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# New Lower Maastrichtian brachiopods (Gulpen Formation, Vijlen Member) from southern Limburg (The Netherlands)

by Eric SIMON

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## Abstract

A large suite of Lower Maastrichtian brachiopods, collected by W. M. Felder from strata subsequently assigned to the Vijlen Member (Gulpen Formation; southern Limburg, The Netherlands) and housed in the collections of the Natuurhistorisch Museum Maastricht has been studied. On the basis of these, several new rhynchonellid, terebratulid and terebratelloid generic and specific are erected, and a new family is introduced. These new records considerably augment our knowledge of brachiopod faunas in the Lower Maastrichtian (*Belemnella obtusa/ B. sumensis* zone interval) of northwestern Europe.

**Key words**: Brachiopods, Lower Maastrichtian, The Netherlands, new taxa

## Résumé

L'étude présentée porte sur une vaste collection de brachiopodes conservée au Natuurhistorisch Museum Maastricht et collectée par W.M. Felder dans des sédiments de la Craie de Vijlen (Formation de Gulpen, Maastrichtien Inférieur) dans la Province du Limbourg du sud (Pays-bas). Plusieurs nouvelles espèces de brachiopodes rhynchonellides, térébratulides et térébratelloides ont été décrites. De nouveaux genres et même une nouvelle famille ont pu également être érigés. Cette étude élargit la connaissance de la faune de brachiopodes des zones à *Belemnella obtusa/B. sumensis* de l'ouest de l'Europe.

**Mots-clefs**: Brachiopodes, Maastrichtien Inférieur, Pays-Bas, nouveaux taxons

## Introduction

Brachiopods of Early Maastrichtian age from NW Europe have been extensively studied; numerous species were already described in works dating back to the nineteenth century. Amongst these, KOENIG (1825), NILSSON (1827), ROEMER (1841), DAVIDSON (1852), BOSQUET (1860), QUENSTEDT (1871), CORNET (1874), LUNDGREN (1885) and PERON (1895) can be cited. More recently, STEINICH (1965) published a detailed monograph dealing with Lower Maastrichtian brachiopods from the white chalk of Rügen (Germany), while material from Denmark and from northern Germany (localities Kronsmoor and Hemmoor), was studied by SURLYK (1969, 1970, 1982), JOHANSEN (1987) and JOHANSEN & SURLYK (1990). Coeval faunules from Belgium (phosphatic chalk of Ciply, *Belemnella obtusa* Zone; Mons basin, Hainaut), were described in detail by SIMON (1998). KEUTGEN (1996, pp. 74-81) was the first to record the typical species amongst early Maastrichtian assemblages in southern Limburg (The Netherlands, Vijlen and Beutenaken areas) and in the Aachen area (Germany). He also presented a brachiopod zonation based on the system proposed by SURLYK (1970). Despite this, the rich brachiopod fauna from the Lower Maastrichtian of NE Belgium and the SE Netherlands, which includes numerous undescribed taxa, is still poorly known. The present paper aims to ameliorate this.

During a number of years, W.M. FELDER collected large suites of macrofossils from temporary outcrops in southern Limburg (The Netherlands), most of which are inaccessible today. This makes the present collection important. However, the material was collected rather ''randomly'', since most specimens were collected from bulk samples rather than handpicked in the field. (John Jagt; personal communication, 2004).

Felder's material, now housed at the Natuurhistorish Museum Maastricht (NHMM), comes from outcrops east of Maastricht, near the belgian-dutch and dutch-german borders (Text-Fig. 1), exposing strata then assigned to the ''*Gulpens Krijt*'' (abbreviation GK). W.M. FELDER (1964) is referred to for more details on outcrops and sections.

A preliminary belemnite zonation and a detailed lithostratigraphical subdivision of the Campanian-Maastrichtian in southern Limburg was presented by VAN DER TUUK (in ROBASZYNSKI et al., 1985) and W.M. FELDER (1975), respectively. Later, KEUTGEN & VAN DER TUUK (1991) proposed a more detailed belemnite zonation. More recently, the biostratigraphy and palaeoecology of Early Maastrichtian invertebrate faunas from this region has been studied exhaustively by KEUTGEN (1996). His proposed biozonation was adopted by JAGT (1999), and it is followed here as well.

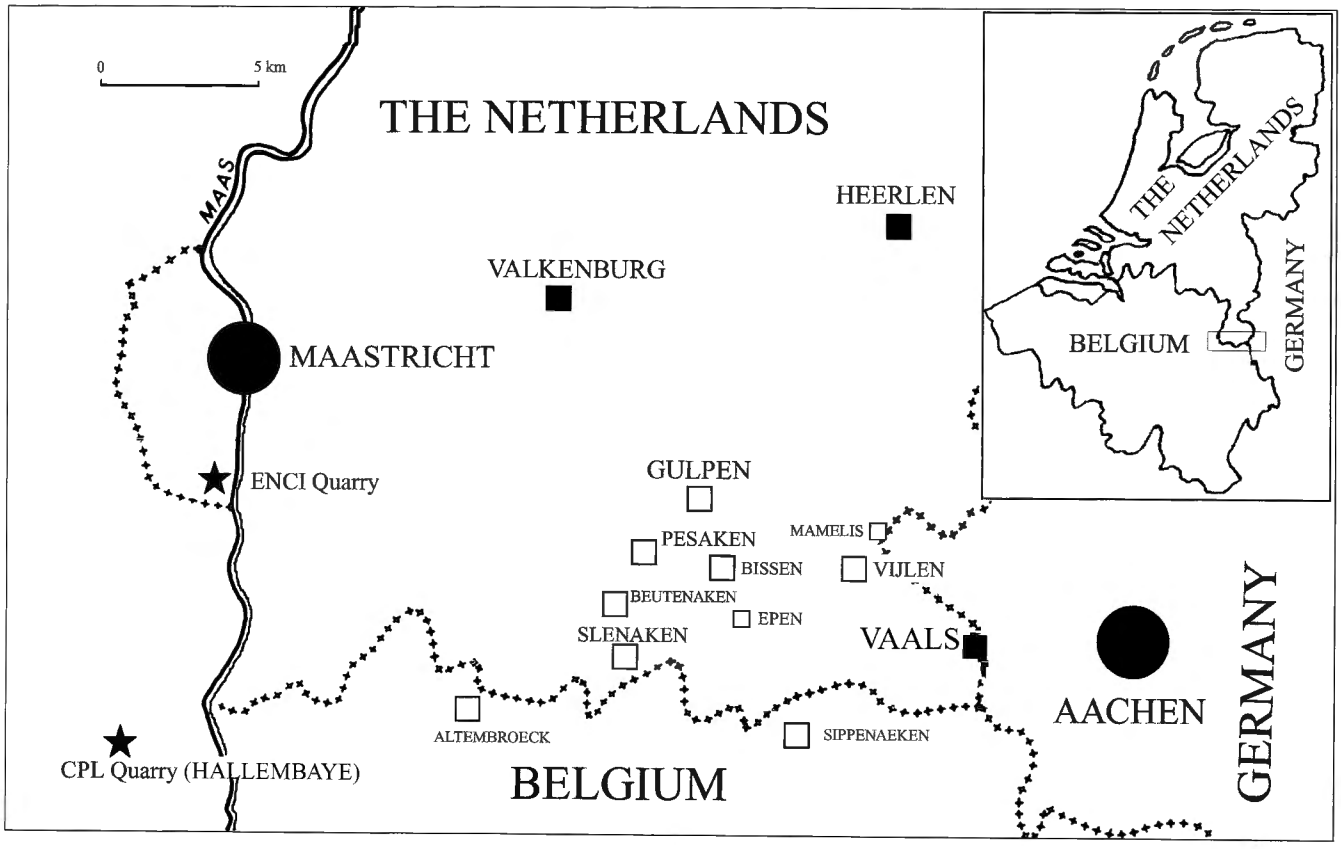


Fig. 1 — Map of southern Limburg (The Netherlands), showing the different locations where Lower Maastrichtian brachiopods were collected (□).

The level from which the specimens studied generally originate is the *Belemnella sumensis* Zone. However, data with the specimens are not always clear so that it is also possible that some material may actually have come from the underlying *Belemnella obtusa* Zone. Belemnites typical of both these zones occur concentrated in so-called 'belemnite graveyards'.

The lowermost portion of the Vijlen Member was assigned by KEUTGEN (1996) to the *B. obtusa* Zone, which means that this level is correlatable with the phosphatic chalk of Ciply, as already outlined by JAGT (1999, p. 23). In fact, some brachiopod species from the basal Vijlen Member, studied in the present paper, are also known from Ciply.

Taxa described from the *B. sumensis* Zone occur in heavily glauconitic chalk and glauconite grains still adhere to the shell surface, even after cleaning. This fauna is very distinctive, differs from faunules known from the *B. obtusa* Zone, and includes a lot of new forms. Of the species described in the present paper, only one (''*Terebratula knerri*'') was previously observed, but not described by BOSQUET (1860). Several species described here are rare, others are uncommon. This explains why their ontogeny could not be studied and why accurate statistical analyses were impossible. Ignoring this fauna would be the other extreme. It was decided to describe it and erect new species, even on the basis of limited material, whenever features were held to be distinctive enough.

## Material and methods

The material studied in the present paper comes mainly from the Felder Collection (NHMM), but also from some other lots preserved in the same institution. Numbers of outcrops are those used in the files of the Geological Survey of The Netherlands (Nederlands Instituut voor Toegepaste Geowetenschappen –TNO, Utrecht); a copy of these files is available at NHMM.

Transverse serial sections were prepared (see AGER, 1965, pp. 212-218 for procedure) and peels were taken on cellulose acetate following the method described by STERNBERG & BELDING (1942). Peels of the serial sections are preserved in the NHMM collections. Photographed specimens were coated with ammonium chloride. To illustrate certain details of shell surfaces, SEM photographs were prepared.

Suprafamilial classification follows WILLIAMS *et al.*(1996) whereas the superfamilial classification follows WILLIAMS *et al.* (2000, pp. 22-27). The description of the loop structure of the terebratelloid brachiopods follows MACKINNON (1993).

## Taxonomic descriptions

Phylum Brachiopoda DUMÉRIL, 1806
Subphylum Rhynchonelliformea WILLIAMS *et al.*, 1996
Class Rhynchonellata WILLIAMS *et al.*, 1996
Order Rhynchonellida KUHN, 1949
Superfamily Hemithyridoidea RZHONSNITSKAIA, 1956
Family Cyclothyrididae MAKRIDIN, 1955
Subfamily Cyclothyridinae MAKRIDIN, 1955

Genus ***Woodwardirhynchia*** SIMON & OWEN, 2001
Type species: *Cretirhynchia cuneiformis* PETTITT, 1950

***Woodwardirhynchia pseudonorvicensis*** n. sp.
Table 1; Text-Fig. 2; Pl. 1, Fig. 1-3.

DIAGNOSIS
Medium-sized, dorsibiconvex, densely costellate rhynchonellid, subtriangular to slightly subpentagonal in outline, oval-lenticular in anterior contour and cuneiform in lateral profile. Shell with shallow ventral sulcus and broad dorsal flattened fold, developed on anterior part. Linguiform extension sharply trapezoidal. Numerous costae reduced in number near the commissure. Intervening sulci narrow, becoming wider near the commissure. Beak short, erect. Sharp beak ridges. Hypothyrid, circular, rimmed foramen . Dental plates posteriorly subparallel, convergent anteriorly. Hinge plates simple, concave ventrally and forked in their anterior part. Crura relatively wide, canaliform posteriorly, showing a ''falciform'' transverse section at mid-length and becoming straight anteriorly.

DERIVATIO NOMINIS
From ''pseudo'' meaning false and ''*norvicensis*'', a specific name for a Campanian *Cretirhynchia* from Norwich (Norfolk, England) alluding to the fact that this new species is a small homeomorph of *C. norvicensis* PETTITT, 1950.

LOCUS TYPICUS
Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen, southern Limburg, The Netherlands.

STRATUM TYPICUM
Base of Vijlen Member (Gulpen Formation, Lower Maastrichtian).

HOLOTYPE
NHMM GK 394 (Table 1; Pl. 1, Fig. 1a-e) a medium-sized adult specimen (ex Felder colln.) from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (?*B. obtusa/B. sumensis* Zone).

PARATYPES
All paratypes (ex Felder colln.) from Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (*B. obtusa/B. sumensis* Zone?).

NHMM GK1379 (Table 1; Text-Fig. 2; Pl. 1, Fig. 2a-e) a medium-sized adult specimen used for transverse serial sections from Zeven Wegen in Vijlenerbosch (62D-15d).

NHMM GK 396 (Table 1; Pl. 1, Fig. 3a-e) a medium-sized adult specimen from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b).

ADDITIONAL MATERIAL
Nine specimens (ex Felder colln.) NHMM GK387 (Table 1), GK389-392, GK393 (Table 1), GK395-396, GK397 (Table 1), GK420 from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (?*B. obtusa/B. sumensis* Zone).

Six specimens (ex Felder colln.) NHMM GK 544-545, GK546 (Table 1), GK547, GK549-550. No locality data but probably Vijlen area, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, Vijlen Member (?*B. obtusa/B.sumensis* Zone).

DESCRIPTION
This uncommon species, is a small homeomorph of *Cretirhynchia* (*Cretirhynchia*) *norvicensis* PETTITT, 1950. Paratype NHMM GK1379 has been used for transverse serial sections in order to check if it was a dwarf specimen of *C. norvicensis* or a subspecies of this, or of any other, related species. It came as some surprise that transverse sections (Text-Fig. 2) showed this rhynchonellid to be, in fact, a new species of *Woodwardirhynchia*.

External characters
The shell is medium-sized (Table 1), slightly longer than wide, subtriangular to subpentagonal in outline, with a dome-shaped oval-lenticular anterior contour and a wide lenticular lateral profile. This species is very dorsibiconvex. The convexity of the ventral valve is very weak, except in its posterior part, near the umbo, whereas the convexity of the dorsal valve is quite strong, resulting in very steep lateral flanks. A shallow sulcus, with sharp lateral edges, takes place on the anterior part of the ventral valve. A flattened dorsal fold is developed and it is limited by steep lateral sides. The linguiform extension is trapezoidal, with a variable height.

The shell is finely costellate and 40 to 54 costae have been observed at mid-valve. The costae are fused near the commissure where the number of costae is reduced to 16-20. The way of fusion of the costae is very similar to that observed in *C. norvicensis* (See illustrations in SIMON & OWEN, 2001, pl. 2, fig. 1-5; pl. 3, fig. 1). A clearly visible step-like growth line is developed near mid-valve.

The beak ridges are sharply developed, a character often observed in representatives of the genus *Woodwardirhynchia*. The beak is short and erect. The interarea is well defined but it is not very extensive. A fairly small hypothyrid foramen, circular and rimmed, is observed.

Table 1 — Measurements (in mm) of rhynchonellid brachiopods described and illustrated in the present paper; all housed in the Natuurhistorisch Museum Maastricht (NHMM) and from the Vijlen Member (Gulpen Formation, Lower Maastrichtian) of the Maastricht area. L: length of the shell, LDV: length of dorsal valve, W: width of the shell, T: thickness of the shell, ØF: diameter of the foramen.

| Genus and species | Reference number | Type of specimen | L mm | LDV mm | W mm | T mm | ØF mm | Linguiform extension | Costae (VV) | Costae fold | Costae sulcus |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Genus *Woodwardirhynchia* | | | | | | | | | | | |
| *W. pseudonorvicensis* n. sp. | NHMM GK387 | Additional material | 17.1 | 15.0 | 17.1 | 12.0 | 0.72 | Trapezoidal | 51 | 10 reduced to 9 | 9 reduced to 5 |
| *W. pseudonorvicensis* n. sp. | NHMM GK393 | Additional material | 13.9 | 11.9 | 13.9 | 10.1 | 0.60 | Trapezoidal | ? | 12 reduced to 4 | 11 reduced to 5 |
| *W. pseudonorvicensis* n. sp. | NHMM GK394 | Holotype | 16.8 | 15.3 | 15.3 | 11.8 | 0.48 | Trapezoidal | 56 | 15 reduced to 8 | 14 reduced to 7 |
| *W. pseudonorvicensis* n. sp. | NHMM GK396 | Paratype | 16.0 | 14.2 | 15.9 | 10.5 | 0.54 | Trapezoidal | 40 | 16 reduced to 5 | 14 reduced to 6 |
| *W. pseudonorvicensis* n. sp. | NHMM GK397 | Additional material | 14.2 | 12.2 | 14.0 | 9.9 | broken | Trapezoidal | ? | 9 reduced to 5 | 10 reduced to 4 |
| *W. pseudonorvicensis* n. sp. | NHMM GK546 | Additional material | 15.6 | 14.3 | 16.0 | 11.0 | 0.60 | Trapezoidal | 42 | 14 reduced to 6 | 16 reduced to 7 |
| *W. pseudonorvicensis* n. sp. | NHMM GK1379 | Paratype (sectioned) | 17.0 | 15.2 | 16.7 | 11.5 | 0.36 | Trapezoidal | 54 | 10 reduced to 6 | 10 reduced to 5 |
| Genus *Cretirhynchia* Subgenus *Homaletarhynchia* | | | | | | | | | | | |
| *C. (H.) postarcuata* n. sp. | NHMM GK941 | Paratype (sectioned) | 13.1 | 11.8 | 14.0 | 8.3 | 0.26 | Trapezoidal | 10 | 3 | 2 |
| *C. (H.) postarcuata* n. sp. | NHMM GK1062 | Additional material | 12.6 | 11.8 | 13.1 | 8.6 | 0.20 | Trapezoidal | 11 | 3 | 2 |
| *C. (H.) postarcuata* n. sp. | NHMM GK1204 | Holotype | 11.9 | 10.6 | 13.0 | 7.9 | 0.26 | Trapezoidal | 11 | 3 | 2 |
| *C. (H.) postarcuata* n. sp. | NHMM GK1375 | Paratype | 13.9 | 11.6 | 15.0 | 10.0 | 0.36 | Arcuate | 16 | 4 | 3 |
| *C. (H.) postarcuata* n. sp. | NHMM GK1376 | Paratype | 11.9 | 10.5 | 13.2 | 8.4 | 0.33 | Trapezoidal | 11 | 4 | 3 |
| *C. (H.) postarcuata* n. sp. | NHMM GK1378 | Paratype (sectioned) | 14.4 | 13.1 | 14.8 | 9.5 | 0.29 | Trapezoidal | 10 | 3 | 2 |

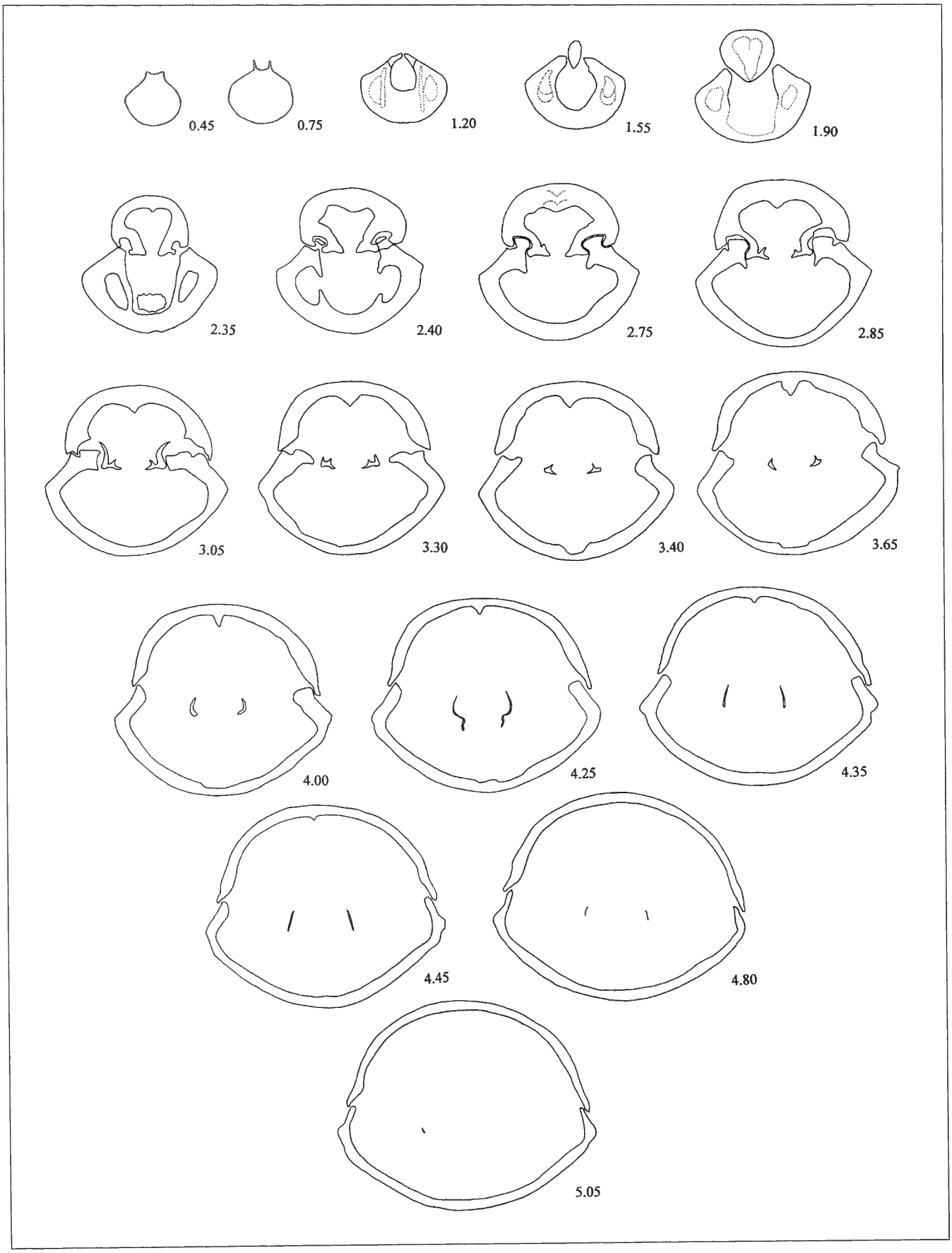


Fig. 2 — Transverse serial sections through the umbonal portion of an adult specimen (NHMM GK1379, ex Felder colln., paratype) of *Woodwardirhynchia pseudonorvicensis* n. sp., from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Base of the Vijlen Member (Gulpen Formation, Lower Maastrichtian). x 4.1

Internal characters

In transverse serial sections, a pedicle collar has not been observed but sometimes this structure is easily overlooked. The dental plates are sub-parallel in their most posterior part but ventrally become convergent. Teeth relatively short but robust.

A persistent septum is developed on the dorsal valve floor. This septum is relatively short and not very elevated. In any case, it is shorter than the crura.

Socket ridges are strong and the sockets are deep. Inner socket ridges are fairly expanded. Hinge plates are relatively simple, concave ventrally and forked anteriorly. Crural bases are inwardly concave and this concavity also affects the posterior part of the crura (canaliform). At mid-length, crura suddenly widen and appear, in transverse section, as a ''falciform'' structure. Anteriorly, crura remain wide but appear straight in transverse section.

## COMPARISON WITH OTHER RHYNCHONELLID BRACHIOPOD SPECIES

### Comparison with *Woodwardirhynchia cuneiformis* (PETTITT, 1950)

*Woodwardirhynchia cuneiformis* is an Upper Turonian species (type species of the genus *Woodwardirhynchia*), which externally is much more dorsibiconvex and exhibits a narrow arcuate linguiform extension. Its dorsal valve is of considerable convexity but is anteriorly flattened, with a broad faint median fold. The beak of *W. cuneiformis* is stronger and more curved.

In *Woodwardirhynchia pseudonorvicensis* n. sp., the convexity of the dorsal valve is weaker and the linguiform extension is sharply trapezoidal. Its dorsal fold is distinctly visible and limited by sharp edges. The beak of *Cretirhynchia pseudonorvicensis* n. sp. is smaller and less erect.

*Woodwardirhynchia cuneiformis* exhibits inwardly concave crura, becoming straight anteriorly as also seen in *W. pseudonorvicensis* n. sp. But a wide ''falciform'' structure is well developed at mid-length in the latter species. In *W. cuneiformis*, this ''falciform'' structure is incipiently developed as seen in SIMON & OWEN, 2001; text-fig. 3, p. 60. Moreover, the dental plates of *W. cuneiformis* are divergent posteriorly becoming subparallel anteriorly and they are never slightly convergent as in *W. pseudonorvicensis* n. sp.

### Comparison with *Woodwardirhynchia tenuicostata* (VON HANSTEIN, 1879)

*Woodwardirhynchia tenuicostata* is a medium-sized species from the phosphatic chalk of Ciply (Lower Maastrichtian, *B. obtusa* Zone). Its shell is ornamented with numerous costae, fused near the commissure. Its linguiform extension is generally subrectangular, more rarely trapezoidal.

*W. tenuicostata* is more transversely-oval than *W. pseudonorvicensis* n. sp. which is more subtriangular. The apical angle is wider in *W. tenuicostata*.

Internal characters are similar but some distinctions avoid any confusion between these two rhynchonellid brachiopods. A pedicle collar is visible in *W. tenuicostata* whereas it is absent (or poorly developed) in *W. pseudonorvicensis* n. sp. In *W. tenuicostata*, the dental plates are ventrally divergent in their posterior part and they become subparallel anteriorly. In *W. pseudonorvicensis* n. sp., the dental plates are posteriorly subparallel but anteriorly, they become slightly convergent. In both species, the concavity of the crura and crural bases is similar but the ''falciform'' wide structure observed in the transverse sections of *C. pseudonorvicensis* n. sp. is less developed in *W. tenuicostata*.

### Comparison with *Cretirhynchia* (*Cretirhynchia*) *norvicensis* PETTITT, 1950

*Woodwardirhynchia pseudonorvicensis* n. sp. is much smaller than *Cretirhynchia norvicensis* which is probably the largest species of *Cretirhynchia* yet described. However, representatives of both species show a similar outline, costellation, type of fusion of the costae, and sharp trapezoidal linguiform extension. Even the sharp beak ridges, the narrow interarea, and the auriculate foramen are very similar in both species.

*Woodwardirhynchia pseudonorvicensis* n. sp. is less transversely oval, is a little more dorsibiconvex and shows a clear cuneiform lateral profile. *Cretirhynchia norvicensis* is often more transversely oval, is slightly less dorsibiconvex and shows a lenticular lateral profile. Internal characters of *C. norvicensis* were accurately described by OWEN (1962, text-fig. 9, p. 68) and new transverse serial sections were made by SIMON & OWEN (2001, text-fig.10, p. 75). This species is *sensu stricto* a representative of the subgenus *Cretirhynchia* PETTITT, 1950 exhibiting small hinge plates, subtriangular in section and crural bases which are subquadrate. Crural bases are not inwardly concave resulting in the development of very simple hinge plates. Raduliform crura have no ''falciform''structure at mid-length. The dorsal septum is longer and higher in *C. norvicensis*.

Forked hinge plates, crura posteriorly canaliform, wide ''falciform'' structure of the crura in section at mid-length and wide straight crura anteriorly, are typical characters of *Woodwardirhynchia pseudonorvicensis* n. sp.

### Comparison with *Cretirhynchia* (*Harmignirhynchia*) *intermedia* PETTITT, 1950

Species included in the subgenus *Harmignirhynchia* SIMON & OWEN, 2001 are transversely-oval in outline, invariably much wider than long, with a lenticular anterior contour and lateral profile. *Cretirhynchia intermedia* PETTITT, 1950 which is the type species of *Harmignirhynchia*, is very dictinct from *Woodwardirhynchia pseu-*

*donorvicensis* n. sp. in being much more equibiconvex and the shell surface is ornamented with very faint costae best visible in the anterior part of the shell; in addition, the interarea is more reduced.

Internal structures of *C.* (*Harmignirhynchia*) *intermedia* are partly similar to the structures observed in *Woodwardirhynchia pseudonorvicensis* n. sp. It is noteworthy that inwardly concave crural bases are observed in transverse serial sections of *Cretirhynchia intermedia*. A wide ''falciform'' structure of the crura is present at mid-length and the crura become straight in their anterior part (SIMON & OWEN, 2001; text-figs 14, p. 84; text-fig. 15, p. 85).

Whereas, the dental plates in *C. (Harmignirhynchia) intermedia* are strongly convergent, in *Woodwardirhynchia pseudonorvicensis* n. sp. they are posteriorly parallel and slightly convergent in their anterior part. The hinge plates in *C. (Harmignirhynchia) intermedia* are thicker and anteriorly subquadrate. In *Woodwardirhynchia pseudonorvicensis* n. sp., hinge plates are ventrally concave and anteriorly forked.

OCCURRENCE
Lower Maastrichtian of southern Limburg (The Netherlands).

Family Tetrarhynchiidae, AGER, 1965
Subfamily Cretirhynchiinae KATZ, 1974

Genus ***Cretirhynchia*** PETTITT, 1950
Type species: *Terebratula plicatilis* J. SOWERBY, 1816

Subgenus ***Homaletarhynchia*** SIMON & OWEN, 2001

***Cretirhynchia (Homaletarhynchia) postarcuata*** n. sp.
Table 1; Text-Fig. 3-4; Pl. 2, Fig. 1-5.

DIAGNOSIS
Small-sized, mainly smooth rhynchonellid with subtriangular to slightly subpentagonal outline, oval-lenticular anterior contour and lenticular lateral profile. Beak extremely short, pointed and erect. Pin-hole foramen. Shell dorsibiconvex with shallow sulcus developed on anterior part. Fold poorly developed on anterior part of dorsal valve. Linguiform extension trapezoidal. Costae poorly developed just along the commissure. Dental plates strong, ventrally convergent. Dorsal septum thick, triangular in transverse section. Crura raduliform, relatively wide, strongly concave in their posterior half.

DERIVATIO NOMINIS
From ''*post*'', Latin prefix meaning ''after'', indicating that this new species is closely related to the Upper Campanian *Cretirhynchia* (*Homaletarhynchia*) *arcuata* PETTITT, 1950.

LOCUS TYPICUS
Bissen, southern Limburg, The Netherlands.

STRATUM TYPICUM
Lower Maastrichtian, Gulpen Formation, lower part of Vijlen Member,?*B. sumensis* Zone.

HOLOTYPE
NHMM GK 1204 (Table 1; Pl. 2, Fig. 3a-e) a medium-sized adult specimen (ex Felder colln.) from Bissen, southern Limburg, The Netherlands (62D-771). Lower part of the Vijlen Member, Gulpen Formation, Lower Maastrichtian (? *B. sumensis* Zone).

PARATYPES
All paratypes (ex Felder colln.) from Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member.

NHMM GK 1378 (Table 1; Text-Fig. 3; Pl. 2, Fig. 1a-e) a relatively large, adult specimen used for transverse serial sections from Zeven Wegen in Vijlenerbosch (62D-15d), ?*B. obtusa*/*B. sumensis* Zone.

NHMM GK 941 (Table 1; Text-Fig. 4, Pl. 2, Fig. 2a-e) medium-sized adult specimen used for transverse serial sections from Vijlenerbosch (62D-15), ?*B. sumensis* Zone.

NHMM GK 1375 (Table 1; Pl. 2, Fig. 4a-e) a relatively large adult specimen with a more arcuate linguiform extension from Zeven Wegen in Vijlenerbosch (62D-15d), ?*B. obtusa*/*B. sumensis* Zone.

NHMM GK 1376 (Table 1; Pl. 2, Fig. 5a-e) a smaller-sized adult specimen with a trapezoidal linguiform extension from Zeven Wegen in Vijlenerbosch (62D-15d), ?*B. obtusa*/*B. sumensis* Zone.

ADDITIONAL MATERIAL
Following 25 specimens (ex Felder colln.) are considered to be assignable to *C.* (*H.*) *postarcuata* n. sp; all are from Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation.

NHMM GK398, GK401, GK403, GK404, GK430, GK601, GK602: from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen Member (*B. sumensis* Zone), just above the belemnite graveyard.

NHMM GK419, GK421, GK 655, GK660: from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen Member (*B. sumensis* Zone).

NHMM GK692, GK697-698, GK711, GK714: from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15d), base of the Vijlen Member (?*B. obtusa*/*B. sumensis* Zone), belemnite graveyard.

NHMM GK853, GK900, GK935: from Vijlenerbosch (62D-15), Vijlen Member (*B. sumensis* Zone).

NHMM GK1062, GK1063, GK1234: from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen Member (?*Belemnella sumensis* Zone).

NHMM GK1138-GK1140: from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), No stratigraphical data but most probably Vijlen Member (?*Belemnella obtusa/Belemnella sumensis* Zone).

DESCRIPTION

External characters

Small to medium-sized (Table 1) rhynchonellid, subtriangular to slightly subpentagonal in outline, lenticular in anterior view and oval-lenticular in lateral profile. The shell is dorsibiconvex. The dorsal valve has its maximum convexity near mid-valve, while it is in the posterior part on the ventral valve. A poorly developed dorsal fold is observed in the anterior part near the commissure. A ventral sulcus is clearly visible but it is shallow and relatively short. The linguiform extension is trapezoidal, rarely arcuate. The erect beak is short but it possesses a pointed tip. The beak ridges are distinct. The hypothyrid foramen is very small, circular and surrounded by protruding conjunct deltidial plates. Interareas are not extended. Except for one, rarely two, visible growth lines, the shell surface is absolutely smooth. An incipient development of costae occurs along the commissure; about 12-14 costae with only three on the fold and two in the sulcus. The costae are better developed in the ventral sulcus than on the dorsal fold.

Internal characters

*Ventral valve*

In transverse serial sections (Text-Figs. 3-4), a development of a pedicle collar is not observed. The shell is thick set in the posterior part of the beak. Dental plates are clearly visible in section: they are thick, ventrally convergent and relatively long. The strong inner socket ridges are ventrally expanded.

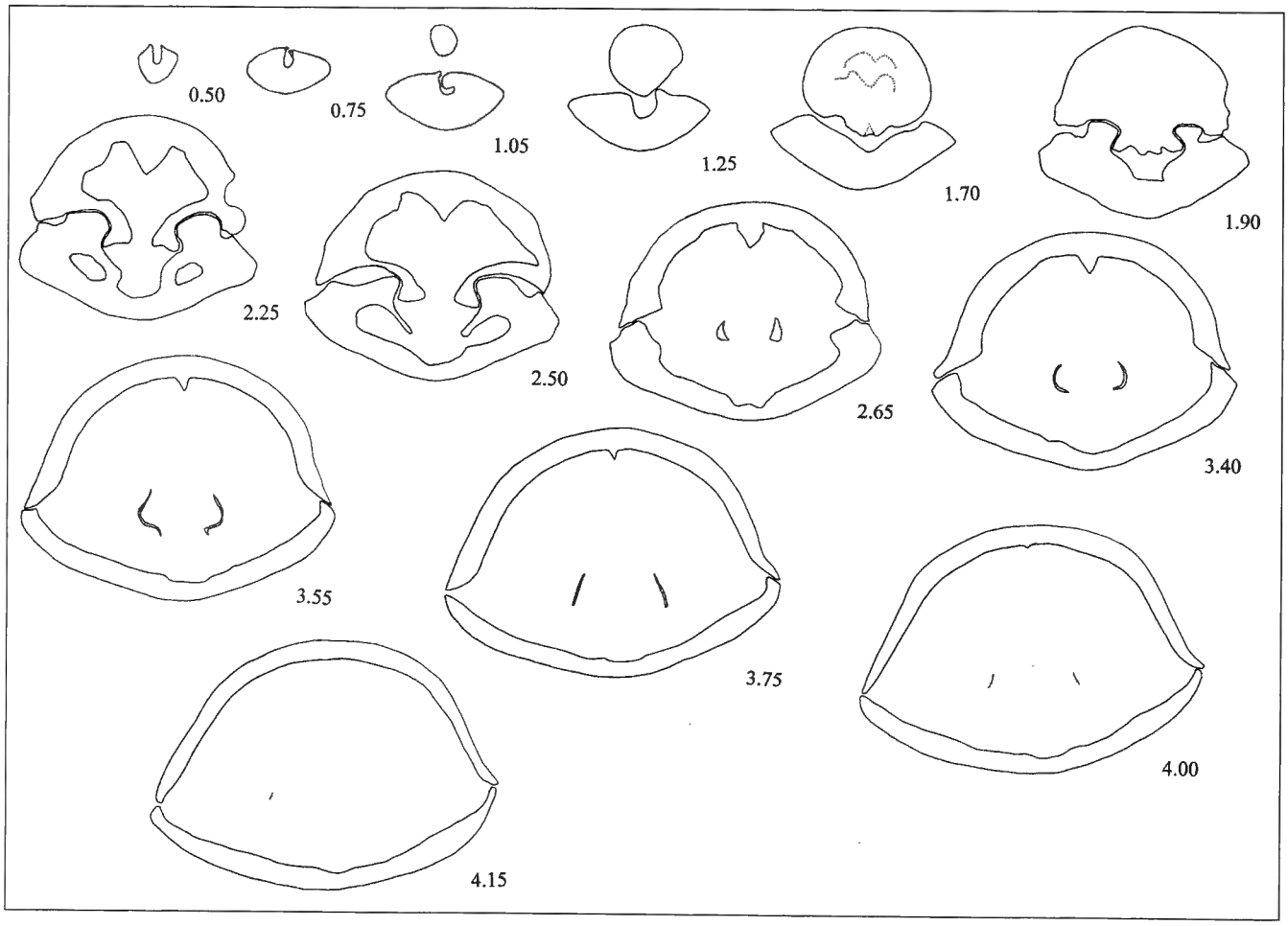


Fig. 3 — Transverse serial sections through the umbonal portion of an adult specimen (NHMM GK 1378, ex Felder colln., paratype) of *Cretirhynchia (Homaletarhynchia) postarcuata* n. sp., from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member. x 4.0

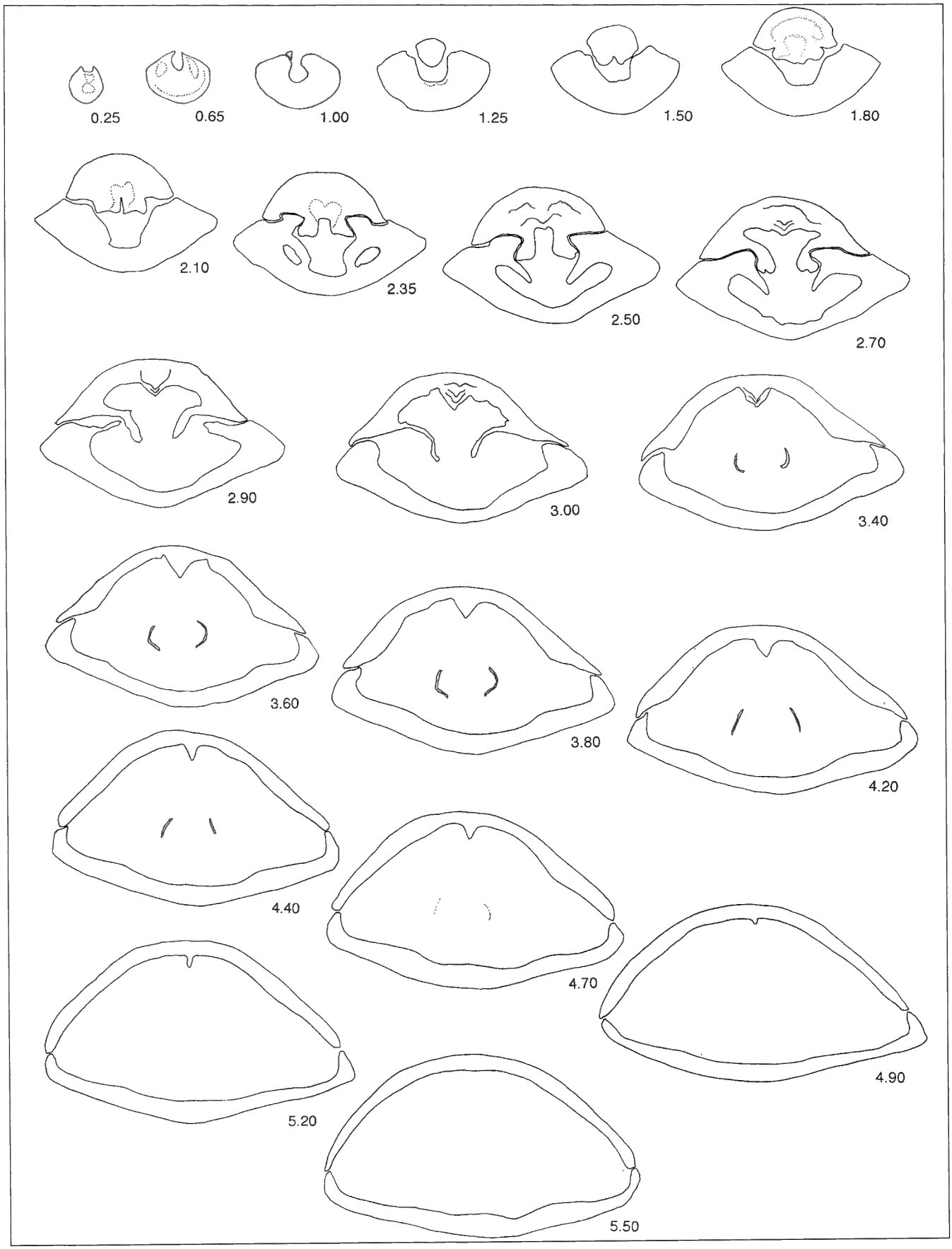


Fig. 4 — Transverse serial sections through the umbonal portion of an adult specimen (NHMM GK 941, ex Felder colln., paratype) of *Cretirhynchia (Homaletarhynchia) postarcuata* n. sp., from Vijlenerbosch (62D-15), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member. x 4.84

*Dorsal valve*

A thick septum is developed on the dorsal valve floor. In transverse section, in its median portion, it has a very broad triangular shape. Anteriorly, the septum becomes thinner and its height decreases.

Crural bases are subquadrate. The crura are inwardly concave in their posterior part. The concavity of the crura, which is fairly important in this species, is maintained throughout the posterior part, up to mid-length. Anteriorly, the crura become blade-like and narrower. The crura are very wide in this species but they do remain close, a typical feature of the subgenus *Homaletarhynchia*.

COMPARISON WITH OTHER SPECIES

Comparison with *Cretirhynchia* (*Homaletarhynchia*) *limbata* (VON SCHLOTHEIM, 1813)

*C. limbata* is a fairly common brachiopod of Early to early Late Maastrichtian age, often collected from Slenaken, there co-occurring with common specimens of *C.* (*H.*) *postarcuata* n. sp. It should be noted that examples of *C. limbata* in this area are generally small and confusion may arise.

VON SCHLOTHEIM (1813) did not provide a diagnosis. For further details see VON HANSTEIN (1879, p. 37), PETTITT (1954, p. 27), STEINICH (1965, p. 24), SIMON (1993, p. 83; 1998, pp. 183-184) and SIMON & OWEN (2001, pp. 91-95; text-fig. 19, p. 93).

*Cretirhynchia limbata* is more transversely oval in outline, shows a characteristically dome-shaped anterior view and a cuneiform lateral profile. In *C. limbata*, the antero-lateral portion of the ventral valve is always flat whereas in *C. postarcuata.* n. sp. this is convex. Radial striation occurs on the shell surface of well preserved *C. limbata* while the shell surface of *C. postarcuata* n. sp. is always smooth.

The costae in *C. limbata* are better developed than in *C. postarcuata* n. sp. The linguiform extension of *C. limbata* is V-shaped whereas it is trapezoidal in *C. postarcuata* n. sp. The beak of *C. limbata* is a little longer and less erect than that of *C. postarcuata* n. sp.

These two species also differ in their internal characters. The concavity of the crura is much stronger in *C. postarcuata* n. sp. than in *C. limbata*. The crura are much wider in *C. postarcuata* n. sp. than in *C. limbata*.

Comparison with *Cretirhynchia* (*Homaletarhynchia*) *robusta* (TATE, 1865)

This Santonian species (Woodburn, Northern Ireland) has most characters in common with *C. limbata*. SIMON & OWEN (2001, p. 99) exhaustively pointed out the distinction between these two species.

*C. robusta* and *C. postarcuata* n. sp. have a similarly narrow interarea, short costae along the commissure and a rather convex dorsal valve. However, *C. robusta* is much more dorsibiconvex than *C. postarcuata* n. sp. The ventral valve in *C. robusta* is nearly flat whereas it is gently convex in *C. postarcuata*. For this reason, in lateral profile, *C. robusta* is clearly cuneiform and *C. postar*cuata n. sp. is lenticular. The linguiform extension is U-shaped in *C. robusta* and trapezoidal in *C. postarcuata* n. sp.

These two species also differ in their internal characters. The dorsal septum in *C. robusta* is relatively shorter and lower than the septum of *C. postarcuata* n. sp., and it does not exhibit the typical, wide triangular aspect in transverse section seen in *C. postarcuata* n. sp. The crura in *C. robusta* are also narrower and less concave than those of *C. postarcuata* n. sp.

Comparison with *Cretirhynchia* (*Homaletarhynchia*) *arcuata* PETTITT, 1950

The new species is closely related to the Late Campanian *C.* (*H.*) *arcuata*. For direct comparison, a paratype of *C. arcuata* from Mousehold Pit, Norwich (Norfolk, England) is illustrated on Pl. 2, Fig. 6.

It is fairly difficult to distinguish *C. arcuata* and *C. postarcuata* n. sp. when only external characters are taken into account. However, *C. postarcuata* n. sp. is subtriangular in outline, lenticular in anterior contour whereas *C. arcuata* is more transversely oval in outline and widely oval in anterior contour. The linguiform extension of *C. arcuata* is arcuate whereas those of *C. postarcuata* n. sp. is trapezoidal. However, this character is relatively variable in both species as some specimens of *C. arcuata* exhibit a trapezoidal linguiform extension and specimens of *C. postarcuata* n. sp. may show an arcuate one.

*C. arcuata* is more equibiconvex than *C. postarcuata* n. sp. which is more dorsibiconvex. The beak of *C. arcuata* is generally more curved but specimens of *C. postarcuata n. sp.* with an evenly erected beak are occasionally observed (Pl. 2, Fig. 1a-e).

In transverse serial sections, *C. arcuata* is more equally biconvex in its posterior part (SIMON & OWEN, 2001; text-fig. 22, p. 96) than *C. postarcuata* n. sp. which shows a more lenticular shape in posterior sections.

Comparison with *Cretirhynchia* (*Homaletarhynchia*) *undulata maastrichtiensis* SIMON & OWEN, 2001.

*Cretirhynchia* (*Homaletarhynchia*) *undulata maastrichtiensis* is common in the upper Vijlen Member and co-occurs with *C.* (*Homaletarhynchia*) *postarcuata* n. sp. Small specimens of *C. undulata maastrichtiensis.* are lenticular in anterior contour and their dorsal valve is always flatter than the dorsal valve of *C. postarcuata* n. sp. which is dome-shaped. The ventral valve of *C. undulata maastrichtiensis* exhibits a strong convexity placed near the umbo. Such a convexity is not observed in *C. postarcuata* n. sp. The shell surface of *C. undulata maastrichtiensis* is ornamented with a faint radial striation whereas the shell surface of *C. postarcuata* n. sp. is smooth.

Serial transverse sections of *C. undulata maastrichtiensis* presented by SIMON (1993, text-fig. 5, p. 80) show narrow crura which have no strong concavity in contrast to *C. postarcuata* n. sp. Moreover, small dorsal umbonal chambers are observed in sections of *C. undulata maastrichtiensis* whereas such are absent in *C. postarcuata* n. sp.

OCCURRENCE
Lower Maastrichtian of southern Limburg (The Netherlands).

Order Terebratulida WAAGEN, 1883
Suborder Terebratulidina WAAGEN, 1883
Superfamily Terebratuloidea GRAY, 1840
Family Terebratulidae GRAY, 1840
Subfamily Nerthebrochinae COOPER, 1983

Genus ***Nerthebrochus*** COOPER, 1983
Type species: *Terebratula robertoni* D'ARCHIAC, 1847

NOTE
The original diagnosis of the genus (COOPER 1983, p. 206) is not very restrictive: "Unequally convex, rectimarginate to uniplicate terebratulaceans having loop with outer hinge plates attached along dorsal edge of crural bases." The material studied here fits this diagnosis as do also other characters of the type species, *Nerthebrochus robertoni* (D'ARCHIAC, 1847) such as a very short loop, wide and concave outer hinge plates attached to the dorsal side of crural bases, non-extended crural processes and broad transverse band, also found in the material described here. For the time being, the new species is left in this genus.

***Nerthebrochus ovalis*** n. sp.
Tables 2-3; Text-Fig. 5; Pl. 1, Fig. 4-6; Pl. 3, Fig. 1.

DIAGNOSIS
Slightly ventribiconvex, elongate-oval, rectimarginate shell with slightly concave lateral commissure. Beak erect, with medium-sized mesothyrid foramen. Symphytium nearly concealed. Inner socket ridges outwardly curved. Outer hinge plates ventrally concave, attached to the dorsal sides of crural bases. Loop very short (LI/LD: 0.24) with non-extended crural processes, anterior to mid-loop and relatively broad transverse band.

DERIVATIO NOMINIS
From "*ovalis*" indicating an oval outline.

LOCUS TYPICUS
Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands.

STRATUM TYPICUM
Base of the Vijlen Member (Gulpen Formation, Lower Maastrichtian)

HOLOTYPE
NHMM GK1358B (Table 2; Pl. 3, Fig. 1a-e) adult specimen from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa/B. sumensis* Zone).

PARATYPES
All paratypes (ex Felder colln.) from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa/B. sumensis* Zone).

NHMM GK1341 (Tables 2-3; Text-Fig. 5; Pl. 1, Fig. 4a-e) an adult specimen used for transverse serial sections.

NHMM GK1339 (Table 2; Pl. 1, Fig. 5a-e) an adult specimen used for transverse serial sections but the loop was broken and incomplete.

NHMM GK720 (Table 2; Pl. 1, Fig. 6a-e) a smaller specimen.

ADDITIONAL MATERIAL (ex Felder colln.)
NHMM GK435, (Table 2) an adult specimen with a slightly more convex dorsal valve from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (?*B. obtusa/B. sumensis* Zone).

NHMM GK533 (Table 2) an adult specimen slightly compressed, without exact provenance, but probably from the Vijlen Member (Gulpen formation).

NHMM GK825, GK879 (Table 2.) adult specimens from Vijlenerbosch (62D-15), southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (*B. sumensis* Zone?).

NHMM GK1355A (Table 2), adult specimen with a more labiate foramen, from Zeven Wegen in Vijlenerbosch (62D-15d), southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa/B. sumensis* Zone).

DESCRIPTION

External characters
The shell is elongate-oval in outline, with greatest width anterior to mid-valve. It is slightly ventribiconvex, giving an unequal lenticular aspect in anterior contour and in lateral profile. All specimens studied have a rectimarginate anterior commissure. The lateral commissure is generally straight but sometimes a very slight dorsal concavity is visible. The shell surface is smooth except for several growth lines. The beak is strong, relatively long and erect. The beak ridges are visible but relatively weak.

Table 2 — Measurements (in mm) of terebratulid brachiopods described and illustrated in the present paper; all housed in the Natuurhistorisch Museum Maastricht (NHMM) and from the Vijlen Member (Gulpen Formation, Lower Maastrichtian) of the Maastricht area. L: length of the shell, LDV: length of dorsal valve, W: width of the shell, T: thickness of the shell, ØF: diameter of the foramen.

| Genus and species | Reference number | Type of specimen | L mm | LDV mm | W mm | T mm | ØF mm | Type of foramen | Anterior commissure | Symphytium |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Nerthebrochus*** COOPER, 1983 | | | | | | | | | | |
| *Nerthebrochus ovalis* n. sp. | NHMM GK435 | Additional material | 18.6 | 16.2 | 12.1 | 11.1 | 0.90 | Subcircular, slightly labiate | Rectimarginate | Small, poorly exposed |
| *Nerthebrochus ovalis* n. sp. | NHMM GK533 | Additional material | 19.0 | 16.5 | 13.1 | 10.7 | 1.74 | Subcircular, slightly labiate | Rectimarginate | Small, poorly exposed |
| *Nerthebrochus ovalis* n. sp. | NHMM GK720 | Paratype; Pl. 2, Fig. 6 | 14.7 | 13.1 | 10.2 | 7.1 | 0.96 | Circular | Rectimarginate | Small, poorly exposed |
| *Nerthebrochus ovalis* n. sp. | NHMM GK825 | Additional material | 18.4 | 16.3 | 12.9 | 10.1 | 1.08 | Subcircular, slightly labiate | Rectimarginate | Small, poorly exposed |
| *Nerthebrochus ovalis* n. sp. | NHMM GK879 | Additional material | 18.5 | 15.9 | 12.2 | 8.5 | 1.44 | Subcircular, slightly labiate | Rectimarginate | Small, exposed |
| *Nerthebrochus ovalis* n. sp. | NHMM GK1339 | Paratype; Pl. 2, Fig. 5 | 18.5 | 15.9 | 13.0 | 10.0 | 1.20 | Subcircular, slightly labiate | Rectimarginate | Small, poorly exposed |
| *Nerthebrochus ovalis* n. sp. | NHMM GK1341 | Paratype; Pl. 2, Fig. 4 | 18.2 | 15.8 | 13.6 | 10.0 | 0.84 | Subcircular, slightly labiate | Rectimarginate | Concealed |
| *Nerthebrochus ovalis* n. sp. | NHMM GK1355A | Additional material | 16.3 | 14.0 | 10.7 | 10.3 | 0.84 | Subcircular, labiate | Rectimarginate | Concealed |
| *Nerthebrochus ovalis* n. sp. | NHMM GK1358B | Holotype; Pl. 3, Fig. 1 | 18.5 | 16.4 | 12.8 | 9.1 | 0.78 | Subcircular, slightly labiate | Rectimarginate | Small, poorly exposed |
| *Nerthebrochus sulcata* n. sp. | NHMM GK475 | Holotype; Pl. 3, Fig. 2 | 14.6 | 13.2 | 11.9 | 8.5 | 1.82 | Circular, not labiate | Unisulcate | Concealed |
| *Nerthebrochus sulcata* n. sp. | NHMM GK1287 | Paratype; Pl. 3, Fig. 3 | 12.7 | 11.1 | 11.2 | 8.4 | 1.14 | Circular, not labiate | Unisulcate | Concealed |
| *Nerthebrochus sulcata* n. sp. | NHMM GK553 | Additional material | 12.6 | 11.2 | 9.3 | 8.5 | 1.20 | Circular, not labiate | Unisulcate | Concealed |
| ***Carneithyris*** SAHNI, 1925 | | | | | | | | | | |
| *Carneithyris* sp. | NHMM GK1131 | Pl. 3, Fig. 5 | 27.6 | 25.1 | 20.0 | 16.0 | 0.90 | Subcircular, slightly labiate | Rectimarginate | Concealed |
| *Carneithyris* sp. | NHMM GK1229 | Pl. 3, Fig. 4 | 28.1 | 25.4 | 20.1 | 15.7 | 1.20 | Subcircular, slightly labiate | Rectimarginate | Concealed |

Table 3 — Measurements of parts of the loop made on sectioned holotypes of *Nerthebrochus ovalis* n. sp. and *Nerthebrochus sulcata* n. sp. from the Vijlen Member (Gulpen Formation) of the Maastricht area. For comparison, measurements given by COOPER (1983, table 55, p. 206) for two specimens of the type species *Nerthebrochus robertoni* (D'ARCHIAC, 1847) are given. Terminology and method of measuring follow COOPER (1983, pp. 14-15). Calculated ratios; a/LI, b/LI, c/LI, d/LI, e/LI, f/LI, e+f/LI, g/W, g/WI, WI/LI, LI/W and WI/W offer an evaluation of the relationships between loop and shell parameters. These relationships are identical to those outlined extensively by COOPER (1983, p. 15).

| **Loop parameters measured** | **Measurements** mm | |
|---|---|---|
| | *Nerthebrochus ovalis* n. sp. NHMM GK1341 | *Nerthebrochus sulcata* n. sp. NHMM GK 475 |
| Length of the loop (LI) | 3.75 | 3.90 |
| Width of the loop (WI) | 2.74 | 2.39 |
| Length to the tip of the crural process (a) | 2.15 | 2.45 |
| Length from tip of the crural process till terminal points (b) | 1.60 | 1.45 |
| Measure of outer hinge plates length ( c ) | 1.45 | 1.40 |
| Measure of crus from end of outer hinge plates to tip of the crural process (d) | 0.70 | 1.05 |
| Distance from crural process to bridge (e) | 1.10 | 1.00 |
| Length from posterior limit of transverse band to terminal points (f) | 0.50 | 0.45 |
| Width of hinge (g) | 3.65 | 2.57 |
| Length of transverse band at its apex (h) | 0.40 | 0.20 |
| Length of the dorsal valve (LD) | 18.2 | 13.2 |
| Width of the shell and dorsal valve (W) | 13.6 | 11.9 |
| Loop Angle (in degree) | 42° | 34° |

| **Calculated ratios** | **Values observed** | | | |
|---|---|---|---|---|
| | NHMM GK 1341 *N. ovalis* | NHMM GK 475 *N. sulcata* | USNM 550945b *N. robertoni* | USNM 551079 *N. robertoni* |
| WI/LI | 0.73 | 0.61 | 0.67 | 0.67 |
| LI/W | 0.28 | 0.33 | – | – |
| WI/W | 0.20 | 0.20 | 0.20 | 0.25 |
| LI/LD | 0.24 | 0.30 | 0.28 | 0.30 |
| a/LI | 0.57 | 0.63 | 0.61 | 0.58 |
| b/LI | 0.43 | 0.37 | 0.39 | 0.42 |
| c/LI | 0.39 | 0.36 | 0.42 | 0.42 |
| d/LI | 0.19 | 0.27 | 0.19 | 0.16 |
| e/LI | 0.29 | 0.26 | 0.19 | 0.17 |
| f/LI | 0.13 | 0.12 | 0.19 | 0.25 |
| e+f/LI | 0.43 | 0.37 | – | – |
| g/WI | 1.32 | 1.07 | 1.16 | 1.08 |
| g/W | 0.27 | 0.13 | 0.24 | 0.28 |

The mesothyrid foramen is subcircular and it is sometimes slightly labiate. The symphytium is nearly concealed but a narrow portion of it may be visible.

Internal characters (Text-Fig. 5)

A poorly developed cardinal process is visible. Sockets are short but relatively deep. The inner socket ridges are outwardly curved and they are more developed than the outer socket ridges. The outer hinge plates are simple, horizontally directed but ventrally concave. The outer hinge plates are attached to the dorsal sides of the crural bases. Inner hinge plates are not developed. The crural bases are not clearly visible but crura are relatively thick in their posterior part and show a subtriangular, thick transverse section. The crural processes are moderately developed and pointed. Tips of crural processes are anterior to mid-loop. Quite short but relatively wide, descending branches are developed from the anterior part of the crural processes. A relatively broad and arched transverse band is observed. Terminal points are extremely short. The loop in this species is fairly short (LI/LD = 0.24). It is one of the shortest loops observed in members of this subfamily. Measurements of portions of the loop are indicated in Table 3.

COMPARISON WITH OTHER SPECIES OF NERTHEBROCHINAE

Representatives of the Cenomanian genera *Harmatosia* COOPER, 1983 (pp. 196-197; pl. 19, fig. 13-22; pl. 29, fig. 8-11; pl. 67, fig. 5, 10, 11) and *Dilophosina* COOPER, 1983 (pp. 187-188; pl. 18, fig. 1-12; pl. 67, fig. 21, 22) exhibit biplicate shells and cannot be confused with *Nerthebro-*

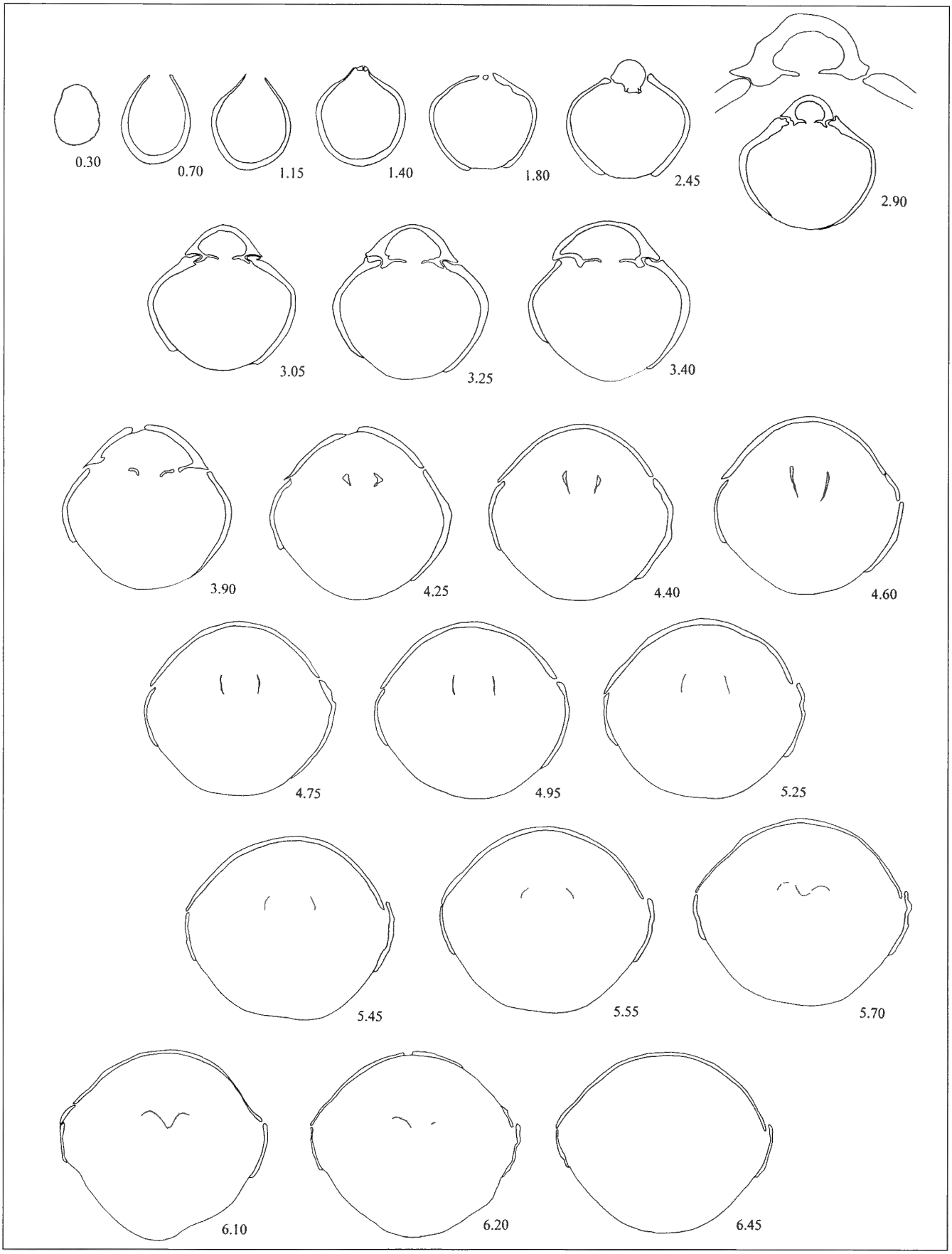


Fig. 5 — Transverse serial sections through the umbonal portion of an adult specimen (NHMM GK 1341, ex Felder colln., paratype) of *Nerthebrochus ovalis* n. sp., from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member. x 3.75

*chus ovalis* n. sp. The sulciplicate Valanginian genus *Hadrosia* COOPER, 1983 (p. 95; pl. 17, fig. 36-41; pl. 67, fig. 8, 9) is also quite distinct from *Nerthebrochus ovalis* n. sp.

Comparison with *Nerthebrochus robertoni* (D'ARCHIAC, 1847)

*Nerthebrochus ovalis* n. sp. is relatively longer and narrower than the Cenomanian type species. The dorsal valve in *N. robertoni* is nearly flat whereas in *N. ovalis* n. sp. it is convex. *N. robertoni* is slightly uniplicate and *N. ovalis* n. sp. is rectimarginate. A more gerontic specimen of *N. ovalis* n. sp. shows a truncate anterior commissure which remains rectimarginate. The loops in both species are very similar but the crural bases are more clearly visible in *N. robertoni* than in *N. ovalis* n. sp. (see COOPER, 1983, pl. 21, fig. 10-11, p. 333).

Comparison with *Najdinothyris becksi* (ROEMER, 1841)
The distinctly triangular outline of the Turonian *N. becksi* and its undulating lateral commissure preclude confusion with *Nerthebrochus ovalis* n. sp. The loop of *Najdinothyris becksi* is narrower and possesses much longer crura than *N. ovalis* n. sp.

Comparison with species of Carneithyridinae MUIR-WOOD, 1965

Comparison with representatives of the genus *Carneithyris* SAHNI, 1925.

Juvenile representatives of this genus often exhibit an external outline similar to that of *Nerthebrochus ovalis* n. sp. But, the former have a relatively smaller foramen, and internally, socket ridges are swollen, thick and erect. In *N. ovalis* n. sp., socket ridges are not swollen and they are outwardly curved. The cardinal process in species of *Carneithyris* is massive, knob-like and possesses a deeply impressed myophore divided medially by a low median ridge. The cardinal process in *Nerthebrochus ovalis* n. sp. is poorly developed. The crural bases are thick in species of *Carneithyris* div. sp. whereas they are weakly apparent in *N. ovalis* n. sp.

OCCURRENCE
Lower Maastrichtian of southern Limburg (The Netherlands).

### *Nerthebrochus sulcata* n. sp.
Table 2-3; Text-Fig. 6; Pl. 3, Fig.2-3.

DIAGNOSIS
Ventribiconvex, widely oval, slightly sulcate shell. Beak short, truncate, suberect with permesothyrid medium-sized, circular foramen. Symphytium concealed. Inner socket ridges short, strong and straight in section. Outer hinge plates ventrally directed and strongly concave, attached to the dorsal sides of crural bases. Loop short (LI/LD: 0.30) with crural processes anterior to mid-loop. Transverse band highly arched with flat median part.

LOCUS TYPICUS
Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen (southern Limburg, The Netherlands)

STRATUM TYPICUM
Base of Vijlen Member (Gulpen Formation, Lower Maastrichtian)

HOLOTYPE
NHMM GK 1287 (Table 2; Pl. 3, Fig. 3a-e) a gerontic adult specimen (ex Felder colln.) from Slenaken-Kerkdel (62C-15), southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (*?B. obtusa/B. sumensis* Zone).

PARATYPE
NHMM GK 475 (Tables 2, 3; Text-Fig. 6; Pl. 3, Fig. 2a-e) an adult specimen (ex Felder colln.) used for transverse serial sections, from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (*?B. obtusa/B. sumensis* Zone).

ADDITIONAL MATERIAL
NHMM GK553 (Table 2), gerontic (?) specimen (ex Felder colln.) with stronger growth lines without provenance data, but probably from the Vijlen Member (Gulpen formation).

DESCRIPTION

External characters
This very rare terebratulid is oval to subpentagonal in outline. This shell is relatively wide (W/L: 0.82), with its greatest width at mid-valve. The shell is slightly ventribiconvex, giving an asymmetrical lenticular appearance in anterior view and in lateral profile. The anterior commissure is unisulcate and the lateral commissure is straight. In gerontic specimens, the lateral commissure becomes dorsally concave. The dorsal valve is rather convex. The beak is short, truncate, strong and suberect. The beak ridges are visible and the foramen is relatively large, circular, permesothyrid and not labiate. The symphytium is totally hidden. The shell surface is smooth, except for sharp growth lines, regularly placed on the shell surface.

Internal characters
The loop observed in this species is very short (LI/LD: 0.30). A cardinal process is weakly developed: it is flat and rather short. The sockets are wide, not elevated. The inner sockets ridges are straight and subtriangular in transverse section. They are rather short. The outer hinge plates are ventrally directed, concave and attached to the

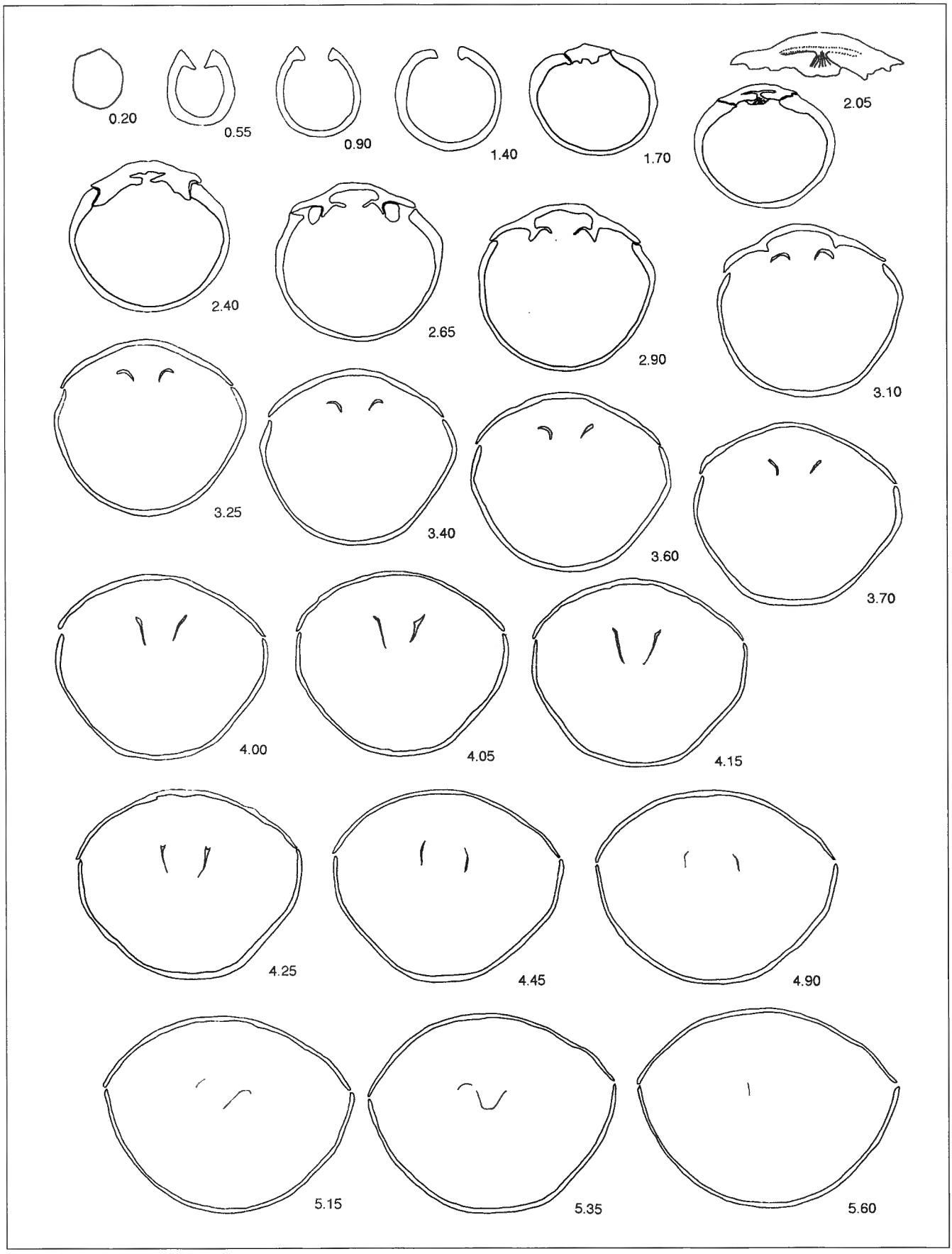


Fig. 6 — Transverse serial sections through the umbonal portion of an adult specimen (NHMM GK 475, ex Felder colln., holotype) of *Nerthebrochus sulcata* n. sp., from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member. X 5.1

dorsal sides of the crural bases. Inner hinge plates are not developed. The crural bases are not very distinct . Crura are very short and crural processes moderately high and pointed. Tips of the crural processes are anterior to mid-loop. The descending branches are extremely short. The transverse band is highly arched and its median part is flat. Terminal points are not developed.

Comparison with *Nerthebrochus robertoni* (D'ARCHIAC, 1847)

The beak in *Nerthebrochus robertoni* is longer than that in *N. sulcata* n. sp. The anterior commissure in the former is very slightly uniplicate whereas that of *N. sulcata* n. sp. is clearly unisulcate. The dorsal valve is less convex in *N. robertoni* than in *N. sulcata* n. sp. The cardinal process is better developed in *N. robertoni* than in *N. sulcata* n. sp.

OCCURRENCE
Lower Maastrichtian of southern Limburg (The Netherlands).

Family Gibbithyrididae MUIR-WOOD, 1965
Subfamily Carneithyridinae MUIR-WOOD, 1965

Genus ***Carneithyris*** SAHNI, 1925
Type species *Carneithyris subpentagonalis* SAHNI, 1925

***Carneithyris*** sp.
Table 2; Table 4; Text-Fig. 7; Pl. 3, Fig. 4-5.

MATERIAL STUDIED
NHMM GK1131 (Table 2; Pl. 3, Fig. 4a-e) adult specimen from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (?*B. obtusa*/*B. sumensis* Zone).

NHMM GK1229 (Table 2; Table 4; Text-Fig. 7; Pl. 3, Fig. 5a-e) adult specimen used for transverse serial sections, from Slenaken-Kerkdel (62C-15), southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa*/*B. sumensis* Zone).

DESCRIPTION

External characters
The shell is biconvex and elongate-oval in outline, elliptical in anterior view and regularly lenticular in lateral profile. The greatest width is at mid-valve and the anterior commissure is rectimarginate. The lateral commissure is straight. The beak is short, suberect and slightly truncate. The beak ridges are clearly visible. The permesothyrid foramen is relatively large slightly labiate. The size of the foramen is variable. When larger (Pl. 3, Fig. 5a) it appears more labiate. The symphytium is completely hidden. The shell surface exhibits numerous faint growth lines and a radial striation. This radial striation is very faint and visible only on some portions of the shell surface and under special lighting conditions (Pl. 3, Fig. 4f). The measurements of the morphological characters are given in Table 2.

Internal characters
The posterior part of the shell is strongly thickened. Teeth are large and inserted in robust socket ridges. Inner socket ridges are very thick and outer hinge plates are obscured by the development of a massive cardinal process. A deeply impressed myophore, divided by a median ridge, is posteriorly placed. Crural bases are very thick, suboval and not laterally compressed. Crura are short, posteriorly thick and ventrally convergent. The crural processes are moderately long and pointed, anteriorly deflected. The descending branches are short and inwardly concave. They support a strongly arched transverse band with a narrowly rounded median crest. Measurements of loop parameters are indicated in Table 4.

COMMENTS
The range of variation within the genus *Carneithyris* is very large. ASGAARD (1975) exhaustively revised the material studied previously by SAHNI (1925), and concluded that only a single genus and two species were valid. For ASGAARD (1975, p. 360) the subfamily Carneithyridinae contains only *Carneithyris* SAHNI (1925) with two species, *C. carnea* (J. SOWERBY, 1812) and *C. subcardinalis* (SAHNI, 1925).

Recently, SIMON (1998, pp. 199-200) studied a large population collected from the phosphatic chalk of Ciply, and on that basis also accepted *Carneithyris ciplyensis* (SAHNI, 1929) as a valid Lower Maastrichtian species. All above-mentioned species have a smooth shell surface and their foramen is rarely labiate.

The new material described here possesses distinct external characters such as a faintly developed radial striation on the shell surface and a slightly labiate, permesothyrid foramen. These characters are more commonly found in representatives of the genus *Neoliothyrina* SAHNI, 1925. Yet, the internal characters such as the swollen cardinal process, the thickened socket ridges, thick outer hinge plates, absence of inner hinge plates and the general outline of the loop confirm that this brachiopod should be assigned to *Carneithyris*.

This material is uncommon in the Lower Maastrichtian deposits of southern Limburg (The Netherlands); it is also known from the Lower Maastrichtian (*B. obtusa* Zone) phosphatic chalk of Ciply (Province of Hainaut, Belgium). It is left in open nomenclature because of limited sample size.

OCCURRENCE
Lower Maastrichtian (probably *B. obtusa* Zone) in southern Limburg (The Netherlands).

Suborder Terebratellidina MUIR-WOOD, 1955
Superfamily Kingenoidea ELLIOTT, 1948
Family Kingenidae ELLIOTT, 1948

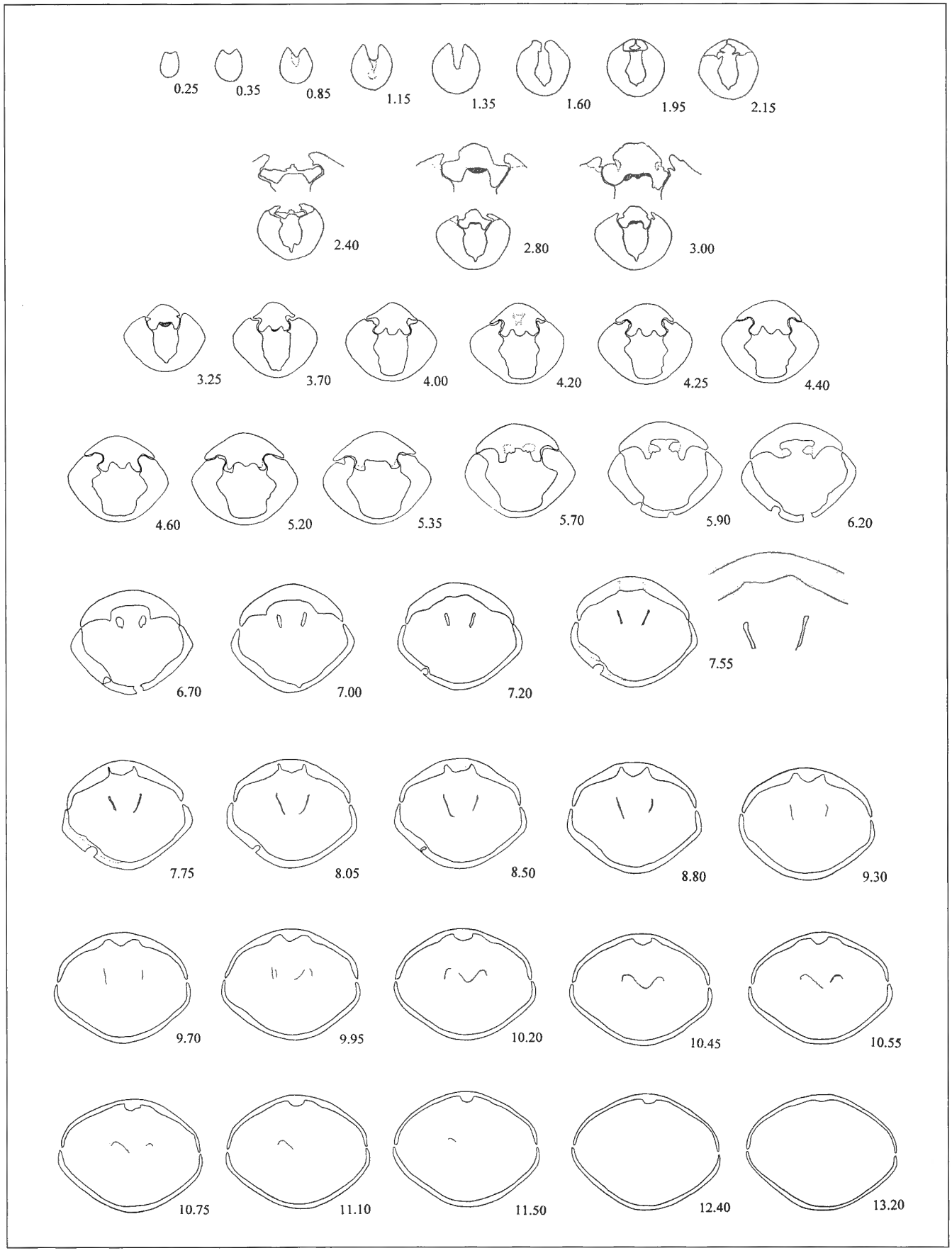


Fig. 7 — Transverse serial sections through the umbonal portion of an adult specimen (NHMM GK 1229, ex Felder colln.) of *Carneithyris* sp., from Slenaken-Kerkdel (62C-15), southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member. x 1.54

Table 4 — Measurements of parts of the loop made on sectioned paratype of *Carneithyris* sp. from the Vijlen Member (Gulpen Formation) of the Maastricht area. For comparison, measurements given by COOPER (1983, table 46, p. 181) for one specimen of *Carneithyris carnea* (J. SOWERBY, 1812) are given. Terminology and method of measuring follow COOPER (1983, pp. 14, 15). Calculated ratios; a/LI, b/LI, c/LI, d/LI, e/LI, f/LI, e+f/LI, g/W, g/WI, WI/LI, LI/W and WI/W offer an evaluation of the relationships between loop and shell parameters. These relationships are identical to those outlined extensively by COOPER (1983, p. 15).

| **Loop parameters measured** | **Measurements** mm |
|---|---|
| | *Carneithyris* sp. NHMM GK1229 |
| Length of the loop (LI) | 8.70 |
| Width of the loop (WI) | 5.90 |
| Length to the tip of the crural process (a) | 5.45 |
| Length from tip of the crural process till terminal points (b) | 3.25 |
| Measure of outer hinge plates length ( c ) | 2.50 (difficult to measure) |
| Measure of crus from end of outer hinge plates to tip of the crural process (d) | 1.35 |
| Distance from crural process to bridge (e) | 2.15 |
| Length from posterior limit of transverse band to terminal points (f) | 1.10 |
| Width of hinge (g) | 3.80 |
| Length of transverse band at its apex (h) | 0.35 |
| Length of the dorsal valve (LD) | 25.40 |
| Width of the shell and dorsal valve (W) | 20.10 |
| Loop Angle (in degree) | 41° |

| **Calculated ratios** | **Values observed** | |
|---|---|---|
| | *Carneithyris* sp. NHMM GK1229 | *C. carnea* USNM32125a |
| WI/LI | 0.68 | 0.76 |
| LI/W | 0.43 | – |
| WI/W | 0.29 | 0.21 |
| LI/LD | 0.34 | 0.27 |
| a/LI | 0.63 | 0.64 |
| b/LI | 0.37 | 0.36 |
| c/LI | 0.29 (?) | 0.36 |
| d/LI | 0.16 | 0.28 |
| e/LI | 0.25 | 0.21 |
| f/LI | 0.13 | 0.15 |
| e+f/LI | 0.37 | – |
| g/WI | 0.64 | 1.12 |
| g/W | 0.19 | 0.24 |

Genus ***Kingena*** DAVIDSON, 1852
Type species: *Terebratula lima* DEFRANCE, 1828

***Kingena limburgica*** n. sp.
Table 5; Pl. 6, Fig. 1-3.

DERIVATIO NOMINIS
"limburgica" refers to the name of the Province of Limburg (The Netherlands).

LOCUS TYPICUS
Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands.

*Stratum typicum*: Base of the Vijlen Member (Gulpen Formation, Lower Maastrichtian).

HOLOTYPE
NHMM GK933 (Table 5; Pl. 6, Fig. 1a-g) adult specimen (ex Felder colln.) from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (?*B. sumensis* Zone).

PARATYPES
All paratypes (ex Felder colln.) are from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (?*B. obtusa*/*B. sumensis* Zone).

NHMM GK658 (Table 5; Pl. 6, Fig. 2a-e), adult specimen

NHMM GK1369 (Table 5; Pl. 6, Fig. 3a-e), juvenile specimen

ADDITIONAL MATERIAL
All specimens are from the ex Felder Collection.

NHMM GK434 (Table 5) large adult specimen from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-

Table 5 — Measurements (in mm) of terebratelloid brachiopods described and illustrated in the present paper; all housed in the Natuurhistorisch Museum Maastricht (NHMM) and from the Vijlen Member (Gulpen Formation, Lower Maastrichtian) of the Maastricht area. L: length of the shell, LDV: length of dorsal valve, W: width of the shell, T: thickness of the shell, ØF: diameter of the foramen.

| Genus and species | Reference number | Type of specimen | L mm | LDV mm | W mm | T mm | ØF mm | Type of foramen | Anterior commissure | Deltidial plates |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Kingena* Davidson, 1852** | | | | | | | | | | |
| *Kingena limburgica* n. sp. | NHMM GK434 | Additional material | 17.7 | 15.6 | 14.7 | 8.6 | 1.09 | Permesothyrid, circular | Rectimarginate | Visible, disjunct |
| *Kingena limburgica* n. sp. | NHMM GK551 | Additional material | 16.1 | 13.7 | 14.6 | 9.5 | 0.97 | Permesothyrid, circular | Rectimarginate | Visible, disjunct |
| *Kingena limburgica* n. sp. | NHMM GK933 | Holotype; Pl. 6, Fig.1 | 15.6 | 13.2 | 13.5 | 9.7 | 1.32 | Permesothyrid, circular | Rectimarginate | Visible, disjunct |
| *Kingena limburgica* n. sp. | NHMM GK658 | Paratype; Pl. 6, Fig. 2 | 17.2 | 15.3 | 15.3 | 9.8 | 1.74 | Permesothyrid, circular | Rectimarginate | Visible, disjunct |
| *Kingena limburgica* n. sp. | NHMM GK1068 | Additional material | 11.2 | 10.4 | 11.8 | 8.2 | 0.90 | Permesothyrid, circular | Rectimarginate | Visible, disjunct |
| *Kingena limburgica* n. sp. | NHMM GK1369 | Paratype; Pl. 6, Fig. 3 | 9.3 | 8.0 | 9.0 | 4.9 | 0.90 | Permesothyrid, circular | Rectimarginate | Visible, disjunct |
| ***Maastrichtiella* n. gen.** | | | | | | | | | | |
| *Maastrichtiella costellata* n. sp. | IRScNB–MI 11002 | Holotype; Pl. 5, Fig. 1 | 11.5 | 10.1 | 10.3 | 7.7 | 1.14 | Mesothyrid, circular | Slightly sulcate | Small, conjunct |
| *Maastrichtiella costellata* n. sp. | NHMM MM8298A | Paratype; Pl. 4, Fig. 1 | 12.1 | 10.3 | 9.4 | 9.6 | 0.96 | Mesothyrid, circular | Slightly sulcate | Small, conjunct |
| *Maastrichtiella costellata* n. sp. | NHMM GK1317 | Paratype; Pl. 4, Fig. 2 | 9.6 | 8.1 | 7.5 | 6.0 | 0.78 | Mesothyrid, circular | Slightly sulcate | Small, conjunct |
| *Maastrichtiella costellata* n. sp. | NHMM GK671 | Paratype; Pl. 4, Fig. 3 | 11.4 | 9.8 | 9.5 | 6.6 | 1.02 | Mesothyrid, circular | Slightly sulcate | Small, conjunct |
| *Maastrichtiella costellata* n. sp. | NHMM GK986 | Paratype; Pl. 4, Fig. 4 | 8.6 | 7.6 | 7.8 | 4.8 | 0.78 | Mesothyrid, circular | Sulcate | Small, disjunct |
| *Maastrichtiella costellata* n. sp. | NHMM GK1147 | Paratype; Pl. 4, Fig. 5 | 9.2 | 8.1 | 7.9 | 5.3 | 0.84 | Mesothyrid, circular | Slightly sulcate | Partly broken |
| ***Mosaethyris* n. gen.** | | | | | | | | | | |
| *Mosaethyris felderi* n. sp. | NHMM GK586 | Holotype; Pl. 5, Fig. 2 | 13.5 | 11.7 | 11.0 | 7.1 | 1.08 | Mesothyrid, circular | Rectimarginate | With deep groove, disjunct |
| *Mosaethyris felderi* n. sp. | NHMM GK593 | Additional material | 13.2 | 11.2 | 10.8 | 6.8 | 1.08 | Mesothyrid, circular | Rectimarginate | With deep groove, disjunct |
| *Mosaethyris felderi* n. sp. | NHMM GK719 | Paratype; Pl. 5, Fig. 3 | 13.7 | 11.8 | 10.7 | 6.6 | 0.96 | Mesothyrid, circular | Rectimarginate | With deep groove, disjunct |
| *Mosaethyris felderi* n. sp. | NHMM GK721 | Additional material | 12.3 | 11.2 | 10.3 | 6.5 | 1.38 | Mesothyrid, circular | Rectimarginate | With deep groove, disjunct |
| *Mosaethyris felderi* n. sp. | NHMM GK719 | Paratype; Pl. 5, Fig. 4 | 14.2 | 12.0 | 11.6 | 7.5 | 1.17 | Mesothyrid, circular | Slight. uniplicate | With deep groove, disjunct |

15b), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (?*B. obtusa/B. sumensis* Zone).

NHMM GK471, GK551 (Table 5) lack precise provenance data; they are here assumed to originate from the Gulpen Formation.

NHMM GK1068 (Table 5) internal mould showing strong dental plates and a septal pillar reaching mid-valve. Collected at the border of the Vijlenerbosch, just south of Zeven Wegen (62D-49a), Vijlen, southern Limburg, The Netherlands. Base of the Vijlen Member, Gulpen Formation, Lower Maastrichtian. (?*B. obtusa/B. sumensis* Zone).

NHMM GK1343 (Table 5) adult specimen from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa/B. sumensis* Zone), belemnite graveyard.

DIAGNOSIS

Large, pentangulate *Kingena*, strongly ventribiconvex. Anterior commissure rectimarginate. Shell surface regularly pustulate. Beak erect with beak ridges clearly defined. Permesothyrid, medium-sized foramen. Deltidial plates visible, small, triangular and disjunct. Strong dental plates present. Loop bilacunar supported by medium-sized septal pillar.

DESCRIPTION

External characters

The adult shell is relatively large (Table 5), subpentagonal in outline [juveniles subcircular], strongly ventribiconvex. The dorsal valve is gently convex with its stronger convexity in its posterior part. The strongest convexity of the ventral valve is also situated in its posterior part near mid-valve. The maximum width of the shell is situated in the posterior part of the shell. In all specimens studied, the anterior commissure is rectimarginate. The shell surface is evenly pustulate (Pl. 6, Fig. 1g). The pustules which are developed in regular rows on the shell surface have a density around 32 pustules/mm$^2$. Growth lines are present. They can be step-like or faint.

The beak is erect. The beak ridges are clearly defined albeit relatively short. The medium-sized, permesothyrid foramen is circular in outline, incomplete and attrite. The deltidial plates are visible, small, triangular and disjunct.

Internal characters

As seen from internal moulds, strong dental plates in the posterior part of the ventral valve are observed. A well-developed median septum is visible in the middle of the dorsal valve floor and it supports fused hinge plates which develop a cardinal trough. The median septum has a moderate length. It extends to the middle of the dorsal valve or just anteriorly. Loop is bilacunar as for the genus.

COMPARISON WITH OTHER SPECIES OF *Kingena*

Comparison with *Kingena pentangulata* (WOODWARD, 1833)

*K. pentagulata* is an Upper Campanian species, fairly common in white chalk facies, with a pentagonal or subpentagonal shell as well, but with the maximum width situated at mid-valve. Its beak is more curved and the deltidial plates are hidden. The beak ridges are poorly defined. The septal pillar in *K. pentangulata* is longer and is developed far beyond the middle of the dorsal valve.
In *Kingena limburgica* n. sp. the maximum width of the shell is situated in the posterior part of the shell. The deltidial plates are not obscured by the curvature of the beak. The beak ridges are clearly defined. The septal pillar is relatively shorter.

Comparison with *Kingena blackmorei* OWEN, 1970

This large species from the Lower Campanian (*Gonioteuthis quadrata* Zone) at East Harnham, Wiltshire (England) is more closely similar to *Kingena limburgica* n. sp. Both species possess clearly defined beak ridges, and visible deltidial plates.
However, the foramen of *K. blackmorei* is much larger and its dorsal valve is relatively flatter than that of *K. limburgica* n. sp.
The septal pillar in *K. blackmorei* is very long and reaches two–thirds of the length of the dorsal valve. The septal pillar in *K. limburgica* n. sp. is much shorter.

OCCURRENCE

Lower Maastrichtian of southern Limburg (The Netherlands).

Superfamily Laqueoidea THOMSON, 1927
Family uncertain

The presence of short but thick dental plates in the ventral valve and the development of a median septum in the dorsal valve with an associate teleform loop suggests placement of this new brachiopod in the superfamily Laqueoidea. However, the absence of lateral connecting bands and of interconnecting bands between the descending and ascending branches of the loop do not allow assignement to the family Laqueidae.

In discussing the familial attribution of *Maastrichtiella* n. gen., it should also be noted that this new genus developed a loop which is similar to those observed in members of the genus *Oblongarcula* ELLIOTT, 1959. In these two genera, there is no attachment with lateral connecting bands to the median septum is observed. No interconnecting bands between descending and ascending branches are developed. Moreover, in both genera, dental plates are present and the development of the cardinal process is relatively weak. The structure of socket ridges

and fused hinge plates, supported by the median septum, is also similar. This suggests that *Oblongarcula* and *Maastrichtiella* n. gen. might be placed in the same family. In this case, *Maastrichitella* n. gen. could represent a Maastrichtian evolutionary stage derived from the genus *Oblongarcula*.

Genus ***Maastrichtiella*** n. gen.
Type species: *Maastrichtiella costellata* n. sp.

DIAGNOSIS OF THE GENUS
Costellate, ventribiconvex terebratelloid, oval-subpentagonal in outline, with lenticular anterior contour and a ventrally dome-shaped lateral profile. Distinct radial areas on median portion of both valves with thicker costae. Anterior commissure slightly sulcate. Beak short and erect. Beak ridges clearly visible. Mesothyrid, circular foramen. Deltidial plates conjunct and subtriangular interarea. Dental plates present. Septal pillar developed to mid-valve, supporting fused hinge plates. Cardinal process incipiently developed. Loop long, teloform with no lateral connecting bands or interconnecting bands developed. Ascending branches extremely wide in their posterior part.

Comparison between Maastrichtiella n. gen. and other Terebratelloid genera

*Maastrichtiella* is a very distinctive genus. However, to avoid any confusion, it is useful to point out the differences between this new genus and other terebratelloid genera. Two genera contain species with oval-elongate shells in outline which are similarly costulate: *Oblongarcula* ELLIOTT, 1959 and *Arenarciarcula* ELLIOTT, 1959.

The first comprises several species. OWEN (1977) presented descriptions and transverse serial sections of three species: *O. oblonga* (J. DE C. SOWERBY, 1829) (type species, Lower Cretaceous), *O. alemannica* OWEN,1977 (Hauterivian) and *O. davidsoni* (WALKER, 1867) (Lower Greensand of Upware), which OWEN (1977, p. 233) considered to be a variety of *O. oblonga*.

Later, TITOVA (1992; pp. 166-167; text-fig. 29; pl. 75, fig. 1) erected *Oblongarcula oweni*, a Middle Cenomanian species from western Kopet Dag.
All these species are relatively small-sized, oval in outline and with a costellate shell ornament. Moreover, their beak is short, robust and erect. Their foramen is also mesothyrid with conjunct deltidial plates.

However, a careful comparison points out distinctive characters between *Oblongarcula* and *Maastrichtiella* n. gen. Members of the former have perfectly oval shells in outline with a round anterior commissure. In *Maastrichtiella* n. gen., the shell is oval-subpentagonal and the anterior commissure is gently truncate.

Internal characters are also distinctive. In the transverse serial sections of species of *Oblongarcula* presented by OWEN (1977, text-fig. 14, 16 and 17) and TITOVA (1992, text-fig. 29) the dental plates are much thinner and longer than those in *Maastrichtiella* n. gen. The cardinal process is a disc-like structure in representatives of *Oblongarcula*, whereas it is a poorly developed structure in *Maastrichtiella* n. gen. The high supporting median septum is persistent in *Oblongarcula*, whereas it is shorter and lower in *Maastrichtiella* n. gen. The structure of the crural bases is also different. They are subcircular in section in *Maastrichtiella* n. gen. whereas they appear angular in *Oblongarcula*. Finally, the structure of the loop is quite different especially when the development of the ascending branches are taken into account. OWEN (1977, text-fig. 16) illustrated complete transverse serial sections for *Oblongarcula oblonga* and it can be seen that ascending branches become nearly horizontal for a moment. In *Maastrichtiella* n. gen., ascending branches remain nearly vertical all along their development and are much wider.

Confusion with representatives of the genus *Arenaciarcula* ELLIOTT, 1959 is also possible. Species such as the Upper Aptian *A. fittoni* (MEYER, 1864) or the Cenomanian *A. beaumonti* (D'ARCHIAC, 1847) have a costate shell with an oval outline. However, the cardinal process in species of *Arenaciarcula* is well developed and appears to be bilobed as shown by OWEN (1977, text-fig. 20).

POPIEL-BARCZYK (1972, pp. 130-133) showed transverse serial sections for *A. beaumonti* (placed by her in the genus *Oblongarcula*). It can be seen that dental plates are much longer and subparallel in *A. beaumonti*. The median septum is very long and high. The loop structure is also quite different. The ascending branches in *A. beaumonti* are provided with long posteriorly directed processes which are well illustrated in POPIEL-BARCZYK (1972, text-fig. 4b; text-fig. 5b).

In *Maastrichtiella* n. gen., the cardinal process is incipiently developed. The median septum is shorter and lower. Dental plates are thick and very short. In *Maastrichtiella costellata* n. sp., long posteriorly directed processes are not developed on the posterior part of the ascending branches of the loop.

***Maastrichtiella costellata*** n. sp.
Table 5; Text-Fig. 8; Pl. 4, Fig. 1-5; Pl. 5, Fig. 1.

? 1852 *Terebratula oblonga* KNER, p. 220, pl. 3, fig.14 [*non Terebratula oblonga* (J. DE C. SOWERBY, 1829)]
.v *1860* *Terebratula knerri* - BOSQUET, N°571 (*nomen nudum*)

Note: In view of the fact that BOSQUET did not describe his material, the binomen *T. knerri* is *nomen nudum*. That author considered this species to be probably (without comments) similar to a species described by KNER (1852) as *Terebratula oblonga*. This name was preoccupied by *Terebratula oblonga* J. DE C. SOWERBY, 1829 [= *Oblongarcula oblonga* (J. DE C. SOWERBY, 1829)]. To avoid confusion, it is better to assign a new name to this taxon.

DIAGNOSIS
As for the genus.

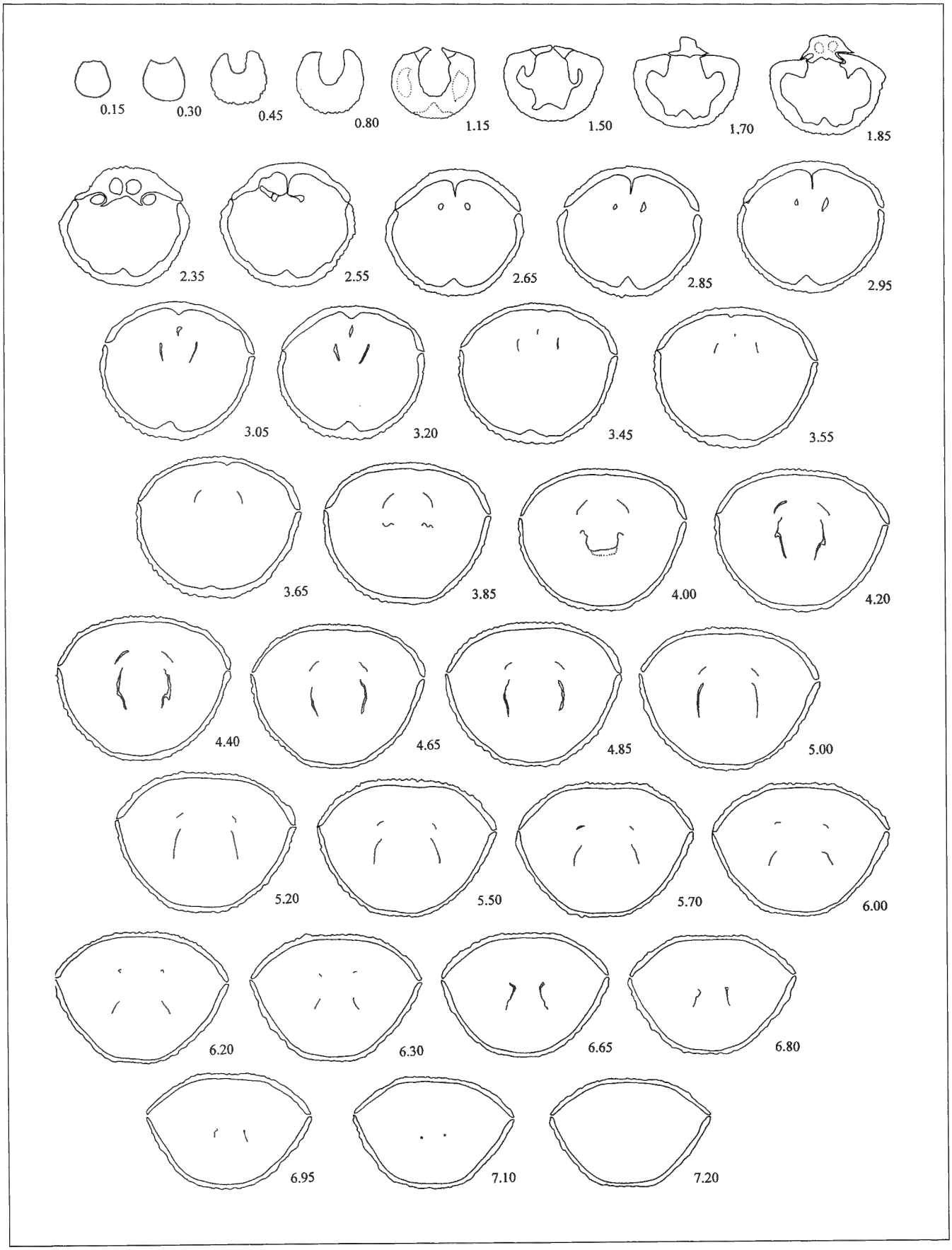


Fig. 8 — Transverse serial sections through the umbonal portion of an adult specimen (NHMM GK 1317, ex Felder colln., paratype) of *Maastrichtiella costellata* n. sp. from Slenaken-Kerkdel (62C-15), southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member. x 5.0

DERIVATIO NOMINIS
The name of the genus refers to the name of the town of Maastricht (The Netherlands) and "*costellata*" refers to the fact that numerous fine costae ornament the shell surface.

LOCUS TYPICUS
Pesaken, southern Limburg, The Netherlands.

STRATUM TYPICUM
Probably base of the Vijlen Member (Gulpen Formation, Lower Maastrichtian)

HOLOTYPE
IRScNB – MI 11002 (Table 5; Pl. 5. Fig. 1a-e) adult specimen (ex Bosquet colln.) from Pesaken, southern Limburg, The Netherlands. No precise stratigraphical data, but probably base of the Vijlen Member, Gulpen Formation, Lower Maastrichtian.

PARATYPES
All paratypes from southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation.

NHMM MM8298A (Table 5; Pl. 4, Fig. 1), adult specimen (ex Max Meyer colln.) from Slenaken-Kerkdel (62C-15), base of the Vijlen Member (?*B. obtusa/B. sumensis* Zone).

NHMM GK 1317 (Table 5; Pl. 4, Fig. 2) adult specimen (ex Felder colln.) used for transverse serial sections (Text-Fig. 8) from Slenaken-Kerkdel (62C-15), base of the Vijlen Member (?*B. obtusa/B. sumensis* Zone).

NHMM GK671 (Table 5; Pl. 4, Fig. 3) adult specimen (ex Felder colln.) from Zeven Wegen in Vijlenerbosch (62D-15d), base of the Vijlen Member (?*B. obtusa/B. sumensis* Zone).

NHMM GK986 (Table 5; Pl. 4, Fig. 4), a smaller specimen (ex Felder colln.) at younger stage of growth, more subcircular in outline from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen. Vijlen Member (?*B. sumensis* Zone).

NHMMGK1147 (Table 5; Pl. 4, Fig. 5, Pl. 6, Fig. 4), small adult specimen (ex Felder colln.), slightly more convex from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen. Vijlen Member (?*B. sumensis* Zone).

ADDITIONAL MATERIAL
NHMM MM351, one relatively small specimen (ex Max Meyer colln.) from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands (ex Felder colln.). Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa/B. sumensis* Zone).

NHMM MM8298B – MM8298K, 10 specimens (ex Max Meyer colln.) from Slenaken-Kerkdel (62C-15), southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa/ B. sumensis* Zone).

NHMM GK 1404A (ex Felder colln.) adult specimen from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands (ex Felder colln.). Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa/B. sumensis* Zone).

NHMM GK1158, (ex Felder colln. ) adult specimen from an old disused quarry (62D-104) in Malensbosch (south-east of Vijlenerbosch), Plombières, province of Liège, Belgium. No stratigraphical data, except Gulpen Formation (probably, base of the Vijlen Member).

DESCRIPTION

External characters
The shell is relatively small (Table 5), subpentagonal in outline, slightly truncate anteriorly, with an oval-lenticular anterior contour and a lenticular lateral profile. At younger stage of growth, the shell is more subcircular in outline. The shell is strongly ventribiconvex and the dorsal valve appears rather depressed. Around 40-45 costae ornament the shell surface. The costae are relatively narrow and separated by narrow intervening sulci. The thickness of the costae and the width of intervening sulci regularly increase from the umbo to the commissure. In the median part of both valves, the costae are thicker and form distinct radial areas. Nine to ten thicker costae are generally observed in these median radial zones. Occasionally, this radial zone, developed on the ventral shell surface, is slightly depressed to form a very slight ventral sulcus. The anterior commissure is slightly unisulcate. In some specimens, the ventral shell surface remains flat, with thicker median costae. In this case, the anterior commissure remains rectimarginate. The lateral commissure is ventrally concave. The beak is short but relatively stout, and erect. Beak ridges are clearly developed. The complete foramen is circular and mesothyrid. The deltidial plates are relatively high, narrow, triangular and conjunct. The interarea is distinctly delimited, has a triangular outline but is not extensive. In juveniles, the foramen may be incomplete with disjunct deltidial plates (Pl. 4, Fig. 4a).

Internal characters (Text-Fig. 8)

*Ventral valve*
The posterior part of the shell is relatively thick and the ventral umbo partially filled with secondary shell. A small pedicle collar is present in the ventral umbo but it is obscured. Dental plates are visible but they are extremely short and thick. The teeth are short but robust. They are relatively flattened in their posterior part but they

become wider and nearly subspherical in their anterior part. A strong ridge is present on the ventral valve floor.

*Dorsal valve*
A very small cardinal process, represented by a small and weak elevated structure, is seen. The sockets are wide and limited by strong outer and inner socket ridges. The hinge plates are fused and form a ventrally concave trough supported by the septal pillar. Hinge plates length is equal to the length of the inner socket ridges. The median septum is moderately long. In some specimens it is developed beyond mid-valve. In others it appears shorter. Crural bases are subcircular in section as are the posterior parts of the crura. Anteriorly, the crura are flattened and develop into the pointed, relatively short crural processes which are inwardly curved. Long descending branches are observed. No lateral connecting bands are developed. The width of the ascending branches rapidly increases from the anterior part of the loop to its posterior portion where they become very wide. The ascending branches, in transverse section, are nearly vertical. The transverse band has been observed; it is narrower than the complete loop itself. The transverse band is anterior to mid-loop. Interconnecting bands joining the descending and ascending branches are not present.

OCCURRENCE
Lower Maastrichtian of southern Limburg (The Netherlands).

Superfamily uncertain
Family Mosaethyrididae n. fam.

DIAGNOSIS
Ventribiconvex, subcircular to subpentagonal-elongate, terebratelloids with a smooth shell surface. Deltidial plates disjunct, separated from the interarea by a deep groove. Short pedicle collar present. Absence of dental plates in the posterior part of the ventral valve. Long, persistent, median septum developed, supporting fused hinge plates forming a septalium. This septalium is formed mainly by outer hinge plates. Inner hinge plates reduced. Loop trabecular.

COMMENTS
*Mosaethyris* n. gen. described below, possesses a lot of characters in common with members of the genus *Kingenella* POPIEL-BARCZYK, 1968. *Mosaethyris* n. gen. and *Kingenella* are here considered to belong to the same new family.

Species of *Kingenella* are widely distributed in the Maastrichtian of Europe. The type species, *K. pseudohebertiana* (PERON, 1895) has been recognised in the Upper Maastrichtian of Poland by POPIEL-BARCZYK (1968, pp. 73-78; text-fig. 28; pl. 19, fig.1-9; pl. 20, fig. 6a-b). There are also records from the phosphatic chalk of Ciply by SIMON (1994), who pointed out that this brachiopod was first described by PERON in 1895. *Kingenella popielae* SIMON, 2004 is known from the Kunrade Limestone (Upper maastrichtian) at Kunrade, southern Limburg, The Netherlands. *K. popielae* is also present in the Polish Upper Maastrichtian.

*Mosaethyris felderi* n. sp. is relatively common in the Lower Maatrichtian brachiopod faunas from southern Limburg (The Netherlands), and it may occur (unpublished data) at Altembroeck (Province of Limburg, Belgium) in correlative levels. Transverse serial sections need to be made in order to substantiate this observation. This group of brachiopods forms an important element of the European Maastrichtian fauna and there is now an urgent need to discuss fully their taxonomic position. Another Campanian brachiopod "*Magas*" *nilssoni* LUNDGREN, 1885 from Oppmanna (Sweden) which certainly should be assigned to a new genus (SIMON, 1994, p. 167), should be included in this discusssion. All this material represents a group which is devoid of dental plates. This group seems to be an evolutionary attempt to produce, in the northern hemisphere, a group of original brachiopods, equivalent to the Terebratellidae in the southern hemisphere. The problem is now to understand better the relationships amongst the Terebratellidina of the northern hemisphere. Knowledge of the ontogeny of species of *Kingenella* and *Mosaethyris* n. gen. would certainly help to resolve this question.

Genus ***Mosaethyris*** n. gen.
Type species: *Mosaethyris felderi* n. sp.

DIAGNOSIS OF THE GENUS
Ventribiconvex, subpentagonal-elongate shell in outline, lenticular in anterior contour and in lateral profile. Shell surface smooth, devoid of pustules, marked with step-like growth lines. Anterior commissure rectimarginate. Beak short, erect. Beak ridges developed. Foramen mesothyrid, medium-sized, incomplete. Deltidial plates small, separated from interarea by a deep groove. Dental plates absent. Hinge plates fused, forming a ventrally concave septalium supported by a long, persistent median septum. Outer hinge plates better developed. Inner hinge plates reduced. Crural bases, subtriangular in transverse section, not distinctly visible as ridges along the cardinal trough. Crural processes short. Narrow lateral connecting bands present. Transverse band slightly posterior to mid-loop.

Main distinctions between *Mosaethyris* n. gen and the genus *Kingenella* POPIEL-BARCZYK, 1968

Obvious external and internal distinctions are observed between *Mosaethyris* n. gen. and the genus *Kingenella* POPIEL-BARCZYK, 1968. Beak ridges in *Kingenella* are poorly developed whereas they are clearly visible in *Mosaethyris* n. gen. The shell is biconvex in *Kingenella* whereas it appears more ventribiconvex in *Mosaethyris* n. gen. The septalium of *Kingenella* is "W" shaped whereas the septalium of *Mosaethyris* n. gen. is simply concave.

***Mosaethyris felderi*** n. sp.
Table 5; Text-Fig. 9; Pl. 5, Fig. 2-5.

DERIVATIO NOMINIS
''*Mosaethyris*'' refers to the name of the River *Mosa*'', ''La Meuse'', ''De Maas'' or ''The Meuse''. The species name ''*felderi*'' is dedicated to W.M. FELDER who made this work possible thanks to his valuable collection of Maastrichtian brachiopods housed in the NHMM.

LOCUS TYPICUS
From Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands.

STRATUM TYPICUM
Base of the Vijlen Member (Gulpen Formation, Lower Maastrichtian).

HOLOTYPE
NHMM GK586 (Table 5; Pl. 5, Fig. 2), adult specimen (ex Felder colln.) from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, Vijlen Member (?*B. sumensis* Zone).

Paratypes
All paratypes (ex Felder colln.) from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa*/*B. sumensis* Zone).

NHMM GK719 (Table 5; Pl. 5, Fig. 3) adult specimen.

NHMM GK1019 (Table 5; Pl. 5, Fig. 4), adult specimen used for transverse serial sections but the remaining loop was incomplete (sections not illustrated).

NHMM GK1348 (Table 5; Pl. 5, Fig. 5), adult specimen used for transverse serial sections (Text-Fig. 9).

ADDITIONAL MATERIAL
NHMM GK436, GK592, GK593 (Table 5) adult specimens, from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member (?*B. sumensis* Zone).

NHMM GK683, GK684, GK721 (Table 5) adult specimens from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa*/*B. sumensis* Zone).

DESCRIPTION

External characters
The shell is ventribiconvex. The ventral valve is most convex at mid-valve whereas the dorsal valve is more convex in its posterior part. The shell is subpentagonal in outline with its greatest width at mid-valve or just above. The shell appears lenticular in anterior contour and in lateral profile. The dorsal valve is much more depressed anteriorly where it becomes nearly flat. The anterior commissure is rectimarginate (Pl. 5, Fig. 2d, 3d) but in some specimens it may be very slightly uniplicate (Pl. 5, Fig. 4d, 5d) A very slight concavity is observed for the lateral commissure. The shell is smooth, devoid of any pustules, but step-like growth lines (2 or 3) are distinct. The beak is very short and erect. The beak ridges are short but highly distinct. The foramen is mesothyrid, relatively small, incomplete and subcircular and often attrite. Some specimens exhibit a slightly permesothyrid foramen (Pl. 5, Fig. 5a). The deltidial plates are disjunct, very small, triangular in shape, and separated from the interarea by a deep, short groove (Pl. 5, Fig. 4f).

Internal characters (Text-Fig. 9)

*Ventral valve*
A very short pedicle collar is observed in transverse serial sections. No dental plates are developed. A ventral ridge is present on the median part of the ventral valve floor. This low ridge is rather short, its anterior end being placed at the same distance as the crural processes.

*Dorsal valve*
A minute cardinal process is incipiently developed. Sockets ridges are very short but relatively thick. Inner socket ridges are as thick as outer ones. The hinge plates are fused to the dorsal median septum resulting in the formation of a ventrally concave cardinal trough. This trough is formed mainly by the outer hinge plates. Inner hinge plates are much reduced. The transverse section made at 2.75 mm from the umbo (Text-Fig. 9) shows (see detail) that inner hinge plates are very narrow between crural bases and the ventral edge of the septal pillar. The median septum is as long as the loop. Its height regularly increases from the posterior part of the shell until the place where the lateral connecting bands are attached to it. Anteriorly, the height of the median septum regularly decreases till the end of the loop. The crural bases are thick and oval-subtriangular in transverse section. In the two specimens sectioned these crural bases are never V-shaped and they are not distinctly visible as sharp ridges along the septalium. The crura are posteriorly suboval in section and they become anteriorly thinner and inwardly concave. The crura are especially short in this species. Crural processes are rather low, pointed and slightly curved medially. The descending branches are relatively narrow and they are much shorter than ascending branches. The lateral connecting bands are very narrow. In the first specimen sectioned, they appear as narrow as 0.2 mm. In the second specimen, they are a little wider (0.3 mm). The transverse band is not clearly seen in transverse section but it is situated posteriorly to mid-loop. The transverse band must also be relatively narrow (± the half of the width of the loop). In the paratype

sectioned and presented (Text-Fig. 9), the loop has a length of 7.0 mm. The length of the dorsal valve is 11.7 mm. The length of the loop represents 59,8% of the length of the dorsal valve.

Comparison with *Kingenella pseudohebertiana* (PERON, 1895) and *Kingenella popielae* SIMON, 2004

Original illustrations of *Kingenella pseudohebertiana* (PERON, 1895) (= *K. kongieli* POPIEL-BARCZYK, 1968) can be found in PERON (1895, pl. 5, fig. 16-22). Photographs in SIMON (1994, pl. 1, fig. 1a-b, 2a-b), illustrations of Upper Maastrichtian Polish material in POPIEL-BARCZYK (1968, pl. 19, fig. 1-9; pl. 20, fig. 6). Lower Maastrichtian specimens from Ciply (Hainaut, Belgium), and from the River Svetlichnaya (Donbass, SE Ukraine) as well as Upper Maastrichtian material from Poland, are illustrated in SIMON (1994, pl. 1, fig. 1-6; pl. 2, fig. 1-6; pl. 3, fig. 1-2, 6-7; pl. 4, fig. 1-2, fig. 4-5).

The specimen illustrated in SIMON (1994, pl. 4, fig. 3) from the valley of Svetlichnaya River, Donbass, southeast Ukraine is probably not a *Kingenella pseudohebertiana* (MACKINNON, personal communication, 1997) and should be restudied on the basis of additional material. This specimen could represent another genus of the same family.

*Kingenella popielae* SIMON, 2004 is a larger species from the Kunrade Limestone at Kunrade, southern Limburg, The Netherlands. Its external characters are quite distinct: the shell is oval in outline, the beak is truncate and suberect, the foramen is larger and the shell surface is capillate. This species is illustrated with transverse serial sections in SIMON (2004, text-figure 3; pl. 2, fig.1– 7).

Shells of *K. pseudohebertiana* and of *Mosaethyris felderi* n. sp. have a generally similar aspect. They are ventribiconvex with a smooth surface showing step-like growth lines. Sometimes, they can have a similar oval-subpentagonal outline. Their foramen is mesothyrid. The long and persistent median septum is often visible through the dorsal valve in both species.

However, shells of *K. pseudohebertiana* are less ventribiconvex than shells of *M. felderi* n. sp. because the dorsal valve of the former is relatively more convex than the dorsal valve of *M. felderi* n. sp which is fairly depressed. The beak ridges in *K. pseudohebertiana* are poorly developed whereas they are clearly visible in *M. felderi*.

Striking distinctions are also visible amongst internal characters.

In *K. pseudohebertiana*, the septalium formed by the fused hinge plates and supported by the median septum is very distinctive. The crural bases in this species are V-shaped and are visible on the ventral side of the cardinal trough. In transverse section the septalium of *K. pseudohebertiana* has a "W" shape. This character which is typical of the genus *Kingenella* is also seen in the transverse serial sections of *K. popielae* SIMON, 2004. Crura in all species of *Kingenella* are V-shaped.

In *Mosaethyris felderi* n. sp., the concave septalium is simply made of the fused hinge plates supported by the high median septum. Crural bases are not distinct in this cardinal region. They are visible only on the anterior side of the septalium and they are thick, oval-subtriangular in section, never V-shaped. The crura are oval in section in their posterior part. The other characters of the loop are similar in both genera.

OCCURRENCE

Lower Maastrichtian of southern Limburg (The Netherlands).

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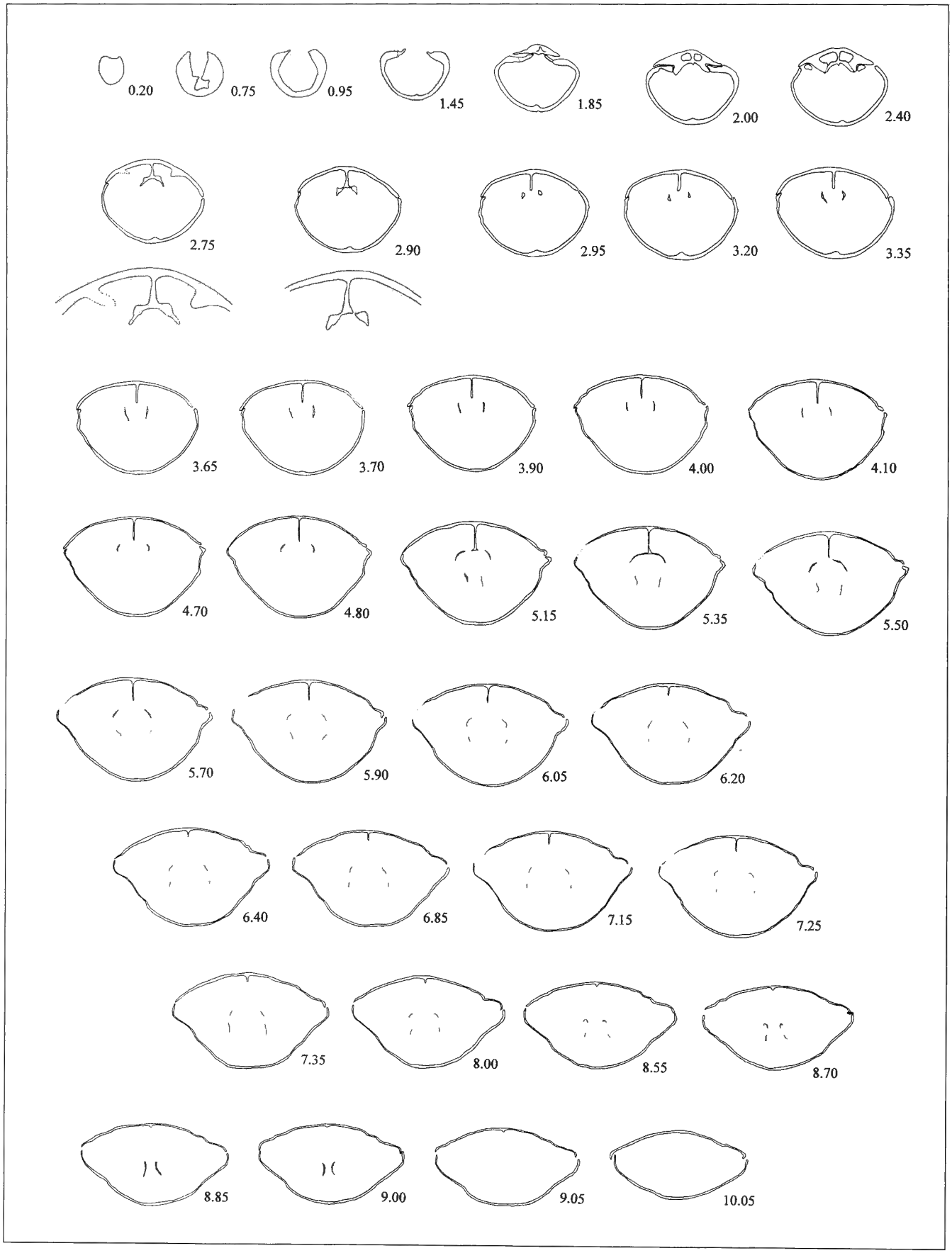


Fig. 9 — Transverse serial sections through the umbonal portion of an adult specimen (NHMM GK 1348, ex Felder colln., paratype) of *Mosaethyris felderi* n. sp. from Nieuwe Weg, Zeven Wegen in Vijlenerbosch, Vijlen, southern Limburg, The Netherlands. Lower Mastrichtian, Gulpen Formation, base of the Vijlen Member. x 3.05

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Eric SIMON
Département de Paléontologie
Section des Invertébrés fossiles
Institut royal des Sciences
naturelles de Belgique
Rue Vautier, 29
B-1000 Bruxelles
Belgique
E-Mail: ericsimon98brach@yahoo.fr

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## Explanation of Plates

### PLATE 1

*Woodwardirhynchia pseudonorvicensis* n. sp.

All material (ex Felder colln.) housed in the NHMM, collected from Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member.?*B. obtusa/B. sumensis* Zone.
a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view. (Magnification: x 1.93).

Fig. 1 — Holotype, NHMM GK394, a medium-sized adult specimen from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b).

Fig. 2 — Paratype, NHMM GK1379, a medium-sized adult specimen used for transverse serial sections ( Text-Fig. 4) from Zeven Wegen in Vijlenerbosch (62D-15d).

Fig. 3 — Paratype, NHMM GK396, a medium-sized adult specimen from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b).

*Nerthebrochus ovalis* n. sp.

All material (ex Felder colln.) housed in the NHMM collections, from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member (?*B. obtusa/B. sumensis* Zone).
a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view. (Magnification: x 2.32).

Fig. 4 — Paratype, NHMM GK1341, an adult specimen used for transverse serial sections (Text-Fig. 5).

Fig. 5 — Paratype, NHMM GK1339, an adult specimen used for transverse serial sections but the loop was broken and incomplete.

Fig. 6 — Paratype, NHMM GK720, a smaller specimen.

### PLATE 2

*Cretirhynchia* (*Homaletarhynchia*) *postarcuata* n. sp.

All material housed in the NHMM (ex Felder colln.) collected from southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view.

Fig. 1 — Paratype, NHMM GK1378, complete adult specimen, from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, used for transverse serial sections (Text-Fig. 2). ?*Belemnella obtusa/Belemnella sumensis* Zone (Magnification: x 2.35).

Fig. 2 — Paratype, NHMM GK941, smaller adult specimen, from Vijlenerbosch (62D-15), Vijlen, used for transverse serial sections (Text-Fig. 3). *B. sumensis* Zone? (Magnification: x 2.28).

Fig. 3 — Holotype, NHMM GK1204, medium-sized adult specimen from Bissen (62D-771). ?*B. sumensis* Zone (Magnification: x 2.4).

Fig. 4 — Paratype, NHMM GK1375, larger adult specimen with a more arcuate linguiform extension from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen. ? *B. obtusa/B. sumensis* Zone (Magnification: x 2.46).

Fig. 5 — Paratype, NHMM GK1376, small specimen with a trapezoidal linguiform extension from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen. ?*B. obtusa/B. sumensis* Zone. (Magnification: x 2.36).

*Cretirhynchia* (*Homaletarhynchia*) *arcuata* PETTITT, 1950

Fig. 6 — Paratype, NHM B.93163, from Mousehold Pit, Norwich, Norfolk, England. Upper Campanian. This specimen, housed in the Natural History Museum in London, has been used for transverse serial sections which are illustrated in SIMON & OWEN, 2001, text-fig. 22, p. 96. It is illustrated here for comparison with *C. postarcuata* n. sp. (Magnification: x 2.2).

## PLATE 3

All material housed in the NHMM, collected from southern Limburg, The Netherlands (ex Felder colln.). Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member, ?*B. obtusa/B. sumensis* Zone.
a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view.

*Nerthebrochus ovalis* n. sp.

Fig. 1 — Holotype, NHMM GK1358B, an adult specimen from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen (Magnification: x 2.13).

*Nerthebrochus sulcata* n. sp.

Fig. 2 — Paratype, NHMM GK475, an adult specimen used for transverse serial sections (Text-Fig. 6) from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen (Magnification: x 3.14).

Fig. 3 — Holotype, NHMM GK1287, an adult specimen from Kirkdil Slenaken (62C-15) (Magnification: x 3.21).

*Carneithyris* sp.

Fig. 4 — NHMM GK1131, adult specimen from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen. (Magnification: x 1.6). 4f: a detail of the capillate surface visible on the right side of the ventral valve (Magnification: x 5.33).

Fig. 5 — NHMM GK1229, adult specimen used for transverse serial sections (Text-Fig. 7), from Slenaken-Kerkdel (62C-15). ?*B. obtusa/B. sumensis* Zone (Magnification: x 1.6).

## PLATE 4

*Maastrichtiella costellata* n. sp.

All material housed in the NHMM collected from southern Limburg, The Netherlands.
Lower Maastrichtian, Gulpen Formation. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view.

Fig. 1 — Paratype, NHMM MM8298A, adult specimen (ex Max Meyer colln.) from Slenaken-Kerkdel (62C-15). Base of Vijlen Member. ?*B. obtusa/B. sumensis* Zone (Magnification: x 3.6).

Fig. 2 — Paratype, NHMM GK1317, adult specimen (ex Felder colln.) used for transverse serial sections (Text-Fig. 8) from Slenaken-Kerkdel (62C-15). Base of Vijlen Member. ?*B. obtusa/B. sumensis* Zone. (Magnification : x 4.6). Fig. 2a bis : details of the beak and of the foramen (Magnification: x 8.3).

Fig. 3 — Paratype, NHMM GK671, adult specimen (ex Felder colln.) from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen. Base of Vijlen Member. ?*B. obtusa/B. sumensis* Zone (Magnification: x 3.75).

Fig. 4 — Paratype, NHMM GK986, a specimen at younger growth stage (ex Felder colln.), more subcircular in outline, from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen. Vijlen Member,?*B. sumensis* Zone (Magnification: x 4.70).

Fig. 5 — NHMMGK1147, paratype, small specimen (ex Felder colln.), slightly more oval, from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b), Vijlen. Vijlen Member ,?*B. sumensis* Zone (Magnification: x 4.0).

## Plate 5

*Maastrichtiella costellata* n. sp.

a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view. (Magnification: x 3.7)

Fig. 1 — Holotype, IRScNB-MI 11002, adult specimen (ex Bosquet colln.) collected from Pesaken, southern Limburg, The Netherlands. No precise stratigraphical data, but probably base of the Vijlen Member, Gulpen Formation, Lower Maastrichtian (?*B. obtusa*/*B. sumensis* Zone).

*Mosaethyris felderi* n. sp.

All the specimens (ex Felder colln.) are housed in the NHMM.
a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view, f: detail of the foramen (Magnification: x 3.5).

Fig. 2 — Holotype, NHMM GK586, adult specimen from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15b) Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, Vijlen Member. ?*B. sumensis* Zone.

Paratypes
All paratypes from Zeven Wegen in Vijlenerbosch (62D-15d), Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of the Vijlen Member,?*B. obtusa*/*B. sumensis* Zone (Magnification: x 3.5).

Fig. 3 — NHMM GK719, adult specimen.

Fig. 4 — NHMM GK1019, adult specimen used for transverse serial sections but the loop was broken and incomplete (sections not illustrated). 4f: permesothyrid foramen and deltidial plates separated from the interarea by a deep groove (Magnification: x 7.2). This specimen is not coated with ammonium chloride.

Fig. 5 — NHMM GK1348, adult specimen used for transverse serial sections (Text-Fig. 9).

## Plate 6

*Kingena limburgica* n. sp.

All the specimens (ex Felder colln.) housed in the NHMM, from Vijlen, southern Limburg, The Netherlands. Lower Maastrichtian, Gulpen Formation, base of Vijlen Member.
a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view, f: detail of the foramen, g: detail of shell surface.

Fig. 1 — Holotype, NHMM GK933, large adult specimen from Nieuwe Weg, Zeven Wegen in Vijlenerbosch (62D-15). ?*B. sumensis* Zone. (1a-e : Magnification: x 3.54). 1f : SEM photograph showing details of the beak with sharp beak ridges and permesothyrid foramen. Deltidial plates are visible (Magnification: x 12). 1g: SEM photograph showing the regularly pustulate shell surface in the middle of the dorsal valve surface (Magnification: x 32).

Fig. 2 — Paratype, NHMM GK658, large adult specimen from Zeven Wegen in Vijlenerbosch (62D-15d),?*B. obtusa*/*B. sumensis* Zone (Magnification: x 2,86).

Fig. 3 — Paratype, NHMM GK1369, juvenile specimen from Zeven Wegen in Vijlenerbosch (62D-15d),?*B. obtusa*/*B. sumensis* Zone (Magnification: x 3.62).

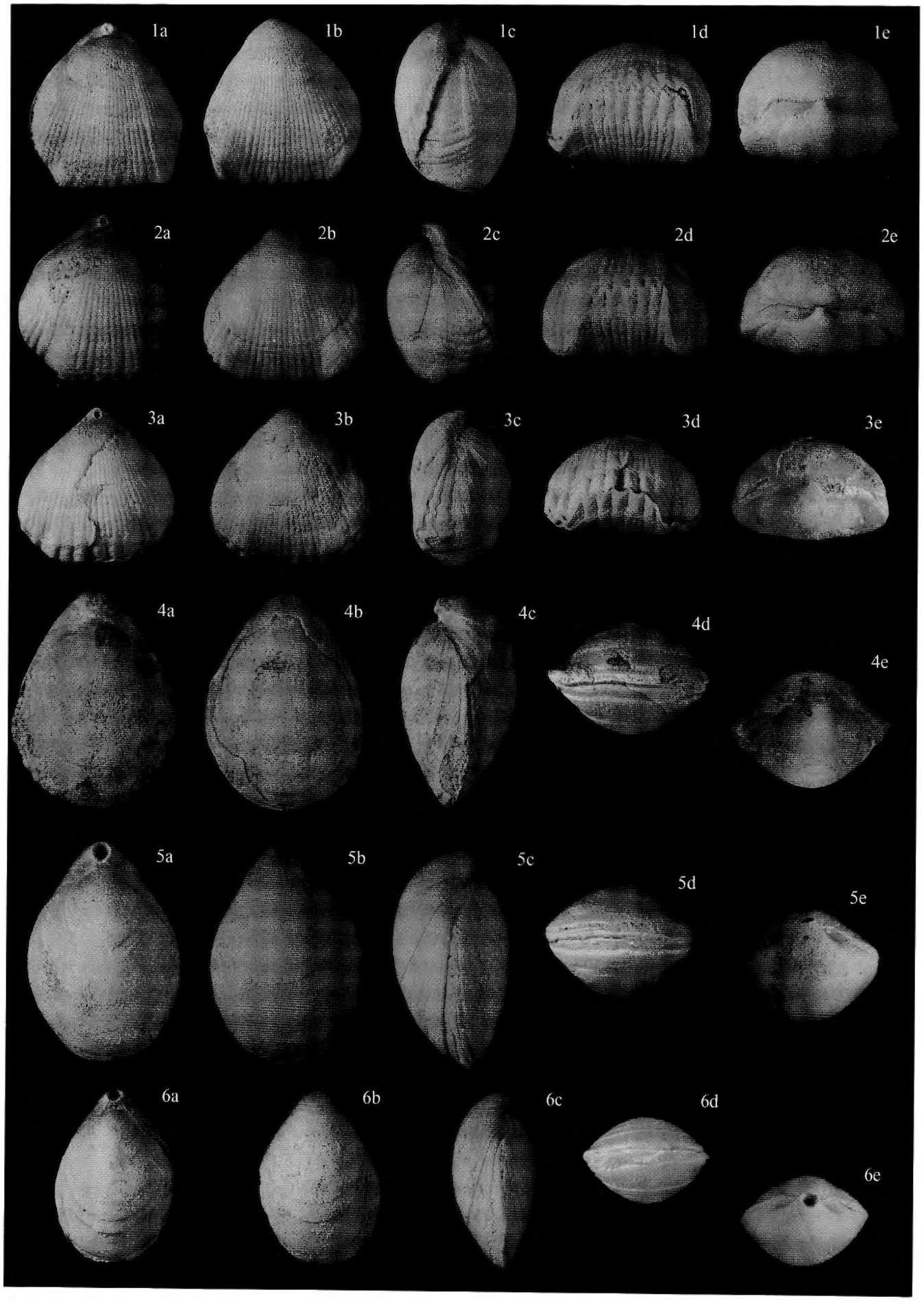
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PLATE 1

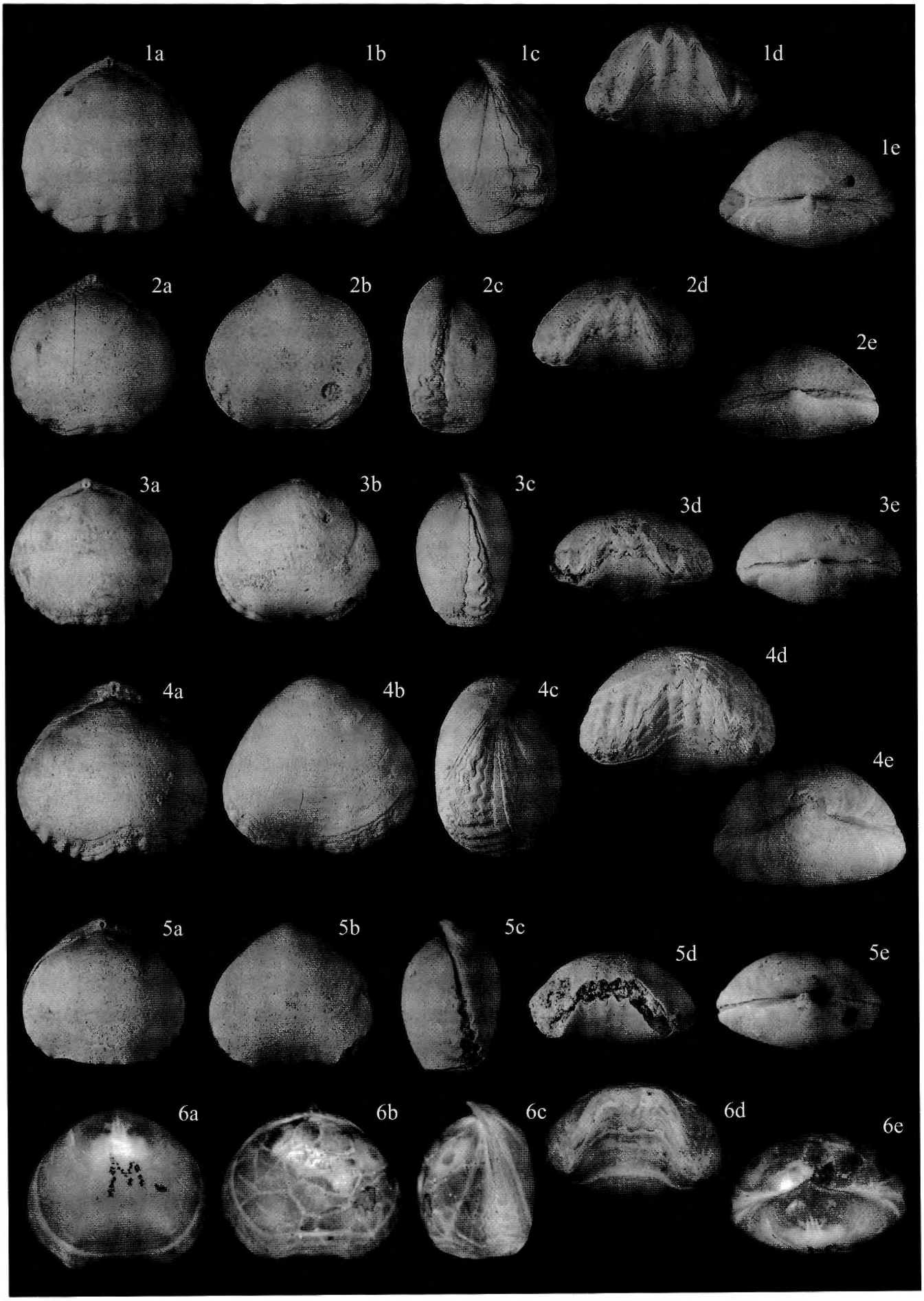
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PLATE 2

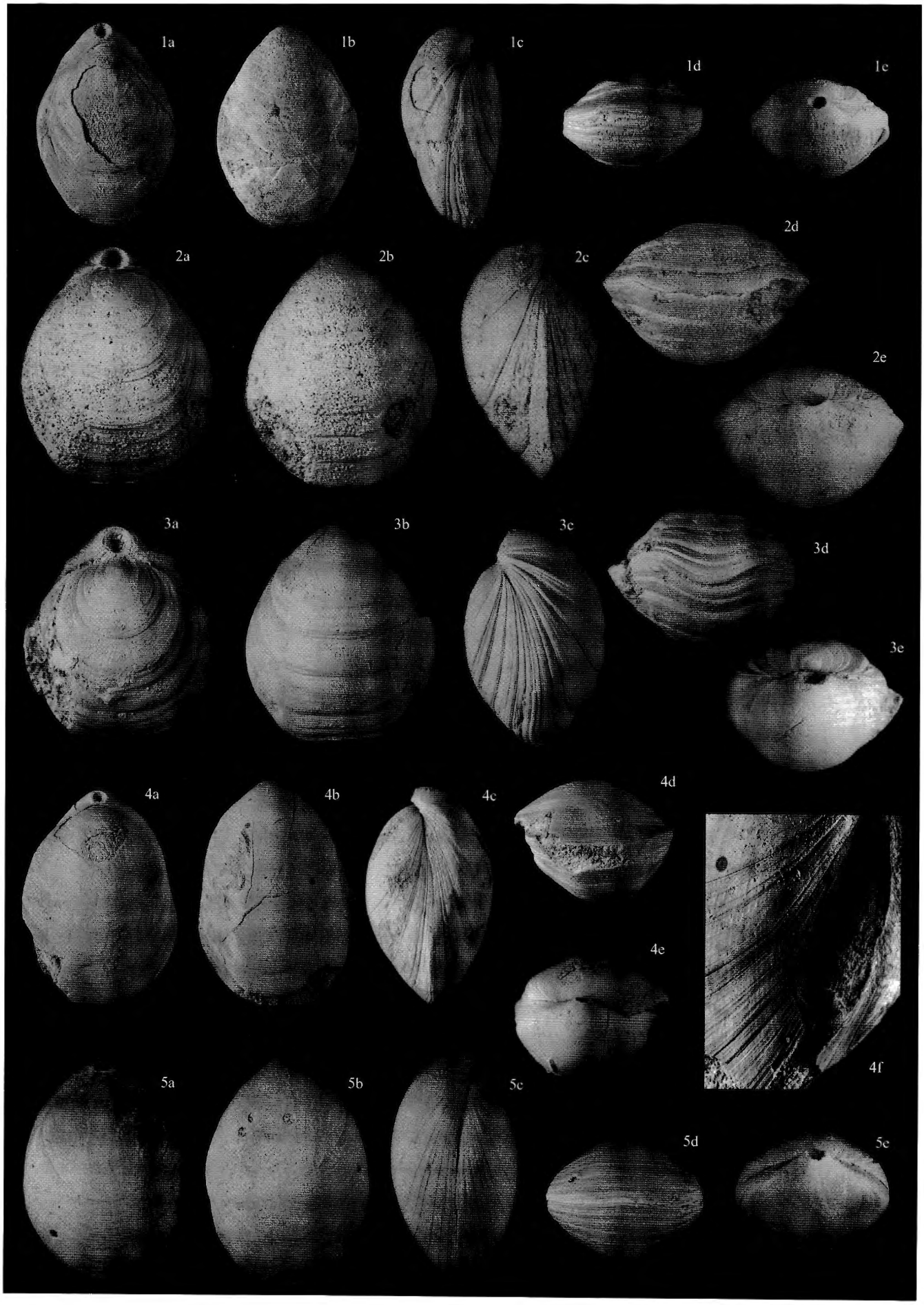
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PLATE 3

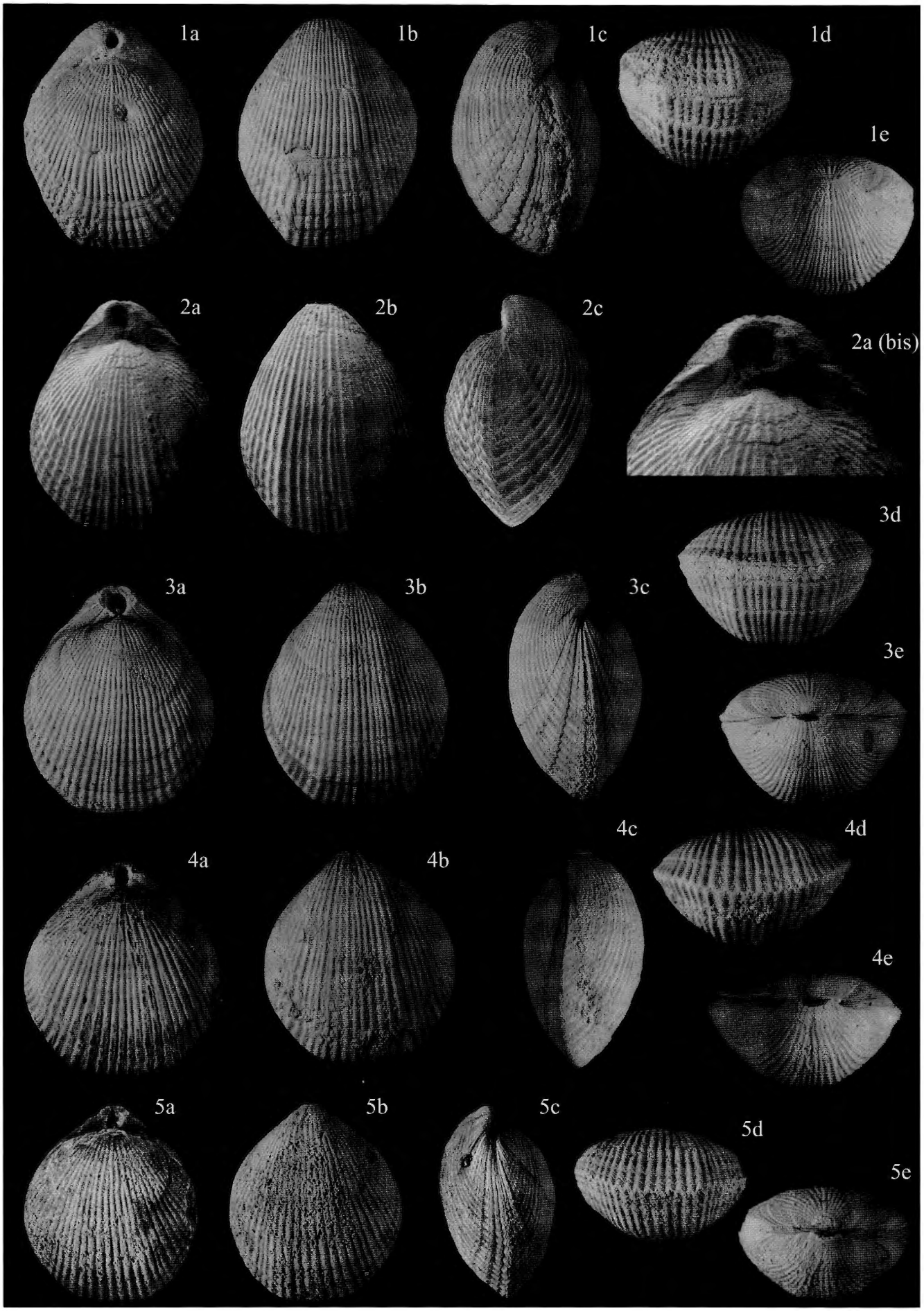
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PLATE 4

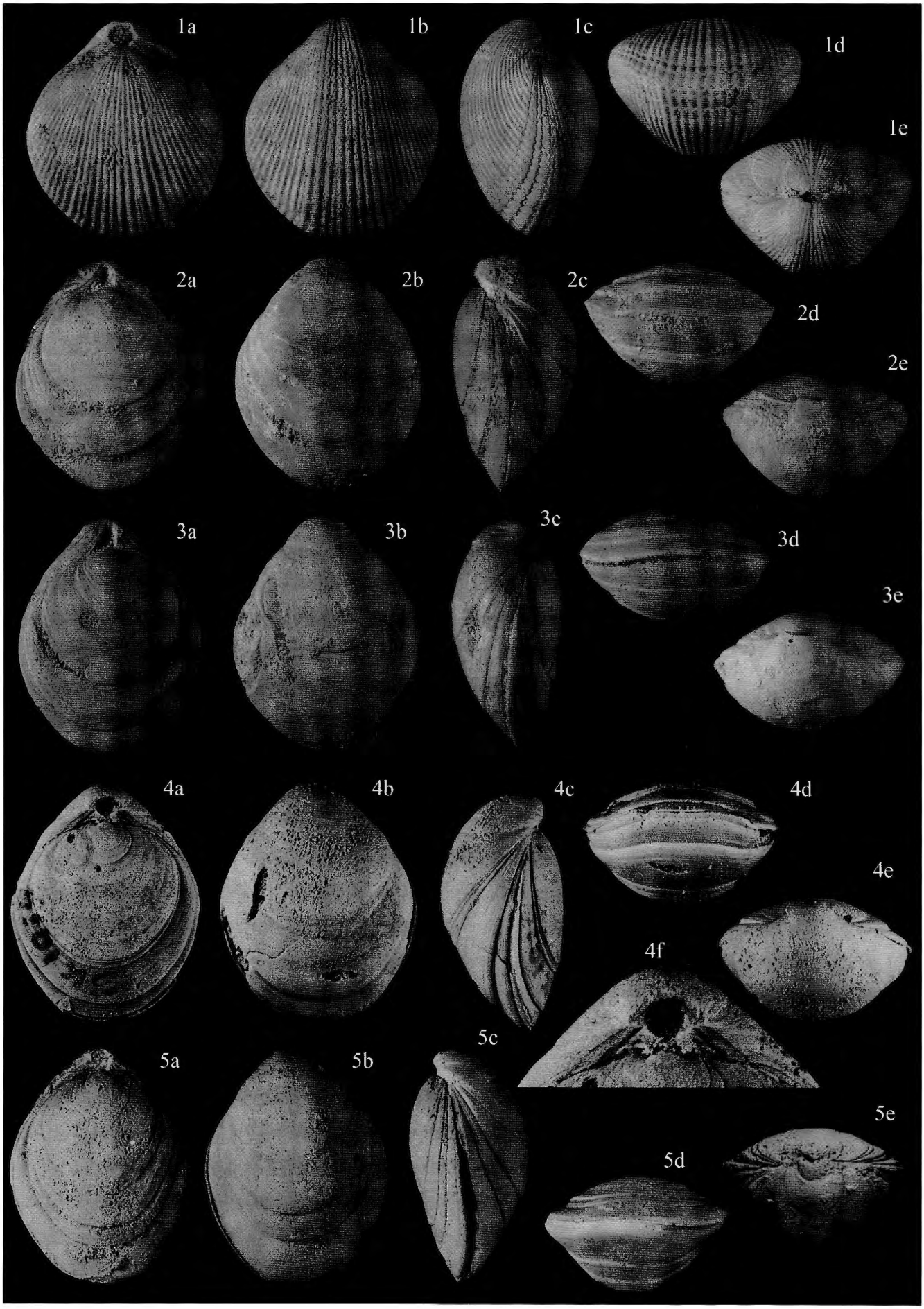
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PLATE 5

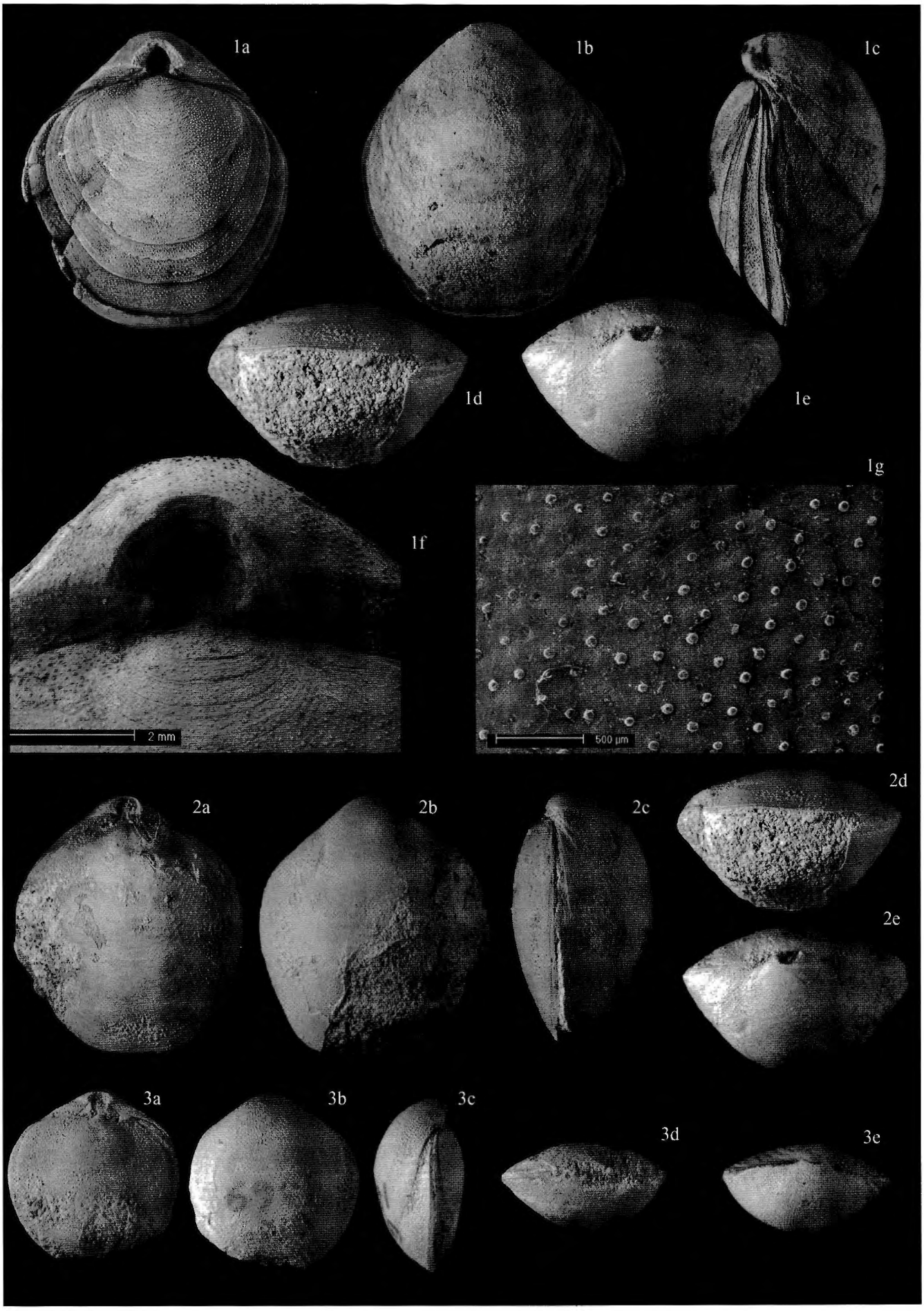


PLATE 6