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Possible presence of *Cretirhynchia undulata* (PUSCH, 1837) in the Vijlen Chalk (Upper Maastrichtian) from Hallembaye (Belgium) and neighbouring area.

by Eric SIMON

Abstract

Two distinct species of *Cretirhynchia* (Brachiopoda, Rhynchonellacea, Rhynchonellidae, Cyclothyridinae) were collected in the Vijlen Chalk (Upper Maastrichtian) from Hallembaye (Belgium). The first one is consistent with the diagnose of *Cretirhynchia limbata* (VON SCHLOTTHEIM, 1813). The second one cannot be connected with species already described for the Belgian fauna. A detailed comparison (for external and internal characters) between the Belgian and the Polish material collected in the Upper Maastrichtian from the middle Vistula river valley has shown numerous similarities with the young adults of *Cretirhynchia undulata* (PUSCH, 1837). This specific determination is proposed for the Belgian material from Hallembaye but it is subject to the study of the material coming from the intervening geographical area (Germany) which is still urgently awaited. Therefore the creation of a new species or new subspecies for the Belgian specimens is not necessary at present.

Key-words: Brachiopods, Rhynchonellidae, Cretaceous, Maastrichtian, Hallembaye, Belgium.

Résumé

Deux espèces nettement distinctes de *Cretirhynchia* (Brachiopoda, Rhynchonellacea, Rhynchonellidae, Cyclothyridinae) ont été récoltées dans la Craie de Vijlen (Maastrichtien Supérieur) à Hallembaye (Belgique). L'une d'elles répond parfaitement à la diagnose de *Cretirhynchia limbata* (VON SCHLOTTHEIM, 1813). La seconde ne peut être assimilée aux espèces, déjà décrites, de la faune belge. Une comparaison détaillée (caractères externes et internes) du matériel belge et du matériel polonais récolté dans le Maastrichtien Supérieur de la vallée moyenne de la Vistule met en évidence de nombreuses similitudes avec les jeunes adultes de *Cretirhynchia undulata* (PUSCH, 1837). Cette détermination spécifique est proposée pour le matériel belge de Hallembaye sous réserve de l'étude nécessaire du matériel provenant de l'espace géographique intermédiaire (Allemagne). La création d'une nouvelle espèce ou d'une nouvelle sous-espèce pour les spécimens belges ne paraît pas indiquée.

Mots-clefs: Brachiopodes, Rhynchonellidae, Crétacé, Maastrichtien, Hallembaye, Belgique.

Introduction

Since the paper of FAUJAS DE SAINT-FOND (1798), the fossils of the chalk from the Liège/Maastricht area were of great interest for numerous palaeontologists and today, they are still an object of considerable attention.

The quarry of the "Ciments Portland Liègeois" (C.P.L. quarry), situated in Haccourt-Hallembaye, Province de Liège (Belgian topographic map, scale 1:25000, sheet n° 61-H, coordinates 174,000/306,000), is one of the places regularly visited for collecting palaeontological specimens (Fig. 1).

The chalk deposits from the Liège/Maastricht area and from the C.P.L. quarry, were studied by FELDER (1975 a, b), ALBERS (1976) and by ALBERS & FELDER (1979). In 1978, ALBERS *et al.* published a lithological

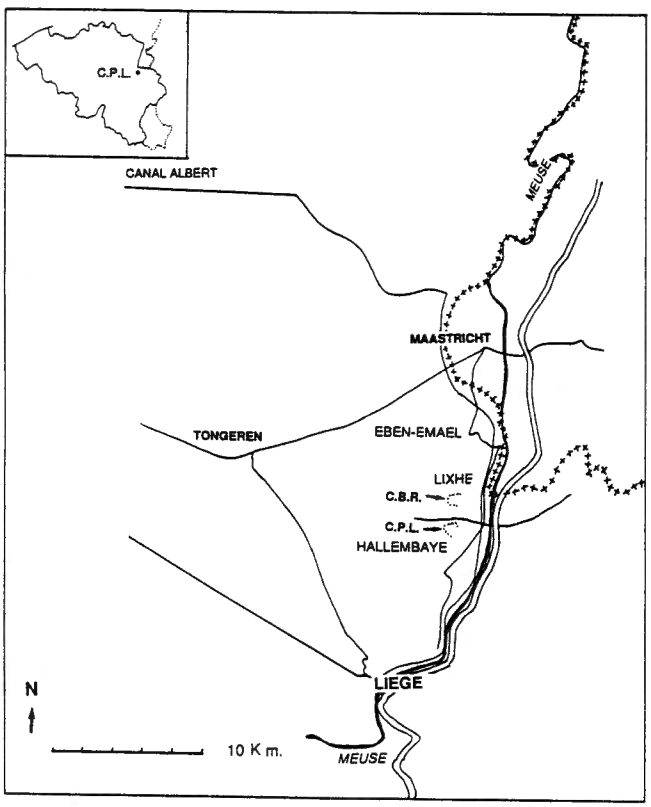

Fig. 1 — Map showing the situation of the C.P.L. quarry in Hallembaye and of the C.B.R. quarry in Lixhe (Prov. Liège, Belgium).

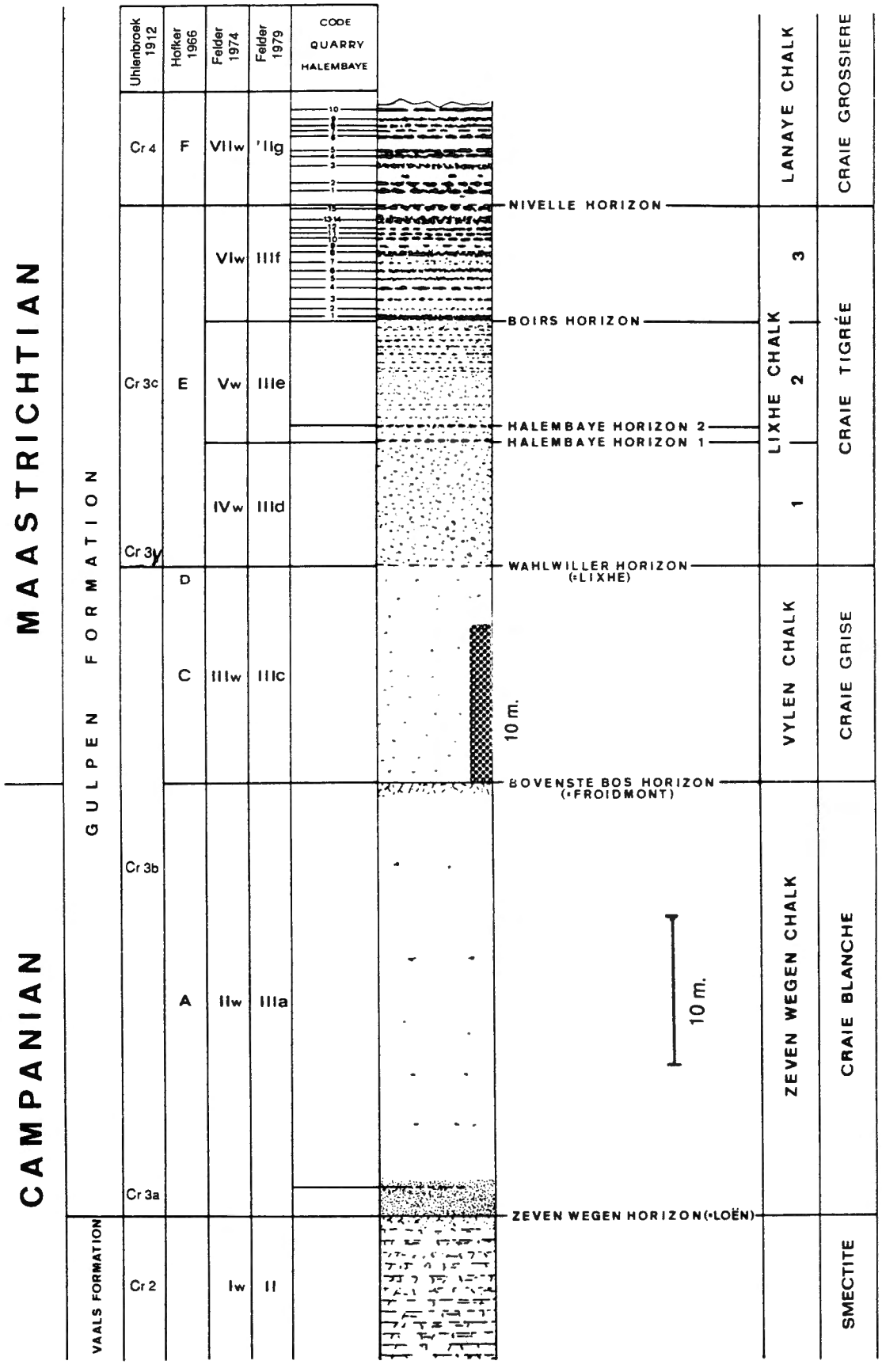

Fig. 2 — Lithological and stratigraphical section observed in the C.P.L. quarry in Hallembaye (Prov. Liège, Belgium). The Vijlen Chalk investigated in this paper is indicated on the figure (black spots). Reprinted from ALBERS *et al.*, 1978.

section of the C.P.L. quarry which is reprinted here for information in Fig. 2. In 1983, FELDER devoted again a special paper to this quarry.

At the bottom of the C.P.L. quarry can be seen the Formation of Vaals represented by the smectite. The Formation of Vaals is capped by the Formation of Gulpen which includes, from the bottom to the top of the quarry; the Zeven Wegen Chalk (maximum 30 m.), the Vijlen Chalk (15 m.), the Lixhe Chalk (25 m.) and the Lanaye Chalk (5 m.). The stratigraphical range of these deposits extends from the upper part of the Lower Campanian (smectite) to the Upper Maastrichtian (Chalk of Lanaye).

The present paper refers mainly to material collected in the Vijlen Chalk from the C.P.L. quarry. This chalk is considered by ROBASZYNSKI *et al.* (1985), by JAGT (1986 a, b) and by JAGT & MICHELS (1987) as belonging to the lowermost part of the Upper Maastrichtian as these authors found only specimens of the *Belemnitella junior* group. This opinion was confirmed recently by KEUTGEN & VAN DER TUUK (1990) who also placed the Vijlen Chalk from the C.P.L. quarry in the *B. junior* Zone.

The presence of *Hoploscaphites tenuistriatus* (KNER, 1850) and of *Hoploscaphites constrictus* (SOWERBY, 1817) permits a correlation between this part of the Vijlen Chalk and the *tegulatus/ junior* Zone of SCHULZ & SCHMID (1983) and SCHULZ *et al.* (1984).

For the Foraminifera, the Vijlen Chalk from the C.P.L. quarry was placed by HOFKER (1966) mainly in his Zone C.

In the C.P.L. quarry, the Vijlen Chalk is separated from the Zeven Wegen Chalk (Upper Campanian) by a hard-ground (Froidmont Horizon) and it is capped by the Wahlwiller Horizon (Fig. 2).

The macrofossils from the Vijlen Chalk in this quarry are quite numerous. Bivalve molluscs (Pectinidae and Ostreidae) are the more abundant and they were described by DHONDT & JAGT (1987, 1988). For Cephalopods, JAGT & KENNEDY (1989) described another ammonite found recently in this deposit: *Acanthoscaphites varians* (LOPUSKI, 1911).

The echinoderms (crinoids, asteroids and ophiuroids) were analysed by JAGT (1986 c, 1991). The echinoids, which are quite abundant, were described by JAGT & MICHELS (1986 and 1987) and by GEYS (1987).

The brachiopods are not rare in this part of the Chalk of Vijlen but they were never extensively studied. ALBERS *et al.* (1978) gave a list of brachiopods species which includes *Magas chitoniformis* (VON SCHLOTTHEIM, 1813), *Terebratulina gracilis* (VON SCHLOTTHEIM, 1813) and *Cretirhynchia limbata* (VON SCHLOTTHEIM, 1813). ["VON SCHLOTTHEIM" is written with "TT" as in the original paper (1813).]

I also found these species but observed that *Cretirhynchia limbata* is very rare at the base of this chalk deposit. It is a little more frequent only at the top of the Vijlen Chalk, just under the Wahlwiller Horizon (see Fig. 2). I was surprised to collect mainly another *Cretirhynchia* species which could not be determined as *C. limbata*. With *Magas chitoniformis*, this species is the most frequent brachiopod in this part of the Vijlen Chalk. From its original features (see: systematic section in this paper), this *Cretirhynchia* cannot be recognized as a species cited in the list of fossils from the Chalk of Limburg (BOSQUET, 1860) nor in more recent papers dealing with the brachiopods fauna of this area. Thus it is a new species of *Cretirhynchia* at least for the Belgian fauna.

The genus *Cretirhynchia* was erected by PETTITT in 1950 for Upper Cretaceous Rhynchonellid species which possess a fairly strong septum in the brachial valve. This feature distinguishes the genus *Cretirhynchia* from the genus *Cyclothyris* M'COY, 1844 (see also OWEN, 1962). Moreover, in *Cretirhynchia* species, broader crura and larger teeth and dental sockets are observed.

Together with formerly described and well known species such as *Cretirhynchia plicatilis* (J. SOWERBY, 1816), *C. octoplicata* (J. SOWERBY, 1816), *C. subplicata* (MANTELL, 1822), *C. lentiformis* (S. WOODWARD, 1833) and *C. limbata* (VON SCHLOTTHEIM, 1813), PETTITT (1950, 1953) described many new species collected in the chalk of Britain. Some of these species are based on a few number of specimens as, for instance, *C. triminghamensis* PETTITT, 1950 (12 specimens). It was supposed to be a synonym of *C. retracta* (ROEMER, 1841) as explained by STEINICH (1965 p.23). For this reason, many authors indicated that a revision of the genus *Cretirhynchia* is needed (STEINICH, 1965 p. 23, WOOD, 1967 p. 274, POPIEL-BARCZYK, 1988 p. 5 and JOHANSEN & SURLYK, 1990 p. 838).

Another common feature encountered in *Cretirhynchia* species is their very large intraspecific variability. It affects all the measured characters as to the length, width, thickness and the apical angle but it also includes all the qualitative characteristics such as the development of the commissure, the aspect of the linguiform extension and the ornementation of the shell surface.

The need for revision of this genus and the high level of intraspecific variability require great care for the description of a new species of *Cretirhynchia*. For these reasons the undetermined *Cretirhynchia* specimens from Hallembaye were carefully compared with the west European described species and mainly with PETTITT's species (1950, 1953). However, no satisfactory determinations could be found. In 1991, during a stay at the Muzeum Ziemi in Warsaw, I had the opportunity to compare the specimens from Hallembaye with the *Cretirhynchia* collection already studied by POPIEL-BARCZYK (1988). It appeared that some Polish specimens of *Cretirhynchia undulata* (PUSCH, 1837) were closely related to the material from Hallembaye. This material was more deeply studied and, in 1992, a second comparison between numerous specimens from Belgium and Poland was made in Warsaw in collaboration with E. POPIEL-BARCZYK. The present paper is devoted to the description of this supposed *Cretirhyn-*

chia undulata from Belgium and concentrates on the distinctive features of this material from Hallembaye compared with the original one from Poland. For the clarity of expression, this "supposed *Cretirhynchia undulata* " will be simply named "*C. undulata* " in the following pages.

Material and methods

In 1987, the author found, 8 specimens of this *Cretirhynchia undulata* from the Lixhe Chalk in the C.B.R. quarry in Lixhe (near Hallembaye). During the year 1991 and 1992, excursions were organised, in collaboration with J. REYNDERS, for collecting more brachiopods in the Vijlen Chalk from the C.P.L. quarry in Hallembaye. No less than 108 specimens of *C. undulata* and 10 specimens of *C. limbata* were discovered.

Eight specimens of *C. undulata* found in the Lixhe Chalk (Upper Maastrichtian) from the the C.B.R. quarry in Lixhe (Fig. 1) and also two specimens, sent to me by J. REYNDERS who found them in the Vijlen Chalk in the C.B.R. quarry, were taken into account.

C. limbata is not a common fossil in this area and this fact was already emphazised by PETTITT (1950 p. 28). In the C.P.L. quarry, only one specimen of *C. limbata* was found at the base of the Vijlen Chalk (1m above the Froidmont Horizon) and 9 specimens were encountered at the top of the Vijlen Chalk (0.5 m under the Wahlwiller Horizon).

On the contrary, *C. undulata* is more uniformely distributed in this deposit although it seems slightly more abundant in the two first meters above the Froidmont Horizon where it is associated with the very common and very large *Magas chitoniformis* (VON SCHLOTTHEIM, 1813) and with the less common *Terebratulina gracilis* (VON SCHLOTTHEIM, 1813).

For *Cretirhynchia undulata*, the material collected is not always well preserved; many specimens being crushed or compressed. Moreover, the internal cavity is often filled with flint nodules and sometimes, the whole specimen appeared flinty. *C. limbata* specimens are generally better preserved.

Among *C. undulata*, 47 specimens were chosen for detailed study. These specimens, of different sizes, are the best preserved. They were measured (Fig. 3) for their length (L), width (W), thickness (T) and for apical angle (ß). The results are presented in Table 1. Specimens of *C. limbata* were also measured but, to obtain an increased number of measures, I was forced to use specimens collected by myself in the Phosphatic Chalk of Ciply (Lower Maastrichtian, *Belemnella obtusa* Zone). Although this material does not come from the same area, it is consistent with the typical *C. limbata* described by PETTITT (1950). He illustrated his own paper with a specimen coming from the same Phosphatic Chalk in St-Symphorien near Mons, Belgium (p. 29. Note that the mention "Upper Campanian" indicated for the Phosphatic Chalk is incorrect).

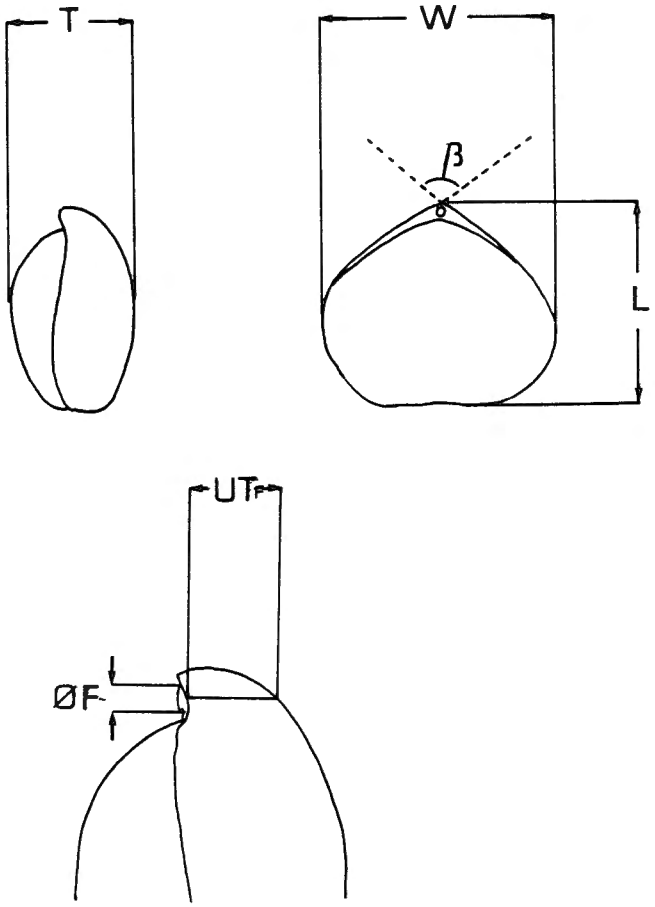

Fig. 3 — Schematic view of a *Cretirhynchia* showing the morphological characteristics measured in this paper (in mm). L = Length, W = width, T = thickness, UTF = Umbo thickness at foramen level, F = position of the foramen and ß = apical angle.

Moreover, the original specimen of FAUJAS DE ST-FOND (which is probably lost), is supposed to come from Ciply and not from Maastricht (VON HANSTEIN, 1879 p. 37).

Both species were also measured for their umbo thickness at foramen level as represented in Fig. 3. This valid characteristic for distinguishing the two species (Fig. 6), was measured by binocular using a graticule with scale. As *Cretirhynchia undulata* (PUSCH, 1837) was originally described from Poland and as it was recently re-studied (POPIEL-BARCZYK, 1988), it was useful to compare the Belgian material with the Polish collections from Kamień, Kazimierz, Janowiec, Nasiłów and Bochotnica. This material consists of Campanian/Maastrichtian Rhynchonellids collections from the middle Vistula river valley which was studied by POPIEL-BARCZYK (1988). It contains 160 *C. limbata* and 69 *C. undulata* . When I was in Warsaw for this study (May, 1992), I had the opportunity to use the W. POŻARYSKI's and the FEDOROWSKI's collections which were reported missing for many years. Recently redis-

Table 1
Morphological characteristics measured on specimens of *Cretirhynchia undulata* (PUSCH, 1837) from Belgium (Hallembaye) and from Poland (Nasiłow and Kazimierz, middle Vistula river valley). Specimens of *Cretirhynchia limbata* (VON SCHLOTTHEIM, 1813) from Belgium (Hallembaye and Ciply) were also measured for comparison. For the Belgian specimens, a highly significant difference between these two species is observed for the umbo thickness measured at foramen level.
The measurements obtained for the neotype of *Cretirhynchia undulata* (PUSCH, 1837) and for the typical *Cretirhynchia limbata* (VON SCHLOTTHEIM, 1813) from Kamień (Poland) are also indicated. L = length, W = width, T = thickness, UTf = umbo thickness at foramen level, ß = apical angle, n = number of specimens measured

		L mm	W mm	T mm	UTf mm	ß in °	L/W —	T/W —	UTf/W —
C. undulata from Hallembaye (Prov. Liège, Belgium), Vijlen Chalk, Upper Maastrichtian n=47	Minimal value	9.91	12.01	5.2	1.7	68	0.62	0.42	0.101
	Maximal value	17.31	20.21	11.1	2.8	116	1.04	0.64	0.19
	Mean value	14.61	16.11	8.1	2.2	105	0.91	0.49	0.14
C. undulata from the middle Vistula river valley (Poland), Upper and Uppermost Maastrichtian n=21	Minimal value	19.01	18.21	9.4	1.8	102	0.91	0.45	0.09
	Maximal value	27.31	27.51	19.8	3.5	112	1.01	0.62	0.13
	Mean value	21.81	22.81	12.6	2.3	109	0.97	0.53	0.101
C. undulata, Neotype, from Kazimierz (Poland) Upper Maastrichtian	—	24.9	26.8	14.6	2.9	106	0.93	0.55	0.11
C. limbata from Hallembaye near Liège, Belgium (Vijlen Chalk, Upper Maastrichtian) and from Ciply (Lower Maastrichtian) n=47	Minimal value	8.1	7.9	3.7	0.9	103	0.72	0.39	0.07
	Maximal value	17.3	20.5	13.01	1.8	148	0.92	0.68	0.13
	Mean value	12.9	15.2	8.1	1.3	118	0.86	0.53	0.09
C. limbata from Kamień (middle Visuta river valley, Poland) Campanian (see Pl. 4, Fig. 1 a-d)	—	16.9	16.5	10.1	1.01	102	1.02	0.61	0.06

covered, these two collections contain many specimens of *C. limbata* and/or *C. undulata* from Upper Campanian deposits (POŻARYSKI's collection) and from Upper Maastrichtian sediments (FEDOROWSKI's collection which also includes some specimens collected earlier by KONGIEL). These two collections are now returned to the Muzeum Ziemi in Warsaw and they can be consulted there. More detailed informations dealing with the stratigraphy of the Polish places cited in this paper, can be found in the papers of POŻARYSKI (1938), BŁASZKIEWICZ (1980), MACHALSKI & WALASZCZYK (1987) and POPIEL-BARCZYK (1988). A map of the Polish places cited in the present paper is drawn in POPIEL-BARCZYK (1988, fig. 1, p. 4).

Serial sections of *Cretirhynchia undulata* and of *C. limbata* from the C.P.L. quarry were made. The specimens were coated with plaster and they were carefully and slowly abraded, using fine carborandum. Each section obtained was photographed and then drawn.

Among the specimens of *C. undulata* used for serial sections, only three gave accurate results. For the well known species *C. limbata*, one specimen was abraded in serial section and the results are used for comparison with *C. undulata* .

Taxonomy follows the Treatise on Invertebrate Palaeontology, volume H, Brachiopoda (D. V. AGER *in* MOORE, 1965). The terminology of WILLIAMS & ROWELL (1965) was followed. The synonymy list is presented following the recommendations of MATTHEWS (1973).

All the material from Belgium described in this paper is conserved at the Institut royal des Sciences naturelles de Belgique, 29-31 rue Vautier, 1040 Brussels, Belgium. The specimens from Poland illustrated in this paper are conserved at the Muzeum Ziemi (Museum of the Earth), Polska Akademia Nauk, Warsaw, Poland.

Systematic description

Phylum Brachiopoda DUMERIL, 1806
Class Articulata HUXLEY, 1869
Order Rhynchonellida KUHN, 1949
Superfamily ***Rhynchonellacea*** GRAY, 1848
Family ***Rhynchonellidae*** GRAY, 1848
Subfamily ***Cyclothyridinae*** MAKRIDIN, 1955
Genus ***Cretirhynchia*** PETTITT, 1950

Type species: *Terebratula plicatilis* J. SOWERBY, 1816

Diagnosis of *Cretirhynchia* (*in* PETTITT, 1950, p. 1).
"Shell biconvex, symmetrical; brachial valve convex, with median fold on anterior part of the valve; pedicle valve less convex, with anterior median sinus; liguiform (*sic*) extension arcuate - V-shaped.

Hypothyrid; umbo short, erect to slightly incurved; foramen small; deltidial plates small, conjunct, produced; beak-ridges distinct; interarea well-defined.

Shell multicostate (or smooth, owing to costae becoming obsolete); costae low, rounded, faint near umbo, becoming elevated and subangular along antero-lateral commissure, and either reduced in number or showing incipient splitting in final adult stages.

Teeth large; dental lamellae short to moderately long, slightly divergent, partly joined to lateral wall.

Median septum of brachial valve moderately strong, commencing at short distance from umbo; septalium absent; cardinal process absent. Hinge- plate broad, divided; dental sockets large, striated; crura radulifer, short, fairly broad; crural bases given off dorsally. Muscle-scars broad-spreading."

Cretirhynchia undulata (PUSCH, 1837)
Material from Belgium: Plate 1, Fig. 1-5, Plate 2, Fig. 1-5 and Plate 3, Fig.1-3.
Material from Poland: Plate 4, Fig. 2-4 and Plate 5, Fig. 1-4.

* 1837 *Terebratula undulata* m. - PUSCH, p. 20, pl. IV, fig. 4 a-c.
1938 *Rhynchonella limbata* v. *undulata* Pus. - POŻARYSKI, p. 20.
1942 *Rhynchonella limbata* Schl. var. *undulata* Pusch - PUTZER, p. 373.
v. 1958 *Cretirhynchia limbata* (Schlotheim, 1813) - FEDOROWSKI, p. 9, pl. I, figs. b, d.
1966 *Cretirhynchia limbata undulata* (Pusch) - MAKRIDIN & KATZ, p.101, pl. I, figs. 7, 8.
. 1984 *Cretirhynchia limbata undulata* (Pusch) - POPIEL-BARCZYK, p. 349, pl. CLI, figs. 7,8.
v.. 1988 *Cretirhynchia undulata* (Pusch, 1837) - POPIEL-BARCZYK, p. 8, fig. 5-7, pl. I, figs. 7-12.
. 1989 *Cretirhynchia limbata undulata* (Pusch, 1837) - POPIEL-BARCZYK, p. 245, pl. CLII, figs. 7, 8.

TYPE MATERIAL

A holotype has not been designated by PUSCH in 1837 and his collection has been destroyed during the World War II (KIEPURA, 1984 cited in POPIEL-BARCZYK 1988).

POPIEL-BARCZYK in 1988 designated a neotype from Kazimierz. This specimen is registered in the Muzeum Ziemi collection under the n° MZ VIII Bra-943/33. This neotype is illustrated in POPIEL-BARCZYK (1988), pl.1, figs. 11, 11a, b.
Locus typicus:
Kazimierz, middle Vistula river valley, Poland.
Stratum typicum :
Upper Maastrichtian

ORIGINAL DESCRIPTION (in PUSCH, 1837 p. 20):
"Ter. subquadrangularis; concentrice undulato-striata; testa dorsalis complanata, a medio longitudinis sinu profundo excavata; testa ventralis prope natem sufflata, a medio jugum obtuse biplicatum formans, non minus a latere praeruptior deflexa; rostrum acutum prominens, foramine minutissimo; area angusta longe decurrens, margine dorsali acuto; angulus cardinis obtusus (108°); margines cardinis fere ad longitudinis medium elongati; margines laterales rotundati breves; frons lata, versus testam dorsalem magis biplicato-reparida et aliquantum producta."

DESCRIPTION OF THE BELGIAN MATERIAL FROM HALLEMBAYE AND NEIGHBOURING AREA.

Material:
Numbers of specimens observed: 119.
— Hallembaye, without precise stratigraphical indication. Expl. Purves. F. Feerderen 23375. IRScNB. I.G. 4919. (1)
— C.P.L. quarry in Hallembaye, Vijlen Chalk, Upper Maastrichtian (108).
— C.B.R. quarry in Lixhe, Vijlen Chalk, Upper Maastrichtian (2)
— C.B.R. quarry in Lixhe, Base of the Lixhe Chalk, Upper Maastrichtian (8)

The specimens of *Cretirhynchia undulata* from Hallembaye show all the typical features of the genus *Cretirhynchia* as described by PETTITT (1950, p. 1).

External characteristics:
The adult shell is medium-sized (Tab. 1) and subtriangular in outline. The anterior or posterior contours are typically lenticular but some old specimens tend towards a more oval-lenticular anterior or posterior contour. The lateral profile of the shell is oval-lenticular. The apical angle varies generally between 106° and 113° (Tab. 1) but it can be narrower for young individuals (as narrow as 68°) or broader in old specimens (116°). Generally, the maximum width is observed just below the middle of the valves. The pedicle valve is slightly less convex than the dorsal valve. A stronger convexity takes place at the base of the beak. The lateral parts of the pedicle valve are never flattened but they are slightly convex and this convexity is responsible for the typical

lenticular anterior contour. A flat median sinus is present on the anterior part of the pedicle valve and its length is always shorter than half the length of this valve. The beak is short, slightly incurved and quite thick in lateral profile. The beak ridges are distinct. The foramen is small, hypothyrid and it seems to be functional, indicating that this *Cretirhynchia* species was living fixed by means of its pedicle. The deltidial plates are small, conjunct. In the intact specimens the deltidial plates are slightly tubular around the foramen.

The more convex dorsal valve has a flat median fold with the same proportions as the corresponding ventral sinus. The external surface of the valves is smooth apart from a delicate radial striation consisting of numerous, regular, faint and extremely narrow grooves.

The anterior commissure is uniplicate. The lateral commissure is straight or slightly wavy when weak folds are developed on the extreme anterior part of the valves. The posterior commissure is not wavy.

The linguiform extension in young specimens has an undulating aspect and it develops into a trapezoidal outline in older specimens. The development of two folds at the top of the linguiform extension, resulting in a more sulciplicate stage of the anterior commissure, is rarely observed. In one aged specimen, these folds appear very weakly (Plate 1, Fig. 4d). However this sulciplicate stage is better developed in two other specimens (Plate 2, Fig. 1d and 2d). The linguiform extension turns at a low angle and is sometimes projected anteriorly.

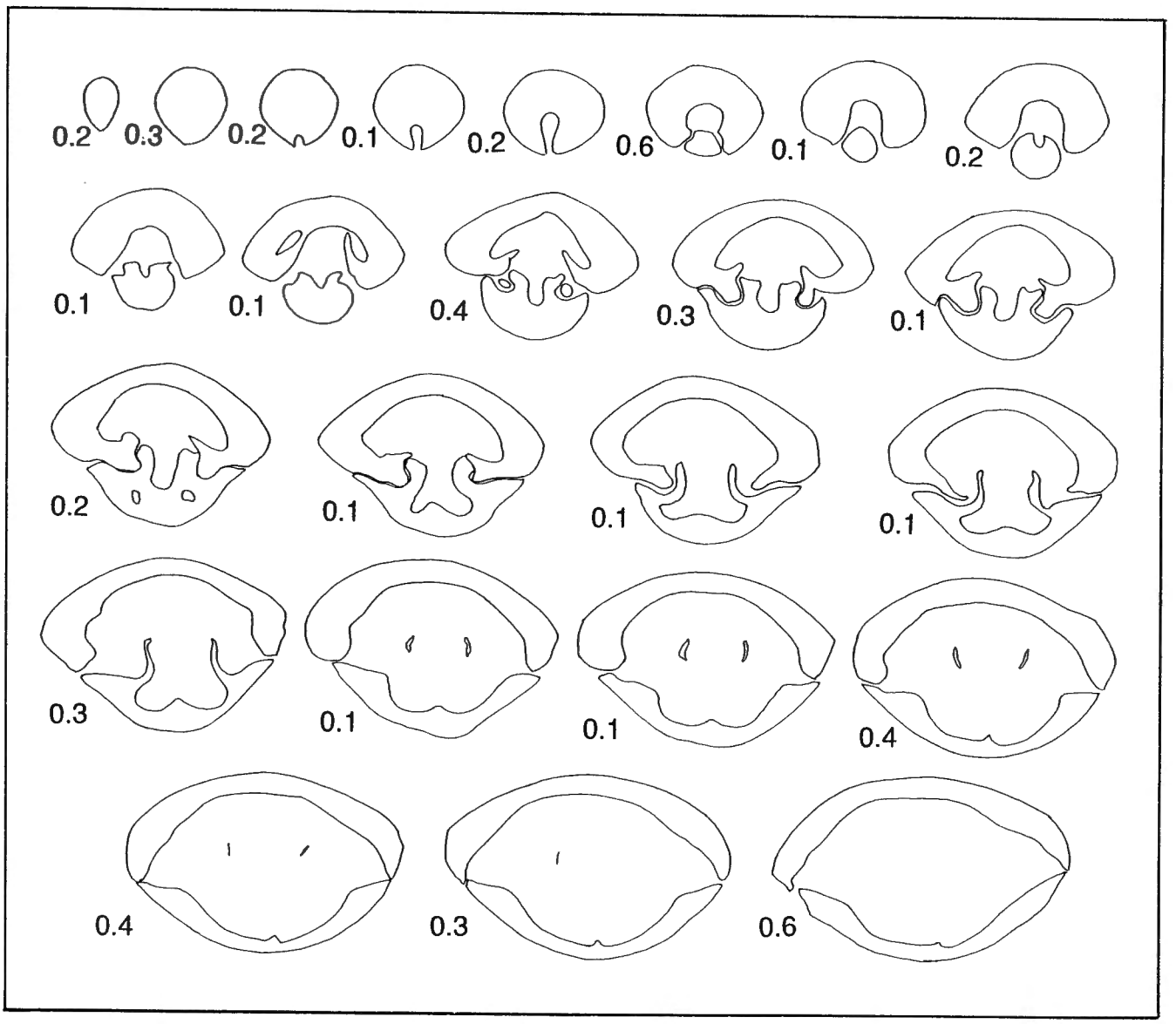

Fig. 4 — Serial sections in a specimen of *Cretirhynchia undulata* from Hallembaye, Vijlen Chalk, Upper Maastrichtian, C.P.L. quarry. (width of the specimen sectionned: 13,2 mm). A strong septum and umbonal chambers in the brachial valve are well visible. These sections are consistent with the results obtained by POPIEL-BARCZYK (1988, fig. 5 and 6 p. 9.)

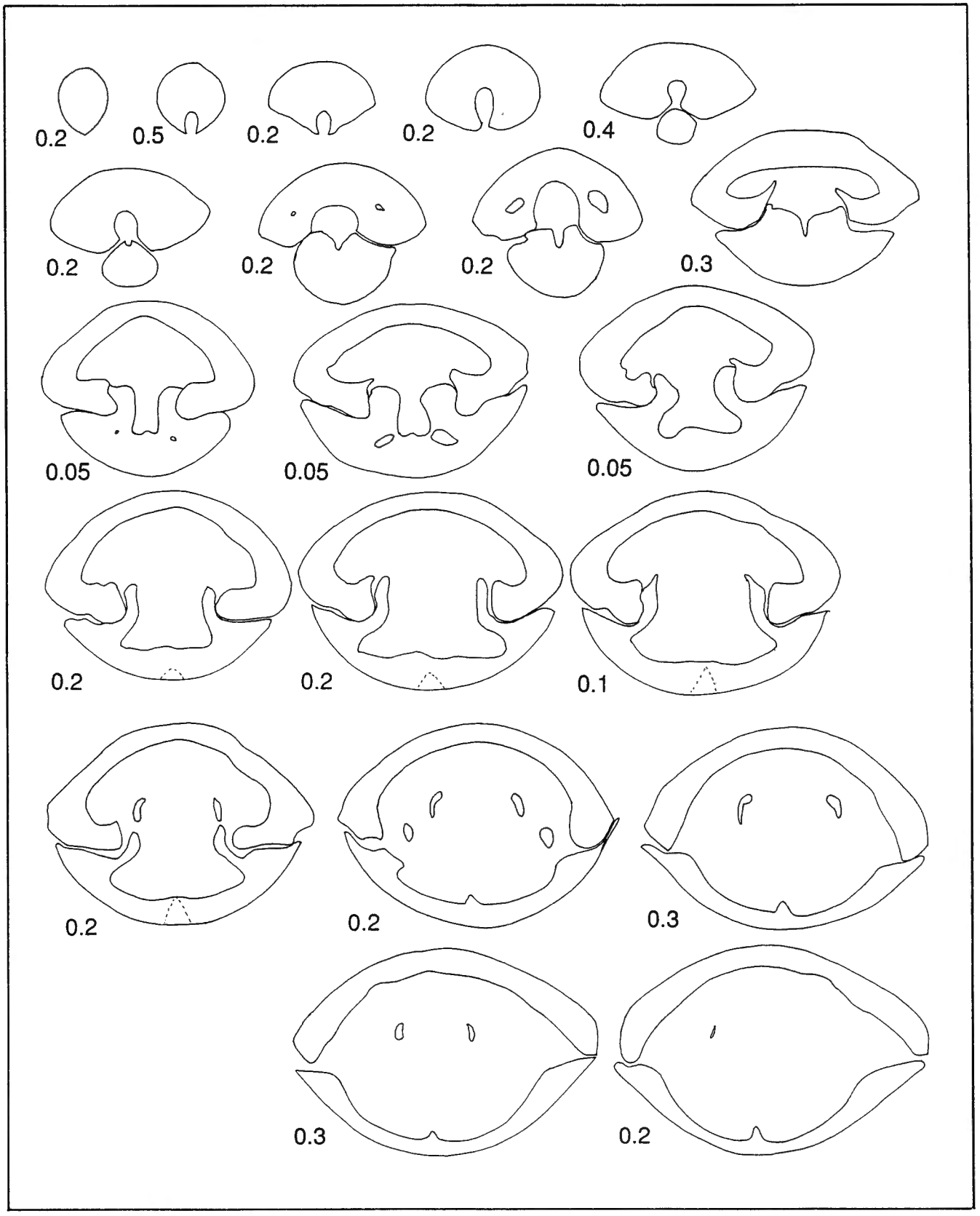

Fig. 5 — Serial sections in a specimen of *Cretirhynchia undulata* from Hallembaye, Vijlen Chalk, Upper Maastrichtian, C.P.L. quarry. (width of the specimen sectionned: 17,3 mm). A septum and umbonal chambers in the brachial valve are well visible. These sections are consistent with the results obtained by POPIEL-BARCZYK (1988, fig. 5 and 6 p. 9.).

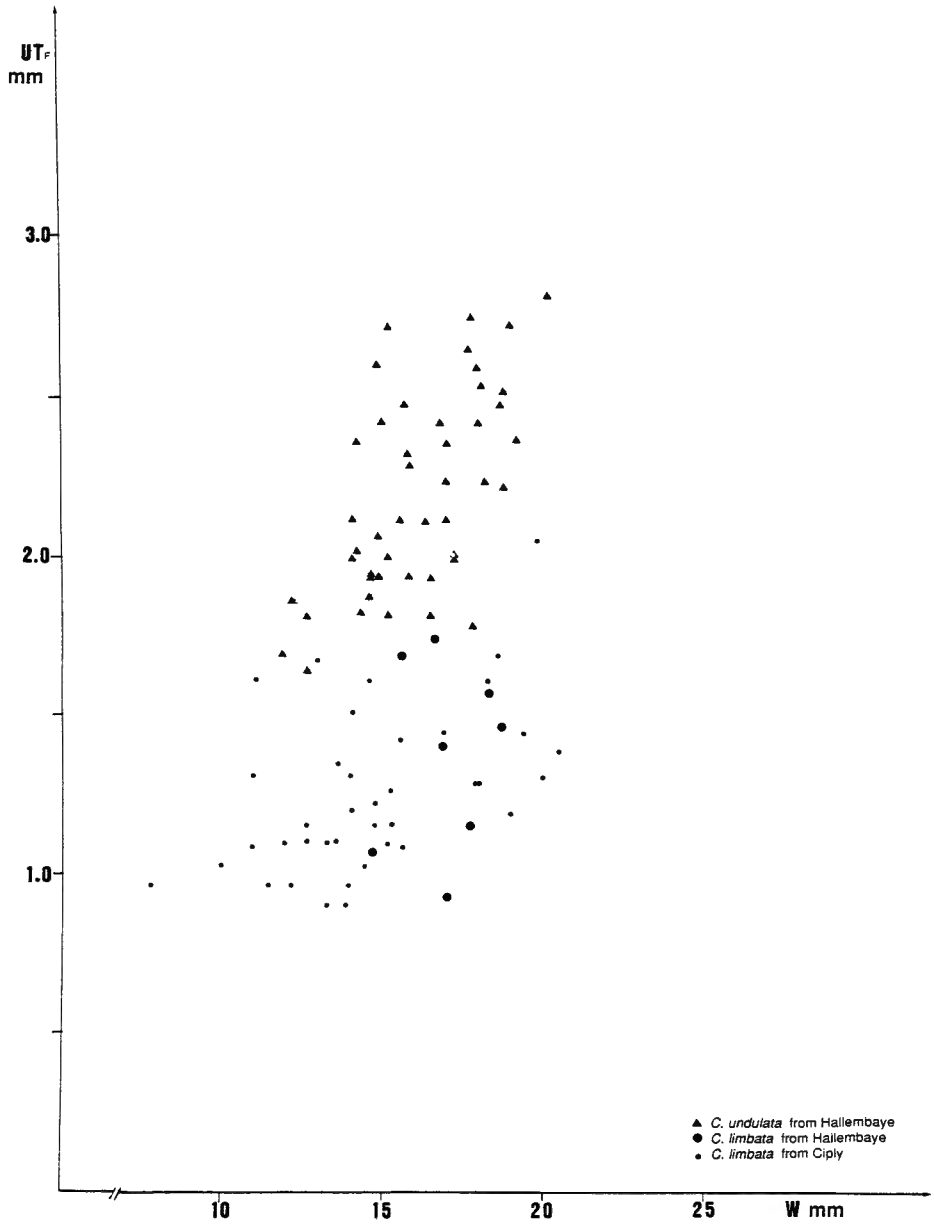

Fig. 6 — Relation between the width of the shell (in mm) and the thickness of the umbo at foramen level (in mm) in *Cretirhynchia undulata* and *Cretirhynchia limbata* from Belgium. A clear distinction between the two species is observed for this feature.

Internal characteristics:
In the dorsal valve, radulifer crura and a median septum are observed. The development of the septum varies from one specimen to another (Fig. 4, 5). The dental sockets are striated and the inner socket-ridges are well developed. There is no cardinal process but thickened hinge plates showing well developed diductor muscles scars. In serial sections only (Fig. 4, 5), very small umbonal chambers are observed in the brachial valve of all specimens.

In the pedicle valve, near the umbo, short divergent dental plates are present resulting in the presence of umbonal chambers in this valve too.

COMPARISON WITH CRETIRHYNCHIA UNDULATA FROM POLAND.

For both the external and internal features described above, the specimens from Hallembaye are consistent with the described characteristics of the Polish specimens (POPIEL-BARCZYK, 1988, p. 8-9). The Belgian specimens are especially similar to the smallest individuals from Poland which are probably the youngest found there. The specimen illustrated pl. 1, figs. 7, 7a and 7b in POPIEL-BARCZYK (1988) is an example of this similarity. In Warsaw, I paid special attention to the younger specimens and it was very dif-

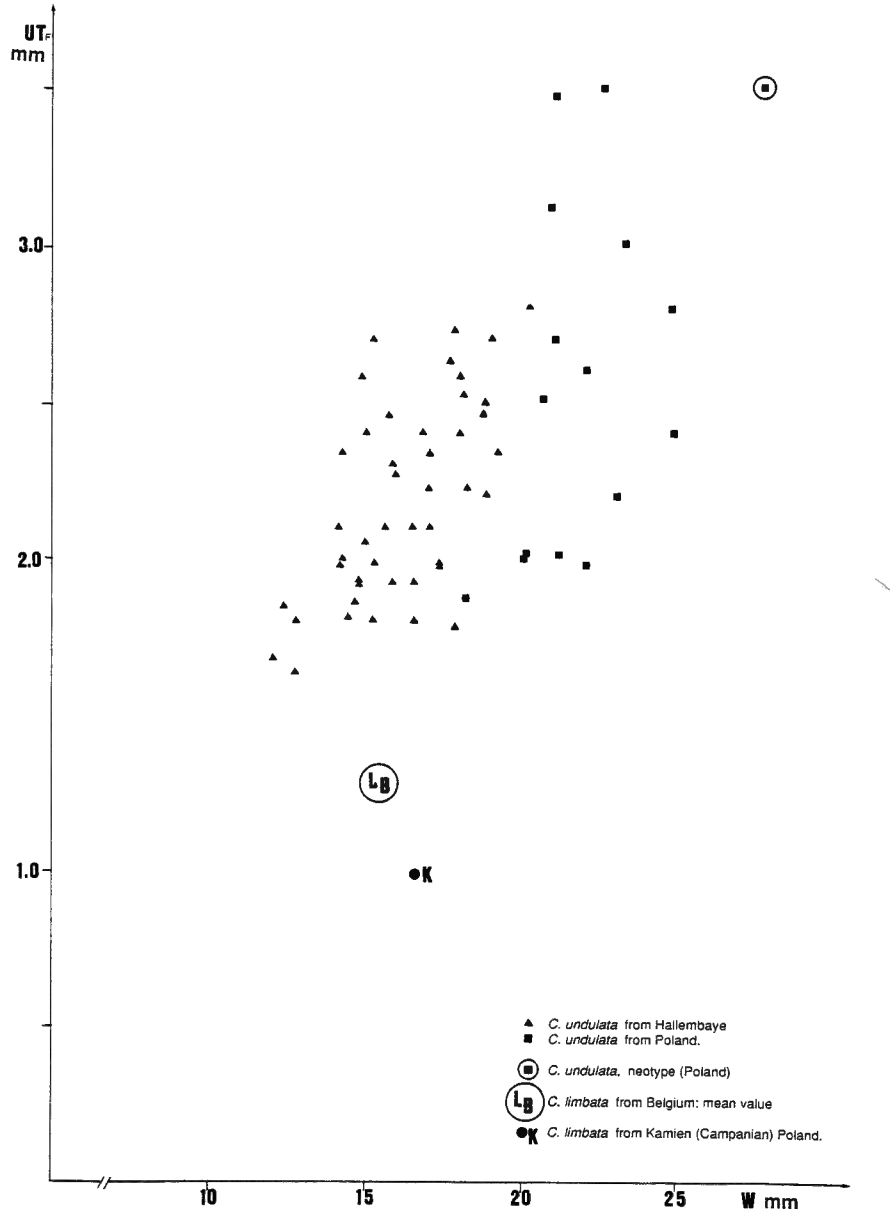

Fig. 7 — Relation between the width of the shell (in mm) and the thickness of the umbo at foramen level (in mm) in *Cretirhynchia undulata* from Hallembaye, Vijlen Chalk, Upper Maastrichtian (Belgium) and from Poland: Nasiłów, Horizon "z", Uppermost Maastrichtian (Bra-1506, Bra-1507, Bra-1508) and Kazimierz, Upper Maastrichtian (Neotype, Bra-943). The mean value observed in *Cretirhynchia limbata* from Belgium is indicated for comparison (LB). The position of the Campanian *Cretirhynchia limbata* from Kamień (Poland) is also drawn (K).

ficult to distinguish objectively this Polish material from the Belgian one when intraspecific variation was taken into account. The shell outline, the apical angle, the external ornamentation, the form and the relative thickness of the beak (Fig. 7) are extremely similar. The commissural development with an undulating or trapezoidal linguiform extension is also similar. The emergence of a biplicate and even sulciplicate anterior commissure concerns only old and gerontic Polish specimens.

Several young Polish specimens are illustrated in this paper (Pl. 4, Fig. 2-4 and Pl. 5 Fig. 1-4) for giving a better idea of the similarity between the Polish and the Belgian specimens.

Internal features also exhibit identical structures especially the presence of umbonal chambers in the brachial valves. This feature was only found in *Cretirhynchia undulata* by POPIEL-BARCZYK (1988) and it seems to be a typical feature for this species.

The main difference observed between the Polish and the Belgian populations is the size which is much larger on average for Polish individuals. This criterium which, I think, is not of significant importance, will be discussed later. Another difference is the convexity of the dorsal valve which is generally stronger in the Polish specimens. However, this character is quite variable and several specimens show a similar convexity to that of the

Belgian ones (Pl. 4, Fig. 2c, 4c and Pl. 5, Fig. 1c, 2c).

The sulciplicate anterior commissure of the Polish specimens is the most obvious difference to be observed, but it is typical of gerontic individuals. Young adults do not exhibit this special characteristic. This will also be discussed later.

In the Polish *Cretirhynchia undulata* the maximal width is generally observed in the anterior part of the shell. But, when this feature is measured on young adult shells, the maximal width is situated just below the middle of the shell as in Belgian specimens.

Comparison between Cretirhynchia undulata from Hallembaye and other Cretirhynchia species.

It is useful to compare our specimens of *Cretirhynchia undulata* with other species which also possess a smooth shell. The Campanian *Cretirhynchia lentiformis* (S. Woodward, 1833), has a circular outline, is more flat and does not exhibit any radial striation. It cannot be confused with *C. undulata*. *C. subplicata* (Mantell, 1822) from the *cortestudinarium* Zone from England, is more biconvex and possesses a different commissural development. The Campanian *C. arcuata* (Pettitt, 1950) is smaller and completely smooth. Its beak is thinner in lateral profile and less recurved than in *C. undulata*.

No confusion can arise with *C. retracta* (Roemer, 1841) from the Lower Maastrichtian of northern Germany and Denmark which shows numerous costae on well preserved specimens and a development of its arcuate/rectangular anterior commissure completely different from that observed in *C. undulata* . *C. retracta* has a domical anterior contour opposed to the lenticular anterior contour of *C. undulata*. Well visible in lateral profile, the linguiform extension of *C. retracta* is more developed and higher resulting in a surelevation of the anterior part of the dorsal valve.

Such rapid growth of the linguiform extension is never observed in *C. undulata*.

Cretirhynchia limbata (Von Schlottheim, 1813) occurs simultaneously with *C. undulata* in the Vijlen Chalk from Hallembaye. These two species can be confused mainly if the material observed is not well preserved. However, the distinctions between these species are well established. Specimens of *C. limbata* from Hallembaye are illustrated on Pl. 3, Fig. 4-5.

C. limbata is more transversely-oval in outline, shows a domical anterior contour and a typical cuneiform lateral profile. On the contrary, *C. undulata* is subtriangular in outline, shows a lenticular anterior contour and a lenticular-oval lateral profile. The antero-lateral parts of the pedicle valve of *C. limbata* are flat. This feature is an adaptation to a free living way of life (Surlyk, 1972, p. 24). Steinich (1965, p. 24) and Pettitt (1950, p. 28) emphasized also this characteristic which is one of the more stable for distinguishing *C. limbata* from *C. undulata*. In this latter species, the antero-lateral parts of the ventral valve are always slightly convex.

C. limbata often has strong growth line anteriorly and some strong costae (10-14) are situated between this growth line and the commissure. This is not observed in *C. undulata* .

The apical angle of *C. limbata* is broader than the apical angle of *C. undulata* (Table 1). The linguiform extension of *C. limbata* is V-shaped and not slightly arcuate or trapezoidal as in *C. undulata*.

The umbo of *C. limbata* is suberected or slightly incurved but it is not so strongly incurved as the umbo of *C. undulata*. Moreover, in lateral profile, the umbo of *C. limbata* is typically thin as indicated in the diagnosis (Pettitt, 1950, p. 28) whereas the umbo of *C. undulata* is thick in lateral profile (Table 1). The thickness of the umbo at foramen level was measured for both species and the results indicate that this feature is distinctive between these two species (Fig. 6). This feature is interesting because it can be measured on all specimens even if they are crushed or compressed because the umbo is thickened and more resistant.

Radial striation is more often observed in *C. undulata* but the same type of striation can be seen quite commonly in specimens of *C. limbata*. For this reason, the radial striation cannot be considered as a distinctive feature. Finally, one internal characteristic, only seen in serial sections, distinguishes also *C. limbata* from *C. undulata*: the exclusive presence of umbonal chambers in representatives of *C. undulata* (Figs. 4, 5). Specimens of *C. limbata* do not possess these small chambers as seen in Fig. 8.

Remarks concerning the Polish specimens of *Cretirhynchia limbata*.

All the characteristics recognized above allow a clear distinction between the Belgian specimens of *C. undulata* and *C. limbata*. The same schedule of distinctive criteria can be applied in Poland for distinguishing *C. undulata* from the Upper Campanian specimens of *C. limbata*. The illustrated Campanian *C. limbata* from Kamień (PL. 4, Fig. 1) confirms this fact. The domical anterior contour, the flat antero-lateral parts of the ventral valve, the thin umbo in lateral profile (Fig. 7) and the V-shaped linguiform extension are evident. This indicates that the "typical" *C. limbata* (= as recognized in the type area) was effectively present in Poland. On the contrary, the Upper Maastrichtian and Uppermost Maastrichtian specimens of *C. limbata* from the middle Vistula River Valley (Nasiłów, Bochotnica, Kazimierz, Janowiec) must be discussed. Popiel-Barczyk (1988, p. 7) gave a detailed description of these collections of *C. limbata* and she indicated clearly the differences between this species and *C. undulata*.

However, in his thesis (1958), Fedorowski, using similar material, did not recognized two species and he

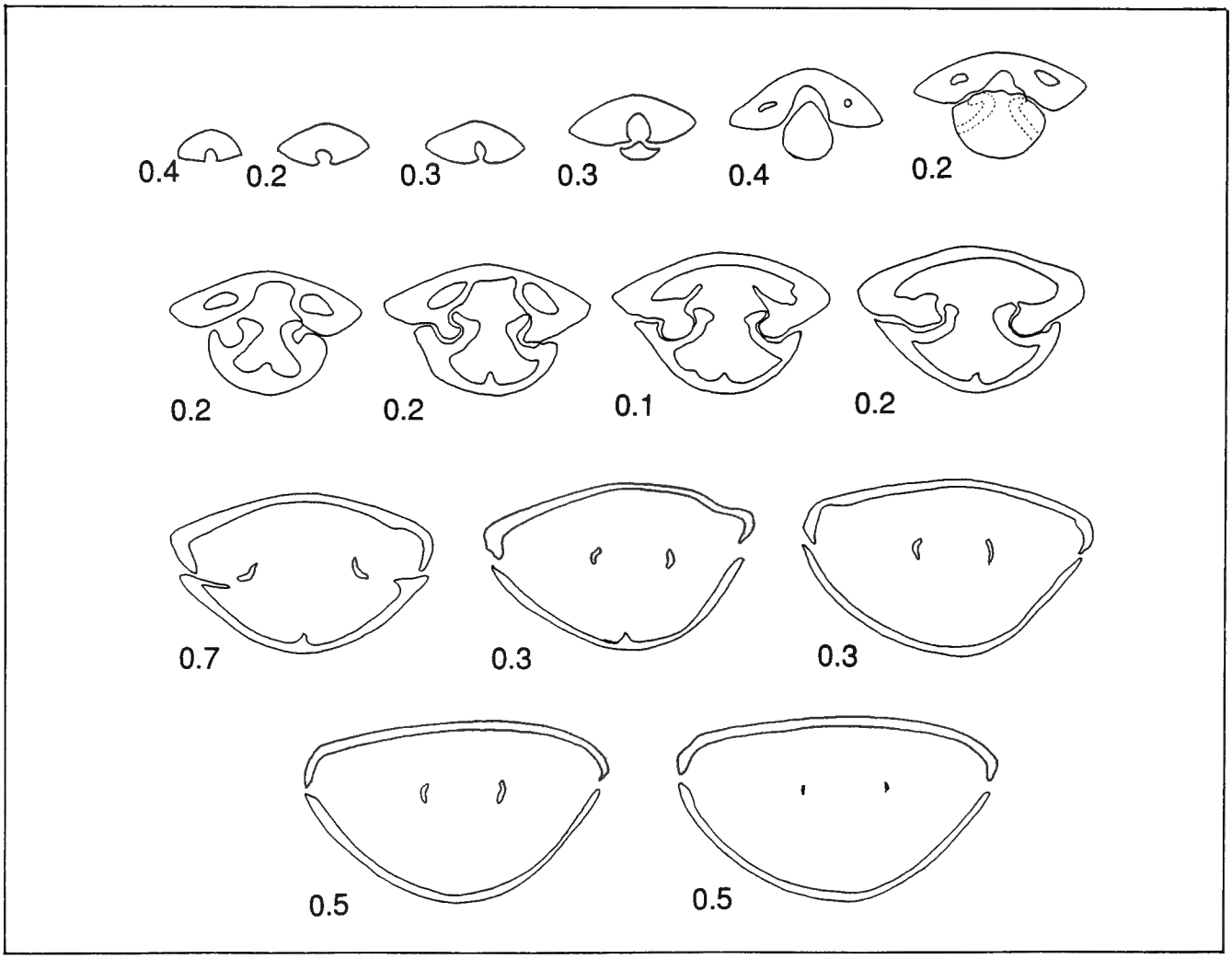

Fig. 8 — Serial sections in a specimen of *Cretirhynchia limbata* from Hallembaye, Vijlen Chalk, Upper Maastrichtian (width of the specimen: 14,3 mm). The strong septum is visible and there is no umbonal chambers in the brachial valve.

mentioned only *C. limbata*. This fact indicates that a confusion is easily possible between the two species collected in the middle Vistula River Valley. I have seen in Warsaw the material used by FEDOROWSKI and I think that numerous specimens from this collection must be determined as *C. undulata*.

For me, the problem is more to easily recognize the specimens of *C. limbata* because in this material, this species does not show a typical flat pedicle valve and often, the umbo is not thin in lateral profile. Moreover, the foramen is larger with deltidial plates forming often a short tube, indicating that these animals were attached by means of their pedicle. The *C. limbata* from the Upper Maastrichtian in Poland was not a free living brachiopod as was the case in the Campanian in Poland and in the Maastrichtian from the type area (Maastricht). Moreover, the Upper Maastrichtian *C. limbata* in Poland were probably living in competition with *C. undulata* . In this case, the shape of the shell could be more similar for the two species and it should illustrate a case of convergence. This opinion needs further study in order to be proved but it has the advantage of introducing a possible explanation for the shape-similarities observed in the two species. The problem is that no *C. undulata* has been found in the Campanian or in the Lower Maastrichtian from the same region in Poland and in such case, it will be difficult to observe an evolution attesting this possible convergence.

All these observations show that great carefulness must be applied for recognizing *C. limbata* from the Upper Maastrichtian in Poland and that the clear differences emphazized between *C. limbata* and *C. undulata* in Belgium are not encountered in Poland for the Upper and Uppermost Maastrichtian specimens.
These foregoing observations on the *C. limbata* specimens from the Upper Maastrichtian in Poland are probably the reason why MAKRIDIN & KATZ (1965) proposed to restrict *C. limbata limbata* to the Campanian, and to establish two subspecies: *C. limbata undulata* (PUSCH) for the Upper Maastrichtian populations from Poland, Ukraine, Lithuania and C.E.I. (in this case this should be the unique subspecies in

Poland) and *C. limbata mangyschlakensis* (MAKRIDIN & KATZ) which is the subspecies found near the Caspian Sea.

I agree also with the restricted presence of the typical *C. limbata limbata* in the Campanian from Poland. But a unique subspecies (*C. limbata undulata*) cannot be applied to the whole Upper Maastrichtian material from this area as seen in POPIEL-BARCZYK (1988). Two species are in fact present: firstly *C. undulata* and a second one which is still named *C. limbata* in POPIEL-BARCZYK (1988). Further study could lead to separate this material from the *C. limbata* species because it is quite different from the typical *C. limbata* from the Maastricht area and from the typical *C. limbata* encountered in the Polish Campanian. The establishment of a new subspecies for the Upper Maastrichtian specimens could be appropriate.

DISCUSSION

The Rhynchonellid material collected in the C.P.L. quarry in Hallembaye undoubtedly contains two different species. The first one is the well known *Cretirhynchia limbata* (VON SCHLOTTHEIM, 1813) which exhibits a smooth shell rarely ornamented with radial striation, transversely-oval in outline, domical in anterior contour, clearly cuneiform in lateral profile, with a short beak, thin in lateral profile, with flat antero-lateral parts of its pedicle valve and with a generally V-shaped linguiform extension. This was a free living species in adult stage.

The second species of *Cretirhynchia* exhibits, on the contrary, a smooth shell generally ornamented with regular radial striation, subtriangular in outline, lenticular in anterior contour, lenticular or oval-lenticular in lateral profile, with a short, more recurved beak, thick in lateral profile, with slightly convex antero-lateral parts of its pedicle valve, and with an arcuate or low trapezoidal linguiform extension. The foramen is functional and this species was living fixed by means of its pedicle.

This second *Cretirhynchia* species has not yet been described from the Maastrichtian Belgian fauna and an initial possibility was to establish a new species because this *Cretirhynchia* does not appear in the western European literature.

But, this very complex genus is in need of revision. Moreover, a large intraspecific variation is always observed. This means that creation of new species needs careful consideration and that all possibilities of connexion with already described species must be exhausted. This methodology was followed in the present work and the specimens from the C.P.L. quarry in Hallembaye undoubtedly show similarities with Polish specimens of *Cretirhynchia undulata* (PUSCH, 1837). Following the criteria cited by POPIEL-BARCZYK (1988, p. 8, 9) the connexion between the Belgian and the young adult Polish specimens was clearly evident. A similar outline, anterior contour and lateral profile, a similar thick beak in lateral profile, a similar arcuate or trapezoidal linguiform extension and the common radial striation of the shell were observed. Moreover, the serial sections of the Belgian specimens illustrate similar internal characteristics to those obtained from the Polish specimens. The presence of umbonal chambers in the brachial valve which is a typical feature of *C. undulata* is the most striking, similar internal characteristic encountered in both the Belgian and Polish specimens.

With so many similarities, it was not useful to establish a new species for the Belgian specimens collected in Hallembaye and I think it would be better to make the connexion between the Belgian and the Polish populations. For these reasons, the determination *"Cretirhynchia undulata"* is proposed for the specimens from Hallembaye.

Differences, of course, are also observed between the two materials. In the Polish specimens, the size is always larger, the linguiform extension exhibits often two (or more) strong folds resulting in two (or more) anterior folds in the dorsal valve and the convexity of the dorsal valve is generally stronger.

The size is not a specific characteristic. Brachiopods size depends on the age but not only on this. The ecological conditions also influence the development of the shell. The Belgian specimens of *C. undulata* were not living in the same ecological conditions as the Polish specimens. This is attested by the difference of sediments: white chalk in Belgium and phosphorite layer and marls in Poland. It is also noteworthy that in Poland (Uppermost Maastrichtian: Horizon "z" from POŻARYSKI, 1938) all the brachiopods are exceptionally large and this is true for both Rhynchonellid and Terebratulid brachiopods. No juvenile nor young adult shells was found in Nasiłow, Bochotnica and Kazimierz. This fact was not fully explained (POPIEL-BARCZYK, 1988) but it indicates that the Maastrichtian Polish material is composed of gerontic individuals or composed of individuals affected by an exceptionnal growth rate which results in a "pseudo-gerontic" aspect appearing very rapidly. In this case, this rapid development could be an adaptation to special ecological conditions which were unfavorable to young specimens.

The large size and the more similar outline observed in the both Maastrichtian Polish *C. limbata* and *C. undulata*, if interpreted as a convergence, can be partly explained by local ecological conditions (for instance; strong current unfavorable for weak and free living individuals, or severe activity of predators affecting mainly young individuals etc...).

In Hallembaye, on the contrary, very young individuals, young adults and older specimens are normally collected. The pyramid of ages is more normal in the material from Hallembaye than in the Polish material but on the other hand the ecological conditions in Hallembaye were completely different too (white chalk facies). The ecological niches occupied by the two

species were different in Hallembaye: *C. undulata* was a fixed brachiopod whereas *C. limbata* was a free living brachiopod. In Poland the two species were living fixed by their pedicle and perhaps they were in competition for the same substrates.

The determination "*C. undulata*" proposed in this paper for the Hallembaye is based on the comparison with the "smallest" Polish specimens (young adults). If a normal pyramid of ages was found in Polish material, the young adults should represent one of the larger class of ages. Accordingly, the diagnose should be mainly based on these specimens and not on gerontic individuals as is the case presently.

For these reasons, I think that the comparison made in this paper is a valid proposition. The second difference pointed out above, was the development of the linguiform extension: two (or more) points resulting in the development of folds in the anterior part of the dorsal valve is a typical feature of *C. undulata* in Poland. This characteristic is, for me, combined with shell development and its increase of size. All the young adults observed don't exhibit such linguiform extension. On the contrary they have the same linguiform extension as the Belgian specimens (Pl. 4 and 5) and this strengthens the connexion between the Belgian and the Polish material.

The third difference was the stronger convexity observed for the dorsal valve of the Polish specimens of *C. undulata*. Once again, this feature concerns more the largest specimens. For the young adults (Pl. 4, 5) the range examined for the convexity of the shell is similar to the range observed for Belgian specimens.

The geographic distribution of *C. undulata* must also be discussed here. This species has been found in eastern Europe; in Poland (POPIEL-BARCZYK, 1988), in Ukraine, Lithuania and C.E.I. (MAKRIDIN & KATZ, 1966).

If the proposition of this paper is accepted, the geographic area of this species will be much more larger and will present a major hiatus between Belgium and Poland. Such an idea is not valid presently because the Campanian and Maastrichtian material from Germany must be revisited for this problem. It is possible that specimens similar to those from Hallembaye could be found in this German material. Specimens similar to the Belgian *C. undulata* were already found near Aachen (by N. KEUTGEN who showed me his material) in the Lower Maastrichtian part of the Vijlen Chalk.

Two very young specimens, which exhibit the same characteristics as the specimens from Hallembaye, were also collected by N. KEUTGEN from the Orsbach Chalk in Schneeberg (Upper Maastrichtian). More material is needed to be sure of the right specific determination of these German specimens but these observations indicate that similar forms of *Cretirhynchia* could be found in Germany. As the German material has not been studied completely, it is also not appropriate to establish a new subspecies (or new variety) for the material extracted in Hallembaye. The complete range of variations from eastern to western European populations must be known before deciding on the necessity of subspecies levels.

This paper sets out several argumentations which allow a connexion between *Cretirhynchia* specimens from Hallembaye and the *Cretirhynchia undulata* from Poland. The morphological characteristics (external and internal), measured on materials from both origins, show obvious similarities. If young Polish adult specimens are taken mainly into account, the similarity between the Belgian and the Polish materials is so close that it would be difficult to distinguish two different species. This is emphasized when a special attention is given to the intraspecific variation. Considering the material available presently, this paper, which is written as a proposition, suggests that the most accurate determination of the Belgian specimens is *Cretirhynchia undulata* (PUSCH, 1837). Relations between the western and the eastern European faunas are not exceptionnal as showed by the works of POPIEL-BARCZYK (1968 & 1988) and the presence of a "Polish" *Cretirhynchia* in Belgium is not so astonishing. But further observations on material from other European regions (mainly Germany) are requested in order to have a definitive opinion on the subject. While waiting for this further observation, the proposition set out here is founded on the largest body of argumentation presently available and therefore should be taken into consideration.

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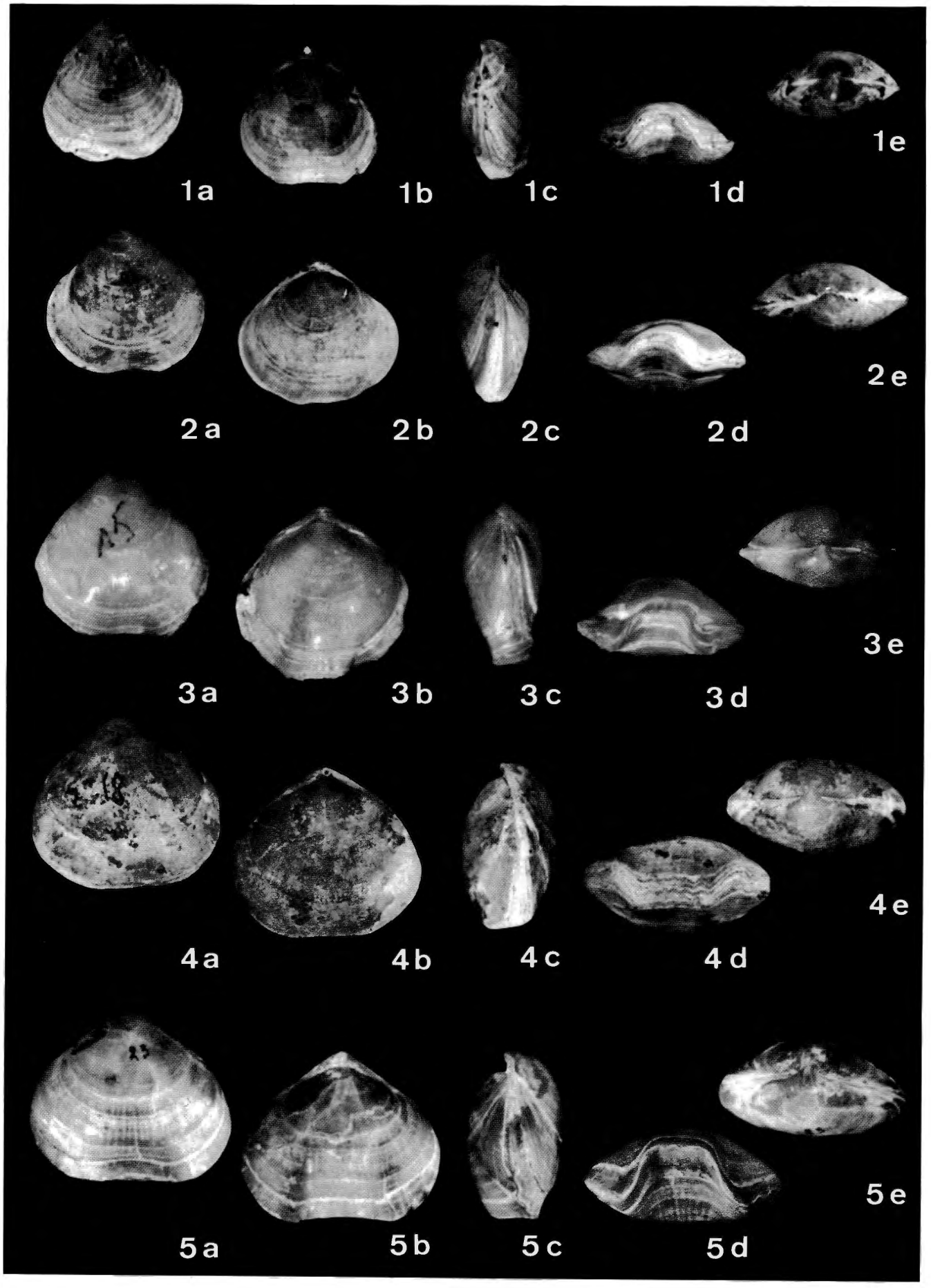
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PLATE 1

Cretirhynchia undulata (PUSCH, 1837)

Locality: C.P.L. Quarry in Hallembaye
Stratigraphy: Vijlen Chalk, Base of the Upper Maastrichtian

All the specimens are presented with the same magnification (x2).
a: ventral view. b: dorsal view. c: lateral profile. d: anterior view and e: posterior view.

Fig. 1 — Specimen with a typical subtriangular outline (small apical angle) and showing a simple undulating anterior commissure.

Fig. 2 — Specimen with a larger apical angle and showing a simple undulating anterior commissure.

Fig. 3 — This specimen shows a trapezoidal linguiform extension. It was empty and was dissected for internal study.

Fig. 4 — An older specimen with low trapezoidal linguiform extension developing slightly two external folds. Growth laminae are present near the commissure.

Fig. 5 — Large adult specimen with trapezoidal linguiform extension. The radial striation is clearly visible on the ventral valve.

PLATE 2

Cretirhynchia undulata (PUSCH, 1837)

All the specimens are presented with the same magnification (x2).
a: ventral view. b: dorsal view. c: lateral profile. d: anterior view and e: posterior view.

Fig. 1 — C.P.L. quarry in Hallembaye, Vijlen Chalk, base of the Upper Maastrichtian. Specimen with a typical subtriangular outline (small apical angle), and with a linguiform extension which is very similar to the linguiform extension observed in numerous Polish specimens including the specimen drawn by PUSCH in 1837. This form of linguiform extension is not common among the Belgian representatives of this species.

Fig. 2 — C.P.L. quarry in Hallembaye. Vijlen Chalk, base of the Upper Maastrichtian. Another specimen showing the "typical" linguiform extension for this species.

Fig. 3 — C.P.L. quarry in Hallembaye. Vijlen Chalk, base of the Upper Maastrichtian. Adult specimen which exhibits an important thickness of the shell, and strong growth lines. The linguiform extension is simply arcuate.

Fig. 4 — C.P.L. quarry in Hallembaye. Vijlen Chalk, base of the Upper Maastrichtian. Adult specimen with a reduced thickness of the shell, discrete growth lines and with a trapezoidal linguiform extension.

Fig. 5 — C.B.R. quarry in Lixhe. Base of the Lixhe Chalk, Upper Maastrichtian.
This specimen is the most gerontic found in the Belgian material described in this paper. It exhibits strong growth lines, an important thickness of the shell and numerous growth laminae near the anterior commissure. The linguiform extension is trapezoidal. Note that the lateral profile is slightly cuneiform.

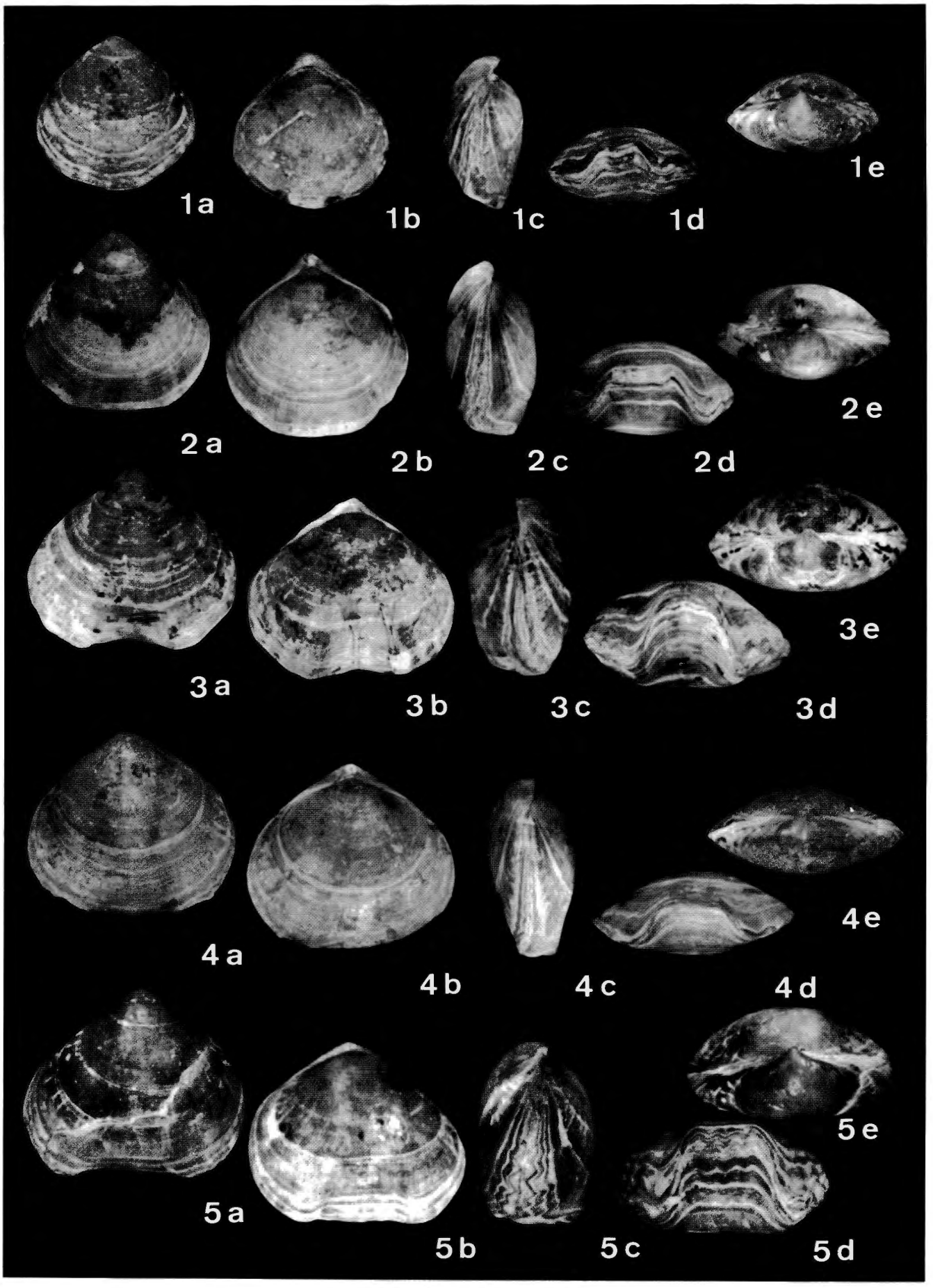
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PLATE 3

Cretirhynchia undulata (PUSCH, 1837)
All the specimens are presented with the same magnification (x2).
a: ventral view. b: dorsal view. c: lateral profile. d: anterior view and e: posterior view.

Fig. 1 — C.P.L. quarry in Hallembaye. Vijlen Chalk, base of the Upper Maastrichtian. This is the youngest specimen found. Note the slightly undulating anterior commissure.

Fig. 2 — C.P.L. quarry in Hallembaye. Vijlen Chalk, base of the Upper Maastrichtian. Adult specimen exhibiting low folds near the anterior commissure. The shell is rather thick and the linguiform extension is arcuate. This specimen was used for serial sections.

Fig. 3 — C.P.L. quarry in Hallembaye. Vijlen Chalk, base of the Upper Maastrichtian. Adult specimen with 3 low folds on the top of the linguiform extension. The shell is very thick.

Cretirhynchia limbata (VON SCHLOTTHEIM, 1813)
All the specimens are presented with the same magnification (x2).
a: ventral view. b: dorsal view. c: lateral profile. d: anterior view and e: posterior view.

Fig. 4 — C.P.L. quarry in Hallembaye. Top of the Vijlen Chalk (50 cm below the Horizon of Wahlwiller). Upper Maastrichtian. Note the typical cuneiform lateral profile, the thin beak in lateral profile,the flat pedicle valve and the V-shaped linguiform extension.

Fig. 5 — C.P.L. quarry in Hallembaye. Top of the Vijlen Chalk (50 cm below the Horizon of Wahlwiller. Upper Maastrichtian. This specimen is attached to a flint. Note the typical cuneiform lateral profile, the thin beak in lateral profile and the flat pedicle valve.

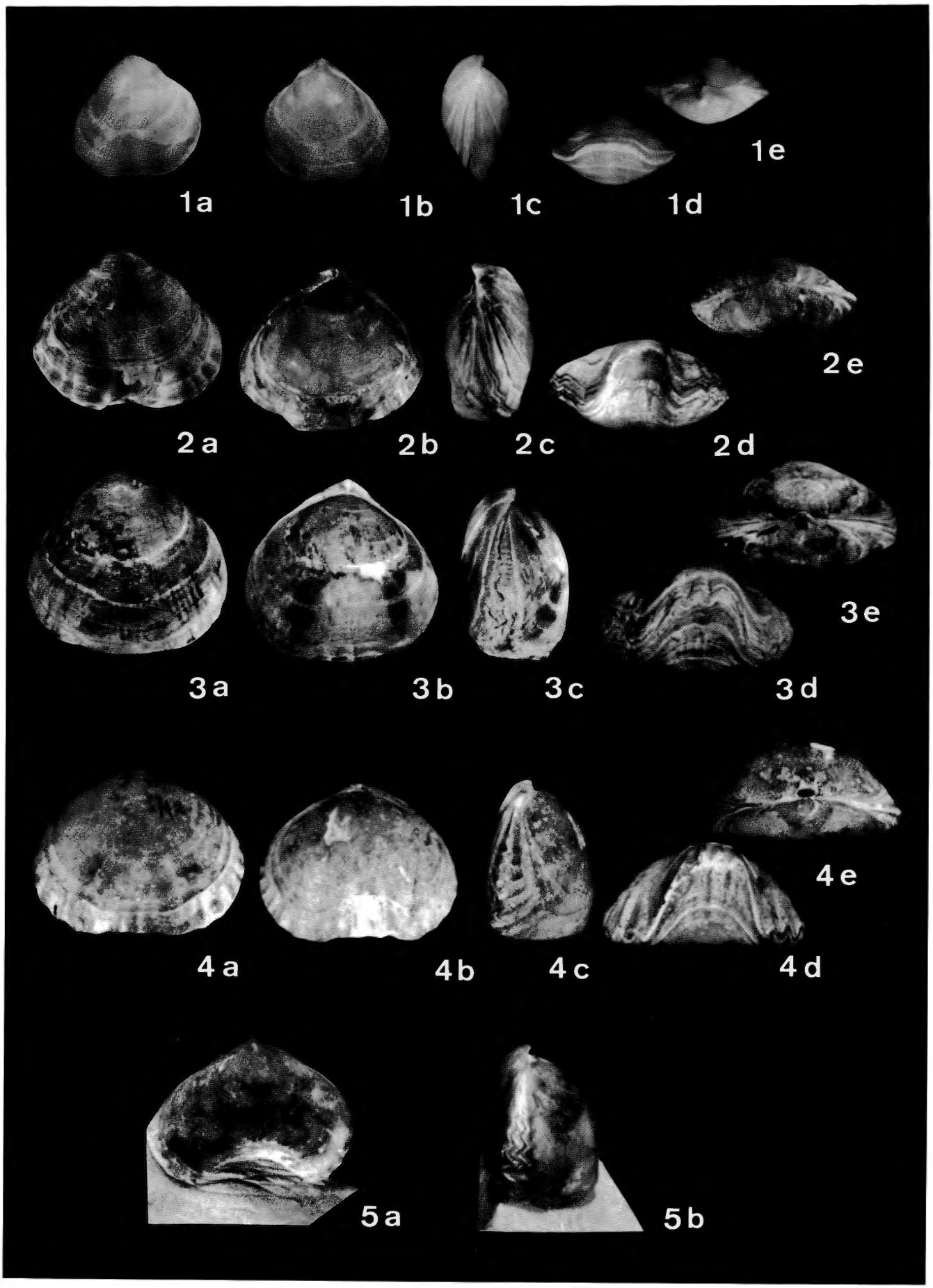
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PLATE 4

All the specimens are presented with the same magnification (x1.75).
a: ventral view. b: dorsal view. c: lateral profile. d: anterior view and e: posterior view.

Cretirhynchia limbata (VON SCHLOTTHEIM, 1813)

Fig. 1 — Specimen from Kamień, middle Vistula river valley, Poland. Horizon "u", Lower Maastrichtian. Collection KONGIEL. Muzeum Ziemi. MZ VIII Bra 1516/a. This specimen shows all the characters described in the diagnose of *C. limbata* and is exactly similar to the specimens found in the type area. Note the flat pedicle valve, the thin beak in lateral profile and the cuneiform lateral profile of the shell.

Cretirhynchia undulata (PUSCH, 1837)

Fig. 2 — Specimen from Nasiłów, middle Vistula river valley, Poland. Horizon "z", Uppermost Maastrichtian. Muzeum Ziemi, MZ VIII Bra 1507. Young individual with a simple arcuate linguiform extension. Note the lenticular lateral profile, the thick beak and the convexity of the pedicle valve.

Fig. 3 — Another specimen from Nasiłów, middle Vistula river valley, Poland. Horizon "z", Uppermost Maastrichtian. Museum Ziemi, MZ VIII Bra 1507. A young specimen with a smaller apical angle.

Fig. 4 — Specimen from Nasiłów, middle Vistula river valley, Poland. Horizon "z", Uppermost Maastrichtian. Museum Ziemi, MZ VIII Bra 1508. This individual is larger and shows already a more gerontic linguiform extension which is common in Polish specimens.

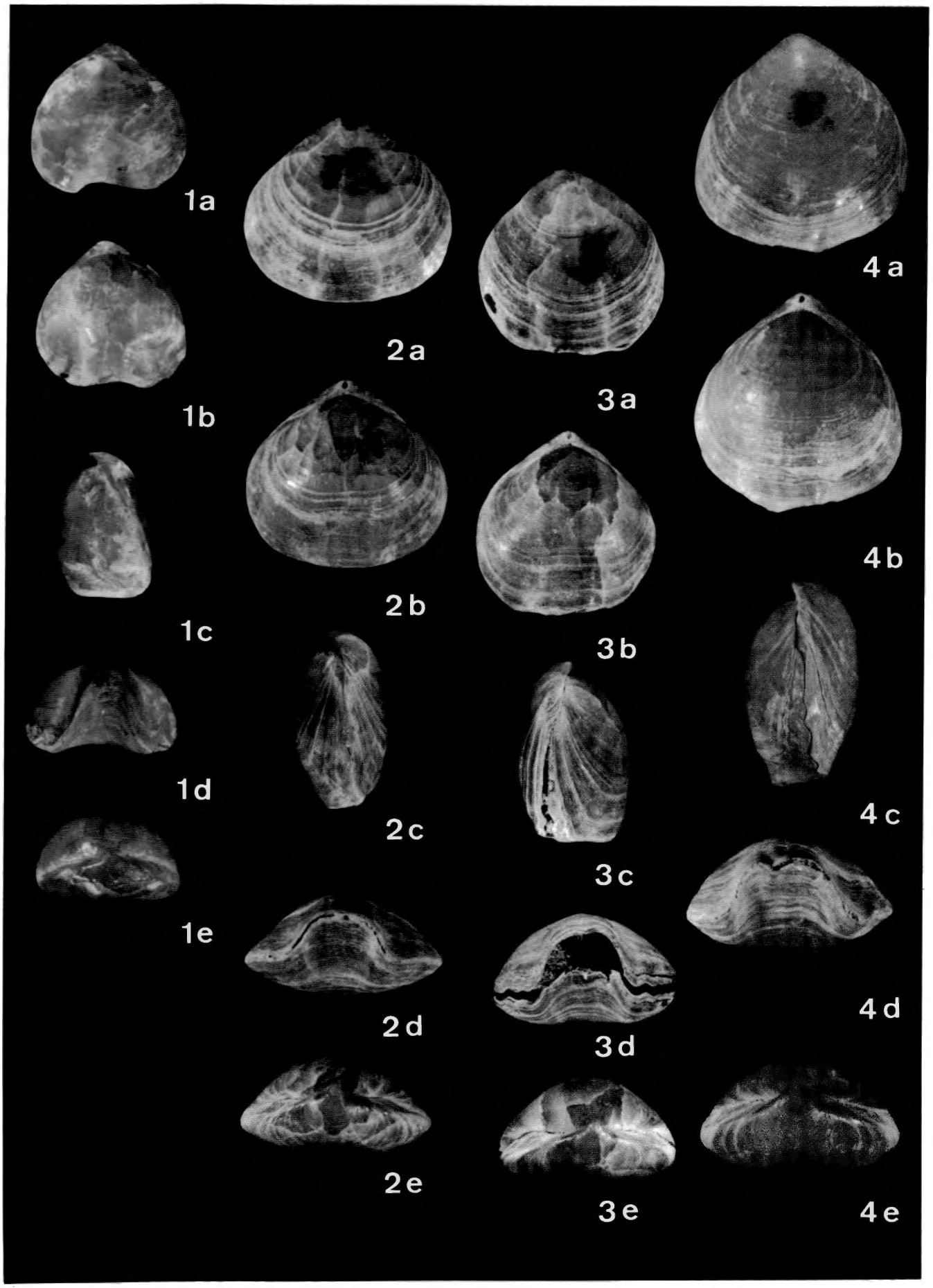
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PLATE 5

Cretirhynchia undulata (PUSCH, 1837)

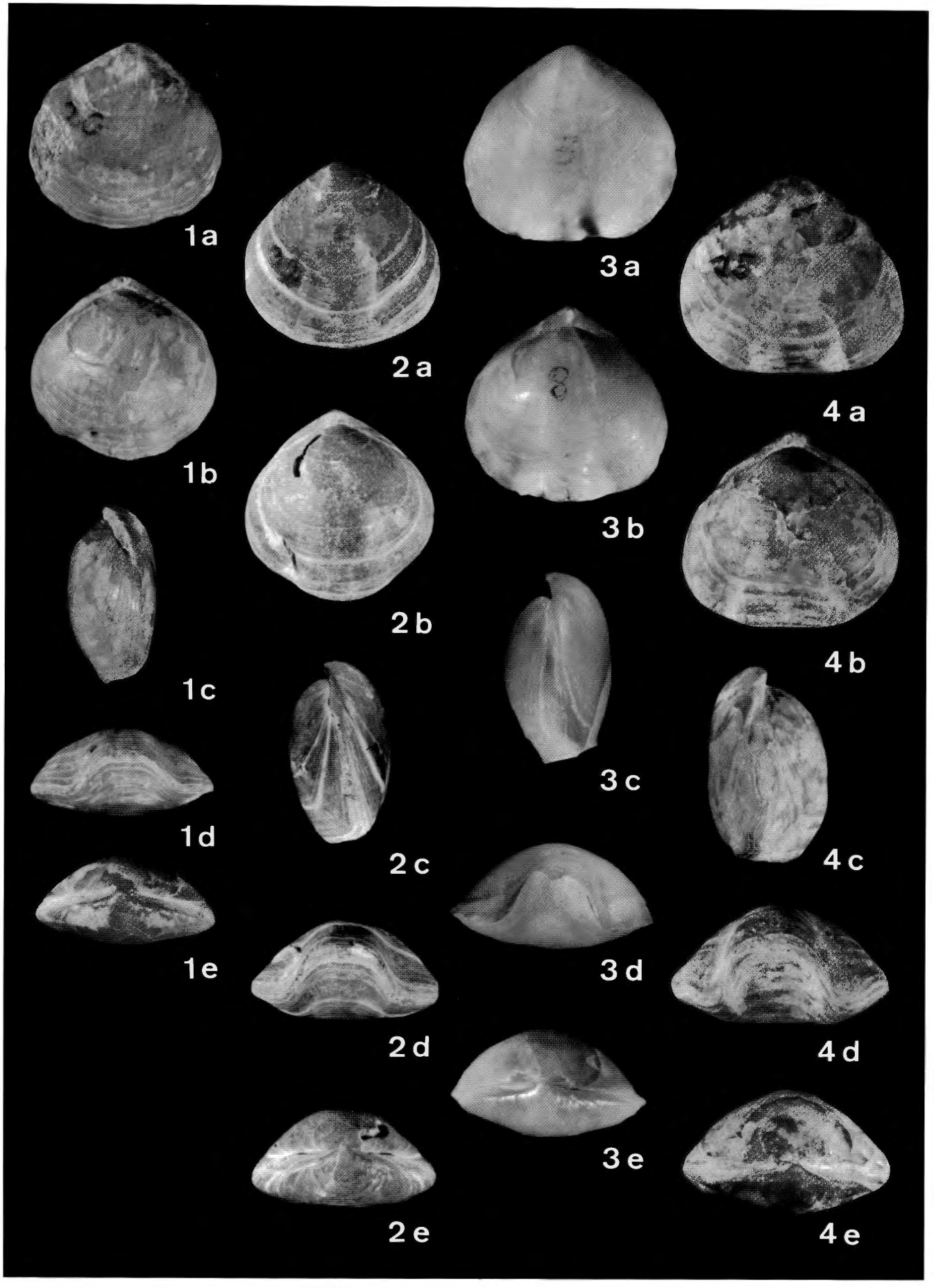
All the specimens are presented with the same magnification (x1.75).
a: ventral view. b: dorsal view. c: lateral profile. d: anterior view and e: posterior view.

Fig. 1 — Specimen from Bochotnica, middle Vistula river valley, Poland. Upper Maastrichtian. Museum Ziemi, MZ VIII Bra 1510/b-20. This individual is a young adult with an arcuate linguiform extension. It is very similar to the Belgian specimens from Hallembaye.

Fig. 2 — Specimen from Bochotnica, middle Vistula river valley, Poland. Horizon "x", Upper Maatrichtian. KONGIEL's Collection used by FEDOROWSKI in 1958. Museum Ziemi, MZ VIII Bra 1510/c. A typical polish young adult with a trapezoidal linguiform extension.

Fig. 3 — Specimen from Nasiłow, middle Vistula river valley, Poland. Uppermost Maastrichtian. Museum Ziemi, MZ VIII Bra 1506/8. This specimen has a well preserved shell and shows the beginning of the development of an older linguiform extension.

Fig. 4 — Specimen from Bochotnica, middle Vistula river valley, Poland. Upper Maastrichtian. Museum Ziemi, MZ VIII Bra 1510/b-15. This rather large and thick specimen shows a simple arcuate linguiform extension. It is very similar to the Belgian specimen illustrated Pl. 2, Fig. 3.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