area), *Gonioteuthis* zones, and the mean value and observed range of the Riedel-Quotient of samples of *Gonioteuthis* from Lägerdorf, Misburg/Höver (Hannover) and other areas (Braunschweig and Essen). Modified from CHRISTENSEN (1988).

DISCUSSION: According to ERNST (1964, 1968) samples of *G. westfalicagranulata* have a mean Riedel-Quotient of 8.0-9.5 (Text-fig. 2). The mean value of this index of the present sample is 9.2, and it can thus be referred to this species.

ERNST (1968) analysed two samples of *G. westfalicagranulata* from NW Germany; these samples have a mean Riedel-Quotient of 9.0, and the observed range is *c.* 5.5-15.0. The observed range of the Riedel-Quotient of the Belgian sample is 6.4-15.0, which is closely similar to the samples from NW Germany.

ERNST (1964, fig. 12) did not indicate the mean Slenderness-Quotient of samples of *G. westfalicagranulata* from NW Germany. He showed, however, that the mean Slenderness-Quotient of *G. westfalica* varied from 6.4-6.9, and the mean Slenderness-Quotient of *G. granulata* is about 5.7. The present sample has a mean Slenderness-Quotient of 6.1, implying that the specimens are stouter than *G. westfalica* and more slender than *G. granulata*. In this respect, the Belgian sample may be referred to *G. westfalicagranulata* as well.

As noted above, calculating the mean Slenderness-Quotient should be discarded, because the relationship of the length of the guard *vs* dorsoventral diameter is generally allometric to strongly allometric. Nevertheless, the mean Slenderness-Quotient has been calculated for the present sample in order to compare it with samples from NW Germany (ERNST, 1964). All specimens from NE Belgium are adult. If juvenile and adolescent specimens had been available, the mean Slenderness-Quotient would have been slightly larger. However, this would not have affected the above conclusion.

To summarise, the present sample is assigned to *G. westfalicagranulata* on the basis of the means of Riedel-Quotient and Slenderness-Quotient, in addition to the observed range of Riedel-Quotient. The sample exhibits a variation with respect to Riedel-Quotient, which does not differ in any significant respect with coeval samples from NW Germany.

DISTRIBUTION: *Gonioteuthis westfalicagranulata* occurs in the upper Middle Santonian *westfalicagranulata* Zone (ERNST, 1964, 1968) (= *rogalae/westfalicagranulata* Zone of Lägerdorf; ERNST & SCHULZ, 1974; SCHULZ *et al.*, 1984).

Middle Santonian belemnite faunas

Four belemnitellid genera occur in the Middle Santonian: *Actinocamax* MILLER, 1823, *Gonioteuthis*, *Belemnellocamax* NAIDIN, 1964 and *Belemnitella* (see CHRISTENSEN, 1988, 1990). In NW Europe, *Actinocamax* is restricted to a single species, *A. verus* MILLER, 1823, *Gonioteuthis* to two species, *G. westfalica* (SCHLÜTER, 1876) and *G. westfalicagranulata*, *Belemnellocamax* to one group, *B.* ex gr. *grossouvrei* (JANET, 1891) and *Belemnitella* to a single species, *B. propinqua* (MOBERG, 1885).

The belemnite fauna of Belgian Limburg comprises but a single species, *G. westfalicagranulata*. The absence of *A. verus* is enigmatic and may be due to collection failure, because this species occurs commonly in the Santonian near-shore "Glauconie de Lonzée" (CHRISTENSEN, 1994) and in the upper Middle Santonian marls at Eriksdal in Scania, Sweden (CHRISTENSEN, 1986). The absence of *B.* ex gr. *grossouvrei* may be explained by its overall rarity. *Belemnitella propinqua* occurs mainly on the Russian Platform and in southern Scandinavia. Outside this area, only three specimens have been recorded from southern England (CHRISTENSEN, 1991). Its absence in Limburg may be explained by its overall rarity in the Central European Subprovince.

INOCERAMID BIVALVES

Superfamily Pteriacea
Family INOCERAMIDAE ZITTEL, 1881 (ICZN 473)

The collections of the Institut royal des Sciences naturelles de Belgique include the following poorly preserved inoceramid material, from the mine shafts discussed herein:

— Charbonnage Houthalen, shaft 1 (IG 9780)
583-585 m *Cordiceramus brancoiformis* (SEITZ, 1961)
Platyceramus cf. *cycloides* (WEGNER, 1905)
— Charbonnage Zolder, shaft 1 (IG 8748)
579.5-582 m *Endocostea baltica* (J. BÖHM, 1907)
— Charbonnage Zolder, shaft 2 (IG 8831)
581.45 m *Endocostea* aff. *baltica*.

The stratigraphic range of *Cordiceramus brancoiformis* is Middle - Upper Santonian in Germany (SEITZ, 1967; TRÖGER, 1987); *Platyceramus cycloides* is known throughout the Santonian and also from the Lower Campanian (TRÖGER, 1987). The oldest *Endocostea baltica* specimens recorded by SEITZ (1967) and TRÖGER (1987) are from the Upper Santonian, but the species reaches throughout the Campanian and possibly into the Maastrichtian (DHONDT, 1993). These ranges agree well with the belemnite and ammonite/nannofossil ages.

NANNOFOSSILS

Nine calcareous sandstone samples were analysed for nannofossils. Due to the high sand content of the material (sample descriptions appear below), nannofossil slides were prepared in the following way: each sample was rinsed, placed into a beaker with distilled water, and subjected to ultrasonic vibration for a few minutes, until break-down of the sample was effected. The suspension was stirred, the coarse (sandy) fraction allowed to settle for a few seconds, and the uppermost (nannofossil-bearing) part of the suspension pipetted onto a glass coverslip on a hotplate. The suspension was allowed to dry. The sediment on the coverslip was then remobilised with a drop of distilled water, and the sediment smeared evenly and more thinly across the coverslip with a flat-sided toothpick. The smear was then dried and mounted on a glass slide, using Norland Optical Adhesive, for examination.

NF ABUNDANCE Common = 1-10/field of view Few = 1-2/10 fields of view Rare = 1/11-100 fields of view . = absent ? = questionable TAXA (IN ALPHABETICAL ORDER)	NF ZONE	SAMPLES	HOUTHALEN 1 583-585 m (2)	CC16/177 CC16 CC16 583-585 m (4) 596.97-598 m (8)	ZOLDER 1 582-584.3 m (7)	CC15/167 CC16 585-590 m (5)	ZOLDER 2 572 m, Cab. 6g. Dr. 3 (1)	CC16	CC16/177 CC16 572 m (3)	CC16 581.45 m (6)	CC16 581.45 m (9)
Ac. acotus			. . .	F R		R	. ? .				
Ah. octoradiata			F C F	F C		C	C C F				
Ah. regularis			F F .	F .		R	. F .				
Am. brooksii (large form)			R F .	F F		.	R . R				
Ar. cymbiformis			. R .	. .		.	. . .				
Bi. ellipticum			F C F	C F		C	C C C				
Bi. sp.			. . R	F R		F	F F F				
Bra. bigelowii			. . .	R .		R	F R F				
Bro. anormis			F F F	F F		C	F F F				
Bro. parca expansa			. F F	F .		F	F F F				
Bro. signata			R F .	F .		F	F F F				
Ca. cf. Ca. obscurus			. . R	. .		.	. R F				
Ca. obscurus			F F .	R .		R	F . .				
Ca. ovalis			. F .	R R		F	F . R				
Ch. amphipons			F R .	R F		R	F F R				
Ch. bifarius			. R .	F .		F	F . .				
Ch. litterarius			. ? .	. .		.	. . .				
Ch. synquadriperforatus			C F F	C R		F	F C C				
Ch. tetragonothyrus?			F C F	C F		F	C C F				
Co. exiguum			R . .	. .		.	R . .				
Co. signum			F C .	F .		F	F F F				
Cre. conicus			. . .	. .		.	R . .				
Cre. striatus			F F R	F F		.	F F F				
Cri. ehrenbergii			R F .	F .		F	F F F				
Cyc. margerelii			R . R	. .		.	F . .				
Cyc. rotaclypeata			. R .	. .		.	. . .				
Cyl. biarcus			. R .	R R		.	R F F				
Di. ignotus			. R .	R .		R	. . .				
Ei. eximius			F F F	F R		F	F C F				
Ei. gorkae			F F F	R R		F	F F F				
Ei. parallelus			. . .	. F		.	. . R				
Ei. turriseiffelii			F F R	F .		F	F F F				
Ga. obliquum			R F F	F R		R	F F F				
Ge. coronadventis			. . .	. .		R	R . .				
Ha. circumradiatus			R . .	. .		.	. . .				
He. anceps			F F F	F F		F	F F F				
He. trabeculatus			R R C	F C		R	R R .				
Ka. magnificus			. . R	R .		R	R . .				
Litha. grillii s.s.			. R R	F R		F	R R R				
Lithr. carniolensis			F F F	F F		F	F C F				
Lo. armilla			R F R	F R		F	F R F				
Lu. arcuatus			. . .	. .		R	. . .				
Lu. cayeuxii			F F F	? F		F	F F F				
Lu. maleformis (long form)			. F F	F .		F	F F F				
Lu. maleformis (short form)			. F .	. .		R	F . R				
Man. pemmatoidea			. . .	R .		R	. . .				
Mar. furcatus s.s.			. . .	F .		.	. . .				
Micr. belgicus			F F R	. .		F	F . F				
Micr. decoratus			F F .	R R		.	. F .				
Micr. helicoideus			R R .	R .		R	F . F				
Micr. undosus			. R .	. .		.	. . .				
Micu. concava			. . .	F .		R	. F .				
Micu. cubiformis			. R .	. .		.	R . F				
Micu. staurophora			. F F	F F		F	F F F				
Micu. swastica			. R .	. .		.	. . .				
Nannoconus regularis			. . .	. R		.	. . .				
Nannoconus sp. (x-section)			. . F	. .		.	. . .				
Oc. cf. Oc. multiplus			. R R	. .		.	. . .				
Pl. fibuliformis			F F F	C F		F	F C F				
Pl.? cf. Zy. sigmoides			. . .	. R		.	. . .				
Pr. bukryi			R R .	. .		.	. F .				
Pr. cf. Pr. grandis			. R .	F .		R	F R R				
Pr. cretacea			F C F	C F		F	C C C				
Pr. ponticula			F F F	F F		F	F F F				
Pr. spinosa (medium form)			. R .	F .		F	R F .				
Pr. spinosa (large form)			R F .	. R		.	F F .				
Pr. stoveri			. R .	. .		R	. . .				
Qu. gothicus			. ? .	? x		.	. . .				
Rac. compactus			F F F	F F		F	F F F				
Rei. anthophorus			F F F	C F		C	C F F				
Rep. parvidentatum			R . .	. .		R	. . R				
Ret. angustiforata			R R .	. .		R	R R .				
Ret. crenulata			F F R	F R		F	F F F				
Rh. angustus			. F R	R R		.	R R R				
Rh. infinitus?			. . .	. .		.	. R .				
Rh. plebeius			. . R	R .		R	. R .				
Rh. reniformis			. R .	. .		R	R . .				
Rh. splendens			. R .	. .		.	. . .				
Ro. crenulatus			R F .	. F		R	F F R				
Sc. fossilis			. F .	R .		R	. . .				
So. horticus			R . .	. .		R	R R .				
St. compacta integra			R . .	. .		.	. R .				
St. crux			. . .	F .		.	F F R				
St. laffittei			. F .	. R		F	F . .				
St. wielnicensis			F F R	R R		F	F F R				
Te. coptensis?			. . .	. R		R	R R .				
Th. ecclesiastica			R F .	C F		F	C F F				
Tr. gabalus			R . .	R R		R	R F F				
Tr. minimus			R R .	F .		R	F R .				
Tr. orionatus			C C C	C C		C	C C C				
Va. mataloza (medium form)			. R .	. .		F	. . .				
Va. mataloza (small form)			F . .	. .		R	R . .				
Wa. barnesae			F F F	F F		F	F F F				
Wa. fossacincta			R . .	R .		.	R . .				
Wa. manivitae			R F F	F R		F	F F F				
Wa. quadriradiata			. . .	R .		.	. . .				
Ze. biperforatus			R F R	F R		F	F F F				
Ze. diplogrammus			. . .	. .		F	. F F				
Ze. erectus			F F .	F R		F	F F F				
Ze. noeliae			. R .	. .		.	. . .				

The nannofossil assemblages in all of the samples are diverse (a total of 100 taxa were identified), but preservation is generally poor to moderate, although this did not affect the identification of any taxa. Etching of calcite is typically predominant in sediments of this nature, where the sand has aided percolation of acidic pore-waters.

The numerical zonation scheme of SISSINGH (1977), modified and summarised by PERCH-NIELSEN (1985), was applied to the assemblages in order to assign biostratigraphical zones. These are summarised below. The stage age-assignments, shown in brackets, are those derived from SISSINGH and PERCH-NIELSEN. Table 1 shows the taxa recorded from each sample and the nannofossil zone assigned on the basis of the assemblage. A complete taxonomic list appears below.

— Charbonnage Houthalen, shaft 1
  583-585 m (sample 2): CC16 (late Santonian)
  583-585 m (sample 4): CC16 (late Santonian), possibly CC17 (Santonian/Campanian)
  596.97-598 m (sample 8): CC16 (late Santonian)

— Charbonnage Zolder (Voort), shaft 1
  582-584.3 m (sample 7): CC15 (late early Santonian), possibly CC16 (late Santonian)
  585-590 m (sample 5): CC16 (late Santonian)

— Charbonnage Zolder (Voort), shaft 2
  572 m (sample 1): CC16 (late Santonian)
  572 m (sample 3): CC16 (late Santonian, possibly CC17 (Santonian/Campanian)
  581.45 m (sample 6): CC16 (late Santonian)
  581.45 m (sample 9): CC16 (late Santonian)

Sample descriptions

— Charbonnage Houthalen
  Shaft 1, 583-585 m (sample 2): indurated, medium-dark grey, calcareous sandstone.
  Shaft 1, 583-585 m (sample 4): relatively soft, cohesive, dark grey, clayey calcareous sandstone.
  Shaft 1, 596.97-598 m (sample 8): relatively soft, cohesive, dark green (Cu ?)/black, calcareous sandstone.
— Charbonnage Zolder (Voort)
  Shaft 1, 582-584.3 m (sample 7): as sample 4.
  Shaft 1, 585-590 m (sample 5): as sample 8.
  Shaft 2, 572 m (sample 1): soft, non-cohesive, dark grey, clayey sandstone.
  Shaft 2, 572 m (sample 3): as above.
  Shaft 2, 581.45 m (sample 6): as above.
  Shaft 2, 581.45 m (sample 9): as above.

←

Table 1.
Nannofossil stratigraphical distribution.

Nannofossil taxonomic list

Acuturris scotus (RISATTI, 1973) WIND & WISE in WISE & WIND, 1977
Ahmuellerella octoradiata (GORKA, 1957) REINHARDT, 1966
A. regularis (GORKA, 1957) VERBEEK, 1977
Amphizygus brooksii BUKRY, 1969
Arkhangelskiella cymbiformis VEKSHINA, 1959
Biscutum ellipticum (GORKA, 1957) GRÜN in GRÜN & ALLEMANN, 1975
Biscutum sp. [similar to *B. ellipticum* but much larger]
Braarudosphaera bigelowii (GRAN & BRAARUD, 1935) DEFLANDRE, 1947
Broinsonia enormis (SHUMENKO, 1968) MANIVIT, 1971
B. parca expansa WISE & WATKINS in WISE, 1983
B. signata (NOEL, 1969) NOEL, 1970
Calculites obscurus (DEFLANDRE, 1959) PRINS & SISSINGH in SISSINGH, 1977
C. cf. *obscurus* [similar to *C. obscurus* but smaller and with much lower birefringence]
C. ovalis (STRADNER, 1963) PRINS & SISSINGH in SISSINGH, 1977
Chiastozygus amphipons (BRAMLETTE & MARTINI, 1964) GARTNER, 1968
C. bifarius BUKRY, 1969
C. litterarius (GORKA, 1957) MANIVIT, 1971
C. synquadriperforatus BUKRY, 1969
C. tetragonothyrus? HILL, 1976
Corollithion exiguum STRADNER, 1961
C. signum STRADNER, 1963
Cretarhabdus conicus BRAMLETTE & MARTINI, 1964
C. striatus (STRADNER, 1963) BLACK, 1973
Cribrosphaerella ehrenbergii (ARKHANGELSKY, 1912) DEFLANDRE in PIVETEAU, 1952
Cyclagelosphaera margerelii NOEL, 1965
C. rotaclypeata BUKRY, 1969
Cylindralithus biarcus BUKRY, 1969
Discorhabdus ignotus (GORKA, 1957) PERCH-NIELSEN, 1968
Eiffellithus eximius (STOVER, 1966) PERCH-NIELSEN, 1968
E. gorkae REINHARDT, 1965
E. parallelus PERCH-NIELSEN, 1973
E. turriseiffelii (DEFLANDRE, 1954) REINHARDT, 1965, BUKRY, 1969
Gartnerago obliquum (STRADNER, 1963) REINHARDT, 1970
Gephyrorhabdus coronadventis (REINHARDT, 1966) HILL, 1976
Haqius circumradiatus (STOVER, 1966) ROTH, 1978
Helicolithus anceps (GORKA, 1957) NOEL, 1970
H. trabeculatus (GORKA, 1957) VERBEEK, 1977
Kamptnerius magnificus DEFLANDRE, 1959
Lithastrinus grillii STRADNER, 1962
Lithraphidites carniolensis DEFLANDRE, 1959
Loxolithus armilla (BLACK in BLACK & BARNES, 1959) NOEL, 1965
Lucianorhabdus arcuatus FORCHHEIMER, 1972
L. cayeuxii DEFLANDRE, 1959
L. maleformis REINHARDT, 1966
Manivitella pemmatoidea (DEFLANDRE in MANIVIT, 1965) THIERSTEIN, 1971
Marthasterites furcatus (DEFLANDRE, 1954) DEFLANDRE, 1959, BUKRY, 1969
Microrhabdulus belgicus HAYE & TOWE, 1963
M. decoratus DEFLANDRE, 1959
M. helicoideus DEFLANDRE, 1959
M. undosus PERCH-NIELSEN, 1973
Micula concava (STRADNER in MARTINI & STRADNER, 1960) BUKRY, 1969, VERBEEK, 1976
M. cubiformis FORCHHEIMER, 1972
M. staurophora (GARDET, 1955) STRADNER, 1963 (= *M. decussata* VEKSHINA, 1959)
M. swastica (sensu PRINS, 1977) STRADNER & STEINMETZ, 1984
Nannoconus regularis DÉRÈS & ACHERITÉGUY, 1980
Octolithus cf. *O. multiplus* (PERCH-NIELSEN, 1973) ROMEIN, 1979 [similar to *O. multiplus* but smaller and with only six blocks visible]
Placozygus fibuliformis (REINHARDT, 1964) HOFFMANN, 1970
P. cf. *Zygodiscus sigmoides* BRAMLETTE & SULLIVAN, 1961 [possibly a predecessor of *Z. sigmoides*]
Prediscosphaera bukryi PERCH-NIELSEN, 1973
P. cretacea (ARKHANGELSKY, 1912) GARTNER, 1968
P. grandis PERCH-NIELSEN, 1979
P. cf. *P. grandis* [similar to *P. grandis* but smaller]
P. ponticula BUKRY, 1969, PERCH-NIELSEN, 1984
P. spinosa (BRAMLETTE & MARTINI, 1964) GARTNER, 1968
P. stoveri (PERCH-NIELSEN, 1968) SHAFIK & STRADNER, 1971
Quadrum gothicum (DEFLANDRE, 1959) PRINS & PERCH-NIELSEN in MANIVIT *et al.*, 1977
Rectapontis compactus (BUKRY, 1969) VAROL & JAKUBOWSKI, 1989
Reinhardtites anthophorus (DEFLANDRE, 1959) PERCH-NIELSEN, 1968
Repagulum parvidentatum (DEFLANDRE & FERT in DEFLANDRE, 1954) FORCHHEIMER, 1972
Retecapsa angustiforata BLACK, 1971
R. crenulata (BRAMLETTE & MARTINI, 1964) GRÜN in GRÜN & ALLEMANN, 1975
Rhagodiscus angustus (STRADNER, 1963) REINHARDT, 1971
R. infinitus (WORSLEY, 1971) APPLEGATE *et al.* in COVINGTON & WISE, 1987
R. plebeius PERCH-NIELSEN, 1968
R. reniformis PERCH-NIELSEN, 1973
R. splendens (DEFLANDRE, 1953) VERBEEK, 1977
Rotelapillus crenulatus (STOVER, 1966) PERCH-NIELSEN, 1984
Scapholithus fossilis DEFLANDRE, 1954
Sollasites horticus (STRADNER *et al.* in STRADNER & ADAMIKER, 1966) ČEPEK & HAY, 1969
Staurolithites compacta integra (BUKRY, 1969)
S. crux (DEFLANDRE & FERT in DEFLANDRE, 1954) CARATINI, 1963
S. laffittei CARATINI, 1963

S. mielnicensis (GORKA, 1957) PERCH-NIELSEN, 1968, CRUX in LORD, 1982
Tetrapodorhabdus coptensis? BLACK, 1971
Thiersteinia ecclesiastica WISE & WATKINS in WISE, 1983
Tranolithus gabalus STOVER, 1966
T. minimus (BUKRY, 1969) PERCH-NIELSEN, 1984
T. orionatus (REINHARDT, 1966a) REINHARDT, 1966b (= *T. phacelosus* STOVER, 1966)
Vagalapilla matalosa (STOVER, 1966) THIERSTEIN, 1973
Watznaueria barnesae (BLACK in BLACK & BARNES, 1959) PERCH-NIELSEN, 1968
W. fossacincta (BLACK, 1971) BOWN in BOWN & COOPER, 1989
W. manivitae BUKRY, 1973
W. quadriradiata BUKRY, 1969
Zeugrhabdotus biperforatus (GARTNER, 1968)
Z. diplogrammus (DEFLANDRE in DEFLANDRE & FERT, 1954)
Z. erectus (DEFLANDRE, 1954) REINHARDT, 1965
Z. noeliae ROOD *et al.*, 1971

Discussion

Of the cephalopods, only the belemnites yield a precise age assignment, viz. *westfalicagranulata* Zone *sensu germanico* (= upper part of middle Santonian). The ammonites have been additionally dated by nannofossils, which generally indicate a late Santonian age, with some of the material being of late early Santonian and latest Santonian/earliest Campanian date.

Ammonite biozonation of the Santonian is still comparatively crude; one of the species recognised amongst the material from Houthalen and Zolder/Voort, *Placenticeras polyopsis*, ranges throughout the Santonian, while the texanitid is specifically indeterminate and thus precludes comparison with occurrences elsewhere. Lithologically, the single specimen referred to *Scaphites kieslingswaldensis fischeri* from Houthalen-shaft 1, at a depth of 583-585 m, differs from the other ammonites recorded from the same depth. It is possible that the occurrence of this species marks the Santonian/Campanian boundary at Houthalen (see also nannofossil data, sample 4).

References

BATTEN, D.J., DUPAGNE-KIEVITS, J. & LISTER, J.K., 1988. Palynology of the Upper Cretaceous Aachen Formation of northeast Belgium. *In*: STREEL, M. & BLESS, M.J.M. (Editors), The Chalk District of the Euregio Meuse-Rhine. Selected papers on Upper Cretaceous deposits. Natuurhistorisch Museum Maastricht/Laboratoires de Paléontologie de l'Université d'État à Liège, pp. 95-103.

BAYLE, E., 1878. Fossils principaux des terrains de la France. *Explication de la Carte géologique de la France*, **4** (1), Atlas, 79 pls.

BLACK, M., 1971. The systematics of coccoliths in relation to the palaeontological record. *In*: FUNNELL, B.M. & RIEDEL, W.R. (Editors), The micropalaeontology of oceans. Cambridge University Press, pp. 611-624.

BLAINVILLE, H.M.D. DE, 1827. Mémoire sur les Belemnites, considerées zoologiquement et géologiquement. Levrault, Paris, 136 pp.

BÖHM, J., 1907. Ueber *Inoceramus Cripsi* Mant. *Zeitschrift der deutschen geologischen Gesellschaft*, **59**: 113, 114.

BRAMLETTE, M.H. & MARTINI, E., 1964. The great change in calcareous nannoplankton fossils between the Maestrichtian and Danian. *Micropaleontology*, **10**: 291-322.

BUKRY, D., 1969. Upper Cretaceous coccoliths from Texas and Europe. *University of Kansas Paleontological Contributions*, **51**: 1-79.

CHRISTENSEN, W.K., 1975a. Upper Cretaceous belemnites from the Kristianstad area in Scania. *Fossils and Strata*, **7**: 1-69.

CHRISTENSEN, W.K., 1975b. Designation of lectotypes for *Gonioteuthis westfalicagranulata* and *G. granulataquadrata*. *Paläontologische Zeitschrift*, **49**: 126-134.

CHRISTENSEN, W.K., 1976. Palaeobiogeography of Late Cretaceous belemnites of Europe. *Paläontologische Zeitschrift*, **50**: 113-129.

CHRISTENSEN, W.K., 1986. Upper Cretaceous belemnites from the Vomb Trough in Scania, Sweden. *Sveriges geologiska Undersökning*, Ca **57**: 1-57.

CHRISTENSEN, W.K., 1988. Upper Cretaceous belemnites of Europe: state of the art. *In*: STREEL, M. & BLESS, M.J.M. (Editors), The Chalk District of the Euregio Meuse-Rhine. Natuurhistorisch Museum Maastricht/Laboratoires de Paléontologie de l'Université d'Etat, Liège, pp. 5-16.

CHRISTENSEN, W.K., 1990. Upper Cretaceous belemnite stratigraphy of Europe. *Cretaceous Research*, **11**: 371-386.

CHRISTENSEN, W.K., 1991. Belemnites from the Coniacian to Lower Campanian chalks of Norfolk and southern England. *Palaeontology*, **34**: 695-749.

CHRISTENSEN, W.K., 1994. Upper Cretaceous belemnites from Lonzée (SE Belgium) and their stratigraphical significance. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **64**: 151-158.

COLLIGNON, M., 1948. Ammonites néocrétacées du Menabe (Madagascar). I. Les Texanitidae. *Annales géologiques du Service des Mines de Madagascar*, **13**: 49-107 [1-63]; 14: 7-101 [64-120].

DEFLANDRE, G., 1959. Sur les nannofossiles calcaires et leur systématique. *Revue de Micropaléontologie*, **2**: 127-152.

DEFLANDRE, G. & FERT, C., 1954. Observations sur les coccolithophoridés actuels et fossiles en microscopie ordinaire et électronique. *Annales de Paléontologie*, **40**: 115-176.

DHONDT, A. V., 1993. Upper Cretaceous bivalves from Tercis, Landes, SW France. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **63**: 211-259.

DOUVILLÉ, H., 1890. Sur la classification des Cératites de la Craie. *Bulletin de la Société géologique de France*, (3) **18**: 275-292.

DUJARDIN, F., 1837. Mémoire sur les couches du sol en Touraine et description des coquilles de la craie et des faluns. *Mémoires de la Société géologique de France*, (1) **2**: 211-311.

ERNST, G., 1964. Ontogenie, Phylogenie und Stratigraphie der Belemnitengattung *Gonioteuthis* Bayle aus dem nordwestdeutschen Santon/Campan. Ein Beitrag zur variationsstatistischen Bearbeitung von Belemniten. *Fortschritte in der Geologie von Rheinland und Westfalen*, **7**: 113-174.

ERNST, G., 1968. Die Oberkreide-Aufschlüsse im Raume Braunschweig-Hannover und ihre stratigraphische Gliederung mit Echinodermen und Belemniten. 1. Teil: Die jüngere Oberkreide (Santon-Maastricht). *Beihefte zu den Berichten der Naturhistorischen Gesellschaft zu Hannover*, **5**: 235-284.

ERNST, G. & SCHULZ, M.-G., 1974. Stratigraphie und Fauna des Coniac und Santon im Schreibkreide-Richtprofil von Lägerdorf (Holstein). *Mitteilungen aus dem geologisch-paläontologischen Institut der Universität Hamburg*, **43**: 5-60.

FORCHHEIMER, S., 1972. Scanning electron microscope studies of Cretaceous coccoliths from the Köpingsberg Borehole no. 1, SE Sweden. *Sveriges geologiska Undersökning*, C **668**: 1-141.

GARTNER, S. Jr, 1968. Coccoliths and related calcareous nannofossils from Upper Cretaceous deposits of Texas and Arkansas. *University of Kansas Paleontological Contributions*, **48**: 1-56.

GILL, T., 1871. Arrangement of the Families of Mollusks. *Smithsonian Miscellaneous Collections*, **227**: xvi + 49 pp.

GISCHLER, E., GRÄFE, K.-U. & WIEDMANN, J., 1994. The Upper Cretaceous *Lacazina* Limestone in the Basco-Cantabrian and Iberian Basins of Northern Spain: Cold-Water Grain Associations in Warm-water Environments. *Facies*, **30**: 209-246.

GROSSOUVRE, A. de, 1894. Recherches sur la craie supérieure, 2. Paléontologie. Les ammonites de la craie supérieure. *Mémoires du Service de la Carte géologique detaillée de la France*. Imprimerie Nationale, Paris, 264 pp. (misdated 1893).

HYATT, A., 1900. Cephalopoda. *In*: ZITTEL, K.A. VON, 1896-1900. *Textbook of Palaeontology*, Macmillan, London/New York, pp. 502-604.

JANET, C., 1891. Note sur trois nouvelles bélemnites sénoniennes. *Bulletin de la Société géologique de France*, (3) **19**: 716-721.

KENNEDY, W. J., 1986. Campanian and Maastrichtian ammonites from northern Aquitaine, France. *Special Papers in Palaeontology*, **36**: 1-145.

KENNEDY, W. J., 1987a. The ammonite fauna of the type Maastrichtian, with a revision of *Ammonites colligatus* Binkhorst. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **56** (1986): 151-267.

KENNEDY, W.J., 1987b. Ammonites from the type Santonian and adjacent parts of northern Aquitaine, western France. *Palaeontology*, **30** (4): 765-782.

KENNEDY, W.J. & CHRISTENSEN, W.K., 1991. Coniacian and Santonian ammonites from Bornholm, Denmark. *Bulletin of the Geological Society of Denmark*, **38**: 203-226.

KENNEDY, W.J. & CHRISTENSEN, W.K., 1993. Santonian ammonites from the Köpingsberg-1 borehole, Sweden. *Bulletin of the Geological Society of Denmark*, **40**: 149-156.

KENNEDY, W.J. & WRIGHT, C.W., 1983. *Ammonites polyopsis* Dujardin, 1837 and the Cretaceous ammonite family Placenticeratidae Hyatt, 1900. *Palaeontology*, **26** (4): 855-873.

MALCHUS, N., DHONDT, A.V. & TRÖGER, K.-A., 1994. Upper Cretaceous bivalves from the Glauconie de Lonzée near Gembloux (SE Belgium). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **64**: 109-149.

MEEK, F.B., 1876. A report on the invertebrate Cretaceous and Tertiary fossils of the upper Missouri country. *In*: HAYDEN, F.V., *Report of the United States Geological Survey of the Territories*, **9**: lxiv + 629 pp.

MILLER, J.S., 1823. Observations on the genus *Actinocamax*. *Transactions of the Geological Society of London*, (2) **2**: 63-67.

MOBERG, J.C., 1885. Cephalopoderna i Sveriges Kritsystem. II. Artsbeskrifning. *Sveriges geologiska Undersökning*, (C) **73**: 1-65.

NAIDIN, D.P., 1964. [Late Cretaceous belemnites of the Russian Platform and adjacent regions. *Actinocamax*, *Gonioteuthis* and *Belemnellocamax*]. University of Moscow, Moscow, 190 pp. (in Russian).

NOEL, D., 1970. Coccolithes crétacés. La craie campanienne du Bassin de Paris. CNRS, Paris, 129 pp.

ORBIGNY, A. d', 1840-1842. Paléontologie française. Terrains crétacés, 1. Céphalopodes, 1-120 (1840), 121-430 (1841), 431-662 (1842), Masson, Paris.

PARKINSON, J., 1811. *Organic remains of a former world*, 3. J. Robson, London, xvi + 479 pp.

PAVLOW, A.P., 1914. [Jurassic and Lower Cretaceous Cephalopoda of northern Siberia]. *Imperatovski Akademii Nauk St. Petersburg, Zapiski Seriia (8), Fiziko-mathematicheskii*, **21**: 68 pp. (in Russian).

PERCH-NIELSEN, K., 1968. Der Feinbau und die Klassifikation der Coccolithen aus dem Maastrichtien von Dänemark. *Det Kongelige Danske Videnskabernes Selskab, Biologiske Skrifter*, **16**: 1-96.

PERCH-NIELSEN, K., 1973. Neue Coccolithen aus dem Maastrichtien von Dänemark, Madagaskar und Ägypten. *Meddelelser fra danske geologiske Forening*, **22**: 306-333.

PERCH-NIELSEN, K., 1979. Calcareous nannofossils from the Cretaceous between the North Sea and the Mediterranean. *In*: WIEDMANN, J. (Editor), Aspekte der Kreide Europas. *International Union of Geological Sciences*, **A6**: 223-272.

PERCH-NIELSEN, K., 1984. Validation of new combinations. *International Nannofossil Association Newsletter*, **6**: 42-46.

PERCH-NIELSEN, K., 1985. Mesozoic calcareous nannofossils. *In*: BOLLI, H.M., SAUNDERS, J.B. & PERCH-NIELSEN, K. (Editors), Plankton Stratigraphy. Cambridge University Press, Cambridge, U.K., pp. 329-426.

REINHARDT, P., 1966. Zur Taxionomie und Biostratigraphie des fossilen Nannoplanktons aus dem Malm, der Kreide und dem Alttertiär Mitteleuropas. *Freiberger Forschungshefte*, **C196**: 5-63.

RIEDEL, L., 1931. Zur Stratigraphie und Faciesbildung im Oberemscher und Untersenon am Südrande des Beckens von Münster. *Jahrbuch der preussischen geologischen Landesanstalt und Bergakademie*, **51**: 605-713.

ROEMER, C.F., 1852. Die Kreidebildungen von Texas und ihre organischen Einschlüsse, mit einer Beschreibung von Versteinerungen aus paläozoischen und tertiären Schichten enthaltenden Anhange. A. Marcus, Bonn, vi + 100 pp.

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. *Bulletin of the Geological Society of Denmark*, **33**: 203-215.

SEITZ, O., 1961. Die Inoceramen des Santon von Nordwestdeutschland. I. Teil (Die Untergattungen *Platyceramus*, *Cladoceramus* und *Cordiceramus*). *Beihefte zum Geologischen Jahrbuch*, **46**: 1-186.

SEITZ, O., 1967. Die Inoceramen des Santon und Unter-Campan von Nordwestdeutschland. III. Teil (Taxonomie und Stratigraphie der Untergattungen *Endocostea*, *Haenleinia*, *Platyceramus*, *Cladoceramus*, *Selenoceramus* und *Cordiceramus* mit besonderer Berücksichtigung des Parasitismus bei diesen Untergattungen. *Beihefte zum Geologischen Jahrbuch* **75**: 1 - 172.

SISSINGH, W., 1977. Biostratigraphy of Cretaceous calcareous nannoplankton. *Geologie en Mijnbouw*, **56**: 37-65.

SOWERBY, J., 1812-1822. *The mineral conchology of Great Britain*. 1, pls 1-9 (1812), pls 10-44 (1813), pls 45-78 (1814), pls 79-102 (1815); 2, pls 103-114 (1815), pls 115-150 (1816), pls 151-186 (1817), pls 187-203 (1818); 3, pls 204-221 (1818), pls 222-253 (1819), pls 254-271 (1820), pls 272-306 (1821); 4, pls 307-318 (1821), pls 319-383 (1822). The author, London.

SPATH, L.F., 1932. A monograph of the Ammonoidea of the Gault, 9. *Monograph of the Palaeontographical Society*, **84**: 379-410.

STOLLEY, E., 1897. Ueber die Gliederung des norddeutschen und baltischen Senon sowie die dasselbe charakterisirenden Belemniten. *Archiv für Anthropologie und Geologie Schleswig-Holsteins*, **2**: 216-302.

STOVER, L.E., 1966. Cretaceous coccoliths and associated nannofossils from France and the Netherlands. *Micropaleontology*, **12**: 133-167.

TRÖGER, K.-A., 1989. Problems of Upper Cretaceous inoceramid biostratigraphy and Palaeobiogeography in Europe and western Asia. *In*: J. WIEDMANN (Ed.), Cretaceous of the Western Tethys. E. Schweizerbart'sche Verlagsbuchhandlung (Nägele und Obermiller), Stuttgart, pp. 911-930.

VERBEEK, J.W., 1977. Calcareous nannoplankton biostratigraphy of Middle and Upper Cretaceous deposits in Tunisia, southern Spain and France. *Utrecht Micropaleontological Bulletins*, **16**: 1-157.

WEGNER, T., 1905. Die Granulatenkreide des westlichen Münsterlandes. *Zeitschrift der deutschen geologischen Gesellschaft*, 57: 112-232.

WRIGHT, C.W. & WRIGHT, E.V., 1951. A survey of the fossil Cephalopoda of the Chalk of Great Britain, primarily a nomenclatorial revision of Daniel Sharpe's "Description of the fossil remains of Mollusca found in the Chalk of England. Cephalopoda (1853-1857)". *Monograph of the Palaeontographical Society*, 104: 1-40.

Typescript submitted: 15.3.1993
Revised typescript received: 1.10.1994

John W.M. JAGT
Dienst KCO
Natuurhistorisch Museum
Maastricht
Postbus 882
NL-6200 AW Maastricht,
The Netherlands

William James KENNEDY
Geological Collections
Oxford University Museum
Parks Road
Oxford OX1 3PW, U.K.

Jacqueline A. BURNETT
Micropalaeontology Unit,
Research School of Geological
and Geophysical Sciences
Birkbeck College & University
College London
Gower Street
London WC1E 6BT, U.K.

Walter Kegel CHRISTENSEN
Geologisk Museum
Oster Voldgade 5-7
DK-1350 Copenhagen K,
Denmark

Annie V. DHONDT
Dept. of Palaeontology
Koninklijk Belgisch Instituut
voor Natuurwetenschappen
Vautierstraat 29
B-1040 Brussels, Belgium

PLATE 1

Figs. 1, 2 — *Scaphites (Scaphites) kieslingswaldensis fischeri* Riedel, 1931, IRSNB 10383, from the Charbonnage Houthalen, shaft 1, at a depth of 583-585 m, x 1.

Figs. 3-6 — *Placenticeras polyopsis* (Dujardin, 1837). 3, 4 - IRSNB 10378a, from Charbonnage Zolder (Voort), shaft 2, at a depth of 581.45 m, x 1. 5, 6 - IRSNB 10378b, from Charbonnage Zolder (Voort), shaft 2, at a depth of 581.45 m, x 1.

Figs. 7, 8 — *Texanites (Texanites)* sp. IRSNB 10377, from Charbonnage Zolder (Voort), shaft 1, at a depth of 583-590 m, x 1.