A reappraisal of some large Late Maastrichtian brachiopods from Kunrade (southern Limburg, The Netherlands)

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Abstract

Three large brachiopod species of Late Maastrichtian age, collected from the Kunrade Limestone facies near Maastricht (southern Limburg, The Netherlands), are re-described. *Terebratulina carinata* VON HANSTEIN, 1879 previously only known from Ciply (Hainaut, Belgium) has now been recognised in the Kunrade material. *Terebratula dessaillyi* PERON, 1895 originally described from the Upper Maastrichtian at Ciply is amongst the largest species collected at Kunrade and is reassigned to the genus *Neoliothyrina* SAHNI, 1925. A large terebratelloid brachiopod, referred to in 1968 by POPIEL-BARCZYK as *Kingenella* sp., has now been collected also in northwest Europe. For the two last-named species, a study of the brachidia (in transverse serial sections) has allowed a reappraisal of their taxonomic affinities and a new species of *Kingenella* has been erected. The palaeoecological and stratigraphical significance of these brachiopod species are discussed.

Key-words: Brachiopods, Cretaceous, Kunrade, The Netherlands, new species.

Résumé

Trois espèces de brachiopodes de grande taille, datées du Maastrichtien Supérieur et collectées à Kunrade (Région de Maastricht, Pays-Bas) font l'objet d'une description amendée. *Terebratulina carinata* VON HANSTEIN, 1879 connue jadis que de Ciply (Hainaut, Belgique) est formellement reconnue dans le matériel collecté à Kunrade. *Terebratula dessaillyi* PERON, 1895 récoltée à l'origine dans le Maastrichtien Supérieur de Ciply, est une des espèces les plus grandes rencontrée à Kunrade. Un grand brachiopode térébratelloïde décrit en 1968 par POPIEL-BARCZYK en tant que *Kingenella* sp. a été découvert pour la première fois en Europe occidentale. Pour ces deux dernières espèces, l'étude des brachidia par les sections transversales sériées, permet d'affiner leurs positions taxonomiques. Une nouvelle espèce de *Kingenella* est érigée. Les intérêts paléoécologique et stratigraphique de ces espèces sont discutés.

Mots-clefs: Brachiopodes, Crétacé, Kunrade, Pays-Bas, espèce nouvelle.

Introduction

The stratigraphical position of the Kunrade Limestone facies in relation to the tuffaceous chalk of the Maastricht Formation has been discussed by several authors. This unit is undoubtedly of Late Maastrichtian age, as demonstrated by KENNEDY (1987, p. 159) who studied the ammonite fauna, and stressed subsequently by FELDER & BLESS (1989), who confirmed the presence of *Belemnitella junior* NOWAK, 1913. A more precise correlation between the Kunrade Limestone and the Maastricht Formation was presented by JAGT (1999, p. 18), who showed that this unit, corresponding to Ecozone IV of FELDER & BLESS (1989, fig. 3, p. 35), would best be correlated with HOFKER's (1966) benthic foraminifer zone F (cited in JAGT, 1999, p. 18). This Ecozone IV equates with the Lanaye Member (Gulpen Formation), a fact already hinted at by JAGT (1988) on the basis of crinoid distribution patterns.

The Kunrade Limestone facies is distributed in the Kunrade-Benzenrade-Heerlen area (Fig. 1), and has yielded large numbers of brachiopods. Both rhynchonellid and terebratulid species are represented. BOSQUET (1860) cited only four brachiopod species from this area, amongst which was the rhynchonellid *Rhynchonella alata* NILSSON, 1827 (*non* LAMARCK, 1819). Recently, SIMON (2003) discussed the taxonomic affinity of this brachiopod, considering it to be a new species of *Almerarhynchia* CALZADA, 1974. SENDEN (1975, pp. 25-27) stressed the gigantic size of the brachiopods from the Kunrade Limestone and was the first author to illustrate its large species of *Terebratulina* and *Terebratula* but failed to give precise diagnoses. His material is studied in the present paper. Among the taxa cited by SENDEN (1975) are *Terebratulina carinata* VON HANSTEIN, 1879 and *Terebratula dessaillyi* PERON, 1895.

The SENDEN Collection in the Natuurhistorisch Museum Maastricht (NHMM) has been restudied and large specimens of a terebratelloid brachiopod collected from Kunrade have been encountered. A careful examination of transverse serial sections and comparison of these specimens with material housed in the Museum of the Earth (Ziemi Muzeum) in Warsaw, has allowed to consider these as belonging to the Upper Maastrichtian *Kingenella* sp. from Nasiłów (Middle Vistula Valley, central Poland), already described by POPIEL-BARCZYK (1968, pp. 78-79, 86, pl. 20, figs. 7-8). This material represents a new species of *Kingenella* POPIEL-BARCZYK, 1968.

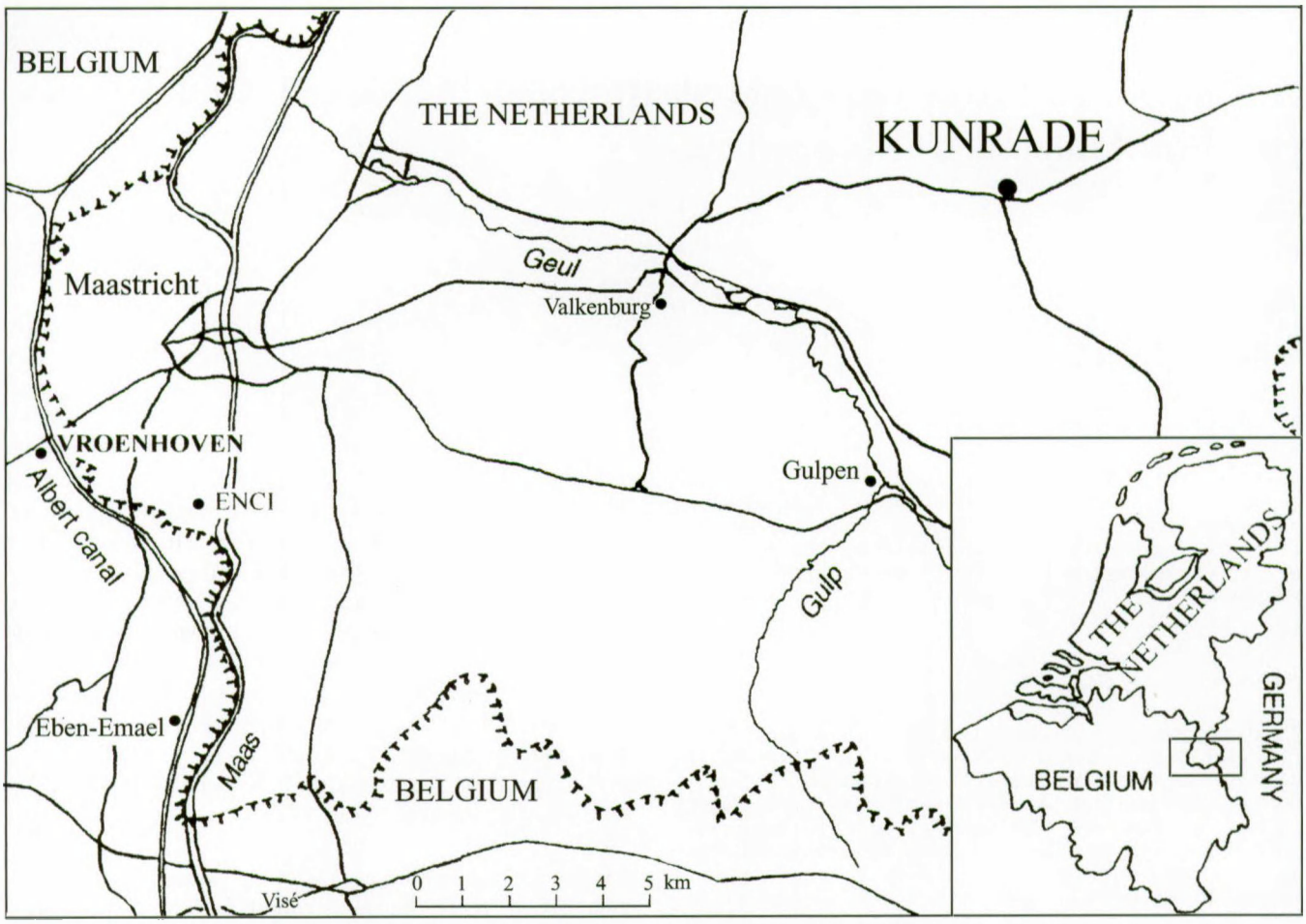


Fig. 1. — Map of southern Limburg (The Netherlands), showing the location of the Kunrade area.

Material and methods

The material studied for the present paper is housed in the Natuurhistorisch Museum Maastricht (NHMM) and at the Royal Belgian Institute of Natural Sciences in Brussels (IRScNB).

NHMM collections from the Kunrade Limestone facies are rich: terebratulids (*Terebratulina carinata* and *Terebratula dessaillyi*) are represented in the SENDEN and the W.M. FELDER collections. Terebratelloid specimens related to the genus *Kingenella* are contained in the SENDEN (10 complete individuals of different sizes) and BLEZER collections (one large, fully adult individual).

The Kunrade material at the IRScNB is not very rich, but complete and well-preserved specimens of *Terebratulina carinata* and of *Terebratula dessaillyi* (BOSQUET collection) have been studied, some of which are here illustrated. Moreover, numerous (several dozens each) brachiopods from the Ciply area (Hainaut, Belgium), identified as *Terebratulina carinata* and *Terebratula dessaillyi* have also been considered.

In 1895, PERON described *Terebratula dessaillyi* from the Craie phosphatée de Ciply; his collection at the Laboratoire de Paléontologie, Département Histoire de la Terre, Muséum national d'Histoire naturelle, Paris (France) has been revised (SIMON, 1993), and a lectotype designated.

Preparation of transverse serial sections follows the method described by AGER (1965, pp. 212-218) and peels were taken on cellulose acetate as outlined by STERNBERG & BELDING (1942). Peels of the serial sections are preserved in the NHMM collections.

Suprafamilial classification follows WILLIAMS et al. (1996). The synonymy list is presented following recommendations by MATTHEWS (1973).

Taxonomy

Phylum Brachiopoda DUMÉRIL, 1806
Subphylum Rhynchonelliformea WILLIAMS *et al.*, 1996
Class Rhynchonellata WILLIAMS *et al.*, 1996
Order Terebratulida WAAGEN, 1883
Suborder Terebratulidina WAAGEN, 1883
Superfamily Terebratuloidea GRAY, 1840
Family Terebratulidae GRAY, 1840
Subfamily Nerthebrochinae COOPER, 1983

Genus ***Neoliothyrina*** SAHNI, 1925
Type species: *Terebratula obesa* DAVIDSON, 1852, p. 53
(non J. DE C. SOWERBY, 1823, p. 54)

The terebratulid described below fits the diagnosis of *Neoliothyrina* given by SAHNI (1925, pp. 375-376) as well as the amended descriptions published by STEINICH (1965, pp. 27-34) and POPIEL-BARCZYK (1968, pp. 52-53). The remarks of COOPER (1983, pp. 205-206) concerning the development and structure of inner hinge plates in *Neoliothyrina* are also taken into account. In the Kunrade species, the structure of the posterior part of the loop is strikingly similar to that seen in sections of the type species. The outer hinge plates are narrow and ventrally concave. Crural bases are broad, flat and distinct; inner hinge plates are well developed.

Neoliothyrina dessaillyi (PERON, 1895)
Plate 1, Figures 1-3; Plate 2, Figure 8, Plate 3, Figures 1-2; Text figure 2; Tables 1, 2

non 1828 *Terebratula Sowerbyi* – DEFRANCE, p. 147
non 1842 *Terebratula Sowerbyi* n. – VON HAGENOW, p. 541, n° 15 (= *Neoliothyrina obesa* SAHNI, 1925).
v. 1874 *Terebratula Sowerbyi* – CORNET, p. 156.
v. 1879 *Terebratula Sowerbyi* – UBAGHS, pp. 117, 217.
* *v.* *1895* *Terebratula Dessaillyi* – PERON, p. 458-460, pl. 4, figs. 7-11.
. 1965 "*Terebratula*" *dessaillyi* Peron – STEINICH, p. 27
. 1965 *Terebratula Dessaillyi* – STEINICH, p. 34

DIAGNOSIS
Large biconvex, sulciplicate *Neoliothyrina* species, oval to slightly subpentagonal in outline, with a distinctly capillate shell surface on its lateral edges. Beak strong, acutely truncate and slightly suberect. Anterior commissure sulciplicate. Foramen large, circular, permesothyrid, situated in the middle of a wide, attrite surface left by the beak ridges worn away. Deltidial plates small, triangular, conjunct. Brachidium relatively short with a longitudinally broad, transverse band. Outer hinge plates narrow, ventrally concave, attached to dorsal edge of crural bases. Inner hinge plates well developed, coalescent in adult specimens in their posterior part.

Table 1 — Measurements (in mm) of *Neoliothyrina dessaillyi* (PERON, 1895), *Terebratulina carinata* VON HANSTEIN, 1879 and *Kingenella popielae* n. sp. specimens studied for present paper; all from the Kunrade Limestone facies (Upper Maastrichtian, *Belemnitella junior* Zone) at Kunrade (southern Limburg, The Netherlands), except the lectotype and paralectotype of *N. dessaillyi* which are from the Phosphatic Chalk of Ciply (Lower Maastrichtian, *Belemnella obtusa* Zone) at Ciply (Hainaut, Belgium). L - length of shell, LDV - length of dorsal valve, W - width of shell, T - thickness of shell, ØF - diameter of foramen.

Species	Reference number	Type of specimen	Remarks	L mm	LDV mm	W mm	T mm	ØF mm	W/LDV
Neoliothyrina dessaillyi	MNHN-DHT S09920	Lectotype (PERON coll.)	Adult	58.3	54.6	50.0	39.6	5.5	0.92
Neoliothyrina dessaillyi	MNHN-DHT J06801	Paralectotype (PERON coll.)	Adult	61.5	58.0	43.4	32.2	4.8	0.75
Neoliothyrina dessaillyi	IRScNB -M.I. n° 10995	Additional material (BOSQUET coll.)	Adult	59.0	54.2	47.9	34.4	6.2	0.81
Neoliothyrina dessaillyi	IRScNB -M.I. n° 10996	Additional material (BOSQUET coll.)	Adult	54.0	49.7	45.2	27.6	5.4	0.91
Neoliothyrina dessaillyi	NHMM 2004 001	Specimen sectioned	Adult	52.1	49.9	40.6	29.6	5.3	0.81
Neoliothyrina dessaillyi	NHMM 19901-242	Additional material (SENDEN coll.)	Juvenile	33.3	30.2	27.7	14.4	3.2	0.92
Terebratulina carinata	IRScNB -M.I. n° 10997	Additional material (BOSQUET coll.)	Adult	52.4	48.1	32.9	23.7	5.0	0.68
Terebratulina carinata	NHMM 2004 002	Additional material (SENDEN coll.)	Adult	44.7	42.1	29.0	23.7	4.6	0.69
Kingenella popielae n. sp.	NHMM 19901 345	Holotype (SENDEN coll.)	Large adult	34.0	30.1	28.9	17.7	5.1	0.96
Kingenella popielae n. sp.	NHMM 19901 373	Paratype sectioned (SENDEN coll.)	Large adult	28.2	24.0	23.0	15.2	3.7	0.96
Kingenella popielae n. sp.	NHMM 19901 178	Paratype (SENDEN coll.)	Medium-sized adult	27.5	25.2	23.3	13.1	4.1	0.93
Kingenella popielae n. sp.	NHMM 2004 002	Paratype (SENDEN coll.)	Medium-sized adult	25.6	21.6	22.2	12.0	4.0	1.03
Kingenella popielae n. sp.	NHMM 19901 269/1	Paratype (SENDEN coll.)	Small specimen	21.6	19.0	18.9	11.1	3.2	0.99
Kingenella popielae n. sp.	NHMM 19901 269/2	Additional material (SENDEN coll.)	Juvenile specimen	15.1	13.1	14.5	6.7	2.1	1.12
Kingenella popielae n. sp.?	NHMM BL 0586/1	Additional material (BLEZER Coll.)	Large adult	29.7	25.6	23.3	16.6	3.8	0.91

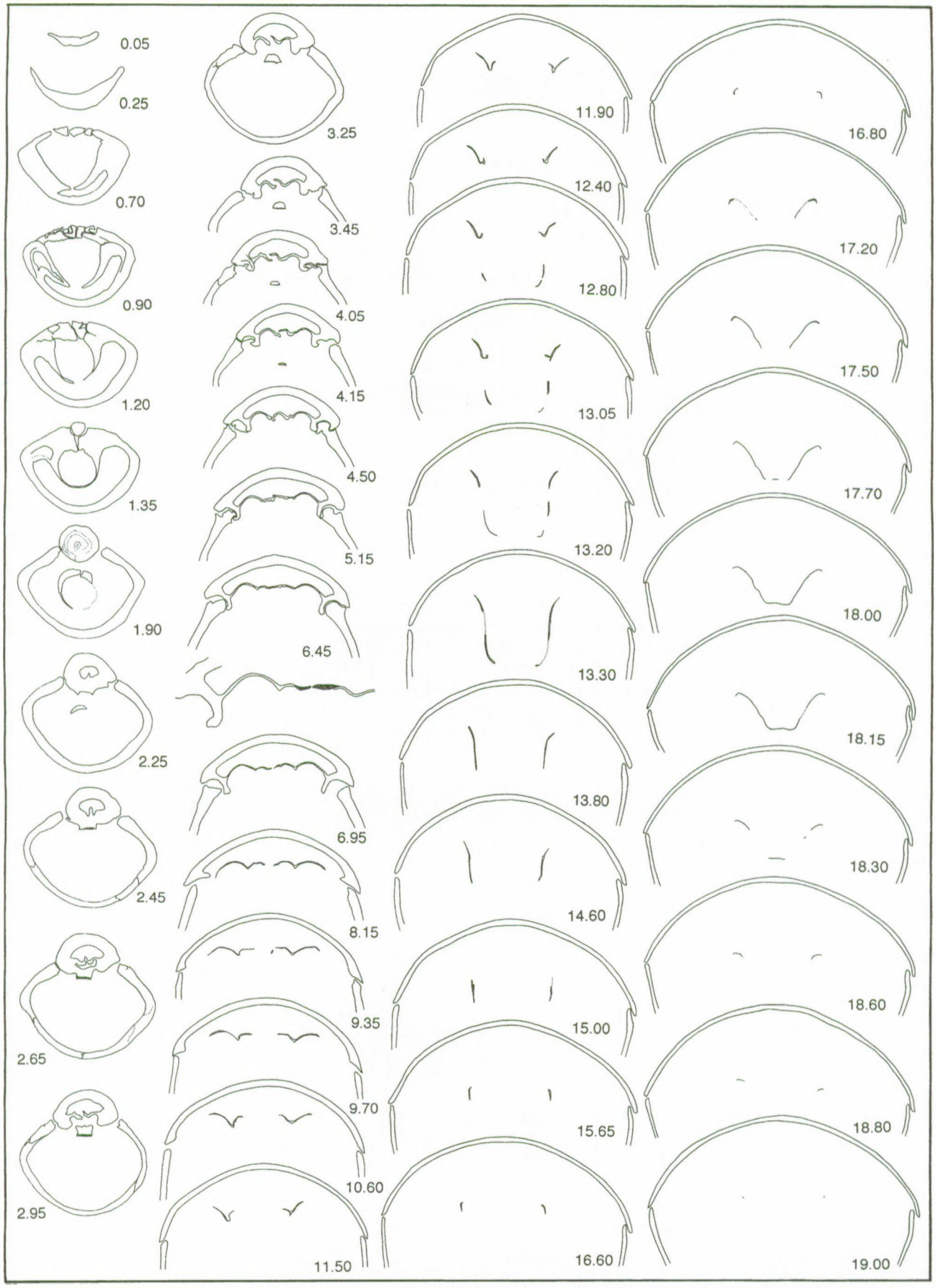


Fig. 2. — Transverse serial sections through the umbonal portion of a medium-sized adult specimen (NHMM 2004 001) of *Neoliothyrina dessaillyi* (PERON, 1895) from the Kunrade Limestone facies at Kunrade, southern Limburg, The Netherlands (*Belemnitella junior* Zone, Upper Maastrichtian), x 1.35.

Table 2 — Measurements of parts of the loop made on sectioned specimen (NHMM 2004 001) of *Neoliothyrina dessaillyi* (PERON, 1895) from the Kunrade Limestone facies (Upper Maastrichtian, *Belemnitella junior* Zone) at Kunrade (southern Limburg, The Netherlands). 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. β: Loop angle. These relationships are identical to those outlined in detail by COOPER (1983, p. 15).

Loop parameters measured	Measurements mm NHMM 2004 001	Calculated ratios	Values observed NHMM 2004 001
Length of the loop (LI)	16.9	WI/LI	0.67
Width of the loop (WI)	11.3	LI/L	0.33
Length to the tip of the crural process (a)	11.3	WI/W	0.28
Length from tip of the crural process till terminal points (b)	5.6	LI/LDV	0.34
Measure of outer hinge plates length (c)	9.3	a/LI	0.67
Measure of crus (end of outer hinge plate to tip of crural process) (d)	1.4	b/LI	0.33
Distance from crural process to bridge (e)	4.4	c/LI	0.55
Length from posterior limit of transverse band to terminal points (f)	1.2	d/LI	0.08
Width of hinge (g)	12.6	e/LI	0.26
Length of transverse band at its apex (h)	0.6	f/LI	0.07
Length of the dorsal valve (LDV)	50.1	e+f/LI	0.33
Width of the shell and dorsal valve (W)	40.4	g/WI	1.12
	degree	g/W	0.31
Loop Angle (β)	37.5	W/LDV	0.81

DERIVATIO NOMINIS: name given by PERON to honour Mr. Dessailly, an industrialist (end of the19th century) at Ciply (Hainaut, Belgium) who offered two specimens of this terebratulid to the Sorbonne University (Paris).

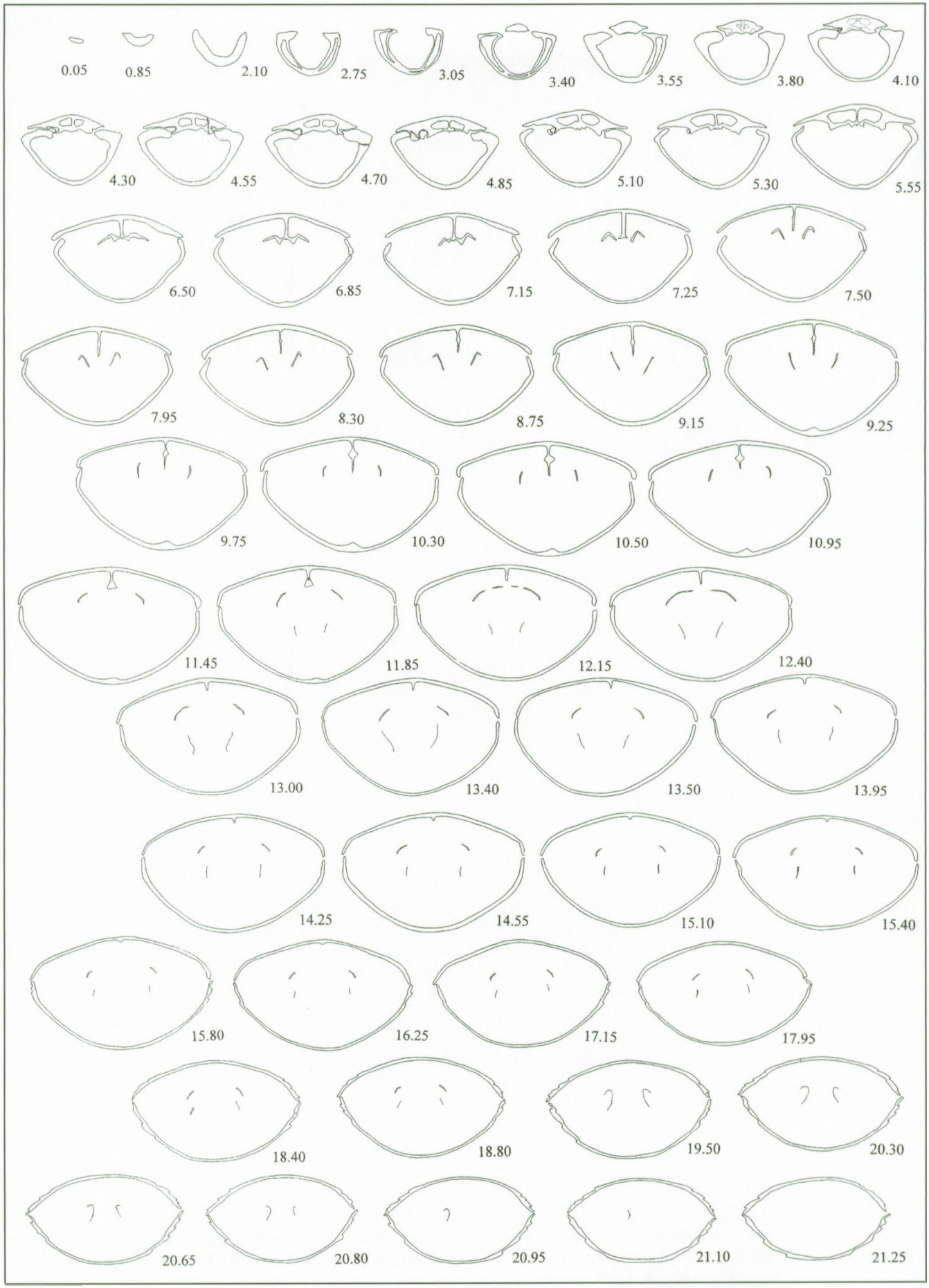
LOCUS TYPICUS: Ciply (Mons Basin, Hainaut, Belgium)

STRATUM TYPICUM: Probably, upper part of the Craie phosphatée de Ciply, *Belemnella obtusa* Zone (Hardground included in the Ciply-Malogne Phosphatic Chalk Formation *sensu* ROBASZYNSKI *et al.*, 2001.). A more precise designation of the *stratum typicum* is rather difficult to establish as PERON (1895, p. 455) himself stressed that;'' ..., on peut sans difficulté sérieuse, distinguer dans la craie brune de Ciply et dans le poudingue qui le surmonte, un nombre plus considérable de types spécifiques, en général bien tranchés.'' In his description of *Terebratula dessaillyi*, PERON (1895, pp. 458, 459) indicated that he had actually collected a specimen yet failed to indicate precisely from where. In the IRScNB collections, the Ciply material in part stems from the top of the Craie phosphatée de Ciply (Lower Maastrichtian, *Belemnella obtusa* Zone) and in part from the Poudingue de La Malogne (a complex deposit in which Upper Maastrichtian and Danian elements are mixed, together with remanié phosphatic pebbles of Early Maatrichtian age). This observation is based on opened specimens revealing the matrix. However, in fully articulated and undamaged specimens, matrix characteristics are invisible and consequently their stratigraphic provenance is uncertain.

LECTOTYPE:
The specimen illustrated in dorsal view in PERON (1895, pl. 4, fig. 7) is very large, yet slightly compressed; the second specimen (pl. 4, figs. 8-11) excellently illustrates this species and is herein formally designated as the lectotype (M.N.H.N.–DHT S09920, Unité de Paléontologie, Département Histoire de la Terre, Muséum National d'Histoire Naturelle (Paris, France) (Pl. 3, Fig. 1; measurements on Table 1).

The lectotype (M.N.H.N.–DHT S09920) is the specimen collected at Ciply by PERON himself. The specimen from the Dessailly Collection in La Sorbonne (Paris), illustrated in PERON (1895, pl. 4, fig. 7) has been lost.

PARALECTOTYPE: the second specimen of the Dessailly Collection (cited but not illustrated in PERON, 1895) is preserved in Paris (M.N.H.N.–DHT J06801 - J.-M. Pacaud, personal communication, 01/2004) and is designated as a paralectotype (Pl. 3, Fig. 3).


0.05
0.85
2.10
2.75
3.05
3.40
3.55
3.80
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15.80
16.25
17.15
17.95
18.40
18.80
19.50
20.30
20.65
20.80
20.95
21.10
21.25

ADDITIONAL MATERIAL:

All other studied specimens were collected from the Kunrade Limestone facies (Upper Maastrichtian, *Belemnitella junior* Zone) at Kunrade near Maastricht (southern Limburg, The Netherlands).

IRScNB –M.I. n° 10995 (ex BOSQUET coll.): large adult specimen, its dorsal valve partly covered by a bryozoon (Table 1; Pl. 1, Figs. 1a-e).

IRScNB –M.I. n° 10996 (ex BOSQUET coll.): adult specimen with clear capillate shell surface on the lateral edges (Tables 1; Pl. 1, Figs. 2a-e).

NHMM 2004 001: adult specimen used for transverse serial sections (Tables 1, 2; Text-fig. 2; Pl. 1, Fig. 3a-e).

NHMM 19901-242 (ex SENDEN coll.): juvenile specimen (Table 1; Pl. 2, Fig. 8a-d).

DESCRIPTION

External characters

Adult specimens attain large sizes (Table 1). PERON (1895, p. 458) cited a specimen measuring 74 mm in length. In the IRScNB coll. (material from Ciply), such large shells are commonly observed. The specimens from Kunrade (IRScNB and NHMM) are slightly smaller (between 47 and 62 mm). The shell is biconvex, albeit slightly depressed. The greatest depth of the ventral valve and dorsal valve situated in their posterior part. Shell subpentagonal in outline, lenticular both in lateral and anterior view. The greatest width anterior to mid-valve. Numerous faint growth lines visible on the shell surface and amongst them several (generally four or five) lines are more steplike. A distinct capillate ornament, well matching that seen in *Neoliothyrina obesa* clearly visible and mainly developed on the lateral edges of the shell surface. Anterior commissure strongly sulciplicate. Beak extremely short and strong and, in most specimens, slightly suberect. In a shell seen in dorsal view, the foramen is not wholly visible. In some specimens the beak is shorter and straight. Foramen is often circular (Pl. 1, Fig. 3e), rarely oval (Pl. 1, Fig. 2e) and permesothyrid. It is situated in the middle of the strongly attrite part of the beak, developing an elliptical surface. This posterior zone often flat due to this attrition. In intact shells, this zone shows a slight concavity exhibiting the circular foramen in its bottom. Foramen not labiate. Beak ridges are relatively sharp. Very small, triangular and conjunct deltidial plates.

Juvenile specimens (NHMM 19901-242, Table 1, Pl. 2, Fig. 8a-d) have a more oval outline and are relatively thinner. Their anterior commissure rectimarginate. Rare capillae visible on lateral portions of shell. Beak very short, slightly suberect and a large circular foramen, in the middle of a strongly attrite elliptical surface, is visible.

Internal characters

In the ventral valve, an excavate, relatively thick and short pedicle collar. In the sectioned specimen, its length reaches 1.2 mm. Around the foramen, shell twice as thick as anteriorly, indicating an adaptation to attrition. The teeth present in the posterior part of the ventral valve, small and weakly developed for a brachiopod of such a large size.

In the dorsal valve, the loop fairly short (LI/LD = 0,34) but quite wide (WI/LI = 0.67 and the loop angle (β) = 37.5°). Cardinal process well developed as a flat, half elliptical plate, the myophore facing ventrally. Socket ridges are short and relatively low. Inner socket ridges directed inwards. The resulting concave sockets subcircular in section and relatively wide. Outer hinge plates clearly developed, with a strong ventral concavity. They are quite long, tapering along the dorsal edge of the crural bases just to the points where the crural processes are developed. This latter character seems to be of generic value since it has also been demonstrated for *N. obesa*. Inner hinge plates developed and coalescent in the posterior part of the cardinalia but free from each other in their anterior part. Crural bases flat. Crural processes narrow, acutely pointed and highly developed. Their tips gently curve inwards. Extremely short and thin descending branches developed from the anterior part of the crural processes and supporting a very wide transverse band, subtrapezoidal in transverse section. Crest of transverse band relatively flat, even slightly concave. Anterolateral extremities are extended into very short points (Text-Figure 2).

COMPARISON WITH OTHER SPECIES OF *NEOLIOTHYRINA*

– *Neoliothyrina obesa* (DAVIDSON, 1852): the Maastrichtian species *N. dessaillyi* and *N. obesa* are relatively large terebratulids with a typical capillate shell ornament. Both have a short and wide loop with a broad transverse band. The posterior part of the cardinalia is strikingly similar in both species, especially regarding the development of outer and inner hinge plates. There is no doubt that *N. obesa* is related to *N. dessaillyi*, the latter representing an adaptation to higher energy settings. Its very short beak, its thick and strong pedicle and the clear attrition of its foramen are characters which suggest that *N. dessaillyi* was able to withstand very strong wave effects.

However, many features, distinguish *N. dessaillyi* from *N. obesa*. The latter has been studied and described in great detail by STEINICH (1965, p. 27), POPIEL-BARCZYK

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Fig. 3. — Transverse serial sections through the umbonal portion of a large-sized adult specimen (NHMM 19901 373, ex collection SENDEN, paratype) of *Kingenella popielae* n. sp. from the Kunrade Limestone facies at Kunrade, southern Limburg, The Netherlands (*Belemnitella junior* Zone, Upper Maastrichtian), x 1.35.

(1968, p. 52) and COOPER (1983, p. 295). STEINICH (1965, fig. 16, 17) published transverse serial sections and drawings illustrating the specific characters of this species. *N. obesa* is generally smaller than *N. dessaillyi*; STEINICH (1965, p. 27) indicated the largest known specimen of *N. obesa* to be 68 mm long and 46 mm wide, a size range observed for medium-sized specimens of *N. dessaillyi*. However, *N. obesa* is much narrower than *N. dessaillyi*, its beak much more erect and not truncate as in *N. dessaillyi*. The foramen in *N. obesa* is labiate and situated in the middle of a concentric subcircular zone of attrition. In *N. dessaillyi* the foramen is not labiate and placed in the middle of a wide elliptical zone of attrition. The loop statistics obtained for *N. dessaillyi* (Table 2) are fairly similar to data presented by COOPER (1983, table 54, p. 205) for *N. obesa*. As discussed above the two loops are rather similar in structure. However, in *N. dessaillyi*, the loop is wider (see values of β, WI/WD and of g/WI in Table 2). The shape of the transverse band also appears to be distinct in both species. In *N. obesa* the transverse band forms a moderately high arch with a rounded crest. In *N. dessaillyi* the transverse band appears subtrapezoidal in section with a flat crest (Text-Figure 2).

– *Neoliothyrina fallax* (LUNDGREN, 1885) *sensu* POPIEL-BARCZYK, 1968, described by POPIEL-BARCZYK (1968, p. 57 pl. 16, figs. 1-3), cannot be confused with *N. dessaillyi* since it is more oval in outline. The central anterior part of the shell is elongated near the commissure. *N. fallax* is much smaller and thinner than *N. desaillyi*. Its foramen is mesothyrid and its anterior commissure is often rectimarginate, episulcate or rarely typified by a very slight biplication. In *N. dessaillyi* the foramen is always permesothyrid and the anterior commissure is strongly sulciplicate. Differences appear also for the loop. In *N. fallax* as drawn by POPIEL-BARCZYK (1968, p. 59, text-fig. 21), the outer hinge plates are much less concave. The inner hinge plates are much less well developed in *N. fallax*. The crest of the transverse band in *N. fallax* is strongly rounded whereas it is flat in *N. dessaillyi*.

– *Neoliothyrina plana* POPIEL-BARCZYK, 1968, resembles *N. fallax* and is very distinct from *N. dessaillyi*. It is much smaller and thinner, and its beak is more erect than that in *N. dessaillyi*. The foramen is mesothyrid and a symphytium is observed. In *N. dessaillyi*, the foramen is permesothyrid and two conjunct triangular deltidial plates are visible. The anterior commissure of *N. plana* is rectimarginate to uniplicate, that of *N. dessaillyi* strongly biplicate. The loop structure in *N. plana* (POPIEL-BARCZYK, 1968, p. 62, fig. 24) is more closely similar to that in the type species. The transverse band appears subtrapezoidal as in *N. dessaillyi* but the development of the inner hinge plates is much weaker in *N. plana*.

COMPARISON WITH OTHER TEREBRATULID BRACHIOPODS

– Comparison with "*Terebratula*" *abrupta* TATE, 1864 *sensu* PERON, 1895

Confirming VON HANSTEIN's (1879, p. 25) views, PERON (1895, p. 460, pl. 5, figs. 1, 2) described a terebratulid from the Maastrichtian of Ciply as *T. abrupta* TATE, 1864. Drawings presented by PERON (1895) show a close resemblance to illustrations given by TATE (1864, pl. 5, fig. 1a-b) of a terebratulid collected from the "Upper Chalk" at Lisburn, Moira and Dungiven (Londonderry, Ireland). The internal structure of this specimen remains unknown. By reaching a length of 53 mm and a width of 38 mm (PERON, 1895, p. 460) this species is much flatter and more regularly oval than *Neoliothyrina dessaillyi*. In *Terebratula abrupta*, the beak is more erect and obliquely truncate and the attrite part of the beak is circular, not elliptical and wide as in *Neoliothyrina dessaillyi*. The anterior commissure of *T. abrupta* is rectimarginate or very slightly biplicate. PERON (1895, p. 460) indicated that some capillae are barely visible on the shell surface (as pointed out by TATE for his specimens) and that these capillae cannot be confused with the ornament seen in *N. dessaillyi*.

DISTRIBUTION

Neoliothyrina dessaillyi is known from the Kunrade area (Kunrade Limestone facies, *Belemnitella junior* Zone) in southern Limburg (The Netherlands) and from Ciply (Mons basin, Hainaut, Belgium) from both the Lower (Craie phosphatée de Ciply, *Belemnella obtusa* Zone) and Upper Maastrichtian (Tuffeau de Saint-Symphorien and base of the Poudingue de La Malogne).

Superfamily Cancellothyridoidea THOMSON, 1926
Family Cancellothyrididae THOMSON, 1926
Subfamily Cancellothyridinae THOMSON, 1926

Genus ***Terebratulina*** D'ORBIGNY, 1847
Type species: *Anomia retusa* LINNAEUS, 1758

BRUNTON & COCKS (1970) designated *Anomia retusa* LINNAEUS, 1758 rather than *A. caput-serpentis* LINNÉ, 1767 as type species of *Terebratulina* [Opinion 924, *Bulletin of Zoological Nomenclature*, **27**(2)].

Terebratulina carinata VON HANSTEIN, 1879
Plate 1, Figures 4-7; Table 1.

pp	1860	*T. striata* Wahl. Sp. – BOSQUET, n° 578.
* *v*	1879	*Terebratulina carinata* sp. n. – VON HANSTEIN, p. 27.
	1879	*Terebratulina striata* Wahl. – UBAGHS, pp. 112, 216.
.	1965	*Terebratulina carinata* v. Hanstein – STEINICH, p. 55.
v.	1996	*Terebratulina carinata* von Hanstein – SIMON, p. 97.
v.	1975	*Terebratulina* – SENDEN, p. 26, fig. 2.
v.	1998	*Terebratulina carinata* von Hanstein, 1879 – SIMON, p. 201, pl. 2, figs3a-e, 4a-b, 5a-b, 6.
	2002	*Terebratulina striata* Wahlenberg – GASPARD, p. 577, fig. 1, 12, *non* fig. 1, 13.

LOCUS TYPICUS: Ciply (Mons Basin, Hainaut, Belgium).

STRATUM TYPICUM: Craie phosphatée de Ciply (Ciply-Malogne Phosphatic Chalk Formation), Lower Maastrichtian, *Belemnella obtusa* Zone.

LECTOTYPE:
GPIBO – HANSTEIN-2, designated by SIMON (1998, p. 201, pl. 2, fig. 3), (Paläontologisches Institut, Rheinische Friedrich-Wilhelms Universität Bonn (Germany), illustrated in SIMON (1998, pl. 2, figs. 3a-e). Measurements are: length 44.6mm, width 32.2 mm, thickness 21.8 mm and length of the dorsal valve 42.9 mm.

ADDITIONAL MATERIAL:
– From the Kunrade Limestone facies in Kunrade (southern Limburg, The Netherlands). Upper Maastrichtian, *Belemnitella junior* Zone.

IRScNB – M.I. n° 10997 (ex BOSQUET coll.): large adult specimen with dorsal valve showing an adnate bryozoan (Pl. 1, Fig. 4a-e).

NHMM 19901 257 (ex SENDEN coll.): large adult specimen with well-preserved, fine and numerous costae (Pl. 1, Fig. 5a-e).
– From the Craie phosphatée de Ciply in Ciply (Mons Basin, Hainaut, Belgium). Lower Maastrichtian, *Belemnella obtusa* Zone.

IRScNB – M.I. n° 10685: large adult specimen, prepared to reveal the brachidium (Pl. 1, Figs. 6-7).

This large species was described in detail by VON HANSTEIN (1879, pp. 27, 28) and differences between it and other taxa were pointed out by that author. However, essential characters of the description are repeated here. *T. carinata* is a large dorsibiconvex species, widely oval in outline, lenticular in lateral profile and dome-shaped in anterior view. Anterior commissure strongly biplicate. This latter character is generally observed but relatively variable as adult specimens, of similar size, can exhibit a rectimarginate (rarely) or a slightly biplicate anterior commissure. Lateral commissure dorsally concave. Beak suberect with well-developed beak ridges. Deltidial plates are small, triangular and disjunct. Umbo of the dorsal valve extremely pointed. A strong, often asymmetrical keel (see also VON HANSTEIN) extends on the anterior part of the ventral valve. Shell surface covered with a multitude of very fine costae. The brachidium was revealed after preparation and described in SIMON (1998, pl. 2, fig. 4a-b); it is reproduced herein (Pl. 1, Figs. 6, 7) and is presented with the ventral valve placed down. Recently new specimens of *T. carinata* were collected at Ciply, from the top of the hardground capping the Craie phosphatée de Ciply. As *Neoliothyrina dessaillyi*, they represent a faunal element adapted to high-energy conditions.

The material collected at Kunrade (Pl. 1, Figs. 4-5) is closely similar to that from Ciply. Large adult specimens exhibit all characters cited above and cannot be separated from the specimens collected at Ciply.

VARIABILITY:
The full variation range of the shell characters of *Terebratulina carinata* remains unknown. Most specimens in collections are large adults. Additional new material, including younger forms, could improve our understanding of the species' ontogeny and would also allow statistical analyses. These data are needed to increase the accuracy of the diagnosis of *T. carinata*.
Also the various Upper Cretaceous species of *Terebratulina* are in urgent need of revision.

For instance, *T. carinata* from Ciply has been confused by GASPARD (2002, pp. 577, 582) with an Upper Campanian representative of *T. striata* (WAHLENBERG, 1821) from the Craie de Meudon. Previously, the Craie phosphatée de Ciply was considered of Late Campanian age. However, ROBASZYNSKI & CHRISTENSEN (1989), on belemnite and foraminiferal faunas, revealed its Early Maastrichtian age. The *Terebratulina* specimen from Ciply illustrated by GASPARD (2002, p. 577, fig. 1, 12) is a *T. carinata* from the Lower Maastrichtian (Craie phosphatée de Ciply) whereas that illustrated on her fig. 1, 13 is a large species of *Terebratulina* from the Craie de Meudon. Confusion between these specimens is easy because in both numerous costae cover the shell surface with a similar density; and their shell size is nearly identical. The beak of *T. carinata* is more erect, a character often observed in material from Ciply. The beak of *T. striata sensu* GASPARD is less erect. The outline of the two specimens illustrated is also different; *T. carinata* is widely oval with the greatest width at mid-valve, whereas *T. striata sensu* GASPARD is more subpentagonal, with the greatest width in the anterior third. However, these characters might be variable. Additional material is needed and a statistical analysis may provide more clues as to the status of these species.

Suborder Terebratellidina MUIR-WOOD, 1955
Superfamily Uncertain
Family Uncertain

Genus ***Kingenella*** POPIEL-BARCZYK, 1968
Type species: *Kingenella pseudohebertiana* (PERON, 1895).
(= *Kingenella kongieli* POPIEL-BARCZYK, 1968)

Kingenella popielae n. sp.
Plate 2, Figures 1– 7, Text-Figure 3; Table 1.

v. 1968 *Kingenella sp.* – POPIEL-BARCZYK, pp. 78-79, pl. 20, figs. 7a-e, 8.

DIAGNOSIS
Large ventribiconvex *Kingenella* species, oval to subpentagonal in outline, lenticular in lateral profile and lenticular to suboval in anterior view. Shell smooth, except on lateral edges where a radial ornament is observed. Anterior commissure rectimarginate to slightly parasulcate. Beak widely obtuse, truncate and slightly suberect. Large foramen, attrite, sometimes subcircular but often irregular in outline. Beak ridges undeveloped. Area large and triangular. Deltidial plates, triangular, disjunct and sepa-

rated from interarea by a deep groove. Dental plates absent. Cardinal process weakly developed. Platform formed of outer hinge plates, crural bases and narrow inner hinge plates fused with septal pillar. Septal pillar, thin, extending along two third of the length of dorsal valve floor. Long and wide loop developing through a bilacunar phase and reaching an adult teloform structure.

DERIVATIO NOMINIS: named in honour of the late Ewa POPIEL-BARCZYK (Warszawa, Poland), who studied Upper Cretaceous brachiopods and who found the first specimens of this *Kingenella* species at Nasiłów.

LOCUS TYPICUS: Kunrade (southern Limburg, The Netherlands).

STRATUM TYPICUM: Kunrade Limestone facies, Upper Maastrichtian (*Belemnitella junior* Zone).

HOLOTYPE:
NHMM 19901 345 (Pl. 2, Fig. 3a-e), large-sized adult specimen (ex SENDEN Coll.), from the Kunrade Limestone facies at Kunrade (southern Limburg, The Netherlands). Measurements on Table 1.

PARATYPES:
All paratypes from the Kunrade Limestone facies at Kunrade (southern Limburg, The Netherlands).

NHMM 19901 373 (ex SENDEN coll.). Adult specimen with subpentagonal outline, used for transverse serial sections. (Table 1; Text-Fig. 3; Pl. 2, Fig. 1a-f).

NHMM 19901 178 (ex SENDEN coll.). Medium-sized adult specimen with oval outline. Beak slightly damaged by attrition. (Table 1; Pl. 2, Fig. 2a-e).

NHMM 2004 002 (ex SENDEN coll.). Smaller specimen presenting a special subrhomboidal outline. (Table 1; Pl. 2, Fig. 5a-f).

NHMM 19901 269/1 (ex SENDEN coll.). Small specimen (Table 1; Pl. 2, Fig. 6a-f).

ADDITIONAL MATERIAL
NHMM BL0586/1 (ex BLEZER coll.). Complete adult specimen with conjunct deltidial plates, a very unusual character for this species (Table 1; Pl. 2, Fig. 4a-f).

NHMM 19901 269/2 (ex SENDEN coll.). Small juvenile specimen (Table 1).

DESCRIPTION
External characters
Adult specimens of *Kingenella popielae* are the largest known representatives of the genus *Kingenella* (Table1). Shell is always ventribiconvex, generally oval to subpentagonal in outline, lenticular in lateral profile and oval to lenticular in anterior view. Younger or smaller specimens appear more subcircular or subrhomboidal in outline. Greatest depth of both ventral and dorsal valves situated near mid-valve. Convexity of dorsal valve much weaker. Greatest width of the specimen situated at mid-valve. Several growth lines present on the shell surface which is otherwise smooth. Pustules on the shell surface always absent. In some specimens, a radial ornament visible on the lateral parts of the shell surface; it does not contain capillae *sensu stricto* but rather faint radial shallow grooves. Anterior commissure rectimarginate in very small specimens but slightly parasulcate in adult specimens. Lateral commissure with a faint dorsal concavity in adults but nearly straight in young specimens. Beak short, rather strong, always obtuse and truncate, slightly suberect. Beak ridges not visible in the material investigated. Foramen large, attrite and generally widely opened. Deltidial plates triangular, disjunct in adult specimens, sometimes conjunct in younger individuals and separated from the interarea by a very deep groove.

Internal characters
Ventral valve
An excavate, very short pedicle collar observed in transverse serial sections (Fig. 3). Dental plates absent. Teeth small and subspherical. No ridge or pseudoseptum developed in the middle of the ventral valve floor. Shell not particularly thick in its posterior part.

Dorsal valve
In the cardinal region, outer hinge plates, crural bases and inner hinge plates fused together and a platform is observed. In transverse section (Text-Figure 3), this platform appears as a "W" and this character typifies representatives of the genus *Kingenella*. Outer hinge plates much wider than inner. A septal pillar, longer than half the length of the dorsal valve floor, is developed. and is visible on the external valve surface. The platform formed of the fused hinge plates is supported by the posterior part of the septal pillar. Vestigial cardinal process present. Blade-like crural bases clearly visible on the ventral side of the cardinal platform and anteriorly they expand into relatively high and pointed crural processes. Descending branches, extending forward from anterior part of crural processes, are much shorter than the lower parts of the ascending branches. The ratio "length of descending branches (2.90 mm)/length of lower part of ascending branches (7.95 mm) = 0.37. Lower portions of ascending branches always thin and narrow in transverse sections whereas upper parts of ascending branches widen in their middle part and narrow again near the transverse band. Transverse band has not been observed in the sections but must be relatively narrow and low. The specimen sectioned for this paper (NHMM19901 373) presents a teloform structure but an attachment to the septal pillar is not observed. A much smaller specimen (length=16 mm) illustrated for its loop by POPIEL-BARCZYK (1968, pl. 20, fig. 8) appears partly broken but shows a bilacunar phase with a strong attachment of the loop to the septal pillar. This specimen is considered herein as a younger individual than the paratype sectioned for the present paper.

A peculiar specimen (ex collection BLEZER, NHMM BL0586/1), also collected from the Kunrade Limestone facies at Kunrade also illustrated herein (Pl. 2, Fig. 4a-f).

This ventribiconvex specimen has a subpentagonal outline and its anterior commisssure is slightly parasulcate. This smooth shell has the general outline, the type of growth lines and the punctation observed in the specimens of *Kingenella popielae* n. sp. The absence of beak ridges and the presence of deeply grooved deltidial plates confirm this possible specific attribution. However, its beak is erect and its foramen is smaller. The deltidial plates are conjunct in this specimen whereas they are generally disjunct in other studied specimens of *K. popielae* n. sp. Also the septal pillar is not visible on the external surface of the dorsal valve. This brachiopod is considered herein as a variant of *K. popielae* n. sp. The holotype and paratypes have an attrite, often damaged beak, linked to the high-energy conditions. NHMM BL 0586/1 may have lived in a quieter environment that led to the development of a beak without attrition. Possibly, similar specimens may be found in future and transverse serial sections could then provide an accurate attribution for such specimens.

COMPARISON WITH *KINGENELLA PSEUDOHEBERTIANA* (PERON, 1895) [= *KINGENELLA KONGIELI* POPIEL-BARCZYK, 1968]

Adults of *Kingenella popielae* n. sp. are much larger than those of *K. pseudohebertiana* and are more ventribiconvex. As shown by SIMON (1994, text-fig. 4, p. 164, pls. 1-2, pp. 172-173), *K. pseudohebertiana* has a transversely oval shell during its youngest stages of growth, but a strong elongation of the shell is observed for its adult and gerontic representatives. Young individuals of *K. popielae* n. sp. are also subcircular or transversely oval in outline but their dorsal valve is always more depressed. Adults of *K. popielae* n. sp. are more oval or subpentagonal in outline and their shell is never as elongate as the shell of large adult specimens of *K. pseudohebertiana*. The lateral parts of the shell surface of *K. pseudohebertiana* are not ornamented with faint radial grooves as is observed in representatives of *K. popielae* n. sp. The loops of the two species have much in common. However, a teloform stage has never been observed in *K. pseudohebertiana* where the loop, in transverse serial sections, appears always attached to the septal pillar (POPIEL-BARCZYK, 1968, fig. 30, p. 76 and SIMON, 1994, fig. 5, p. 165). When the length of descending branches and of ascending branches are compared, it is obvious that descending branches are relatively longer in *K. pseudohebertiana* than in *K. popielae* n. sp. The ratio "length of descending branches/length of ascending branches" reaches 0.94 in *K. pseudohebertiana* and only 0.37 in *K. popielae* n. sp.

Note

PERON presented his observations on brachiopods collected from Ciply on August 11, 1894 at the "Congrès de Caen", organised by the "Association Française pour l'Avancement des Sciences". Yet, these results were effectively published in volume **23** (2) of this "Association" dated 1895. The correct date for *Kingenella pseudohebertiana* is thus 1895, and not 1894 as previously indicated (see SIMON, 1994).

DISTRIBUTION

Kingenella popielae n. sp. is an Upper Maastrichtian species, known to date from Kunrade (Kunrade Limestone facies) in southern Limburg (The Netherlands) and also from the "phosphorite layer" (local horizon "z") at Nasiłów (Vistula River valley, Poland).

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Explanation of plates

PLATE 1

Neoliothyrina dessaillyi PERON, 1895) from the Kunrade Limestone facies at Kunrade (southern Limburg, The Netherlands). Upper Maastrichtian, *Belemnitella junior* Zone. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view

Fig. 1 — Complete specimen (ex collection BOSQUET), IRScNB-M.I.n° 10995. Large adult specimen with its dorsal valve showing an adnate bryozoon. The original label of BOSQUET mentions "*Terebratula* n. sp. " indicating his awareness of the unique specific status of his material (x 0.75).
Fig. 2 — Complete specimen (ex collection BOSQUET), IRScNB-M.I.n° 10996. Large adult specimen with its dorsal valve ornamented with clearly visible capillate ornament (x 0.75).
Fig. 3 — Complete specimen, NHMM 2004 001. Large adult specimen used (Figure 2) for transverse serial sections (x 0.78).

Terebratulina carinata VON HANSTEIN, 1879. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view

Fig. 4 — Complete specimen (ex collection BOSQUET), IRScNB-M.I.n° 10997, from the Kunrade Limestone facies at Kunrade (southern Limburg, The Netherlands). Upper Maastrichtian, *Belemnitella junior* Zone (x 0.65).
Fig. 5 — Complete specimen (ex collection SENDEN), NHMM 19901 247) from the Kunrade Limestone facies at Kunrade (southern Limburg, The Netherlands). Upper Maastrichtian, *Belemnitella junior* Zone (x 0.83).
Fig. 6 — Brachidium in oblique lateral view of IRScNB M.I. n° 10685, from Craie phosphatée de Ciply at Ciply (Hainaut, Belgium) Lower Maastrichtian, *Belemnella obtusa* Zone (x 2.55).
Fig. 7 — Brachidium in oblique anterior view of the same specimen (Fig. 6). (x 2.55).

PLATE 2

Kingenella popielae n. sp. from the Kunrade Limestone facies at Kunrade (southern Limburg, The Netherlands). Upper Maastrichtian, *Belemnitella junior* Zone. Illustrated specimens housed in the NHMM collections.

Fig. 1 — Paratype, complete specimen (ex collection SENDEN), NHMM 19901-373. Specimen used for transverse serial sections (Text-Fig. 3). a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view (Magnification: x 1.3) and f: a detailed view of foramen and deltidial plates (x 1.78).
Fig. 2 — Paratype, complete specimen (ex collection SENDEN), NHMM 19901-178. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view. Posterior part of the foramen slightly damaged. (x 1.50).
Fig. 3 — Holotype, complete specimen (ex collection SENDEN), NHMM 19901-345. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view (x 0.93).
Fig. 4 — Complete adult specimen (ex collection BLEZER), NHMM BL0586/1. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view (Magnification: x 1.0) and f: detailed view of foramen and deltidial plates (x 1.95). Specimen with conjunct deltidial plates, a very unusual character for this species.
Fig. 5 — Paratype, small complete specimen (ex collection SENDEN), NHMM 2004 002. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view (x 0.98) and f: a detailed view of foramen and deltidial plates (x 2.1).

Fig. 6 — Paratype, small complete specimen (ex collection SENDEN), NHMM 19901-269/1. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view (x 1.0) and f: a detailed view of foramen and deltidial plates (x 1.64).

Fig. 7 — Paratype, specimen opened to expose internal structures (ex collection SENDEN). NHMM 19901-109. 7a: internal view of the ventral valve, 7b: external view of the ventral valve, 7c: internal view of the dorsal valve showing structure of hinge plates, 7d: external view of the dorsal valve. (x 1.25).

Neoliothyrina dessaillyi (PERON, 1895) from the Kunrade Limestone facies at Kunrade (southern Limburg, The Netherlands). Upper Maastrichtian, *Belemnitella junior* Zone. Specimen is preserved in the NHMM.

Fig. 8 — Paratype. NHMM 19901-242. Young complete specimen (ex collection SENDEN) showing a more oval outline. 8a: dorsal view, 8b: ventral view, 8c: lateral view (Magnification: x 0.77) and 8d: a detailed view of foramen (x 1.66).

PLATE 3

Neoliothyrina dessaillyi (PERON, 1895) from the Phosphatic Chalk of Ciply at Ciply (Mons, Basin, Hainaut, Belgium). Lower Maastrichtian, *Belemnella obtusa* Zone. Specimens preserved in the MNHN in Paris.

Fig. 1 — Lectotype. MNHN-DHT S09920. Cast of a fully adult specimen (ex collection PERON) collected in Ciply by PERON himself. The dorsal valve is a somewhat damaged. PERON's illustration (1895, pl. 4, fig. 8-11) is slightly "embellished" as it does not show the damaged part of the dorsal valve. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view (x 0.90), f: detailed view of the attrite foramen (x 2.4) and g: detailed view of the capillate surface of the dorsal valve (x 2.35).

Fig. 2 — Paralectotype. MNHN-DHT J06801. Cast of a fully adult specimen (ex collection PERON) collected in Ciply and cited by PERON (1895, p. 458) but not illustrated. a: dorsal view, b: ventral view, c: lateral view, d: anterior view, e: posterior view (Magnification: x 0.90) and f: a detailed view of foramen and deltidial plates (x 2.18).

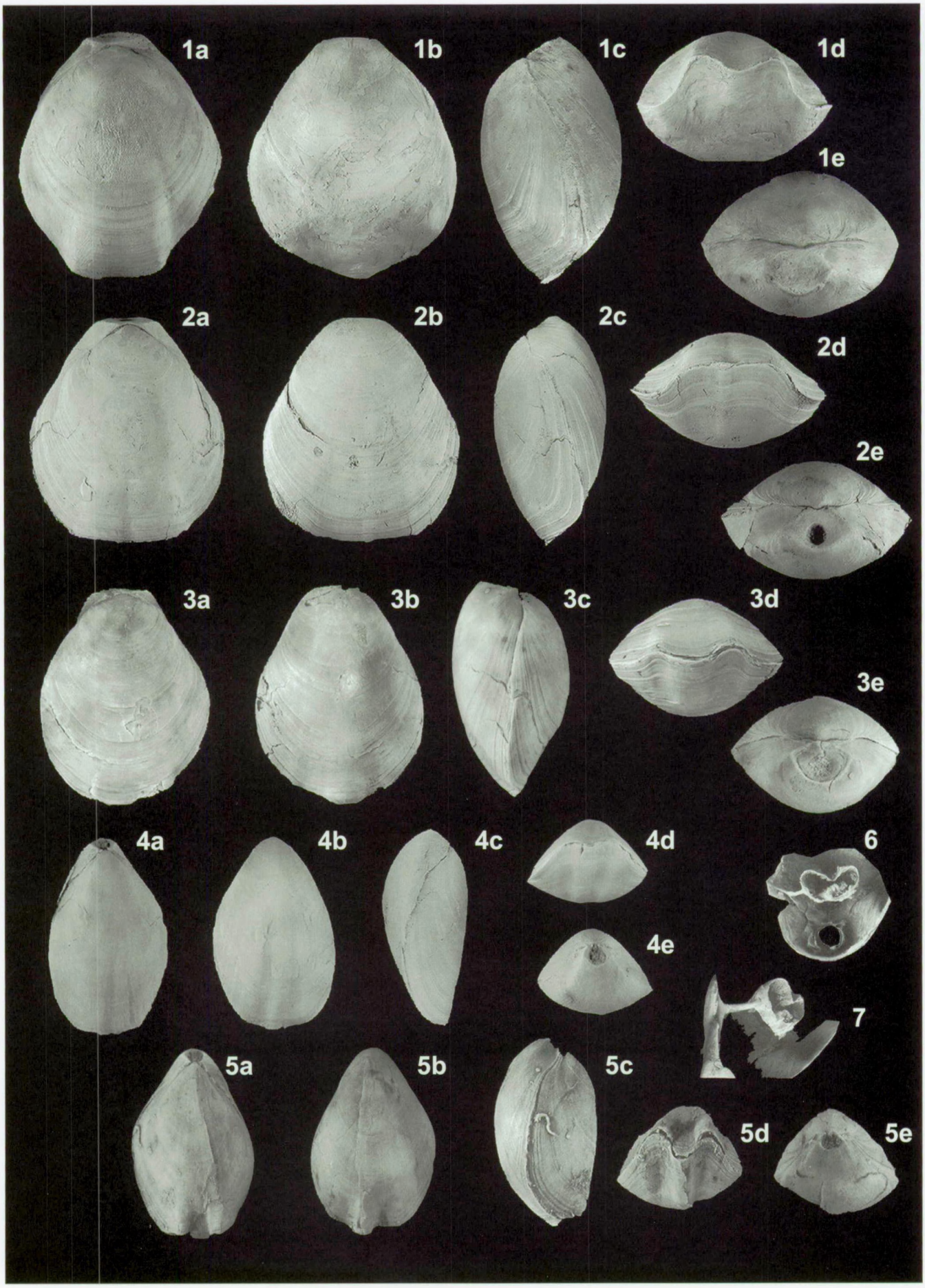
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PLATE 1

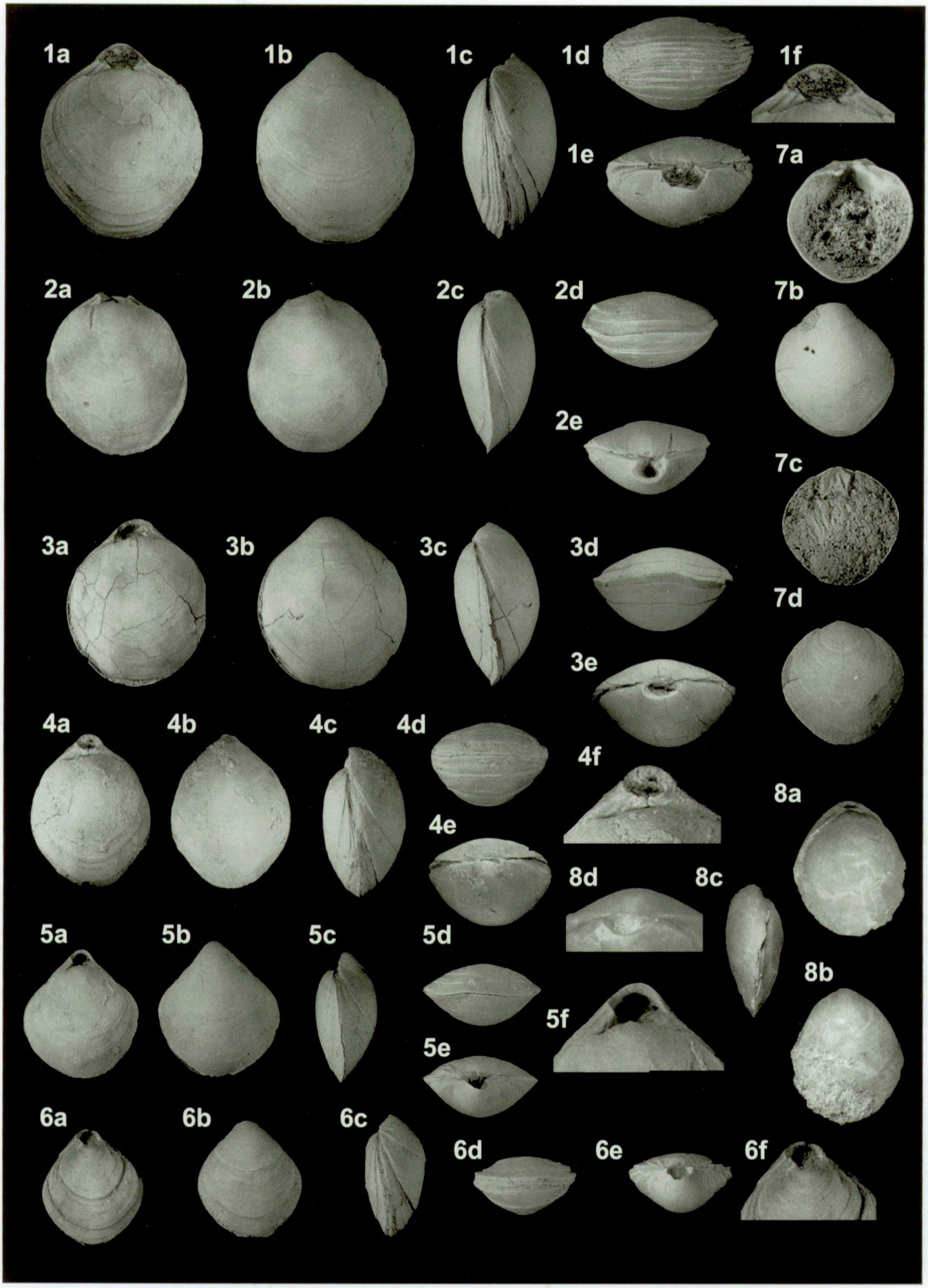
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PLATE 2

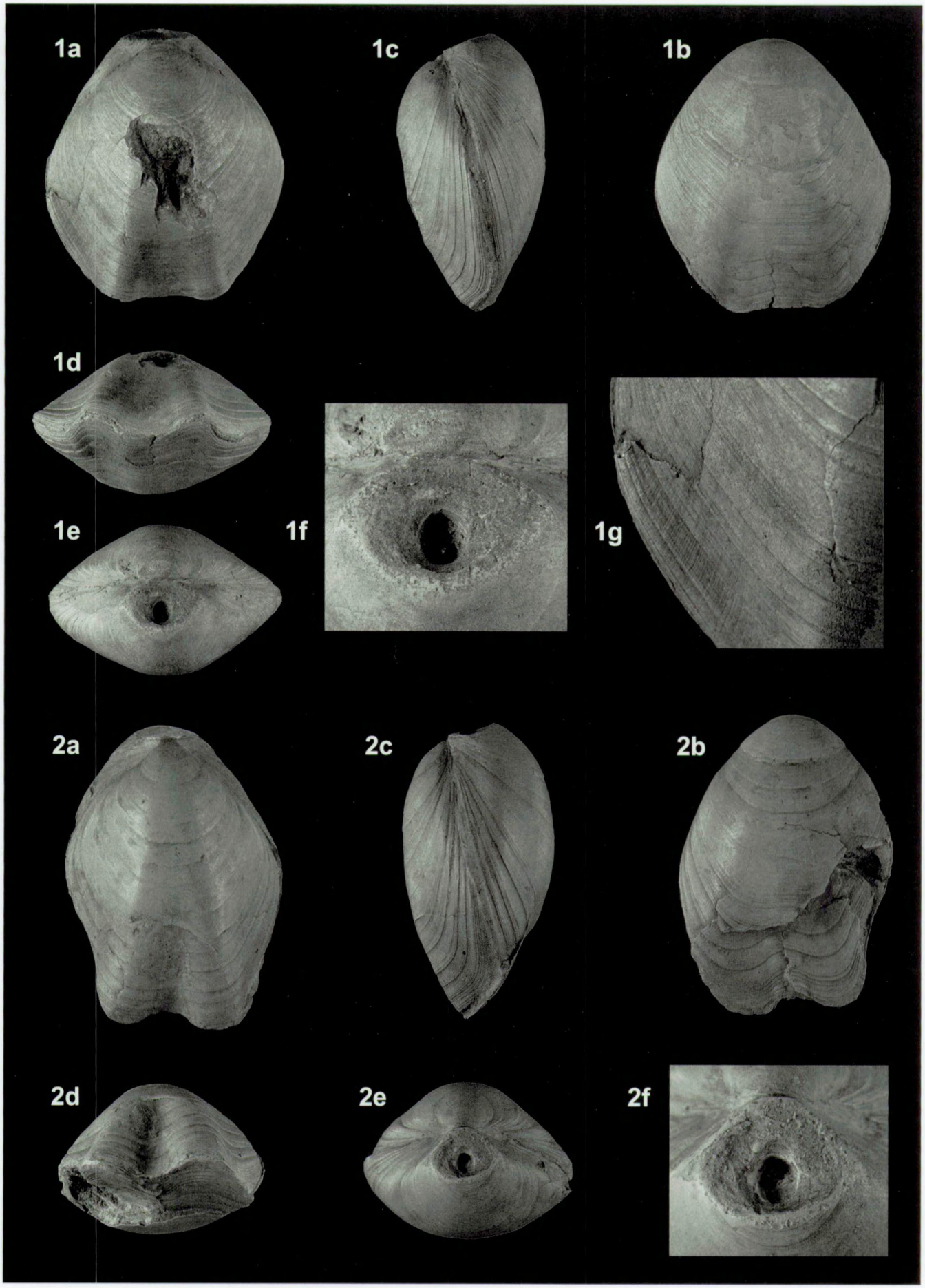

PLATE 3