Upper Campanian brachiopods from the Mons Basin (Hainaut, Belgium): the brachiopod assemblage from the *Belemnitella mucronata* Zone

by Eric SIMON

Abstract

Upper Campanian brachiopods from the top of the "Craie de Trivières" and from the base of the "Craie d'Obourg" (*Belemnitella mucronata* Zone) collected in Cuesmes (Mons Basin, Hainaut, Belgium) were studied for their palaeoecological significance. A stratigraphical correlation with the micromorphic brachiopod zone (*tenuicostata - longicollis* Zone) described by SURLYK for the white chalk from Northern Europe is observed. A new species of *Argyrotheca* DALL, 1900 is described.

Key words: Brachiopods, Cretaceous, Campanian, Cuesmes, Belgium.

Résumé

Les brachiopodes du Campanien supérieur, extraits du sommet de la Craie de Trivières et de la base de la Craie d'Obourg (Zone à *Belemnitella mucronata*) à Cuesmes (Bassin de Mons, Hainaut, Belgique) ont fait l'objet d'une étude paléoécologique. On observe une corrélation stratigraphique avec la zone à microbrachiopodes "*tenuicostata - longicollis* ", décrite par SURLYK pour les craies blanches du nord de l'Europe. Une nouvelle espèce, appartenant au genre *Argyrotheca* DALL, 1900 est décrite.

Mots-clefs: Brachiopodes, Crétacé, Campanien, Cuesmes, Belgique.

Introduction

This paper deals with the macromorphic and micromorphic brachiopods collected from the Craibel quarry (Fig. 1) in Cuesmes (Mons Basin, Hainaut, Belgium). Detailed informations concerning the geology of Cretaceous deposits in the Mons Basin can be found in CORNET & BRIART (1866, 1870 and 1874), BRIART & CORNET (1880), CORNET (1922), LERICHE (1935), MARLIÈRE (1969 and 1970) and in MARLIÈRE & ROBASZYNSKI (1975). Upper Cretaceous Foraminifera from the Mons Basin have been studied by HOFKER (1959 & 1960) and more recently by ROBASZYNSKI (*in* ROBASZYNSKI & CHRISTENSEN, 1989). The belemnites from the Mons Basin were described by CHRISTENSEN (*in* ROBASZYNSKI & CHRISTENSEN, 1989) and by CHRISTENSEN (1999). Stratigraphical analysis based on ammonites was reported by KENNEDY (1993). In the Mons Basin (Fig. 2), the Upper Campanian is represented by white chalk deposits. The

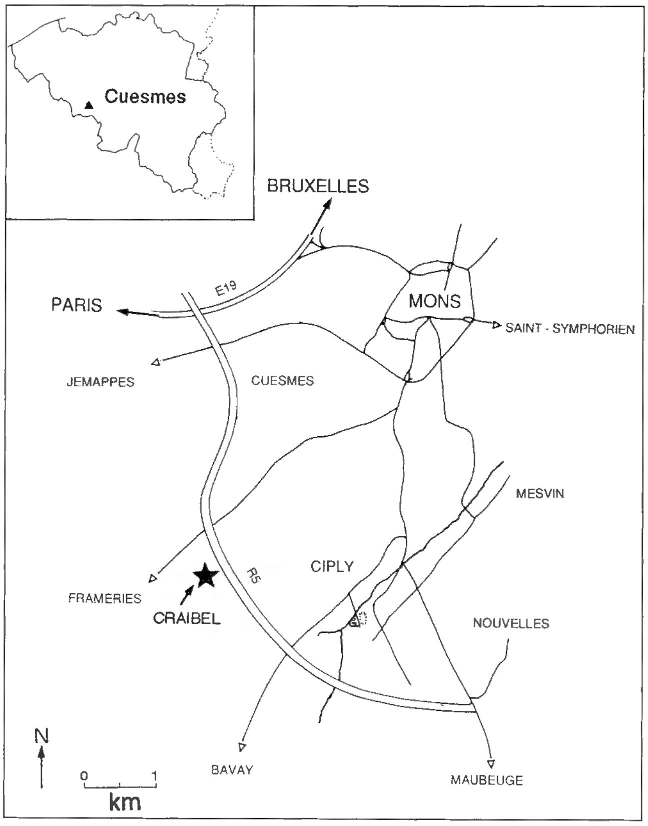

Fig. 1 — Map showing the position of Craibel quarry in Cuesmes (Mons Basin, Hainaut, Belgium).

lower part of the Upper Campanian is represented by the top of the "Craie de Trivières" (BRIART & CORNET, 1880). This chalk is greyish, without flint layers. In the Craibel quarry, the top of the "Craie de Trivières" is overlain by a thin hardground (10-15 cm thick) which is not always present elsewhere in the Mons Basin. This hardground is covered by the "Craie d'Obourg" (CORNET & BRIART, 1870). In some parts of the Mons Basin, a phosphatic conglomerate occurs at the base of the "Craie d'Obourg". But, in the Craibel quarry, this conglomerate is absent. A hiatus is thus observed in the sequence of chalk deposition. Obourg chalk is white-grey, progressively changing to a pure white chalk at its top, known as the "Craie de Nouvelles" (CORNET & BRIART, 1870). The limit between the "Craie d'Obourg" and the "Craie de Nouvelles" is not precisely visible. The upper part of the "Craie de Nouvelles" shows three flint layers. The upper part of the Upper Campanian is represented in the Mons Basin by the "Craie de Spiennes", a coarse-grained chalk containing many flint bands (Fig. 2).

In the Craibel quarry, the "Craie de Spiennes" is absent and the sections exposed exhibit the top of the "Craie de Trivières" (4m) directly followed (except the hiatus at its base) by the "Craie d'Obourg" (6m). With a discontinuity, due to faults, some other sections display the "Craie de Nouvelles" (± 25m) covered by a flint layer at the top, which probably corresponds to the first flint layer of the "Craie de Nouvelles" (Fig. 2).

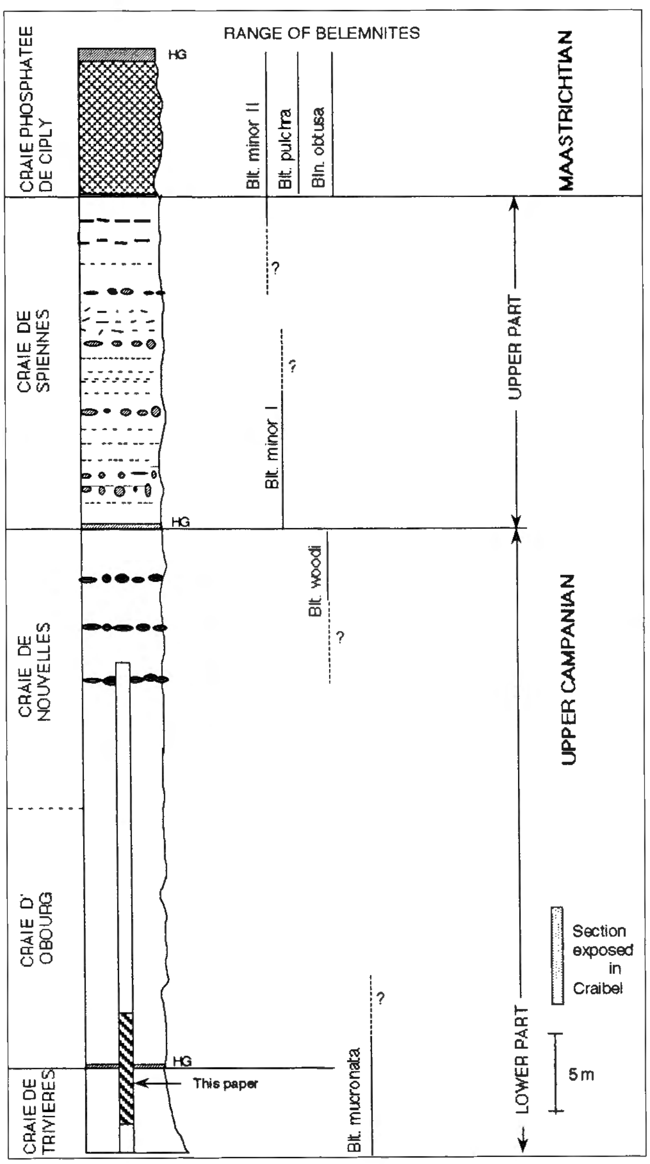

Fig. 2 — Schematic section showing the stratigraphical succession observed through the Campanian-Maastrichtian chalks in the Mons Basin (Hainaut, Belgium). The zone studied in the Craibel quarry is indicated. The range of belemnites follows CHRISTENSEN, 1999. HG: hardground.

In this paper (Fig. 2), the uppermost 4 m of the "Craie de Trivières" and the lowermost 3 m of the "Craie d'Obourg" are taken into account. These chalk layers must be reported to the *Belemnitella mucronata* Zone. ROBASZYNSKI & CHRISTENSEN (1989, p. 397) collected only *Belemnitella mucronata* (VON SCHLOTHEIM, 1813) from the uppermost 5 m of the "Craie de Trivières" to the basal 1.2 m of the "Craie d'Obourg" in the C.C.C. (Crayères, Cimenteries et Chaux) West quarry at Harmignies (Mons Basin). This opinion was recently confirmed by CHRISTENSEN (1999, p. 107).

In the Craibel quarry, the section studied in this paper can be correlated with the *Belemnitella mucronata* Zone described by ROBASZYNSKI & CHRISTENSEN (1989) and CHRISTENSEN (1999) for the C.C.C. West quarry in Harmignies. *Belemnitella mucronata* is very abundant in the top of the "Craie de Trivières" but rare in the basal part of the "Craie d'Obourg". The interval above the hardground between 1.2 m and 3.0 m does not yield any belemnites. Whether *Belemnitella woodi* CHRISTENSEN, 1995 occurs in this part of the "Craie d'Obourg" is not known. This belemnite is a typical species for the top of the "Craie de Nouvelles" (CHRISTENSEN, 1999, p. 112). The brachiopod assemblage extracted from this interval (1.2 - 3.0 m) is similar to the assemblage extracted from the lower interval (0 - 1.2 m) above the hardground. For these reason, this interval is considered, in this paper, as part of the *B. mucronata* Zone. The presence of *B. mucronata* indicates that the chalk deposits studied herein must be reported to the lower part of the Upper Campanian. This allows to correlate the studied chalk layers with similar *B. mucronata* Zones in Norfolk (CHRISTENSEN, 1999, p. 105), in the Maastricht-Aachen area (CHRISTENSEN, 1999, p. 105) and in the Höver-Misburg-Ahlten area near Hannover (CHRISTENSEN, 1999, p. 106).

Chalk deposits studied in the Craibel quarry, especially the top of the "Craie de Trivières", suggest high energy water conditions resulting in the presence of a hardground and of several visible hardened chalk layers. Allochtonous material, such as small rocks (limestone, small rolled quartz pebbles), are currently found in many sieved samples of this chalk. In these conditions, a part of the brachiopod assemblage was affected by transportation and crushing.

A description and a detailed map of the Craibel quarry were published by PACYNA (1988, pp. 4-7). This quarry is disused since 1996 but most of the sections visible between 1988 and 1996 are still accessible today.

This paper is a first step towards a detailed study of the Upper Campanian brachiopods from Belgium. Other papers will be devoted to the brachiopods from the "Craie de Nouvelles" and the "Craie de Spiennes" in the Mons Basin. Correlations with the brachiopod assemblages from Northern Europe, England and Poland are a useful complement to the understanding of the brachiopod distribution in Europe and to their stratigraphical significance.

Materials and methods

Ninety-one samples of chalk were collected in the Craibel quarry. Fifty-four samples representing a total amount of 172.5 kg of dried "Craie de Trivières" were collected from a 3.70 m interval directly underlying the hardground. Thirty-seven samples representing a total amount of 118 kg of dried "Craie d'Obourg" were also collected from a 3.25 m interval overlying the hardground.

All samples were air dried at a temperature of 20°C for at least three weeks. When dry, each sample was weighed and treated with supersaturated Glauber salt solution, following SURLYK (1972). This method was also described in detail by SIMON (1992, p. 123).

To establish the total number of individuals of each species in a sample, the highest number of isolated ventral valves or dorsal valves was added to the number of complete bivalved specimens found. Sometimes the number of fragments is taken into account.

The number of specimens collected for each species, can be found in the taxonomical part of this paper. A large number of samples were collected in order to obtain accurate results and to be able to describe the complete brachiopod fauna for the section investigated.

The micromorphic brachiopods were measured for their length (L), width (W), thickness (T), length of dorsal valve (DL), length of hinge line (WH), diameter of foramen (ØF). The number of ribs on either dorsal (DVR) and ventral valves (VVR) was determined for ribbed species.

Where possible, size-frequency diagrams were established. As shown by SURLYK (1972, pp. 36-37), an ecological evaluation of size-frequency distribution can only be made if some factors are carefully controlled. Size-selective or shape selective transport, crushing or solution are factors influencing the shape of the histograms and stable conditions of deposition must be confirmed for the specimens investigated. For these reasons, studies of size-frequency distributions were not undertaken on some species affected by transport and crushing and also for species for which stable conditions of deposition could not be confirmed.

An ultrasonic bath was used for cleaning the specimens of micromorphic brachiopods and SEM photographs were made at Institut royal des Sciences naturelles de Belgique in Brussels.

The ecological groups cited in this paper were designated by SURLYK in 1972 (pp. 16-27, text-fig. 5).

The material collected for this work is preserved in the Institut royal des Sciences naturelles de Belgique in Brussels.

The supra-ordinal classification used in this paper follows the classification proposed by WILLIAMS *et al.* (1996). Morphological terms used to describe the cardinalia of articulate brachiopods follow the recommendations of BRUNTON *et al.* (1996). The synonymy lists are presented following the recommendations of MATTHEWS (1973).

State of preservation of the collected brachiopods.

Shells of macrobrachiopods are relatively well preserved. Many specimens are often found as bivalved shells. Some species such as *Cretirhynchia woodwardi* (DAVIDSON, 1855) exhibit crushed or distorted shells. The shell of *C. woodwardi* is rather thin.

Macrobrachiopod shells are not found in living position: their orientation is totally random. This is first evidence of bioturbation and of transportation, even if transport did not take place over long distances.

Micromorphic brachiopod shells suffered from transportation and most specimens are fragmentary. Specimens extracted as complete bivalved shells and as more or less intact dorsal or ventral valves represent 22,5 % of the total number of specimens collected. Fragments, represent 77, 5 % of the total number of specimens collected. Some species are always better preserved than others. Transportation can partly explain this phenomenon. *Rugia spinicostata* JOHANSEN & SURLYK, 1987 is generally fragmented, rarely as intact dorsal valve and exceptionally (1 specimen) as complete bivalved specimen. Its spiny rib sculpture is always broken. *Isocrania campaniensis* ERNST, 1984 is never collected bivalved: dorsal valves were always transported after the individuals died. For these brachiopods, transportation explains the poor state of preservation of their shells.

Leptothyrellopsis polonicus BITNER & PISERA, 1979 is a species with a very fragile, thin shell. Most of the specimens found are shell fragments, indicating a transportation in high energy water conditions. But, some intact specimens of *Leptothyrellopsis polonicus* were buried rapidly after death and are perfectly preserved, showing good internal structure (MACKINNON *et al.*, 1998).

For other species such as *Rugia tenuicostata* STEINICH, 1963, most of the shells collected are well preserved and often found as bivalved specimens. Their serrate rib sculpture, made of small triangular tubercles, is also well preserved. This indicates that shells of *Rugia tenuicostata* were not directly affected by transport even if transport occurred. It is suggested that these brachiopods possessed a thick and resistant periostracum, covering the shell when living. A similar observation is made for *Terebratulina chrysalis* (VON SCHLOTHEIM, 1813) for which intact rib sculpture is also observed, even on the fragmented specimens.

There are no striking differences between the state of preservation of the brachiopods extracted from the top of the "Craie de Trivières" and those obtained from the basal part of the "Craie d'Obourg". This means that the ecological conditions were rather similar during the deposition of these two chalks.

Results

The macromorphic brachiopods

A total of 308 macromorphic brachiopods attributable to 5 species, were found in the section investigated from the Craibel quarry. 293 individuals were collected from the top of the "Craie de Trivières" whereas only 15 specimens were extracted from the basal 3 meters of the "Craie d'Obourg". The relative abundance of each species is illustrated in Fig. 3.

The great density of macromorphic brachiopods in the

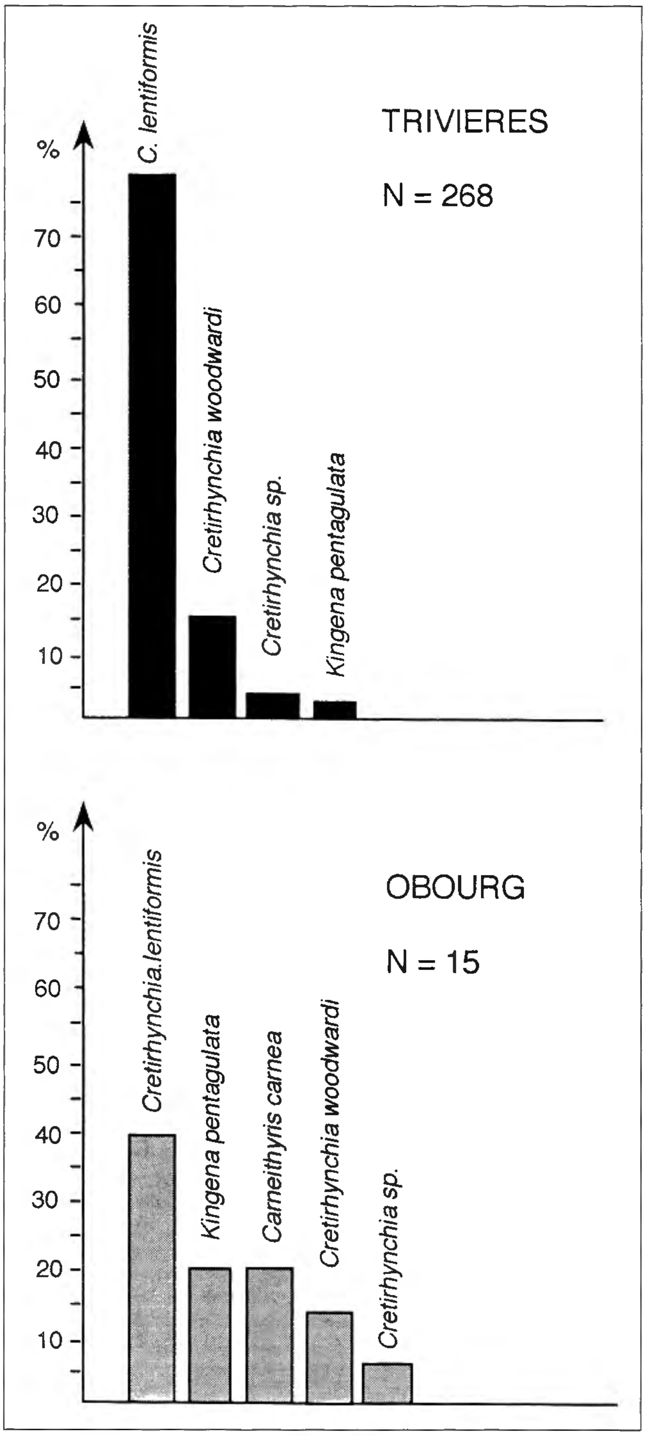

Fig. 3 — Relative abundance (in % of total number of individuals) of macromorphic brachiopod species collected from the top of the "Craie de Trivières" and from the base of the "Craie d'Obourg" in the Craibel quarry in Cuesmes (Mons Basin, Hainaut, Belgium). N: total number of individuals collected.

top of the "Craie de Trivières" is due to the abundance of *Cretirhynchia lentiformis* (WOODWARD, 1833) which represents 77.2 % of the total quantity of macrobrachiopod specimens found at this level. Other species, such as *Cretirhynchia woodwardi* (DAVIDSON, 1855), *Cretirhynchia* sp. and *Kingena pentagulata* (WOODWARD, 1833) are much rarer. In the basal three meters of the "Craie d'Obourg", macrobrachiopods are uncommon. The same taxa are rare. The most striking difference between the "Craie de Trivières" and the "Craie d'Obourg" is the sudden disappearance in the "Craie d'Obourg" of *Cretirhynchia lentiformis*. *Carneithyris carnea* (J. SOWERBY, 1812), a rare brachiopod at this level, was not discovered in the "Craie de Trivières" and only three specimens were obtained from the "Craie d'Obourg". This brachiopod has a larger foramen and is thought to have used its pedicle as a drag anchor (ASGAARD, 1975 p. 361, SIMON, 1998 p. 185). The relative high energy water conditions, observed in the top of the "Craie de Trivières" and in the base of the Craie d'Obourg, were not favourable for this species.

Most of the macrobrachiopods collected from the studied section, belong to the same ecological group: the group of medium to large sized forms, confined to hard substrate (cf. group 1b of SURLYK, 1972, p. 17). However, for SURLYK, the species of this ecological group are confined to "large" hard substrates and they possess generally a very large foramen (*Neoliothyrina* sp. for instance). The macromorphic species collected from the "Craie de Trivières" exhibit a small foramen. Their pedicle was very thin and these species seem to be adapted for living attached to extremely small substrates or directly fixed in the sediment.

The macromorphic brachiopod assemblage from the uppermost 4 m of the "Craie de Trivières" is similar to the brachiopod assemblage observed in the uppermost part of the Pre-Weybourne$_5$ Chalk or at the base of the Weybourne$_1$ Chalk in Keswick, Norfolk. WOOD (1988, pp. 32-34, 52-53) noted for these faunal belts a similar brachiopod assemblage, with a great abundance of *Cretirhynchia lentiformis*, associated with *Cretirhynchia woodwardi* and *Kingena pentagulata*.

The lowermost 3 m of the "Craie d'Obourg" in the Craibel quarry could be related to the Weybourne$_2$ faunal belt described by WOOD (1988, pp. 34-35) who stressed the striking absence of *C. lentiformis* but a continuous presence of *C. woodwardi* in this chalk.

When successions in the Mons Basin and in Norfolk are compared, a gap is visible between the stratigraphical sequences based on belemnites (CHRISTENSEN, 1999, p. 104, fig. 7) and the sequences based on the faunal belts including brachiopod assemblages (WOOD, 1988, pp. 29-34). For the belemnite sequences in Norfolk, the *B. mucronata* Zone *sensu* CHRISTENSEN (1999) is limited to the top of the Pre-Weybourne$_3$ faunal belt. The typical brachiopod assemblage, exhibiting the great abundance of *C. lentiformis* associated with *C. woodwardi* and *K. pentagulata*, is described by WOOD (1988, p. 34) from the Weybourne$_1$ faunal belt which is included by CHRISTENSEN (1999, p. 104, fig. 7) in the *Belemnitella woodi* Zone. In the Mons Basin (Craibel quarry in Cuesmes and C.C.C. West quarry in Harmignies) the top of the "Craie de Trivières", in the *B. mucronata* Zone *sensu* CHRISTENSEN (1999), shows a perfect correlation with the *Cretirhyn-*

Table 1 — Small sized brachiopods from the top of the "Craie de Trivières" and from the base of the "Craie d'Obourg" (lower part of the Upper Campanian, *Belemnitella mucronata* Zone) collected from the Craibel quarry in Cuesmes (Mons Basin, Hainaut, Belgium). Minimal number of individuals extracted by the Glauber salt method, in 91 samples representing a total amount of 230 kg of dry chalk.

CHALK OF TRIVIERES				SMALL SIZED BRACHIOPODS EXTRACTED: NUMBER OF INDIVIDUALS										Total of brachiopods extracted/level	Total of brachiopods for 100 kg chalk / level
	Number of samples	∑ of kg of chalk extracted	Position under the hardground (cm)	*Rugia tenuicostata*	*Terebratulina chrysalis*	*Leptothyrellopsis polonicus*	*Rugia spinicostata*	*Isocrania campaniensis*	*Argyrotheca obourgensis*	*Argyrotheca hirundo*	*Praelacazella wetherelli*	*Cretirhynchia cf. lentiformis*	Kingena pentagulata		
	12	32.98	0 - 20	30	22	16	2	1	0	0	0	1	0	72	218
	1	3.00	20 - 40	2	4	5	1	0	0	0	0	0	0	12	400
	9	25.60	50 - 70	120	61	65	16	2	0	0	0	0	0	264	1031
	2	7.80	70 - 90	35	8	13	3	1	0	0	0	0	0	60	769
	2	7.10	90 - 110	22	13	6	0	0	0	0	0	0	1	42	592
	3	9.80	110 - 130	49	29	22	5	2	0	0	0	0	0	107	1092
	3	9.35	180 - 200	40	12	24	1	1	0	0	0	0	0	78	834
	7	23.95	210 - 230	138	60	56	6	1	0	0	0	0	0	261	1090
	4	13.15	230 - 250	32	12	19	0	0	0	0	0	0	0	63	479
	3	11.95	250 - 275	53	29	17	2	1	0	0	0	0	0	102	854
	4	13.45	300 - 325	27	12	9	0	0	0	0	0	0	0	48	357
	3	10.90	325 - 350	31	12	25	1	4	0	0	0	0	0	73	670
	1	3.40	350 - 370	5	4	2	0	0	0	0	0	0	0	11	324
TOTAL	54	172.43	0 - 370	584	278	279	37	13	0	0	0	1	1	1193	Mean/100 kg chalk
Individuals/100 kg chalk				339	161	162	21	8	0	0	0	1	1		692

CHALK OF OBOURG				SMALL SIZED BRACHIOPODS EXTRACTED: NUMBER OF INDIVIDUALS										Total of brachiopods extracted/level	Total of brachiopods for 100 kg chalk / level
	Number of samples	∑ of kg of chalk extracted	Position above the hardground (cm)	*Rugia tenuicostata*	*Terebratulina chrysalis*	*Leptothyrellopsis polonicus*	*Rugia spinicostata*	*Isocrania campaniensis*	*Argyrotheca obourgensis*	*Argyrotheca hirundo*	*Praelacazella wetherelli*	*Cretirhynchia cf. lentiformis*	Kingena pentagulata		
	12	34.95	0 - 20	19	11	14	4	2	0	2	0	1	0	53	152
	1	2.80	20 - 40	6	7	0	1	0	0	0	1	0	0	15	535
	9	25.70	50 - 70	43	23	20	6	2	0	0	0	0	0	94	366
	2	7.75	110 - 130	32	8	19	0	3	0	0	0	0	0	62	800
	4	14.50	130 - 150	33	26	15	1	7	5	8	0	0	1	96	662
	2	7.80	150 - 170	13	7	1	0	4	2	0	0	0	0	27	360
	2	6.70	180 - 200	29	14	3	0	0	2	0	0	0	0	48	100
	2	7.30	210 - 230	14	8	9	2	0	0	0	1	0	0	34	466
	1	3.50	250 - 275	5	4	0	0	0	2	0	0	0	0	11	100
	2	6.95	300 - 325	12	5	4	1	1	2	0	0	0	0	25	359
TOTAL	37	117.95	0 - 325	206	113	85	15	19	13	10	2	1	1	465	Mean/100 kg chalk
Individuals/100 kg chalk				175	96	72	13	16	11	9	2	1	1		394

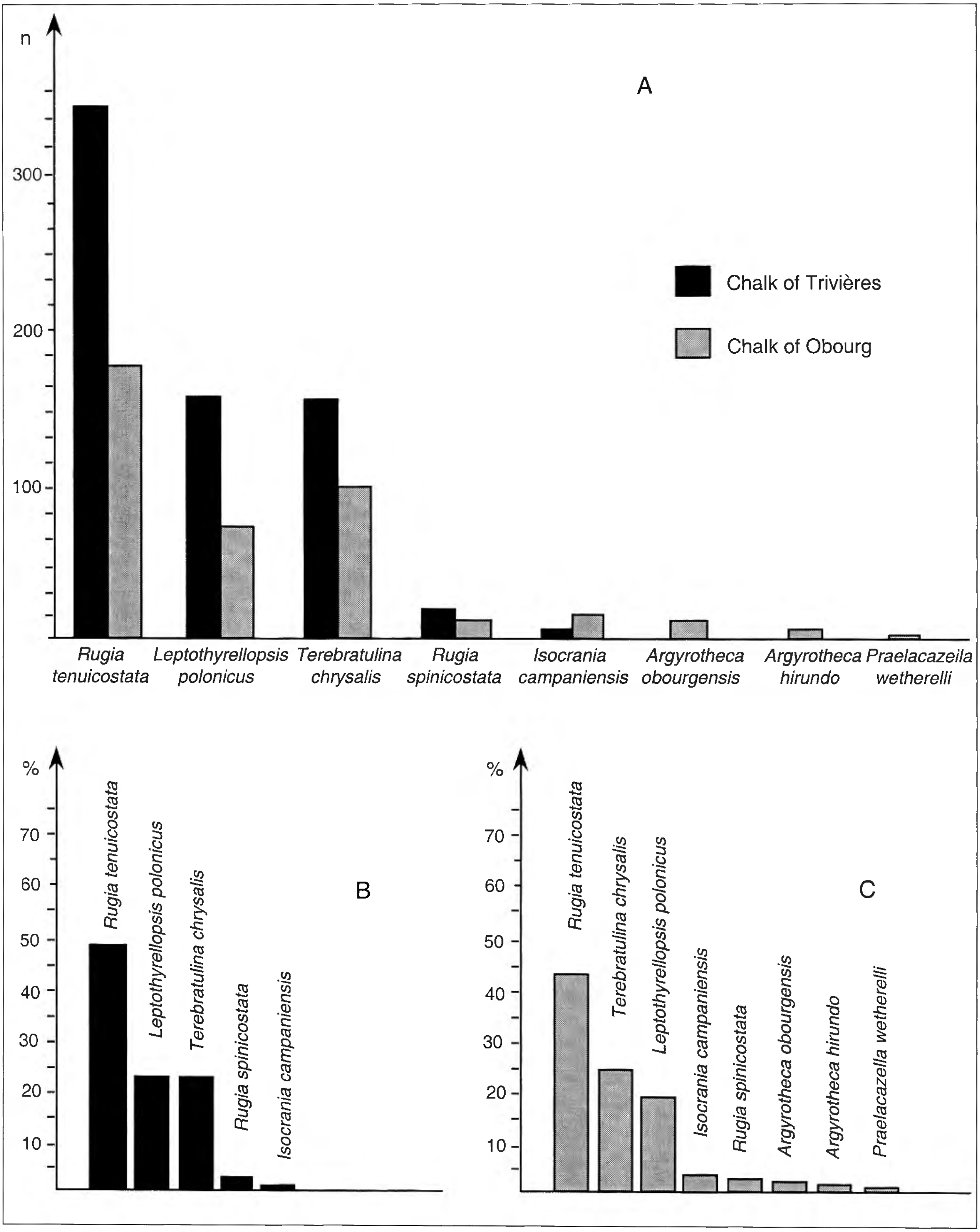

Fig. 4 — Relative abundance of individuals of small sized brachiopod species collected from the top of the ''Craie de Trivières'' and from the base of the ''Craie d'Obourg'' in the Craibel quarry in Cuesmes (Mons Basin, Hainaut, Belgium).
A: Comparison between the number of individuals of small sized brachiopod species extracted from the ''Craie de Trivières'' and the ''Craie d'Obourg''. B: Relative abundance (in % of total number of individuals) of small sized brachiopod species extracted from the ''Craie de Trivières''. C: Relative abundance (in % of total number of individuals) of small sized brachiopod species extracted from the ''Craie d'Obourg''.

chia lentiformis assemblage which should be thus slightly older in the Mons Basin than the similar Weybourne$_1$ faunal belt of Norfolk. On the other hand, if the Weybourne$_2$ faunal belt of Norfolk is similar to the basal 3 m of the Craie d'Obourg in the Mons Basin, the gap with the belemnite sequence is still present, as the lowermost 1.2 m of the Craie d'Obourg is included in the *B. mucronata* Zone (CHRISTENSEN, 1999, pp. 99-101) whereas Weybourne$_2$ faunal belt of WOOD (1988, p. 34) is included in the *B. woodi* Zone (CHRISTENSEN, 1999, p. 104, fig. 7).

The micromorphic brachiopods

A total amount of 1,659 individuals of small sized brachiopods were found in the chalk samples collected from the investigated section in the Craibel quarry. Six micromorphic species are represented. Juvenile specimens of three macromorphic species were extracted. One species of *Isocrania* and one species of *Praelacazella* were also found, using the same extraction method. The detailed results concerning this material are presented in Table 1. A direct comparison between the brachiopod fauna respectively found in the ''Craie de Trivières'' and in the ''Craie d'Obourg'' is illustrated in Fig. 4 (A).

Table 1 presents separately the results obtained for the ''Craie de Trivières'' and for the ''Craie d'Obourg''. A great difference in the mean density of species between these two types of chalk is observed. The mean density of species is nearly twice as high for the top of the ''Craie de Trivières'' as for the basal 3 m of the ''Craie d'Obourg'' (692 individuals/100 kg chalk in Trivières against 395 individuals/100 kg chalk in Obourg).

The density of brachiopod species is variable, indicating a discontinuous distribution. But, the density is significantly lower just below and just above the hardground separating the ''Craie de Trivières'' from the ''Craie d'Obourg''. These zones were affected by stronger water currents and most small sized brachiopods suffered during transportation. The highest densities for brachiopod species are observed in the ''Craie de Trivières'' for the levels 50/70 cm, 110/130 cm and 210/230 cm below the hardground. A higher amount of small bryozoans was also extracted from the samples collected at these levels. This confirms a positive relationship between the development of micromorphic brachiopods and the relative abundance of small bryozoans. SURLYK (1972, p. 34) observed a similar relation between micromorphic brachiopods and bryozoans in the Danish Maastrichtian chalk.

The mean diversity, based on the number of species, is extremely low in the top of the ''Craie de Trivières''; only seven species, including juveniles of macromorphic species, were discovered. The mean diversity is much higher in the basal 3 m of the ''Craie d'Obourg'' where eleven species were found.

The brachiopod assemblages found in both types of chalk are extremely similar when dominant species are examined (Fig. 4, B, C).

In both types of chalk, the three most abundant species are the same. The dominant species is, by far, *Rugia tenuicostata* STEINICH, 1963. The specimens of *R. tenuicostata* collected in Cuesmes are generally without deltidial plates and the foramen is attrite. This feature suggests that the pedicle was quite short. Attrition of the foramen is due to permanent water current.

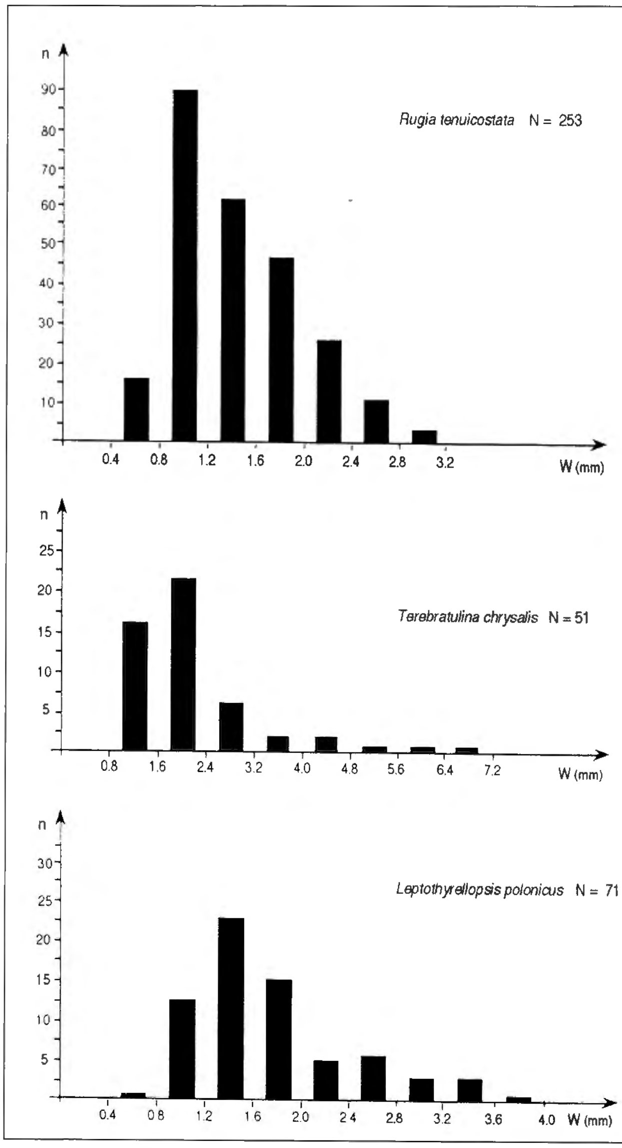

Fig. 5 — Size-frequency diagrams of *Rugia tenuicostata* STEINICH, 1963, of *Terebratulina chrysalis* (VON SCHLOTHEIM, 1813) and of *Leptothyrellopsis polonicus* BITNER & PISERA, 1979 found in samples collected from the *Belemnitella mucronata* Zone in the Craibel quarry (MonsBasin, Hainaut, Belgium). N: total numbers of individuals measured. n: number of individuals in the different size-classes. Abscissa is width (in mm) of individuals measured.

Lower Upper Campanian specimens of *Rugia tenuicostata* previously illustrated from Lägerdorf in Germany (JOHANSEN, 1987b, pl. 6, figs. 1-3), from Keswick in Norfolk (JOHANSEN & SURLYK, 1990, pl. 6, fig. 7) and from Mielnik in Poland (BITNER & PISERA, 1979, pl. 4, fig. 4b) also lack deltidial plates and their foramen is attrite. On the contrary, Maastrichtian specimens of *R. tenuicostata* exhibit always well preserved deltidial plates (STEINICH, 1965, pl. 11, Fig. 4a, JOHANSEN, 1987b, pl. 6, fig. 4). This observation suggests that the European populations of *R. tenuicostata* which can be referred to the *B. mucronata Zone* had a short pedicle and that attrition of the foramen arose under high energy water conditions. Maastrichtian representatives of this species probably developed a longer pedicle and/or were living in quieter conditions.

Terebratulina chrysalis (VON SCHLOTHEIM, 1813) and *Leptothyrellopsis polonicus* BITNER & PISERA, 1979 are co-dominant species. Although less common, *Rugia spinicostata* JOHANSEN & SURLYK, 1987 and *Isocrania campaniensis* ERNST, 1984 are present throughout the section investigated. *Rugia spinicostata* is a Campanian species (SURLYK, 1982, p. 263, JOHANSEN, 1987b, p. 157 and JOHANSEN & SURLYK, 1990, p. 856). This spiny brachiopod greatly suffered during transportation. The ornamentation of its shell, constituted of long spines, offered enough resistance to allow water movements to have a strong hold on this type of shell. This is also confirmed by the fact that most specimens of *R. spinicostata* illustrated in previous papers have broken spines (BITNER & PISERA, 1979, JOHANSEN, 1987b, pl. 5, figs. 1-3, and JOHANSEN & SURLYK, 1990, pl. 7, figs. 3-10).

Isocrania campaniensis has a limited stratigraphical range. It is only known from the Upper Campanian. The specimens from Belgium (Harmignies, Cuesmes) and France are considered as the oldest specimens discovered (ERNST, 1984, p. 64). The ventral valve of *I. campaniensis* is extremely flat and this characteristic is recognized as a useful adaptation, giving greater stability in high energy situations (SURLYK, 1973, p. 231).

This assemblage of micromorphic brachiopods includes mainly the representatives of three ecological groups. *Rugia tenuicostata*, *Leptothyrellopsis polonicus* and *Rugia spinicostata* are minute species attached to extremely small, hard substrates by means of their pedicle (ecological group Ia of SURLYK, 1972, p. 16). *Terebratulina chrysalis* is a species directly attached to the sediment by means of its divided, root-like pedicle (ecological group Ic of SURLYK, 1972, p. 21). Finally, *Isocrania campaniensis* was a brachiopod cemented on a small substrate. It belongs to ecological group IV of SURLYK (1972, p. 27) but it is an intermediate representative between group IVa (brachiopods cemented at juvenile stage and free living at adult stage) and group IVb (brachiopods widely cemented to large substrates during their whole life).

Representatives of secondary free living brachiopods are totally missing (ecological group II of SURLYK, 1972, p. 16). For instance, *Magas chitoniformis* (VON SCHLOTHEIM, 1813), a free living brachiopod species known from the Upper Campanian to the latest Maastrichtian, has not been collected in the samples from the studied section in the Craibel quarry. To survive, free living brachiopods request quiet water conditions. Their absence here confirms that energetic water conditions were a significant ecological factor in these chalk deposits.

According to the results obtained for the "Craie d'Obourg" (Table 1), it appears that three micromorphic brachiopod species increase the mean diversity. All are representatives of the genus *Argyrotheca* DALL, 1900, a genus which apparently is missing in the top of the "Craie de Trivières". The presence of *Argyrotheca* could indicate that the water was shallower weaker in the "Craie d'Obourg" than in the "Craie de Trivières" as the Recent representatives of this genus are rarely found at a depth exceeding 200 m (JOHANSEN, 1989a, p. 165). *Argyrotheca* species show a very large foramen and their shell is pressed tightly against the substrate by means of a very strong pedicle. They may have had a preference for an attachment to certain kinds of substrates such as bryozoans (JOHANSEN, 1989a, p. 165 following a personal communication of ASGAARD, 1983).

Two specimens of the rare *Praelacazella wetherelli* (MORRIS, 1851) were found in the "Craie d'Obourg" but this is possibly not significant.

Juvenile specimens of macromorphic brachiopods are extremely rare and they are evenly distributed in the two types of chalk.

Valid size-frequency diagrams cannot be established for *Rugia spinicostata* and for *Argyrotheca* species because crushing and/or selective shape transportation occurred for these species. Moreover these species are not abundant enough for establishing a reasonable statistical diagram of size-frequency. Size-frequency diagrams have been established for *Rugia tenuicostata*, *Terebratulina chrysalis* and for *Leptothyrellopsis polonicus* (Fig. 5). For the three species investigated, size-frequency diagrams show a strong right skewed distribution. These results confirm that small pedunculate brachiopod populations consist mainly of juveniles and young adult specimens. A high juvenile mortality is observed, suggesting early maturity. Similar results were obtained for the Danish chalk by SURLYK (1972, text-fig. 16-18) and for the micromorphic brachiopods from the phosphatic chalk of Ciply by SIMON (1998, text-figs. 6, 8).

From a stratigraphical standpoint, the micromorphic brachiopod assemblage found in the *B. mucronata* Zone of the Craibel quarry enter in the *tenuicostata-longicollis* Zone as defined by SURLYK (1982, 1983, 1984). This Zone is extensive and covers most of the Upper Campanian chalk deposits. As proposed by JOHANSEN & SURLYK (1990, p. 832) for the chalk of Norfolk, this zone could be later subdivided when the study of brachiopod faunas from continuous sections through the Upper Campanian will be completed.

The micromorphic brachiopod assemblage from the *B. mucronata* Zone of the Craibel quarry is comparable with the species collected by JOHANSEN & SURLYK (1990) from the Weybourne Chalk in Norfolk. But, the species of micromorphic brachiopods from the *B. mucronata* Zone have a wide stratigraphical range. *Rugia tenuicostata* is known from the Upper Campanian and becomes extinct at the Maastrichtian-Danian boundary (JOHANSEN, 1987b, p. 163). A comparatively similar range is established for *Leptothyrellopsis polonicus* (MACKINNON *et al*, 1998, p. 177) but for *Terebratulina chrysalis*, the range extends from the Upper Campanian to the Lower Danian (SIMON, 1998, p. 201). As cited above, shorter stratigraphical ranges, limited to Campanian chalk deposits are observed for *Rugia spinicostata* and for *Isocrania campaniensis*. The latter species is probably the most interesting candidate for establishing a subzone, as it seems confined to the Upper Campanian. This hypothesis must be confirmed by further studies.

Conclusions

The study of macromorphic and micromorphic brachiopods from the lower part of the Upper Campanian, *Belemnitella mucronata* Zone, collected in the Craibel quarry, from the uppermost part of the ''Craie de Trivières'' and the lowermost part of the Craie d'Obourg, is a first step in the study of the Campanian chalk deposits in the Mons Basin. The upper part of the Craie d'Obourg and the ''Craie de Nouvelles'' as well as the ''Craie de Spiennes'' will be investigated in a near future.

The number of species (12) collected from the Craibel quarry is rather low. Separately, each species collected, has a relative long stratigraphical range with the exception of *Isocrania campaniensis* which is limited to the Upper Campanian. The micromorphic brachiopod assemblage is reported to be the *tenuicostata-longicollis* Zone of SURLYK. From this point of view, there are no differences between the uppermost part of the ''Craie de Trivières'' and the lowermost part of the ''Craie d'Obourg''. Strong differences were observed in the mean density of species. The density is much lower for the ''Craie d'Obourg'' than for the ''Craie de Trivières''. On the contrary, the species diversity is higher for the Craie d'Obourg.

The brachiopod material collected from the *B. mucronata* Zone clearly illustrates palaeoecological adaptations to high energy water conditions. The absence of any secondary free living brachiopod species is consistent with this opinion. The Campanian *Rugia tenuicostata*, by far, the most dominant species, exhibits an adapted shape to such water conditions, which is different from the shape observed in the Maastrichtian representatives of this species.

Brachiopods for which a size-frequency diagram has been established, show a right skewed distribution. This indicates that these species were affected by a high juvenile mortality and that an early maturity was necessary to maintain the level of the populations.

Systematic description

Phylum Brachiopoda DUMÉRIL, 1806
Subphylum Craniiformea WILLIAMS *et al.*, 1996
Class Craniata WILLIAMS *et al.*, 1996
Order Craniida WAAGEN, 1885
Suborder Craniidina WAAGEN, 1885
Superfamily Cranioidea MENKE, 1828
Family Craniidae MENKE, 1828
Genus *Isocrania* JAEKEL, 1902
Type species: *Crania Egnabergensis* RETZIUS, 1781

Isocrania campaniensis ERNST, 1984
Table 1, Text-Figure 4, Plate 1,
Figures 1a-b, 2a-b, 3a-b.

pp.	*1887*	*Crania ignabergensis* Retzius - PÉRON, pp. 195-196.
. *v*	*1979*	*Isocrania costata* (Sowerby, 1823) - BITNER & PISERA, p. 70, text-fig. 2.
*	1984	*Isocrania campaniensis* n. sp. - ERNST, fig. 26, fig. 27, pp. 63-64, pl. 5, figs. 1-2.
?	1989	*Isocrania egnabergensis* (Retzius, 1781) - POPIEL- BARCZYK, p. 242, pl. 153, figs. 9a-b.
?	1990	*Isocrania costata* (J. de C. Sowerby, 1823) - JOHANSEN & SURLYK, p. 836, pl. 1, figs. 3-4.

Stratigraphical range: Upper Campanian.

Material:
Craie de Trivières: no bivalved shells, two dorsal valves, three damaged dorsal valves, three ventral valves, one damaged ventral valve, six fragments.
Craie d'Obourg: no bivalved shells, three dorsal valves, two damaged dorsal valves, three ventral valves, four damaged ventral valves, ten fragments.

Ventral valve
Medium to large specimens with a subcircular outline. Valves are slightly wider than long. The ventral valve is very flat with a relatively large attachment area located posteriorly. The ratio L_p/L_a is rather low and varies between 0.24 and 0.30 for our specimens. L_p is the distance from the protegulal node to the posterior margin of the valve. L_a is the distance from the protegulal node to the anterior margin of the valve. The ribs are strongly developed. The number of ribs is relatively high and varies from 14 to 27. The number of primary ribs varies from 8 to 13. The ribs are protruding slightly beyond the valve margin. The surface between the ribs is wide and densely covered with small spines.

The posterior adductor scars are quite large and placed near each other. The strong anterior adductor scars are not placed in the middle of the valve floor but slightly posteriorly. They are separated by an acute rostellum.

Dorsal valve
The dorsal valve is low conical, subcircular in outline. The umbo is placed in a very posterior position. The ratio

L_p/L_a is especially low and varies from 0.17 to 0.36 for the specimens collected from the Craibel quarry. The ribs are coarse and their total number varies from 14 to 17 in our specimens. The number of primary ribs reaches 11-12. The rib interspaces are wide and spiny. The numerous spines are erected and they can be as long as the height of the principal ribs in well preserved specimens. Posterior adductor scars are large and situated near each other. Small interior muscle scars are subcircular and are in contact with the posterior adductor scars. Anterior adductor scars are slightly placed posteriorly and are reniform. In our specimens, the elevator and protractor muscle scars are not clearly defined. This material is consistent with the original description given by ERNST (1984, pp. 63-64).

Subphylum Rhynchonelliformea
WILLIAMS *et al.*, 1996
Class Rhynchonellata WILLIAMS *et al.*, 1996
Order Rhynchonellida KUHN, 1949
Superfamily Rhynchonelloidea D'ORBIGNY, 1847
Family Rhynchonellidae D'ORBIGNY, 1847

Nomenclative note: the family-group names based on *Rhynchonella* should be attributed to D'ORBIGNY, 1847 and not to GRAY, 1848 (MANCEÑIDO, OWEN & MORRIS, 1993 p. 193).

Subfamily Cyclothyridinae MAKRIDIN, 1955
emended OWEN, 1962
Genus *Cretirhynchia* PETTITT, 1950
Type species: *Terebratula plicatilis* J. SOWERBY, 1816

Note concerning the genus *Cretirhynchia*
Although the revision of the genus *Cretirhynchia* has been recently undertaken, the results published herein still follow the work of PETTITT (1950).

Cretirhynchia* cf. *lentiformis (WOODWARD, 1833)
Table 1, Text-Figure 3, Plate 1, Figure 4a-c.

Material:
Craie de Trivières: one early juvenile, complete, bivalved specimen.
Craie d'Obourg: one damaged specimen (collected at the top of the hardground).

It is very difficult to recognize juvenile specimens of *Cretirhynchia*. The specimen presented here is well preserved. The shell is smooth except for a marked growth line and it is oval-subtriangular in outline. The beak is pointed and slightly tilted backwards. A short pedicle collar is developed. The hypothyridid foramen is relavively large at this stage of growth. This specimen may represent a juvenile of *Cretirhynchia lentiformis* (WOODWARD, 1833) which is the most abundant rhynchonellid brachiopod in the "Craie de Trivières".

Cretirhynchia lentiformis (WOODWARD, 1833)
Table 1, Text-Figure 3, Plate 5, Figures 2a-e, 3a-e.

*	1833	*Terebratula lentiformis* - WOODWARD, S., p. 49, pl. 6, fig. 11.
pp.	1855	*Rhynchonella limbata* Schlotheim - DAVIDSON, pp. 79- 80, pl. 12, figs. 4-5.
.*v*	1950	*Cretirhynchia lentiformis* (S. Woodward) - PETTITT, pp. 1, 26-27, 29, table 3, pl. 2, figs. 1a-c.
.	1961	*Cretirhynchia lentiformis* (S. Woodward) - PEAKE & HANCOCK, p. 320.
.	1988	*Rhynchonella lentiformis* - ROWE *in* WOOD, C.J., pp. 10, 21, 58, 59, 86.
.	1988	*Cretirhynchia lentiformis* - WOOD, C.J., pp. 21, 25, 29, 34-35, 42, 49-50, 53-56, 58-59, 61, 79, 81-82, 87-88.
v non	1988	*Cretirhynchia lentiformis* (Woodward, 1833) - POPIEL- BARCZYK, pp. 11-12, text-figs. 10-11, pl. 2, figs. 7-9. (= *C. arcuata* PETTITT, 1950).
. *v*	1988	*Cretirhynchia arcuata* Pettitt, 1950 - POPIEL-BARCZYK, pp. 12-13, pl. 2, fig. 10.
.	1989	*Cretirhynchia lentiformis* (Woodward, 1833) - POPIEL- BARCZYK, p. 245, pl. 152, figs. 1a-c.
	1990	*Cretirhynchia lentiformis* (Woodward) - JOHANSEN & SURLYK, p. 838.
p.p.	1992	*Cretirhynchia lentiformis* (Woodward, 1833) - POPIEL- BARCZYK, p. 14.

Stratigraphical range: lower to middle Upper Campanian. In the Mons Basin, *Cretirhynchia lentiformis* is very abundant in the top of the "Craie de Trivières" and occurs more rarely in the "Craie d'Obourg".

Material:
Craie de Trivières: 230 complete bivalved specimens. Numerous fragments extracted from the chalk samples treated for the study of the micromorphic brachiopods.
Craie d'Obourg: six complete bivalved specimens.

This material is generally consistent with the description given by PETTITT (1950, pp. 26-27). The numerous specimens investigated are relatively small, about 10 mm in length, 9-10 mm in width and 5-7 mm in thickness. Valves are equally convex with a slight median fold on the dorsal valve corresponding to a narrow and shallow sinus on the ventral valve. The linguiform extension is small, but clearly trapezoidal in most studied specimens. More rarely, some flat specimens exhibit a slightly arcuate linguiform extension. The umbo is fairly broad. The beak is thin and the hypothyridid foramen is extremely small. At first glance, the shell surface seems nearly smooth except for faint growth-lines. But, careful study of a large sample, observed under good light condition, show numerous faint ribs which are constantly present on the anterior part of the shell, the posterior part and in some cases, only the middle part of the shell remains smooth. Only very young specimens are totally smooth. This character distinguishes *Cretirhynchia lentiformis* from *C. arcuata* PETTITT, 1950. In *C. arcuata*, the shell is smooth on its whole surface and "costae" are only developed on large specimens near the antero-lateral commissure.

PETTITT (1950, p. 26) based his description on a poorly developed specimen. He stated in his diagnosis: "linguiform extension very small, arcuate, or anterior commissure may be rectimarginate". Considering that the shell was smooth, PETTITT placed *C. lentiformis* in his "*Cretirhynchia limbata* series". This introduced confusion between *C. lentiformis* and *C. arcuata*. A similar confusion arose with the material collected from the middle Vistula river valley in Poland (POPIEL-BARCZYK, 1988, pp. 11-13, pl. 2, Figs. 7-9, 10). In that paper, POPIEL-BARCZYK describes *C. lentiformis* under the name *C. arcuata* and *C. arcuata* must be interpreted as the real *C. lentiformis*. The material collected from Norfolk is strictly identical to the material collected from Cuesmes. Further information concerning the internal structure of this species will be given later in a paper dealing with the revison of the genus *Cretirhynchia*.

Cretirhynchia woodwardi (DAVIDSON, 1855)
Text-Figure 3, Plate 5, Figures 4a-e.

	1833	*Terebratula gallina* - WOODWARD, S.,p. 49, pl. 6, fig. 12. (*non* BRONGNIART, 1822)
*	1855	*Rhynchonella plicatilis* var. *woodwardi* - DAVIDSON, pp. 77-78, pl. 10, figs. 43, 44 (*non* figs. 45, 46).
.	1866	*Rhynchonella octoplicata*, d'Orb. - CORNET & BRIART, p. 126, 187 (*non* p. 189).
.	1874	*Rhynchonella plicatilis* , Sow. - CORNET & BRIART, p. 549
?	1871	*Terebratula plicatilis* Sw. - QUENSTEDT, p. 167, pl. 41, fig. 57.
.	1879	*Rhynchonella plicatilis* Sow. sp. - UBAGHS, pp. 128, 217.
.	1887	*Rhynchonella plicatilis* , Sow. - RUTOT & VAN DEN BROECK, pp. 155, 156.
. *v*	1950	*Cretirhynchia woodwardi* (Davidson) - PETTITT, pp. 1, 4,16, 21-22, table 2, pl. 1, figs. 4a-c, pl. 2, figs. 5a-c.
.	1954	*Cretirhynchia woodwardi* (Davidson) - PETTITT, pp. 48, 49.
.	1961	*Cretirhynchia woodwardi* (Davidson) - PEAKE & HANCOCK, p. 320.
.	1988	*Cretirhynchia woodwardi* Pettitt - WOOD, C.J., pp. 25, 29, 34-35, 54-55, 61, 63-65, 81.
v non	1988	*Cretirhynchia woodwardi* (Davidson, 1852) - POPIEL- BARCZYK, p. 15, pl. 3, figs. 5-6.
.	1990	*Cretirhynchia woodwardi* (Davidson) - JOHANSEN & SURLYK, p. 838.
non	1995	*Cretirhynchia woodwardi* (Davidson, 1852) - SIMON *in* JAGT *et al.*, p. 11.

Stratigraphical range: Upper Campanian.

Material:
Craie de Trivières: 43 complete, bivalved specimens and several fragments. Craie d'Obourg: two complete, bivalved specimens.

The material collected from the Craibel quarry is perfectly consistent with the description given by PETTITT (1950, pp. 21-22). The specimens are wider than long and they are transversely oval in outline. The dorsal valve is more convex than the ventral one. The sinus of the ventral valve is shallow and corresponds to a broad anterior median fold on the dorsal valve. The linguiform extension is broad, arcuate in most specimens. The ribs, fine at first become wider towards the anterior commissure where they show clearly incipient splitting in all the specimens collected from Cuesmes. The hypothyridid foramen of *C. woodwardi* is fairly broad and circular. The shell is quite thin in this species and crushed or compressed individuals are not rare. PETTITT did not investigate the internal structure of *C. woodwardi* with sectioned specimens. The topotype illustrated by PETTITT (1950, pl. 2, figs. 5a-c), collected from the Chalk of Norwich (Norfolk) is a slightly compressed specimen. In Norfolk, *C. woodwardi* has a limited stratigraphical range and is typical of the Weybourne Chalk *sensu* WOOD (1988, pp. 29-35). In the Mons Basin, *C. woodwardi* is found from the top of the "Craie de Trivières" through the "Craie d'Obourg" - Nouvelles. It cuts off sharply at the top of the "Craie de Nouvelles". Its stratigraphical range is thus similar in Belgium and in Norfolk.

Cretirhynchia sp.
Text-Figure 3, Plate 5, Figures 5a-e, 6a-c.

Stratigraphical range: Upper Campanian. In the Mons Basin, this *Cretirhynchia* is known from the top of the "Craie de Trivières" (*Belemnitella mucronata* Zone) to the top of the "Craie de Nouvelles" (*Belemnitella woodi* Zone).

Material:
Craie de Trivières: twelve complete, bivalved specimens.
Craie d'Obourg: one bivalved specimen.

External characters
Medium sized *Cretirhynchia* about 14.0 / 19.5 mm long, 14.5 / 21.2 wide and 7.3 / 11.5 mm thick, subtriangular (small specimens) to transversely oval (larger specimens), oval in lateral profile and lenticular in anterior view. The dorsal valve is slightly more convex than the ventral valve, with a very low dorsal median fold on its anterior part. The ventral valve shows a maximal posterior convexity near the umbo and its sinus is low, flattened but slightly wider than the corresponding dorsal fold. The broad linguiform extension is trapezoidal. The beak is short, erect, its extremity pointed and curved . The beak ridges are very distinct. The hypothyridid foramen is circular with conjunct protruding deltidial plates. The interareas are slightly curved but the posterior commissure is nearly straight. Numerous ribs are visible (47 to 53). They are low, very fine and faint in the posterior part of the shell but wider anteriorly. In the studied specimens, the ribs are not reduced in number near the anterior part of the shell. Only a little reduction of the

number of ribs has been observed in one specimen which seems to have been bitten during its growth. Incipient splitting is never observed. Eight to ten ribs are visible in the bottom of the sinus at the anterior commissure whereas seven to nine ribs are present on the dorsal fold. Fine concentric growth lines are perceptible on the shell surface and sometimes, a few laminae are developed near the commissure.

Internal characters

In transverse sections, strongly convergent dental plates are seen. The hinge plates are simple and subtriangular. Radulifer crura are present and the crural base is subquadrate. A persistent dorsal septum is developed on the dorsal valve floor.

Comments

The general outline of large shells of *Cretirhynchia* sp. is quite similar to the shell outline of *Cretirhynchia intermedia* PETTITT, 1950. But, in the latter species, a reduction of the number of ribs near the anterior commissure is always observed. Moreover, the linguiform extension of *C. intermedia* is generally U-shaped. However, in the collections of the Natural History Museum in London, specimens, from East Hornham near Salisbury, have a more trapezoidal linguiform extension.

The smaller specimens of *Cretirhynchia* sp. have a subtriangular outline similar to those of *C. norvicensis* PETTITT, 1950. In this latter species the linguiform extension is trapezoidal but a strong reduction of the number of ribs is always observed on the anterior part of the shell. The foramen is relatively smaller in *C. norvicensis* than in *Cretirhynchia* sp. *C. norvicensis* is generally much larger than *Cretirhynchia* sp.

For its internal characters, *Cretirhynchia* sp. is nearer to *C. intermedia*, the internal structures of *C. norvicensis* being much heavier.

Cretirhynchia sp. could be a new species of *Cretirhynchia*. But, the number of specimens collected is actually not sufficient for clearly establishing the status of this new species. More material will soon be available as more specimens of this species from the "Craie de Nouvelles" in the Mons Basin are being collected. For these reasons, it is preferable to leave *Cretirhynchia* sp. in open nomenclature.

Order Terebratulida WAAGEN, 1883
Suborder Terebratulidina WAAGEN, 1883
Superfamily Terebratuloidea GRAY, 1840
Family Terebratulidae GRAY, 1840
Subfamily Carneithyridinae MUIR-WOOD, 1965
Genus *Carneithyris* SAHNI, 1925
Type species: *Carneithyris subpentagonalis* SAHNI, 1925

Carneithyris carnea (J. SOWERBY, 1812)
Text-Figure 3, Plate 5, Figures 1a-c.

*	1812	*Terebratula carnea* - J. SOWERBY, p. 47, pl. 15, figs. 5-6.
	1823	*Terebratula elongata* - J. DE C. SOWERBY, p. 49, pl. 435, figs. 1-2.
.	1961	*Carneithyris carnea* - PEAKE & HANCOCK, p. 316, text-fig. 6.
.	1965	*Terebratula carnea* Sow. - STEINICH, pp. 45-46.
.	1988	*Terebratula carnea* J. Sowerby - WOOD, C.J., p. 93.
.	1988	*Terebratula carnea* J. Sowerby - ROWE *in* WOOD, C.J., pp. 21, 58, 85-86, 88.
.	1988	*Carneithyris carnea* (J. Sowerby) - WOOD, C.J., pp. 21, 29, 35-39, 59, 61, 63-65, 69-72, 89, 93-95, 97-100.
.	1988	*Terebratula elongata* J. de C. Sowerby - WOOD, C.J., p. 93.
.	1998	*Carneithyris carnea* (J. Sowerby, 1812) - SIMON, pp. 197-199, text-fig. 2, pl. 1, fig. 2a, pl. 3, figs. 2a-c, 4a-c, 5a- c, pl. 4, figs. 1a-c, 2a-c, 3a-d, 4.

Note

A more complete synonymy list can be consulted in SIMON (1998, p. 198).

ASGAARD (1975) revised the numerous genera and species erected by SAHNI (1925 and 1929) for the Campanian and Maastrichtian terebratulid brachiopods from England. Only the genus *Carneithyris* remains valid. Two species, *Carneithyris carnea* (J. SOWERBY, 1812) and *Carneithyris subcardinalis* (SAHNI, 1925) are considered as valid. The first one is a Campanian species whereas the second one is Maastrichtian.

Species described under the genera *Pulchrithyris*, *Magnithyris*, *Ellipsothyris*, *Ornithothyris*, *Carneithyris* and *Chatwinothyris symphytica in* SAHNI (1925) and species of *Carneithyris*, *Ellipsothyris*, *Magnithyris*, *Chatwinothyris symphytica* and *Ornithothyris carinata in* SAHNI (1929) are considered as synonyms of *Carneithyris carnea* (J. SOWERBY, 1812).

Stratigraphical range: Upper Campanian to Lower Maastrichtian.

Material:
Craie de Trivières: none.
Craie d'Obourg: one complete bivalved specimen, two slightly damaged bivalved specimens.

The few specimens collected in the Craibel quarry are medium sized, subpentagonal in outline, oval-lenticular in lateral profile and lenticular in anterior view. The largest specimen is 25.9 mm long, 21.4 mm wide and 13.5 mm thick. The shell is smooth except for numerous concentric growth lines. The anterior commissure is rectimarginate. The beak is strongly curved but not in contact with the umbo of the dorsal valve. Beak ridges distinct. The submesothyridid foramen is relatively large and circular. Specimens from the Craibel quarry are very similar to *Carneithyris pentagonalis* described and illustrated by SAHNI (1925, p. 365, pl. 25, figs. 3, 3a and pl. 26, fig. 3) except for the symphytium which is not visible.

Internal structures were not investigated due to lack of material.

Family Cancellothyrididae THOMSON, 1926
Subfamily Cancellothyridinae THOMSON, 1926
Genus *Terebratulina* D'ORBIGNY, 1847
Type species: *Anomia retusa* LINNÉ, 1758

Nomenclative note:
Since 1970, the accepted type species for the genus *Terebratulina* is *Anomia retusa* LINNÉ, 1758 and not *Anomia caput-serpentis* LINNÉ, 1767. This follows Opinion 924 in the Bulletin of Zoological Nomenclature, 27(2).

Terebratulina chrysalis (VON SCHLOTHEIM, 1813)
Table 1, Text-Figure 5, Plate 1, Figures 5a-c, 6a-d, 7, Plate 2, Figures 1, 2a-b, 3a-b, 7.

	1803 (?)	Térébratules Fossiles - FAUJAS DE SAINT-FOND, pl. 26, fig. 9.
*	1813	*Terebratulites chrysalis* - VON SCHLOTTHEIM, p. 113.
	1835	*Terebratula chrysalis* Schloth. - VON BUCH, p. 227.
p.p.	1841	*T. striatula* Mantell - ROEMER, p. 39, p. 144.
p.p.	1847	*Terebratulina striata* d'Orb., 1847 - D'ORBIGNY, p. 65, Atlas (1851), pl. 504, figs. 9-13.
.	1887	*Terebratulina chrysalis*, Schlotheim - PÉRON, pp. 183- 186.
.	1965	*Terebratulina chrysalis* (Schlottheim, 1813) - STEINICH, p. 53, text-figs. 44-61, pl. 8, figs. 1a-d, pl. 9, figs. 1-5, 9a- b, 10a-b.
	1977	*Bisulcina chrysalis* (Schlotheim) - TITOVA, pp. 81-82, text-fig. 6, pl. 10, fig. 1.
?	1977	*Bisulcina campaniensis* (d'Orbigny) - TITOVA, pp. 82-83, text-fig. 7, pl. 10, fig. 2.
?	1977	*Bisulcina tunicata* (Vanchurov) - TITOVA, pp. 83-84, text-fig. 8, pl. 10, fig. 3.
.	1979	*Terebratulina chrysalis* (Schlotheim, 1813) - BITNER & PISERA, pp. 73-74, pl. 3, figs. 12-15.
.	1982	*Terebratulina chrysalis* Schlotheim, 1813 - NECHRIKOVA, pp. 41-42, pl. 4, figs. 6-9.
.	1987a	*Terebratulina chrysalis* (Schlottheim, 1813) - JOHANSEN, p. 14, pl. 4, figs. 1-5, text-figs. 14 A-D.
.	1988	*Terebratulina* cf. *chrysalis* (Schlotheim) - WOOD, C.J., p. 71, 75, 92, 99.
?	1990	*Terebratulina chrysalis* (Schlotheim), 1813 - MUÑOS, p. 67, 76, pl. 2, fig. 1.
.	1998	*Terebratulina chrysalis* (VON SCHLOTTHEIM, 1813) - SIMON, pp. 200-201, table 1, text-fig. 5, pl. 5, figs. 4, 5a-b, 6a-f.

Note:
A more complete synonymy list can be found in STEINICH (1965, pp. 53-54) and in SIMON (1998, p. 200).
The genus *Bisulcina* erected by TITOVA (1977, p. 81) is based on very slight characteristics and is not considered here (See also remarks in BITNER & PISERA, 1979, p. 74 and in SURLYK, 1982, p. 265).

Stratigraphical range: Upper Campanian to Upper Maastrichtian and Lower Danian.

Material:
Craie de Trivières: 33 complete, bivalved specimens, six opened, complete, bivalved specimens, 12 damaged, complete specimens, seven ventral valves, 14 dorsal valves and 612 fragments.
Craie d'Obourg: Nine complete, bivalved specimens, four opened, complete, bivalved specimens, one damaged, complete specimen, seven ventral valves, 11 dorsal valves and 256 fragments.

An accurate description of this species and a detailed explanation of its ontogenetic development has been published by STEINICH (1965, pp. 53-54).

JOHANSEN (1987a, p. 15) has confirmed the comments of STEINICH for specimens from the Danish chalk. Specimens from the Craibel quarry are mainly juveniles, extracted from the chalk by the Glauber salt method. Only large specimens are directly collected from the outcrop. This indicates that *Terebratulina chrysalis* (VON SCHLOTTHEIM, 1813) was represented in both "Craie de Trivières" and "Craie d'Obourg" by very young, early mature individuals as shown by the size-frequency diagram in Figure 4. These young specimens are consistent with the descriptions given by STENICH and JOHANSEN.

Larger specimens (5.0 to 8.0 mm long), however, exhibit very different shapes.

Specimens of the first type (type a) follow the ontogenetic development described by STEINICH (1965, pp. 53-54). The length increases rapidly resulting in a shell which is much longer than wide. The convexity of their dorsal valve is moderate. The ornamentation of the ribs is made of small tubercles regularly spaced. The foramen is oval-triangular and relatively large (Plate 2, Figure 7).

Other specimens (type b), become circular in later growth stage. The dorsal valve remains very flat. Sometimes, the ribs are much finer and more numerous. The ornamentation of the ribs is made of serrate, very small tubercles. The beak is slightly tilted backwards and the foramen is medium sized, oval to circular (Plate 1, Figure 5).

A third type of shape is still recognized (type c). In these specimens, the shell is longer than wide and they are oval in outline. The dorsal valve is clearly more convex and the ribs are thicker. The ornamentation of the ribs is made of more widely spaced, rough tubercles. The foramen is circular and clearly smaller (Plate 1, Figure 7).

Similar variation in shape has been observed for Upper Campanian specimens of *Terebratulina* gr. *chrysalis* collected from the Chalk of Zeven Wegen in the C.P.L. quarry in Hallembaye near Maastricht (Jagt, personal communication, 1996) and also in Polish Upper Campanian material, as observed in Mielnik by BITNER & PISERA (1979, p. 74), who assigned all these variations to one species: *Terebratulina chrysalis*. Specimens from the

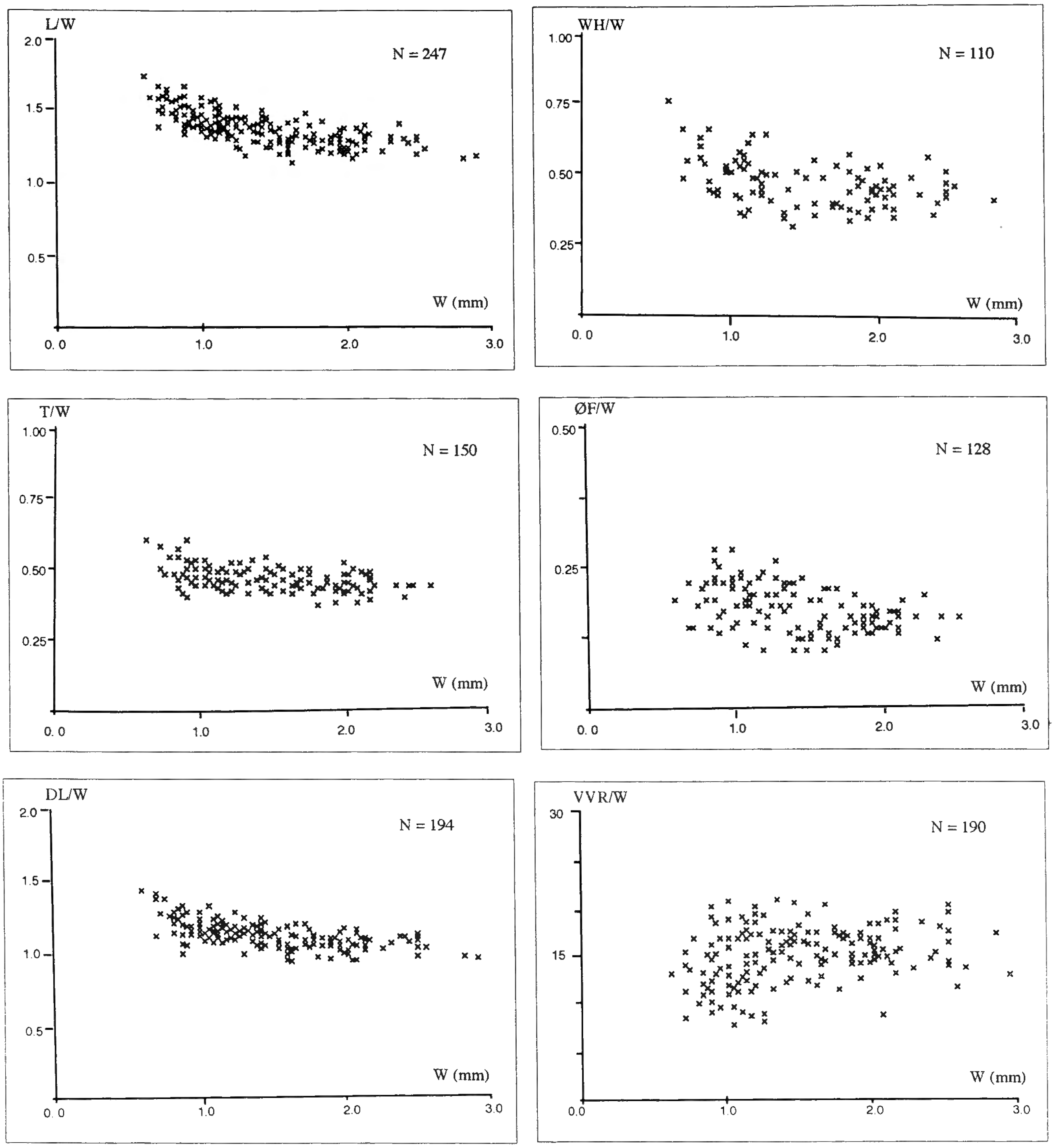

Fig. 6 — Scatter diagrams of *Rugia tenuicostata* STEINICH, 1963 collected from the top of the "Craie de Trivères" and from the base of the "Craie d'Obourg" (Lower part of the Upper Campanian,*Belemnitella mucronata* Zone) in the Craibel quarry (Mons Basin, Hainaut, Belgium). N: number of specimens measured. W: width (in mm). L/W: ratio shell length (in mm) to width (in mm). T/W: ratio shell thickness (in mm) to width (in mm). DL/W: ratio dorsal valve length (in mm) to width (in mm). WH/W: ratio shell hinge line (in mm) to width (in mm). ØF/W: ratio foramen diameter (in mm) to width (in mm). VVR/W: ratio number of ribs on ventral valve to width (in mm).

Craibel quarry of the "a" type are strictly identical to the Maastrichtian specimens collected from Rügen (Northern Germany).

It is tempting to separate the specimens reported to the "b" and "c" types. A discrimination between smaller specimens (juveniles and specimens as long as 3.0/4.0 mm) has been tried. For most specimens, it was nearly impossible to report them, clearly, to one of the types described above. Generally, smaller specimens are transitional forms. For these reasons, only one species, *Tereb-*

ratulina chrysalis, can be recognized in the Upper Campanian chalk.

Subfamily Chlidonophorinae MUIR-WOOD, 1959
Genus *Rugia* STEINICH, 1963
Type species: *Rugia tenuicostata* STEINICH, 1963

Rugia tenuicostata STEINICH, 1963
Table 1, Text-Figures 4, 5, 6, Plate 2, Figures 4a-c, 5a-d, 6a-b, Plate 3, Figures 1a-c, 2a-c, 3a-c, 4a-b.

*	1963	*Rugia tenuicostata* sp. n. - STEINICH, pp. 737-739, figs. 6- 8.
. v	1965	*Rugia tenuicostata* Steinich, 1963 - STEINICH, pp. 93, 115-121, 122-124, 203, 205, text-figs. 162-174, pl. 11, figs. 3a-d, 4.
.	1970	*Rugia tenuicostata* Steinich,1963 - SURLYK, figs. 2, 3.
.	1972	*Rugia tenuicostata* Steinich, 1963 - SURLYK, pp. 18- 19, text-figs. 2, 5, 12, 16.
. v	1979	*Rugia tenuicostata* Steinich, 1963 - BITNER & PISERA, pp. 67, 77, 83-84, pl. 4, figs. 3-6, pl. 5, fig. 3.
.	1982	*Rugia tenuicostata* - SURLYK, p. 262, 263, 264, text-fig. 1, pl. 1, figs. f-h.
.	1984	*Rugia* cf. *tenuicostata* Steinich - SURLYK & JOHANSEN, text-fig. 1.
.	1987a	*Rugia tenuicostata* Steinich, 1963 - JOHANSEN, pp. 22, 24, 25, 46, text-figs. 18 F-G, pl. 7, fig. 2.
.	1987b	*Rugia tenuicostata* Steinich, 1963 - JOHANSEN, pp. 159- 163, Text-figs. 3, 14 A-F, pl. 6, figs. 1-5.
.	1988	*Rugia tenuicostata* Steinich, 1963 - JOHANSEN, text-fig. 2, pl. 2, fig. 1.
.	1989a	*Rugia tenuicostata* Steinich 1963 - JOHANSEN, text-fig. 2.
.	1989b	*Rugia tenuicostata* Steinich 1963 - JOHANSEN, text-fig. 2.
.	1990	*Rugia tenuicostata* Steinich, 1963 - JOHANSEN & SURLYK, pp. 849, 852, text-fig. 2, pl. 6, fig. 7.
.	1998	*Rugia tenuicostata* Steinich, 1963 - SIMON, pp. 202, 203.

Stratigraphical range: lower Upper Campanian to lower Lower Maastrichtian.

Material:
Craie de Trivières: 121 complete, bivalved specimens, 22 opened, bivalved specimens, 29 damaged, bivalved specimens, 127 ventral valves, 134 dorsal valves and 595 fragments.
Craie d'Obourg: 26 complete, bivalved specimens, 11 opened, bivalved specimens, 9 damaged, bivalved specimens, 31 ventral valves, 41 dorsal valves and 220 fragments.

Rugia tenuicostata has been described in detail by STEINICH (1963, p. 738 and 1965, p. 116), by JOHANSEN (1987b, p. 159) and by JOHANSEN & SURLYK (1990, p. 852). The holotype is from the Lower Maastrichtian at Jasmund, Rügen, Germany.
The morphological characters measured on the specimens collected from the *B. mucronata* Zone in Cuesmes are reported in Table 2. The ratios shell length to width, dorsal valve length to width, thickness to width, hinge line to width and number of ribs to width are illustrated on Figure 6.

JOHANSEN (1987b, p. 163) pointed out that *Rugia tenuicostata* tends to become more elongate, more pointed subtriangular in outline and finely ribbed in the Maastrichtian part of its range.

Indeed, the specimens collected from the ''Craie de Trivières'' and from the ''Craie d'Obourg'' are less elongate, more oval with coarser ribs than the specimen from Rügen (Lower Maastrichtian). But, other differences between Upper Campanian and Maastrichtian populations can be emphasized.

In Upper Campanian specimens, the convexity of the dorsal valve is weaker and in some cases, the shell can be nearly plano-convex. The foramen is attrite and deltidial plates are rarely visible. Only three specimens collected in Cuesmes show intact deltidial plates. Without deltidial plates, the foramen appears larger, wider and more triangular than the foramen observed in Maastrichtian specimens (see STEINICH, 1965, pl. 11, fig. 3a, JOHANSEN, 1987b, pl. 6, fig. 4, JOHANSEN, 1988, pl. 2, fig. 2 and this paper Plate 3, Figs. 1c, 4b). This phenomenon seems to be

Table 2 — Morphological characters measured on the specimens of *Rugia tenuicostata* STEINICH, 1963 collected from the top of the ''Craie de Trivières'' and from the base of the ''Craie d'Obourg'' (lower part of the Upper Campanian, *Belemnitella mucronata* Zone) in the Craibel quarry in Cuesmes (Mons Basin, Hainaut, Belgium). L: length of the specimens (in mm). W: width of the specimens (in mm). T: thickness of the specimens (in mm). DL: length of the dorsal valve of measured specimens (in mm). WH: hinge line (in mm). ØF: diameter of the foramen (in mm). NR/DV: number of ribs on the dorsal valve. NR/VV: number of ribs on the ventral valve. N: number of specimens measured.

Rugia tenuicostata	L mm	W mm	T mm	DL mm	WH mm	ØF mm	NR/VV	NR/DV
Minimum	1,0	0,6	0,4	0,8	0,4	0,10	6	7
Maximum	3,5	3,1	1,1	3,1	1,4	0,46	51	46
Mean	1,9	1,4	0,7	1,7	0,7	0,25	23	23
N	247	253	150	194	110	128	190	227

very common in Upper Campanian populations of *R. tenuicostata* and it has been observed elsewhere in Northern and Western Europe. All the Upper Campanian specimens illustrated in the literature show attrition of the foramen with an absence of deltidial plates (see BITNER & PISERA, 1979, pl. 4, figs. 3b, 4b, pl. 5, fig. 3b for Polish specimens from Mielnik, JOHANSEN, 1987b, pl. 6, fig. 1 for German specimens from Lägerdorf and JOHANSEN & SURLYK, 1990, pl. 6, fig. 7 for English specimens from Norfolk). As the attrition of the foramen must have been realized on living specimens, it is obvious that ecological conditions and/or the way of life of *R. tenuicostata* were quite different during the Upper Campanian and the Maastrichtian. For Upper Campanian specimens, high energy water conditions, as described above, can be considered. A shorter and more robust pedicle, fixing the foramen firmly on the substrate, was probably the main reason responsible for this attrition.

The rib pattern varies between Upper Campanian and Maastrichtian representatives: primary ribs are slightly heavier than secondary ribs in Upper Campanian specimens, but Lower Maastrichtian specimens show a more regular rib pattern. In Upper Campanian specimens the ribs are bending slightly towards the lateral commissure. Further straight radial ribs are visible on Maastrichtian specimens.

Despite these persistent differences, Upper Campanian and Maastrichtian specimens must be considered as representatives of the same species. Upper Campanian and Maastrichtian specimens are different ecotypes, the Upper Campanian individuals being adapted to high energy water conditions and the Lower Maastrichtian ones being adapted to low energy water situations (STEINICH, 1965, p. 195 and SURLYK, 1972, p. 13-14). Moreover, brachidia are strictly identical in both Campanian and Maastrichtian specimens (STEINICH, 1965, pl. 11, fig. 4 and this paper Plate 2, Figure 6).

Rugia spinicostata JOHANSEN & SURLYK, 1987 *in* JOHANSEN, 1987b
Table 1, Text-Figure 5, Plate 3, Figures 5-6.

.v 1979 *Rugia spinosa* Surlyk, 1970 - BITNER & PISERA, p. 78, pl. 3, figs. 4-8.
. 1982 *Rugia spinosa* s. l. Surlyk - SURLYK, pp. 262-263, text-fig. 1.
. 1984 *Rugia spinosa* s. l. Surlyk - SURLYK, p. 219, text-fig. 2.
* 1987b *Rugia spinicostata* n. sp. - JOHANSEN & SURLYK *in* JOHANSEN, pp. 152-157, 159, text-figs. 11 A-F, pl. 5, figs. 1-3.
. 1988 *Rugia spinicostata* Johansen & Surlyk 1987 *in* JOHANSEN 1987b - JOHANSEN, text-fig. 2, pl. 2, fig. 2.
. 1989a *Rugia spinicostata* Johansen & Surlyk *in* JOHANSEN 1987b - JOHANSEN, p. 246, text-fig. 2.
. 1989b *Rugia spinicostata* Johansen & Surlyk *in* JOHANSEN 1987b - JOHANSEN, p. 151, text-fig. 2.
. 1990 *Rugia spinicostata* Johansen & Surlyk, 1987 *in* Johansen, 1987b - JOHANSEN & SURLYK, pp. 854, 856, pl. 7, figs. 3-10

Stratigraphical range: upper lower Lower Campanian to lower upper Upper Campanian.

Material:
Craie de Trivières: one complete, bivalved specimen, one opened, bivalved specimen, five damaged, bivalved specimens, two ventral valves, 12 dorsal valves and 32 fragments.
Craie d'Obourg: no complete specimen, two ventral valves, five dorsal valves and 9 fragments.

The material collected in the *B. mucronata* Zone of the Craibel quarry agrees with the diagnosis and accurate description of JOHANSEN & SURLYK, though it is not well preserved due to transportation. Only one complete, bivalved specimen has been found. The main distinction between *Rugia spinicostata* and the Lower Maastrichtian *Rugia spinosa* SURLYK, 1970 is the presence of long spines extending from regularly spaced radial ribs in *R. spinicostata*. The ribs of *R. spinosa* are poorly developed and irregular. The two species, which are rather small, are also different in outline. *R. spinicostata* is larger than *R. spinosa*, with a longer and less pointed beak. Its foramen is also a little larger.

R. spinicostata is restricted from the *lingua-quadrata* Zone to *grimmensis-granulosus* Zone (JOHANSEN, 1987b, p. 157).

Suborder Terebratellidina MUIR-WOOD, 1955
Superfamily Megathyridoidea DALL, 1870
Family Megathyrididae DALL, 1870
Genus *Argyrotheca* DALL, 1900
Type species: *Terebratula cuneata* RISSO, 1826

Nomenclative note:
Lacking dental plates, the members of the family Megathyrididae have been placed in the superfamily Terebratelloidea KING, 1850 (ELLIOTT & HATAI, 1965, p. H830). However, dental plates have been discovered, as early ontogenetic relicts, by MACKINNON & SMIRNOVA (1995, p. 680, text-figs. 7-1, 7-2 , 7-3) in *Praeargyrotheca hexaplicata* (SMIRNOVA, 1972), in *Krimargyrotheca concinna* (SMIRNOVA, 1972) and in *Evargyrotheca alta* (SMIRNOVA, 1972) , three Lower Cretaceous (Berriasian) megathyridid brachiopods from Crimea. The presence of dental plates, associated with some other morphological characters, (see MACKINNON & SMIRNOVA, 1995) indicate an affinity with Zeilleroidea. The opinion of these authors is followed herein, and the family Megathyrididae is placed in the superfamily Megathyridoidea DALL, 1870.

Argyrotheca hirundo (VON HAGENOW, 1842)
Table 1, Text-Figure 5, Plate 3, Figure 7a-c.

* 1842 *Orthis hirundo* n. - VON HAGENOW, p. 545, pl. 9, figs. 9a- d.

1846 *Orthis hirundo* v. Hg. - BOLL, p. 210.
1850 *T. hirundo* (*Orthis h.*) v. Hag. - GEINITZ, H.B., p. 212, n° 24.
1856 *Argiope hirundo* v. Hag. sp. - BOLL, p. 35.
. 1859 *Orthis hirundo* - BOSQUET, p. 48.
1866 *Argiope hirundo* Hag. sp. 1842 - SCHLOENBACH, pp. 310, 314.
1871 *Orthis hirundo* - QUENSTEDT, p. 708, pl. 61, fig. 189.
. 1883 *Cistella hirundo* - DE MORGAN, p. 389.
1895 *Argiope hirundo* Hag. - DEECKE, p. 74.
? 1909 *Argiope danica* de Morgan - BRÜNNICH NIELSEN, p. 171, pl . 1, figs. 43-45 (STEINICH, 1965 *citavit* p. 152).
. 1927 *Argyrotheca hirundo* (von Hagenow) - THOMSON, p. 212.
. 1965 *Argyrotheca hirundo* (Hagenow, 1842) - STEINICH, pp. 152-159, text-figs. 232-249, pl. 16, fig. 3, pl. 17, figs. 3a-d.
. 1972 *Argyrotheca hirundo* (Hagenow, 1842) - SURLYK, text- fig. 5, p. 17, p. 20.
. 1979 *Argyrotheca hirundo* (Hagenow, 1842) - BITNER & PISERA, p. 79, pl. 4, figs. 7.
. 1982 *Argyrotheca hirundo* (Hagenow) - SURLYK, text-fig. 1, pl. 3, figs. f-h.
. 1984 *Argyrotheca hirundo* (Hagenow) - SURLYK & JOHANSEN, text-fig. 1.
. 1987a *Argyrotheca hirundo* (Hagenow 1842) - JOHANSEN, p. 34, text-figs. 23 A-H, pl. 14, figs. 1-8.
. 1988 *Argyrotheca hirundo* (Hagenow 1843) - JOHANSEN, text-fig. 2, pl. 3, fig. 2.
. 1989a *Argyrotheca hirundo* (Hagenow 1843) - JOHANSEN, p. 246, text-fig. 2.
. 1989b *Argyrotheca hirundo* (Hagenow 1843) - JOHANSEN, p. 151, text-fig. 2.
. 1990 *Argyrotheca hirundo* (Hagenow, 1842) - JOHANSEN & SURLYK, pp. 858, 860, pl. 3, figs. 6-8.
. 1995 *Argyrotheca hirundo* (Hagenow, 1842) - MACKINNON & SMIRNOVA, p. 676.

Stratigraphical range: Upper Campanian to Maastrichtian.

Material:
Craie de Trivières: none.
Craie d'Obourg: two complete, bivalved specimens, one ventral valve, four dorsal valves and three fragments.

External characters
Specimens collected in the Craibel quarry are strikingly similar to the Maastrichtian specimens collected from Rügen (Germany) by STEINICH (1965, pl. 17, figs. 3a-d). The specimens collected by JOHANSEN & SURLYK (1990, pl. 3, fig. 6-8) from the Maastrichtian-Campanian boundary in Norfolk, appear nearly identical. No variation occurs between Campanian and Maastrichtian material.

The shell is subtriangular in outline, biconvex with a rather flat dorsal valve. The hinge can be quite long as it often shows spiny extensions. The shell is ornamented with 4-6 strong ribs arranged in two bundles separated by a relatively broad furrow on both valves. The beak is pointed and suberect with a concave interarea. A large, triangular, hypothyridid foramen is limited by narrow deltidial plates. A strong pedicle collar is clearly visible.

Internal characters
Inner socket ridges are strong and divergent anteriorly. They do not extend to the shell margin. The cardinal process is rather small. Small hinge plates are present and attached laterally to the inner socket ridges and medially to the dorsal septum. This septum is higher anteriorly than posteriorly and its anterior part is not serrate.

Crura are short and the crural processes are convergent. Brachial bands are denticulated anteriorly and they are fused with the valve floor at half their length. Near the base of the median septum, brachial bands appear again and they are attached laterally to the anterior part and to the top of the septum.

In the ventral valve, the teeth are strong and a thin median septum is present.

Table 3 — Morphological characters measured on the holotype and three paratypes of *Argyrotheca obourgensis* n. sp. collected from the base of the "Craie d'Obourg" in the Craibel quarry in Cuesmes (lower part of the Upper Campanian, *Belemnitella mucronata* Zone). L: length of the specimens (in mm). DL: length of dorsal valve (in mm). W: width of the specimens (in mm). T: thickness of the specimens (in mm). NR1: number of primary ribs. NR2: number of secondary ribs. FRW: width of median furrow (in mm). SPT-DV: thickness of the dorsal septum (in mm). DV: dorsal valve. C: complete bivalved specimen. VV: ventral valve.

Argyrotheca obourgensis n. sp.			L mm	DL mm	W mm	T mm	NR1 + NR2	FRW mm	SPT-DV mm
HOLOTYPE	IST - 10812	DV	-	1.2	3.2	-	6+2	0.14	0.16
PARATYPE	IST - 10813	C	1.0	0.6	2.7	0.7	6+0	0.07	-
PARATYPE	IST - 10814	DV	-	1.4	3.7	-	6+2	0.16	0.16
PARATYPE	IST - 10815	VV	1.7	-	2.8	-	6+1	0.25	-

Argyrotheca obourgensis n. sp.
Table 1, Table 3, Text-Figure 5, Plate 4,
Figures 1a-c, 2a-b, 3a-b, 4a-b.

Derivatio nominis
The species name is derived from the name of the village of Obourg near Mons (Mons Basin, Hainaut, Belgium) and refers also to the ''Craie d' Obourg'' from which the species has been collected.

Holotypus
Argyrotheca obourgensis n. sp. Plate 4, Figures 1a-c. The holotype is preserved in the Institut royal des Sciences naturelles de Belgique in Brussels, IRScNB - IST n°10812. The morphological characters measured on the holotype are indicated in Table 3.

Paratypes
A. obourgensis n. sp. Plate 4, Figures 2a-b. IRScNB - IST n°10813. Complete bivalved specimen.
A. obourgensis n. sp. Plate 4, Figures 3a-b. IRScNB - IST n° 10814. Dorsal valve.
A. obourgensis n. sp. Plate 4, Figures 4a-b. IRScNB - IST n° 10815. Ventral valve.

Locus typicus
Cuesmes near Mons, Craibel quarry.

Stratum typicum
Base of the Craie d'Obourg, lower Upper Campanian, *Belemnitella mucronata* Zone.

Diagnosis
Shell transversely-oval in outline with long wing-like extensions of the hinge line. Dorsal valve as convex as ventral valve. Shell surface with 6-8 subparallel ribs, in two bundles, separated by a deep median furrow. Dorsal valve with small cardinal process. Very heavy septum without any indentation on its anterior slope. Crura extremely small, generally not visible. Hinge plates small, subcircular to oval, clearly separated from each other. Ventral valve with external median furrow and with thin and short median septum. Wide triangular hypothyridid foramen. Pedicle collar relatively short. Teeth small.

Material:
Craie de Trivières: none.
Craie d'Obourg: one complete, bivalved specimen, one damaged, bivalved specimen, one reconstructed ventral valve, five damaged ventral valves, 4 dorsal valves and 5 fragments.

External characters
Shell transversely-oval in outline with long and very narrow wing-like extensions of the hinge line. Shell biconvex with the dorsal valve as convex as the ventral valve. The anterior commissure is rectimarginate with metacarinate folding. An extremely slight sulcation in the middle of the valve can be detected, due to the development of a deep furrow on the dorsal vave. Six strong ribs distributed in two symmetric bundles are present on both valves. These ribs are typically subparallel but on the lateral parts of the valve, a secondary smaller rib is often observed. The ribs are slightly protruding along the anterior commissure. On the dorsal valve, a deep median furrow is clearly visible and this is a specific character for this species. The width of this furrow is constant on its whole length. On the ventral valve, a similar median furrow, with a constant width is observed, but it appears shallower than the furrow of the dorsal valve.

The beak is straight, not very pointed, with a broad apical angle (122° on measured specimen). The interarea is relatively narrow. The deltidial plates are not visible on the specimens observed. Circular punctae are visible on both valves. The diameter of the punctae measured on the valve floor reach a value between 10.2 µm and 16.4 µm whereas the punctae measured on the external side of the valve reach a value between 22.7 µm and 33.1 µm.

Internal characters
Dorsal valve
The outer socket ridges are low and they are as long as the wing-like extension. The inner socket ridges are triangular in outline, relatively thin, but quite high in their proximal part and as low as the outer socket ridges in their distal part. Descending branches of the loop are directly attached to inner sides of the inner socket ridges. Crural processes are broken off and their precise orientation is presently unknown. A very small cardinal process is visible. The hinge plates are elongate-oval and widely separated from each other. The ribbons of the brachidium are slightly spinous anteriorly in their proximal part, where they are free from the valve floor (one spine visible in the holotype). The ribbons adhere tightly to the dorsal valve floor. Near the anterior part of the dorsal septum, the ribbons of the brachidium are free from the valve floor again. They adhere to the lateral sides of the dorsal septum and arise to its top.

The dorsal septum is heavy, its thickness being equal to the width of the deep external median furrow. The posterior part of the dorsal septum is very low. Its height increases regularly to one third of the anterior part of the valve floor. Sometimes (see holotype) the posterior part of the septum is widely concave. Anteriorly, the height of the septum steeply increases. In lateral view, this part of the septum is narrowly subtrapezoidal, with a slight concave depression on the top. The anterior slope of the septum is very steep, without any indentation. The internal anterior margin of the valve is smooth.

Ventral valve
A short pedicle collar is developed. A thin septum is present and reaches the middle of the valve floor. Negative impressions of the ribs are visible on the internal valve floor. The small teeth, which support the

long and narrow hinge structures, have no thickened bases.

Comparison with other species

Confusion between *Argyrotheca obourgensis* n. sp. and other Upper Cretaceous species is difficult. The very long and narrow wing-like extensions of the shell, the strong subparallel ribs, distributed in two bundles, and the very deep median furrow present on the dorsal valve are very distinctive characters.

However, distinction with some species exhibiting wing-like extensions of the shell must be considered. *A. coniuncta* STEINICH, 1965 is semi-circular in outline and its wing-like extensions are shorter. The ribs are more numerous and they are never subparallel. A deep median furrow is not present on the dorsal valve of *A. coniuncta*. On the contrary, a secondary, smaller rib is often present in the shallow furrow of this species. Internally, in *A. coniuncta*, the hinge plates are fused and form a wide platform, whereas in *A. obourgensis* n. sp., the hinge plates are widely separated.

Among the species described and illustrated by BOSQUET in 1859, *A. faujasi* (BOSQUET, 1859) and *A. microscopica* (VON SCHLOTHEIM, 1813) must be considered.

The uppermost Maastrichtian *A. faujasi* has no wing-like extensions comparable to those of *A. obourgensis* n. sp. In *A. faujasi* the more numerous ribs extend radially, they are never subparallel. Internally, the ribbons of the brachidium are much more wide in *A. faujasi*. The adherence of the ribbons with the valve floor is not complete in *A. faujasi*, especially in its middle part (see BOSQUET, 1859, pl. 5, fig. 7).

The uppermost Maastrichtian *A. microscopica* (VON SCHLOTHEIM, 1813) exhibits long wing-like extensions of the hinge. But, the ribs in *A. microscopica* extend radially and they are regularly distributed. They are strongly protruding above the anterior margin of the shell, are never subparallel and not distributed in two bundles. The dorsal valve of *A. microscopica* is depressed or flat. It is never convex as in *A. obourgensis* n. sp. A deep median furrow is not present on the dorsal valve of *A. microscopica*.

The internal anterior margin is typically granulated in *A. microscopica* whereas it is smooth in *A. obourgensis* n. sp.

Superfamily Terebratelloidea KING, 1850
Family Laqueidae HATAI, 1965 emended by RICHARDSON, 1975
Subfamily Kingeninae ELLIOTT, 1948 emended by RICHARDSON, 1975
Genus *Kingena* DAVIDSON, 1852
Type species: *Terebratula lima* DEFRANCE, 1828

Kingena pentagulata (WOODWARD, 1833)
Table 1, Text-Figure 3, Plate 4, Figures 5-6.

*	1833	*Terebratula pentagulata* - WOODWARD, p. 49, pl. 6, fig. 10.
.	1847	*Terebratula hebertiana* d'Orb., 1847 - D'ORBIGNY, p. 108- 109, N° 1142 + Atlas (1851), pl. 514, figs. 5-10.
p.p.	1852	*Kingena lima* Defrance Sp. - DAVIDSON, pp. 42-45, pl. 4, figs. 16, 18, 20.
?	1860	*Megerlea pustulosa* - BOSQUET, n°390 (*nomen dubium*).
.	1860	*Megerlea lima* Defr. sp. - BOSQUET, n° 572.
.	1866	*Terebratula Hebertina*, d'Orb. (*sic*) - CORNET & BRIART, pp. 128, 187.
	1879	*Megerleia lima*? Defr. sp. - UBAGHS, p. 128.
p.p.	1887	*Kingena lima* Defr. sp. - PÉRON, p. 188, pl. 2, fig. 13.
	1894	*Kingena lima* Defrance - POSSELT, pp. 47-48.
	1904	*Kingena lima* (Defrance) - JUKES-BROWNE, pp. 267, 482.
	1908	*Kingena lima* (Defrance) - ROWE, p. 252.
.	1961	*Kingena lima* (Defrance) - PEAKE & HANCOCK, p. 320.
?	1968	*Kingena* sp. - STEINICH, p. 342-345, text-figs. 4-5.
.	1970	*Kingena pentagulata* (Woodward) - OWEN, pp. 35, 41-42, 46, 59, 64-67, 68, text-figs. 6, 13, pl. 7, figs. 6-7, pl. 8, figs. 2-6.
.	1972	*Kingena pentagulata* (Woodward) - SURLYK, p. 17.
	1979	*Kingena* sp. - BITNER & PISERA, p. 81, pl. 5, figs. 1-2.
.	1982	*Kingena pentagulata* - SURLYK, text-fig. 1.
.	1984	*Kingena pentagulata* (Woodward, 1833) - POPIEL- BARCZYK, p. 249, pl. 151, fig. 2.
	1985	*Kingena pentagulata* - MUÑOZ, p. 111.
.	1987a	*Kingena pentagulata* (Woodward 1833) - JOHANSEN, p. 42, pl. 20, figs. 5-6.
.	1988	*Kingena pentagulata* (Woodward 1833) - JOHANSEN, p. 44, text-fig. 2.
.	1988	*Kingena pentagulata* (S. Woodward) - WOOD, C.J., pp. 34, 50, 54, 61, 79, 81-82.
.	1989a	*Kingena pentagulata* (Woodward 1833) - JOHANSEN, p. 246, text-fig. 2.
.	1989b	*Kingena pentagulata* (Woodward 1833) - JOHANSEN, p. 151, text-fig. 2.
.	1989	*Kingena pentagulata* (Woodward, 1833) - POPIEL- BARCZYK, p. 249, pl. 151, fig. 2.
.	1990	*Kingena pentagulata* (Woodward, 1833) - JOHANSEN & SURLYK, pp. 862, 864, pl. 11, figs. 6-8.
.	1992	*Kingena pentagulata* Woodward, 1833 - POPIEL- BARCZYK, p. 32.
.	1992	*Kingena pentagulata* (Woodward, 1833) - TITOVA, p. 161, text-fig. 26, pl. 76, figs. 9-10.

Stratigraphical range: Upper Campanian.

Material:
Craie de Trivières: eight damaged, bivalved specimens, one juvenile ventral valve and several fragments from adult shells. Craie d'Obourg: three slightly damaged, bivalved specimens, one slightly damaged, bivalved, juvenile specimen and several fragments from adult shells.

The material extracted in the Craibel quarry is consistent with the diagnosis and the accurate description given by OWEN (1970, pp. 64-67). Illustrated Belgian specimens, collected from the "Craie d'Obourg" and from the "Craie de Nouvelles", can be seen in OWEN (1970) on pl. 8, figs. 2a-c and 3a-c.

Kingena blackmorei OWEN, 1970 which is a typical species from the *G. quadrata* Zone has not been found in the top of the "Craie de Trivières" in the Craibel quarry. Juveniles of *Kingena pentagulata* (WOODWARD, 1833) are extremely rare (Table 1) indicating a possible low rate of mortality for the young specimens and/or a rapid growth rate.

Superfamily uncertain
Family uncertain
Genus *Leptothyrellopsis* BITNER & PISERA, 1979
Type species: *Leptothyrellopsis polonicus* BITNER & PISERA, 1979

Leptothyrellopsis polonicus BITNER & PISERA, 1979
Table 1, Text-Figure 5.

* *v*	1979	*Leptothyrellopsis polonicus* sp. n. - BITNER & PISERA, pp. 82-83, text-fig. 5, pl. 7, figs. 1-4.
.	1982	*Leptothyrellopsis polonicus* Bitner and Pisera - SURLYK, text-fig. 1, pl. 3, figs. c-e.
.	1988	*Leptothyrellopsis polonicus* Bitner and Pisera - JOHANSEN, text-fig. 2.
.	1989a	*Leptothyrellopsis polonicus* Bitner and Pisera 1979 - JOHANSEN, text-fig. 2.
.	1989b	*Leptothyrellopsis polonicus* Bitner and Pisera 1979 - JOHANSEN, text-fig. 2.
.	1990	*Leptothyrellopsis polonicus* Bitner and Pisera, 1979 - JOHANSEN & SURLYK, pp. 868-869, pl. 11, figs. 1-4.
.*v*	1995	*Leptothyrellopsis polonicus* Bitner and Pisera, 1979 - SIMON *in* JAGT *et al.*, p. 12.
.*v*	1998	*Leptothyrellopsis polonicus* Bitner & Pisera, 1979 - MACKINNON, SIMON & BITNER, pp. 175-177, pl. 1, figs. 1-7.
.*v*	1998	*Leptothyrellopsis polonicus* Bitner & Pisera, 1979 - SIMON, p. 186, table 1, pp. 187, 210, text-figs. 5-6, pl. 8, figs. 3-4.

Stratigraphical range: lower Lower Campanian to upper Upper Maastrichtian.

Material:
Craie de Trivières: 25 complete, bivalved specimens, 11 opened, bivalved specimens, 25 damaged, bivalved specimens, 86 mostly damaged ventral valves, 108 mostly damaged dorsal valves and 230 fragments .
Craie d'Obourg: five complete, bivalved specimens, two opened, bivalved specimens, nine damaged, bivalved specimens, 23 damaged ventral valves, 44 damaged dorsal valves and 50 fragments.

A reappraisal of *Leptothyrellopsis polonicus* BITNER & PISERA, 1979 has been recently published by MACKINNON, SIMON & BITNER (1998) and material collected from the Craibel quarry was illustrated in that paper.

Order Thecideida ELLIOTT, 1958
Suborder Thecideidina ELLIOTT, 1958
Superfamily Thecideacea GRAY, 1840 [ELLIOTT, 1958]
Family Thecideidae GRAY, 1840
Subfamily Lacazellinae BACKHAUS, 1959
Genus *Praelacazella* SMIRNOVA, 1969
Type species: *Thecidium valanginiense* DE LORIOL, 1868

Praelacazella wetherelli (MORRIS, 1851)
Table 1, Text-Figure 5, Plate 4, Figures 7a-b, 8.

*	1851	*Thecidea Wetherelli* - MORRIS, p. 86, pl. 4, figs. 1-3.
.	1852	*Thecidea Wetherelli*, Morris - DAVIDSON, p. 14, pl. 1, figs. 15-26.
	1853	*Thecidea Wetherelli* Morris - SÜSS, p. 1001.
.	1853	*Thecidea Wetherelli* Morris - GRAY, **4,** p. 119.
.	1871	*Thecidea Wetherelli* - QUENSTEDT, p. 699, pl. 61, figs. 133-134.
.	1874	*Thecidium Wetherelli* Morris - DAVIDSON, p. 22.
	1904	*Thecidium Wetherelli* MORRIS - JUKES-BROWNE, pp. 42, 66, 85.
?	1907	*Thecidium vermiculare* Sow. - DEECKE, p. 105.
	1908	*Thecidium wetherelli* - ROWE, p. 320.
	1911	*Thecidium wetherelli* Morris - KITSCHIN, p. 35.
.	1959	*Lacazella (Bifolium) wetherelli* (Morris, 1851) - BACKHAUS, pp. 35-37, pl. 2, figs. 1-3.
.	1965	*Lacazella (Bifolium) wetherelli* (Morris, 1851) - STEINICH, pp. 15-16, pl. 4, figs. 2, 3a-b.
.	1970	*Praelacazella wetherelli* (Morris) - PAJAUD, pp. 120- 121, text-fig. 46F, pl. 1, fig. 2, pl. 13, fig. 7.
.	1972	*Bifolium wetherelli* (Morris, 1851) - SURLYK, pp. 27-28, text-figs. 5.
.	1974	*Praelacazella wetherelli* (Morris, 1851) - PAJAUD, p. 333.
.	1988a	*Lacazella (Bifolium) wetherelli* (Morris) - JOHANSEN, text- fig. 2.
.	1989a	*Lacazella (Bifolium) wetherelli* Morris, 1851 - JOHANSEN, p. 246, text-fig. 2.
.	1989b	*Lacazella (Bifolium) wetherelli* Morris, 1851 - JOHANSEN, pp. 151, 162, text-figs. 2, 36.
.	1990	*Lacazella (Bifolium) wetherelli* (Morris, 1851) - JOHANSEN & SURLYK, p. 868, pl. 1, fig. 7.
.	1990	*Praelacazella wetherelli* (Morris), 1851 - MUÑOZ, pp. 61, 76, text-figs. 6, 7, 13, pl. 1, figs. 4-7.
.	1990	*Praelacazella wetherelli* (Elliott), 1953 - MUÑOZ, text- fig. 8.

Stratigraphical range: Upper Campanian to Maastrichtian.

Material:
Craie de Trivières: none.
Craie d'Obourg: one complete, bivalved specimen attached on a bryozan, one dorsal valve.

The complete specimen found in the Craibel quarry is consistent with the descriptions given by BACKHAUS (1959, p. 35), JOHANSEN & SURLYK (1990, p. 868), PAJAUD (1970, p. 120) and MUÑOZ (1990, p. 61).

Generally, this brachiopod is cemented to the substrate by the whole surface of the ventral valve (see BACKHAUS, 1959, p. 37, pl. 2, fig 2 and STEINICH, 1965, pl. 4, fig. 2). The specimen from the Craibel quarry is fixed only by its posterior part on a bryozoan. A similar specimen, also fixed posteriorly on a bryozoan, has been illustrated by STEINICH (1965, pl. 4, figs. 3a-b).

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PLATE 1

Brachiopods collected from the Craibel quarry in Cuesmes (Mons Basin, Hainaut, Belgium). Lower Upper Campanian, *Belemnitella mucronata* Zone.

Fig. 1 — Ventral valve of *Isocrania campaniensis* ERNST, 1984 collected from the top of the ''Craie de Trivières'' (70 / 90 cm below the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). 1a: ventral view. 1b: dorsal view. IRScNB - IST n°10792. (Magnification: x 6).

Fig. 2 — Ventral valve of a young specimen of *Isocrania campaniensis* ERNST, 1984 collected from the base of the ''Craie d'Obourg'' (300 / 325 cm above the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). 2a: ventral view. 2b: dorsal view. IRScNB - IST n°10793. (Magnification: x 16.5).

Fig. 3 — Dorsal valve of a young specimen of *Isocrania campaniensis* ERNST, 1984 collected from the base of the ''Craie d'Obourg'' (110 / 130 cm above the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). 3a: dorsal view. 3b: ventral view. IRScNB - IST n° 10794. (Magnification: x 11).

Fig. 4 — Complete, bivalved specimen of a juvenile *Cretirhynchia* , probably a juvenile of *Cretirhynchia lentiformis* (WOODWARD, 1833) collected from the base of the ''Craie d'Obourg'' (0 / 20 cm above the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). 4a: dorsal view. 4b: ventral view. 4c: lateral view. IRScNB - IST n°10795. (Magnification: x 20,5).

Fig. 5 — Complete, bivalved specimen of *Terebratulina chrysalis* (VON SCHLOTHEIM, 1813) collected from the base of the ''Craie d'Obourg'' (top of the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). This is a small adult shell with a circular outline (described herein as type ''b''). 5a: dorsal view. 5b: ventral view. 5c: lateral view. IRScNB - IST n°10796. (Magnification: x 9).

Fig. 6 — Complete, bivalved specimen of *Terebratulina chrysalis* (VON SCHLOTHEIM, 1813) collected from the base of the ''Craie d'Obourg'' (90 / 110 cm above the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). Small adult shell with an elongate outline (described herein as type ''a''). 6a: dorsal view. 6b: ventral view. 6c: lateral view. (Magnification: x 9). 6d: Detailed view of the brachidium. (Magnification: x 23). IRScNB - IST n°10797.

Fig. 7 — Dorsal view of a very young, complete, bivalved specimen of *Terebratulina chrysalis* (VON SCHLOTHEIM, 1813) collected from the base of the ''Craie d'Obourg'' (130 / 150 cm above the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). This is a very young shell, with an oval outline (described herein as type ''c''). IRScNB - IST n°10798. (Magnification: x 20).

PLATE 2

Brachiopods collected from the Craibel quarry in Cuesmes (Mons Basin, Hainaut, Belgium). Lower Upper Campanian, *Belemnitella mucronata* Zone.

Fig. 1 — Ventral view of a juvenile dorsal valve of *Terebratulina chrysalis* (VON SCHLOTHEIM, 1813) with immature brachidium, collected from the top of the ''Craie de Trivières'' (50 / 70 cm below the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). IRScNB - IST n°10799. (Magnification: x 24).

Fig. 2 — Complete, bivalved, juvenile specimen of *Terebratulina chrysalis* (VON SCHLOTHEIM, 1813) collected from the top of the ''Craie de Trivières'' (330 / 350 cm below the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). Primary ribs are only visible at this stage of growth. 2a: dorsal view. 2b: ventral view. IRScNB - IST n°10800. (Magnification: x 34).

Fig. 3 — Complete, bivalved, young specimen of *Terebratulina chrysalis* (VON SCHLOTHEIM, 1813) collected from the top of the ''Craie de Trivières'' (90 / 120 cm below the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). Secondary ribs are already present at this stage of growth. 3a: dorsal view. 3b: ventral view. IRScNB - IST n°10801. (Magnification: x 20.5).

Fig. 4 — Complete, bivalved, early juvenile specimen of *Rugia tenuicostata* STEINICH, 1963 collected from the top of the ''Craie de Trivières'' (175 / 200 cm below the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). 4a: dorsal view. 4b: ventral view. 4c: lateral view. IRScNB - IST n°10802. (Magnification: x 50).

Fig. 5 — Complete, bivalved, adult specimen of *Rugia tenuicostata* STEINICH, 1963 collected from the top of the ''Craie de Trivières'' (50 / 70 cm below the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). 5a: dorsal view. 5b: ventral view. 5c: lateral view. (Magnification: x 32). 5d: detail of the foramen with deltidial plates. IRScNB - IST n°10803. (Magnification: x 70).

Fig. 6 — Opened, bivalved, adult specimen of *Rugia tenuicostata* STEINICH, 1963 collected from the top of the ''Craie de Trivières'' (0 / 20 cm below the hardground separating the ''Craie d'Obourg'' from the ''Craie de Trivières''). 6a: ventral valve in dorsal view. 6b: dorsal valve with intact brachidium in ventral view. IRScNB - IST n°10803. (Magnification: x 20).

Brachiopod collected from Rügen (Germany). Lower Maastrichtian, *spinosa-subtilis* Zone.

Fig. 7 — Complete, bivalved specimen of *Terebratulina chrysalis* (VON SCHLOTHEIM, 1813) Small adult shell with a typical elongate outline (described herein as type "a"). Specimen offered by H. LEIPNITZ (Uelzen, Germany). IRScNB - IST n°10804. (Magnification: x 20).

PLATE 3

Brachiopods collected from the Craibel quarry in Cuesmes (Mons Basin, Hainaut, Belgium). Lower Upper Campanian, *Belemnitella mucronata* Zone.

Fig. 1 — Complete, bivalved, adult specimen of *Rugia tenuicostata* STEINICH, 1963 collected from the top of the "Craie de Trivières" (200 / 225 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). Subtriangular, elongate specimen with pointed beak. 1a: dorsal view. 1b: lateral view. (Magnification: x 30). 1c: a detail of the foramen showing attrition of deltidial plates. (Magnification: x 75). IRScNB - IST n°10805.

Fig. 2 — Complete, bivalved, adult specimen of *Rugia tenuicostata* STEINICH, 1963 collected from the top of the "Craie de Trivières" (50 / 70 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). Specimen is less elongate and more oval. 2a: dorsal view. 2b: ventral view. 2c: lateral view. IRScNB - IST n°10806. (Magnification: x 20).

Fig. 3 — Complete, bivalved, adult specimen of *Rugia tenuicostata* STEINICH, 1963 collected from the top of the "Craie de Trivières" (50 / 70 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). Large adult specimen with oval outline. Foramen is relatively large. 3a: dorsal view. 3b: ventral view. 3c: lateral view. IRScNB - IST n°10807. (Magnification: x 20).

Fig. 4 — Complete, bivalved, adult specimen of *Rugia tenuicostata* STEINICH, 1963 collected from the top of the "Craie de Trivières" (50 / 70 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). Specimen with oval outline. 4a: dorsal view. (Magnification: x 20). 4b: a detail of the foramen showing attrition of deltidial plates. (Magnification: x 60). IRScNB - IST n°10808.

Fig. 5 — Dorsal valve in dorsal view of *Rugia spinicostata* JOHANSEN & SURLYK, 1987 *in* JOHANSEN, 1987b, collected from the top of the "Craie de Trivières" (250 / 275 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). IRScNB - IST n°10809. (Magnification: x 34).

Fig. 6 — Complete, bivalved, adult specimen of *Rugia spinicostata* JOHANSEN & SURLYK, 1987 *in* JOHANSEN, 1987b, collected from the top of the "Craie de Trivières" (230 / 250 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). Ventral view. IRScNB - IST n°10810. This specimen has been destroyed during SEM procedure and it was not possible to illustrate it in dorsal view. (Magnification: x 30).

Fig. 7 — Complete, bivalved, adult specimen of *Argyrotheca hirundo* (VON HAGENOW, 1842) collected from the base of the "Craie d'Obourg" (130 / 150 cm above the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). 7a:dorsal view. 7b: ventral view. 7c: lateral view. IRScNB - IST n°10811. (Magnification: x 24).

PLATE 4

Brachiopods collected from the Craibel quarry in Cuesmes (Mons Basin, Hainaut, Belgium). Lower Upper Campanian, *Belemnitella mucronata* Zone.

Fig. 1 — *Argyrotheca obourgensis* n. sp. , holotype, collected from the base of the "Craie d'Obourg" (130 / 150 cm above the hardground separating the "Craie d'Obourg" from the ""Craie de Trivières""). 1a: dorsal valve in ventral view. 1b: same dorsal valve in oblique anterior view. (Magnification: x 24). 1c: same dorsal valve in dorsal view. (Magnification: x 25.7). IRScNB - IST n°10812.

Fig. 2 — *Argyrotheca obourgensis* n. sp. , paratype. Complete, bivalved specimen collected from the base of the "Craie d'Obourg" (top of the hardground separating the "Craie d'Obourg" from the ""Craie de Trivières""). 2a: slightly oblique posterior view. 2b: oblique dorsal view. IRScNB - IST n°10813. (Magnification: x 26).

Fig. 3 — *Argyrotheca obourgensis* n. sp. , paratype. Dorsal valve collected from the base of the "Craie d'Obourg" (170 / 200 cm above the hardground separating the "Craie d'Obourg" from the ""Craie de Trivières""). 3a: ventral view. 3b: oblique lateral view to show the dorsal septum in lateral profile. IRScNB - IST n°10814. (Magnification: x 24).

Fig. 4 — *Argyrotheca obourgensis* n. sp. , paratype. Ventral valve collected from the base of the "Craie d'Obourg" (250 / 275 cm above the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). 4a: dorsal view. 4b: ventral view. IRScNB - IST n°10815. (Magnification: x 24).

Fig. 5 — Dorsal valve of a juvenile specimen of *Kingena pentagulata* (WOODWARD, 1833) in dorsal view. This specimen has been

collected from the top of the "Craie de Trivières" (90 / 120 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). IRScNB - IST n°10816. (Magnification: x 20).

Fig. 6 — Slightly damaged, bivalved young specimen of *Kingena pentagulata* (WOODWARD, 1833) in dorsal view. This specimen has been collected from the base of the "Craie d'Obourg" (130 / 150 cm above the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). IRScNB - IST n°10817. (Magnification: x 20).

Fig. 7 — *Praelacazella wetherelli* (MORRIS, 1851). Complete bivalved specimen collected from the base of the "Craie d'Obourg" (200 / 230 cm above the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). 7a: oblique lateral view. 7b: slightly oblique anterior view. IRScNB - IST n°10818. (Magnification: x 13.5).

Fig. 8 — *Praelacazella wetherelli* (MORRIS, 1851). Damaged dorsal valve in ventral view, collected from the base of the "Craie d'Obourg" (50 / 70 cm above the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). IRScNB - IST n°10819. (Magnification: x 18).

PLATE 5

Brachiopods collected from the Craibel quarry in Cuesmes (Mons Basin, Hainaut, Belgium). Lower Upper Campanian, *Belemnitella mucronata* Zone.

Fig. 1 — Bivalved specimen of *Carneithyris carnea* (J. SOWERBY, 1812) collected from the base of the "Craie d'Obourg" (150 / 175 cm above the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). 1a: dorsal view. 1b: ventral view. 1c: lateral view. IRScNB - IST n°10820. (Magnification: x 1.5).

Fig. 2 — Complete, bivalved specimen of *Cretirhynchia lentiformis* (WOODWARD, 1833) collected from the top of the "Craie de Trivières" (50 / 70 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). 2a: dorsal view. 2b: ventral view. 2c: anterior view showing an arcuate-trapezoidal linguiform extension. 2d: lateral view showing growth laminae near the anterior commissure. 2e: posterior view. IRScNB - IST n°10821. (Magnification: x 2.8).

Fig. 3 — Another complete, bivalved specimen of *Cretirhynchia lentiformis* (WOODWARD, 1833) collected from the top of the "Craie de Trivières" (150 / 175 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). 3a: dorsal view. 3b: ventral view. 3c: anterior view showing a trapezoidal linguiform extension. The fine ribs present in the sinus are clearly visible. 3d: lateral view. 3e: posterior view. IRScNB - IST n°10822. (Magnification: x 2.8).

Fig. 4 — Complete, bivalved specimen of *Cretirhynchia woodwardi* (DAVIDSON, 1855) collected from the top of the "Craie de Trivières" (50 / 70 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). 4a: dorsal view. The relatively large, circular foramen is clearly visible. 4b: ventral view. 4c: anterior view showing a arcuate linguiform extension, typical for this species. 4d: lateral view. 4e: posterior view. IRScNB - IST n°10823. (Magnification: x 1.6).

Fig. 5 — Slightly damaged, bivalved specimen of *Cretirhynchia* sp. collected from the top of the "Craie de Trivières" (50 / 75 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). 5a: dorsal view. 5b: ventral view. 5c: anterior view. 5d: lateral view. 5e: posterior view. IRScNB - IST n°10830. (Magnification: x 2.16).

Fig. 6 — Slightly damaged, bivalved specimen of *Cretirhynchia* sp. collected from the top of the "Craie de Trivières" (100 / 125 cm below the hardground separating the "Craie d'Obourg" from the "Craie de Trivières"). 5a: dorsal view. 5b: ventral view. 5c: anterior view. IRScNB - IST n°10824. (Magnification: x 2.2).

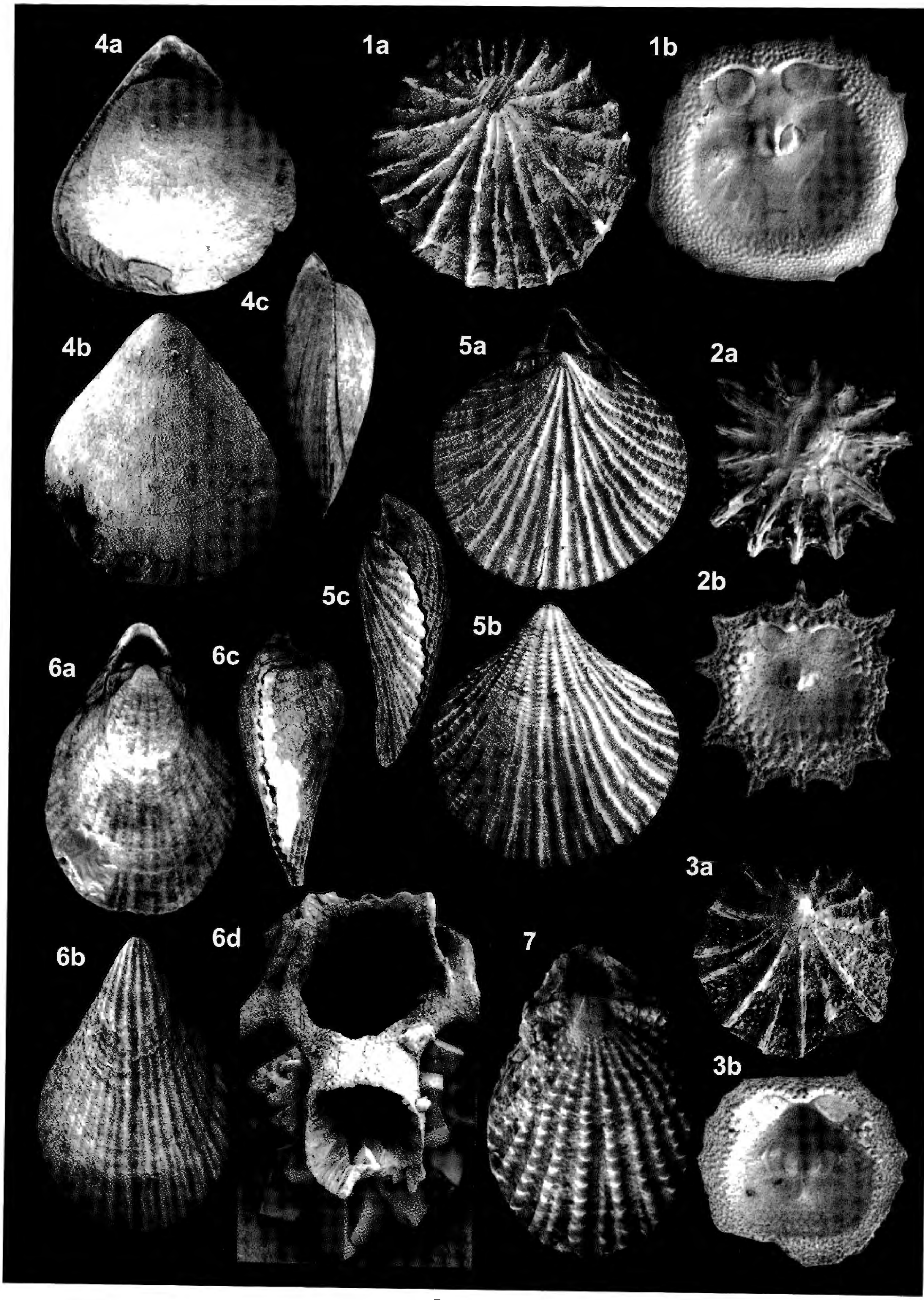
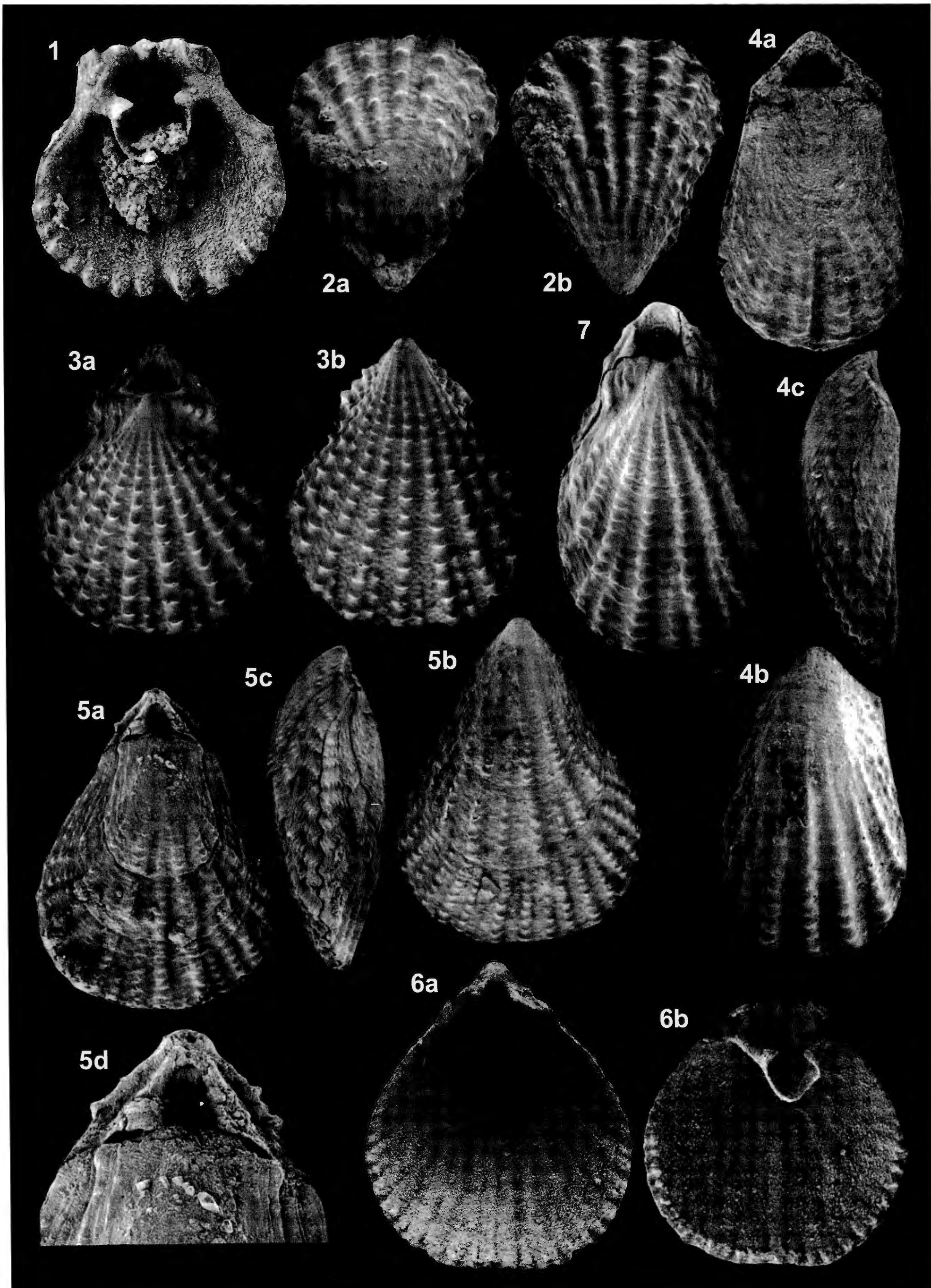


PLATE 1



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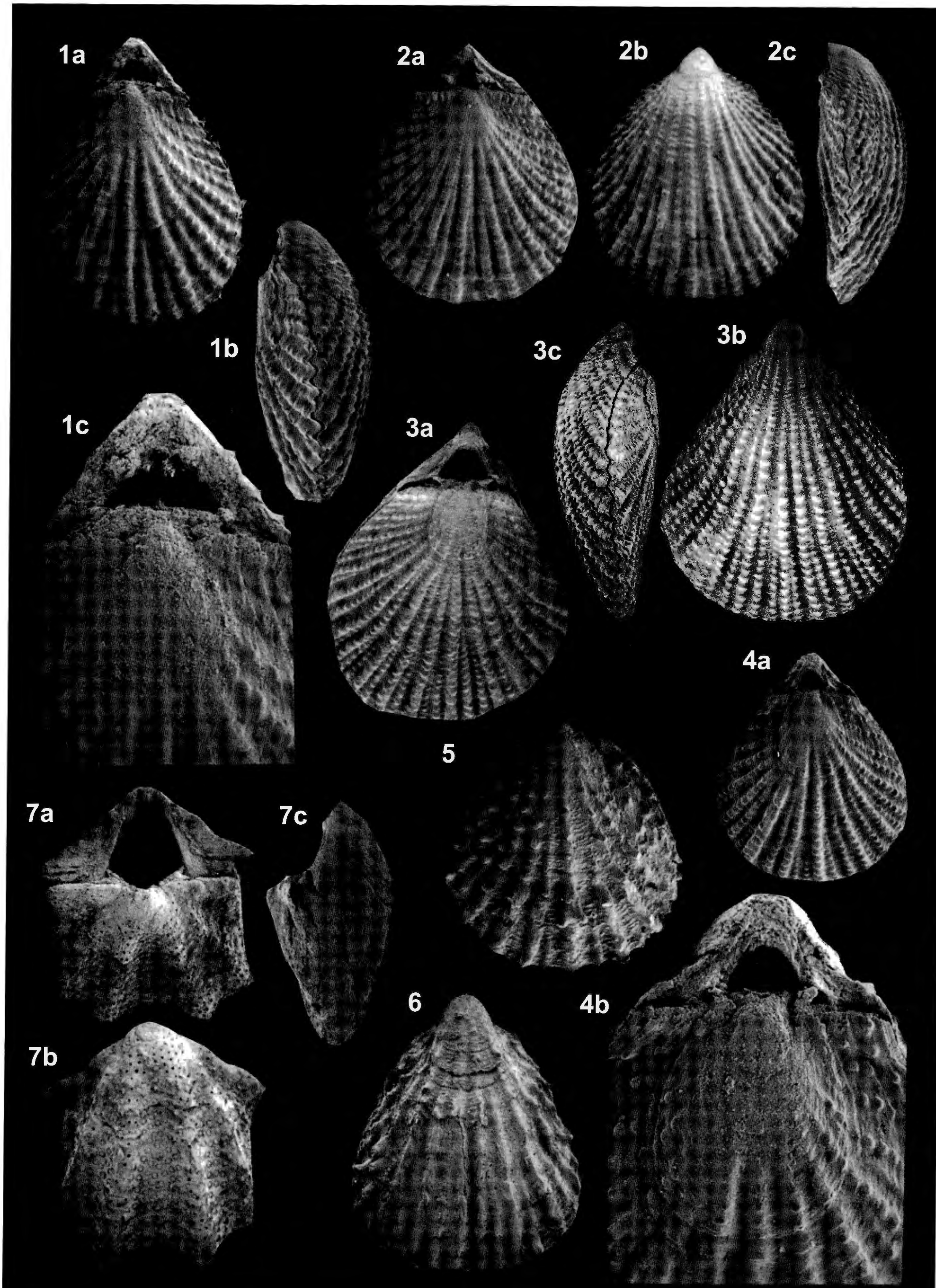

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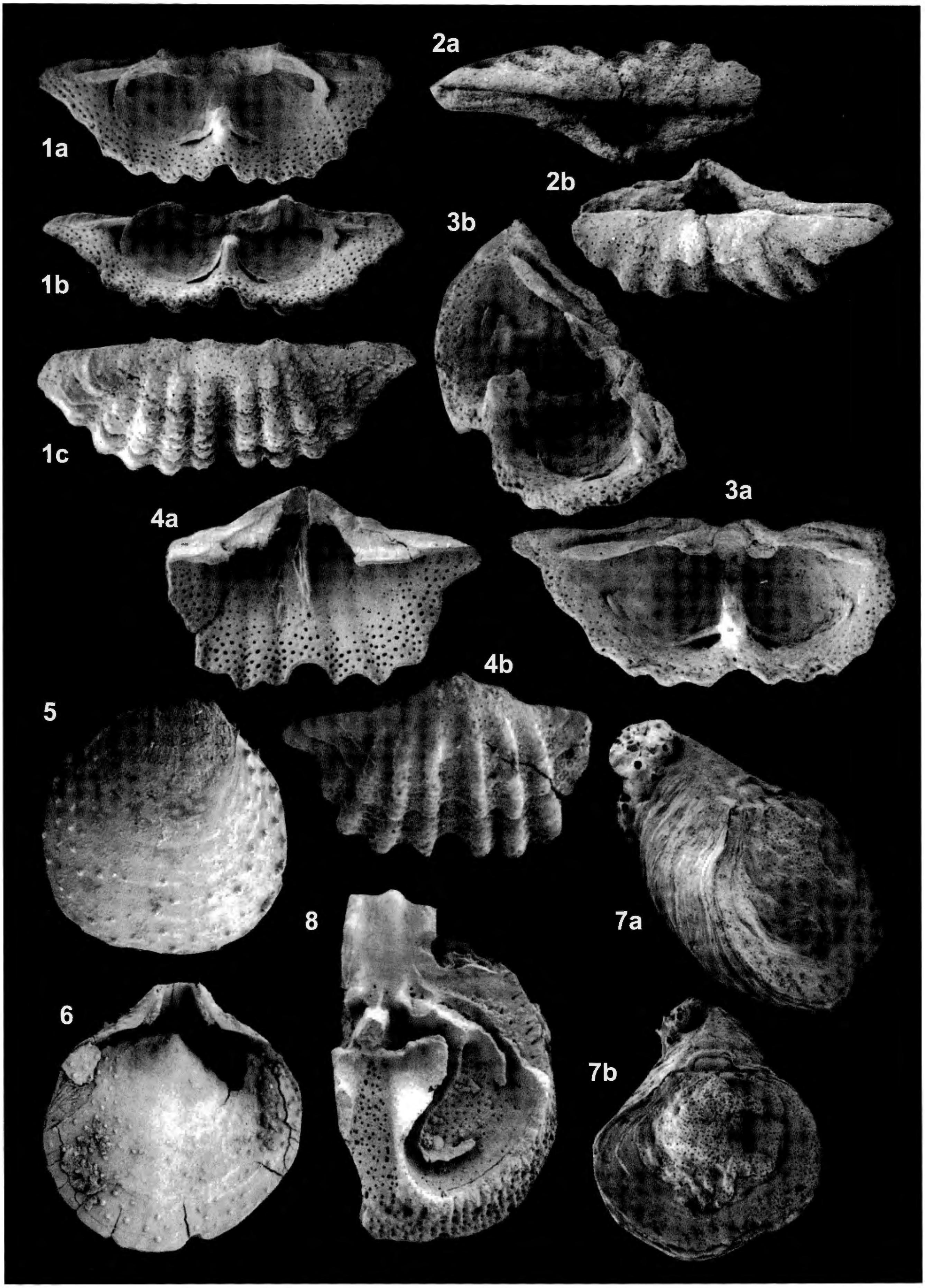

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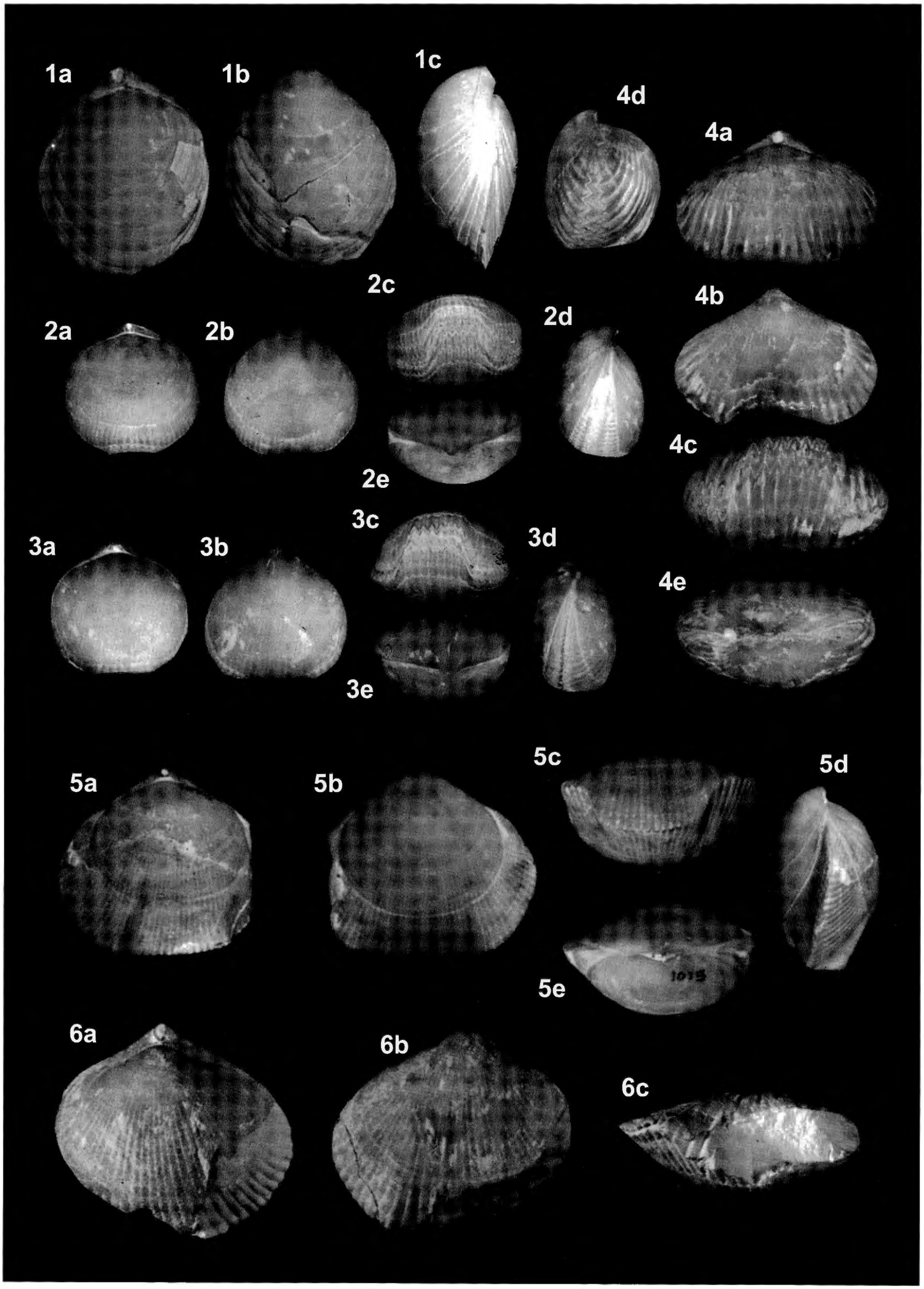
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PLATE 5