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JOUANNETIA (BIVALVIA, PHOLADIDAE) AND *NERITOPSIS* (GASTROPODA, NERITOPSIDAE), TWO MOLLUSCS FROM THE DANIAN (PALAEOCENE) OF THE MAASTRICHT AREA (SE NETHERLANDS AND NE BELGIUM)

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From Danian deposits in the SE Netherlands (Curfs quarry at Geulhem) and NE Belgium (Albert Canal section) two interesting mollusc species are described and illustrated, viz. the bivalve *Jouannetia (Jouannetia)* sp., known in the form of internal and external moulds, and the gastropod *Neritopsis* sp., exclusively known by its opercula. The main purpose of this paper is to stimulate future research into the Danian mollusc faunas in this part of the North Sea Basin.

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SAMENVATTING

Jouannetia (Bivalvia, Pholadidae) en *Neritopsis* (Gastropoda, Neritopsidae), twee mollusken uit het Danien (Paleoceen) in de omgeving van Maastricht (ZO Nederland en NE België).

De molluskenfauna van de Kalksteen van Geulhem (Houthem Formatie; Paleoceen, Danien) uit de omgeving van Maastricht is helaas nog vrijwel onbestudeerd, hoewel rijke fauna's, zij het in de vorm van kernen en afdrukken, aanwezig zijn. Met name is dit het geval in de groeve Curfs te Geulhem (gem. Valkenburg aan de Geul) en in ontsluitingen langs het Albertkanaal, juist op Belgisch grondgebied.

Ter stimulering van het onderzoek van deze Paleocene molluskenfauna's worden in dit artikel twee interessante soorten nader beschreven, n.l. *Jouannetia (Jouannetia)* sp., een boormossel waarvan kernen en afdrukken gevonden zijn in de groeve Curfs, en de gastropode *Neritopsis* sp., waarvan tot op heden alleen de kalkige opercula bekend zijn. Beide soorten worden in open nomenclatuur vermeld.

INTRODUCTION

In contrast to several groups of microfossils and, among the macrofossils, the Echinodermata, molluscs from the Palaeocene deposits in the Maastricht area have received only little attention. The main reason for this is, of course, their state of preservation. Since all aragonite matter is always dissolved in the deposits concerned, most mollusc shells are only found in the form of moulds and casts and are therefore difficult to study and of little attractiveness to collectors.

Up to the present day no paper has been devoted to the study of these Palaeocene molluscs, although several species were described in papers treating the Cretaceous mollusc faunas from the same area (Binkhorst van den Binkhorst, 1873; Bosquet, 1860, 1868). It was only in the mid 1950s that the upper parts of the chalks in the Maastricht area were recognized as being of Palaeocene age (Hofker, 1955), although almost a century earlier Triger (1860, see Jagt & Janssen, 1988, this issue) had already compared these deposits with the Tuffeau de Ciply, likewise a Palaeocene deposit in the Mons Basin, Belgium.

No mollusc material of any importance has ever been brought together in public collections from the two main localities yielding Palaeocene mollusc faunas, which have been accessible during the last decades (the former Curfs quarry at Geulhem, and temporary outcrops along the Albert Canal between Vroenhoven and Veldwezelt). In the Curfs quarry it is still possible to collect new material (see next section), but the exposures along the Albert Canal are, for the greater part, no longer accessible. Here several levels contained concentrations of molluscs; some material from this locality is present in the van Birgelen (Heerlen) collection (van der Ham, pers. comm.).

In the context of a renewed interest in the Palaeocene in The Netherlands it is regrettable that so little attention is paid to the molluscs, a potentially very useful group, not only for biostratigraphic correlations, but also for palaeoecological interpretations. It is therefore the sincere hope of the present authors that one or more malaco-palaeontologists will take up the challenge in the near future. As a stimulus to such a worthwhile project preliminary descriptions of two very interesting molluscs are given in this paper.

SOME NOTES ON THE MOLLUSC FAUNA OF THE FORMER CURFS QUARRY AT GEULHEM

In the Curfs quarry Palaeocene molluscs occur predominantly in two levels, viz. in the middle part of the Geulhem Member, about 3.5-4 m above the Vroenhoven Horizon, and near the top of the member. In both cases moulds and casts of molluscs are found in indurated limestones, generally showing sufficient details of form and sculpture to enable identification. These indurated parts of the limestone occur in more friable chalks, in which molluscs are equally present, but the sediment is too crumbly for the specimens to be collected and preserved satisfactorily, except for some calcitic mollusc shells, like oysters, which are not dissolved.

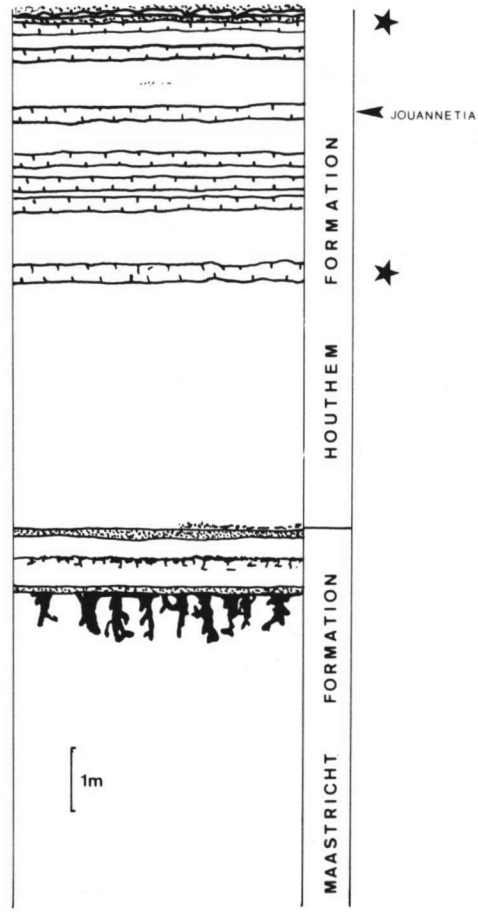


Fig. 1. Schematic lithology of the former Curfs quarry at Geulhem, Valkenburg aan de Geul, province of Limburg, The Netherlands; with indication of the mollusc-bearing levels (*) and the level in which *Jouannetia* was found.

During Whitsuntide 1988 the 'Werkgroep voor Tertiaire en Kwartaire Geologie' organized a fieldtrip to the Curfs quarry, directed by the first author. During this trip the second author collected some mollusc material for the collections of the Rijksmuseum van Geologie en Mineralogie (RGM) at Leiden, where now at least some specimens are present. This material, collected from both mollusc-bearing levels, comprises mainly the smaller and, of course, the more common species.

Bivalves are more abundant than gastropods, but also among this latter group a remarkable diversity can be noted. Common bivalves are, for instance, Lucinidae, Carditidae, Astartidae and Cardiidae. Among the gastropods a *Turritella* sp. is the most common representative, but Naticidae are not very rare either.

SYSTEMATIC PART

Classis Bivalvia
Subclassis Heterodonta
Ordo Myoida
Subordo Pholadina
Superfamilia Pholadoidea
Familia Pholadidae Lamarck, 1809
Subfamilia Jouannetiinae Tryon, 1862
Genus *Jouannetia* Desmoulins, 1828
Subgenus *Jouannetia* s.str.

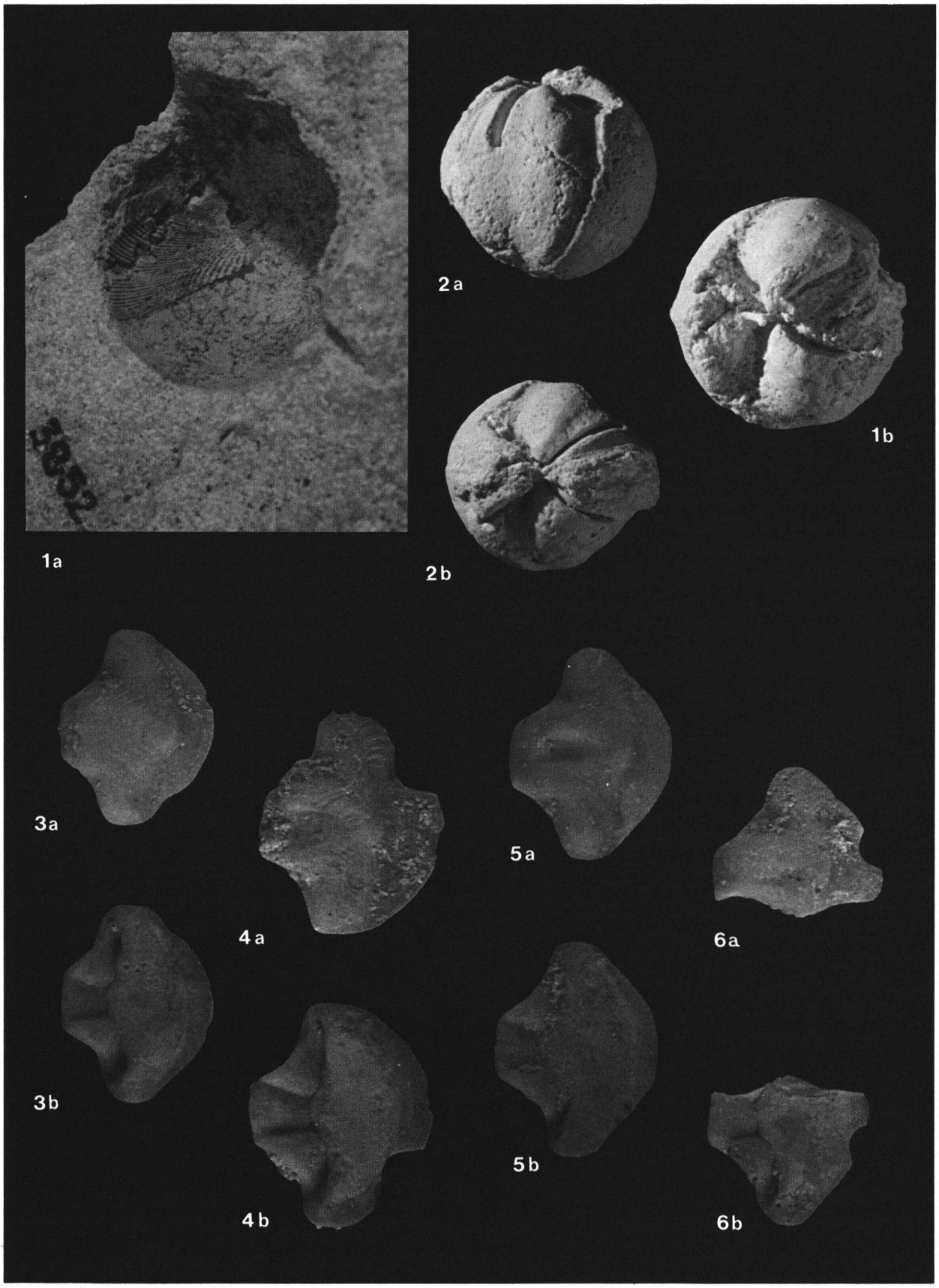
Type species—Jouannetia semicaudata Desmoulins, 1828 by original designation (Miocene, Aquitaine Basin, France; not '? Eocene', as stated by Turner, 1969, p. N719).

Jouannetia (Jouannetia) sp.
Pl. 1, Figs 1a-b, 2a-b.

Material studied—Two bivalved internal moulds of adult specimens with parts of corresponding external moulds (coll. RGM 229 349a-d), one fragmentary external mould (coll. RGM 229 349e), one external mould of bivalved juvenile specimen (coll. RGM 229 368); all leg./don. J.W.M. Jagt (ex coll. Jagt resp. nos 3852, 3853, unnumbered and 4369). All this material was collected from the Geulhem Member (Houthem Formation), exposed in the former Curfs quarry (now Ankersmit Holding B.V.), at Geulhem, municipality of Valkenburg aan de Geul, province of Limburg, The Netherlands. Specimens RGM 229 349a-e (ex coll. Jagt nos 3852, 3853 and unnumbered) stem from the upper part of the section exposed, c. 1.5 m below the upper boundary of the Geulhem Member.

Explanation of Plate 1.

Figs 1-2. *Jouannetia (Jouannetia)* sp.
Former Curfs quarry at Geulhem, Valkenburg aan de Geul, The Netherlands, c. 1.5 m below upper boundary of Geulhem Member (Houthem Formation; Palaeocene, Danian). 1a: external mould; 1b: internal mould, umbonal view (diameter 14 mm); leg. J.W.M. Jagt, coll. RGM 229 349b and 229 349c. 2a: internal mould, right lateral view; 2b: dto, umbonal view (diameter 11.6 mm); leg. J.W.M. Jagt, coll. RGM 229 349e.
Figs 3-6. *Neritopsis* sp., opercula.
Albert Canal section, North of Vroenhoven bridge, East bank near km mark 24.500, at Riemst, Belgium, c. 8-9 m above Vroenhoven Horizon, Geulhem Member (Houthem Formation; Palaeocene, Danian); leg. J.W.M. Jagt, coll. RGM 229 369-229 372.
3a-6a: exterior views; 3b-6b: interior views (heights resp. 7.4, 8.2, 8.0 and 5.6 mm).


1a
2a
1b
2b
3a
4a
5a
6a
3b
4b
5b
6b

Specimen RGM 229 368 (ex Jagt no 4369) is from the middle part of the section, c. 3.5-4 m above the Vroenhoven Horizon, which marks the base of the Geulhem Member.

Description—The two available internal moulds have the following dimensions (in mm):

	height	length	diameter
RGM 229 349c	14.4	14.2 +	14.0
RGM 229 349e	12.7	13.3	11.6

The larger one of these moulds is damaged or incompletely filled with matrix, thus obscuring details of its posterior part. On one or both of these specimens the following details of the original shells are visible: shell very globose, symmetrical, almost spherical, but somewhat longer than high and slightly tapering backwards. The truly spherical anterior part of the individuals is completely closed by the callum, the left part of which slightly overlaps that of the right valve. The upper part of the callum reaches beyond the umbones in both valves (lateral view, Pl. 1, Fig. 2a). Between the protruding parts of the callum and the umbones lie the considerably thickened anterior dorsal margins, both bearing a distinctly impressed muscle scar at their extreme ends. The boundary between the anterior margin and the callum is distinct in both valves, as the shell apparently was less thin-walled than the callum, resulting in a clear constriction on the inner moulds. The anterior and posterior margins of the shell meet ventrally, enclosing an angle somewhat smaller than 90°.

An internal dorso-ventral ridge is only distinct in the left valve, preceded by a slight swelling of the shell-wall, which is also present in the right valve. The posterior dorsal margin is also thickened, but considerably less than the anterior one, reaching slightly higher than the umbones.

Starting immediately behind the umbones a high and narrow lamella (visible as a deep and narrow slit on the internal moulds) is present in both valves, running obliquely backwards to approximately one third of the shell height. These lamellae diverge only slightly from the posterior dorsal margins. Together (dorsal view, Pl. 1, Figs 1b, 2b) they enclose an angle of somewhat less than 90°.

Neither one of the two available moulds demonstrates the presence of a siphonoplax, as in both the posterior part is more or less incompletely preserved.

Three fragmentary external moulds of adult specimens, two of which correspond with the above described internal moulds, show some details of the outer surface morphology. In specimen RGM 229 349a the anterior part of the left valve with callum is preserved. The surface sculpture is only well-developed towards the antero-ventral margin and consists of numerous very fine and minutely dentated concentric ridges. Towards the anterior end of the shell a radial sculpture is developed, which finally is somewhat stronger than the concentric ornamentation. Some ten of these radial lines are visible on the mould, just behind the boundary of the callum, which apparently had an entirely smooth surface.

The external mould of specimen RGM 229 349b (Pl. 1, Fig. 1a), corresponding with internal mould RGM 229 349c (Pl. 1, Fig. 1b), shows the anterior dorsal part of the shell and a further fragment of the same mould reveals some details of the sculpture on the ventral part of the left valve. This specimen demonstrates that the callum overlies the anterior dorsal part of the shell. The sculpture of the valves is similar to that of the above described specimen, but here it can be observed that the very fine concentric ridges lose their denticulation and increase quickly in strength towards the posterior side of the shell, abruptly changing direction on the only weakly visible dorso-ventral

groove, enclosing an angle of about 100-110°. Again the posterior parts of the shell are not preserved. Similar observations on the anterior parts can be made in a third specimen (RGM 229 349e).

Finally, an external mould of a juvenile specimen is available (RGM 229 368), showing the almost complete outer sides of the two valves. In this specimen (height about 4.6 mm) accessory plates are not yet developed and the two valves lie dislocated in anterior direction (with their front margins touching) in what appears to be their own borehole. In both these valves a dorso-ventral groove is distinctly present. Preceding this groove the concentric sculpture is weak and clearly flexuous, behind the groove the ridges are stronger and very regular. Especially towards the margins the concentric ridges are finely denticulate. A true radial sculpture seems to be absent.

Discussion—Species of the genus *Jouannetia* are known to occur in self-made boreholes in shales and soft rocks (Turner, 1969). For the material discussed here it is clear, that the external moulds of the adult specimens, which appear as spherical holes in a relatively hard limestone matrix, do not represent the actual boreholes of the *Jouannetia* shells, but that they are merely the impressions of isolated reworked shells in the sediment. This is evidenced by the fact that the sculpture of the shells is preserved on the inner sides of the holes, which could not be the case if these were the actual boreholes. It is quite surprising that such complete specimens were apparently removed from their original boring site and were subsequently embedded in soft sediment. Still, the presence of *Jouannetia* points to the presence, at the time of deposition, of solidified limestone rocks, indicating considerable breaks in sedimentation.

Jouannetia is a conservative, cosmopolitan genus, representatives of which are known from the Cretaceous to the present time (Kelly, 1988). Diagnostic features of the species are usually based on slight differences in sculpture and shell proportions, or on the morphology of the posterior accessory plates. The oldest known species, *J. supracretacea* (de Ryckholt, 1852), was described from '... le silex, à Ciply.' (de Ryckholt, 1852, p. 116). At Ciply (Belgium) Maastrichtian as well as Palaeocene deposits (Tuffeau de Ciply) are present, both containing flints. The Palaeocene flints are light grey (de Heinzelin & Glibert, 1957, p. 56), the Cretaceous ones presumably black. Without having seen de Ryckholt's material it is impossible to decide from which part of the Ciply section *J. supracretacea* was collected and therefore we prefer to mention the Geulhem material in open nomenclature, until a direct comparison is made possible. The presence of *J. supracretacea* in the Danian is acknowledged, by the way, by Hinsch *et al.* (1988, p. 346), who mentioned the last occurrence of this species in the BM 2 = Cipliacella pulchella Zone (based on benthic molluses), which is of Late Danian age.

Classis Gastropoda
Ordo Archaeogastropoda
Subordo Neritopsina
Superfamilia Neritoidea
Familia Neritopsidae Gray, 1847
Subfamilia Neritopsinae Gray, 1847
Genus *Neritopsis* Grateloup, 1832

Type species—*Neritopsis moniliformis* Grateloup, 1832 by monotypy (Miocene, Adour Basin, SW France), not *Neritopsis radula* (Linné, 1758) (Recent, Indopacific), as stated for example by Cossmann (1888, p. 85).

Neritopsis sp.
Pl. 1, Figs 3-6, Pl. 2, Figs 1-3

Material studied—Riemst (Belgium, province of Limburg), section along the Albert Canal, North of Vroenhoven bridge, West bank of canal, near km marks 23.500-23.600 (see fig. 5-1 in Albers *et al.*, 1978); Danian [lowermost 0.5 m of Geulhem Member (Houthem Formation)]: 3 opercula, leg. J.W.M. Jagt, coll. RGM 229 373-229 375 (Pl. 2, Figs 1-3).

As above, East bank of the canal, approx. near km mark 24.500; Danian [Geulhem Member, c. 8-9 m above Vroenhoven Horizon (= base Geulhem Mbr) (Houthem Formation)]: 4 opercula, leg. J.W.M. Jagt, coll. RGM 229 369-229 372 (Pl. 1, Figs 3-6). The two above mentioned localities are indicated on a location map in Jagt & Collins (1988, in the present issue; localities 4 and 5 respectively).

As above [Geulhem Member, c. 2.5 m above Vroenhoven Horizon (= base Geulhem Mbr) (Houthem Formation), in level with abundant *Tylocidaris hardouini* and no *T. bruennichi*]: 6 opercula, leg./coll. R.W.J.M. van der Ham, Delft, The Netherlands, registration nr 436.

Description—Opercula calcareous, apparently calcitic (as all aragonite is dissolved in the deposits concerned), rather solid. All available specimens demonstrate more or less distinct traces of transportation.

The outer side of the opercula is convex, the inner side is slightly concave. The abaxial margin is strongly curved, semicircular. Adaxially the opercula are straight, but with a prominent central protuberance. The inner side of this protuberance is excavated and provided with a more or less developed horizontal ridge. Both below and above the protuberance the inner side of the opercula possesses deep excavations, which are abaxially cut off by the sharp and flexuous boundary of the thickened, but still slightly concave abaxial part of the operculum. Incremental lines, roughly following the adaxial margin, are visible on the better preserved specimens.

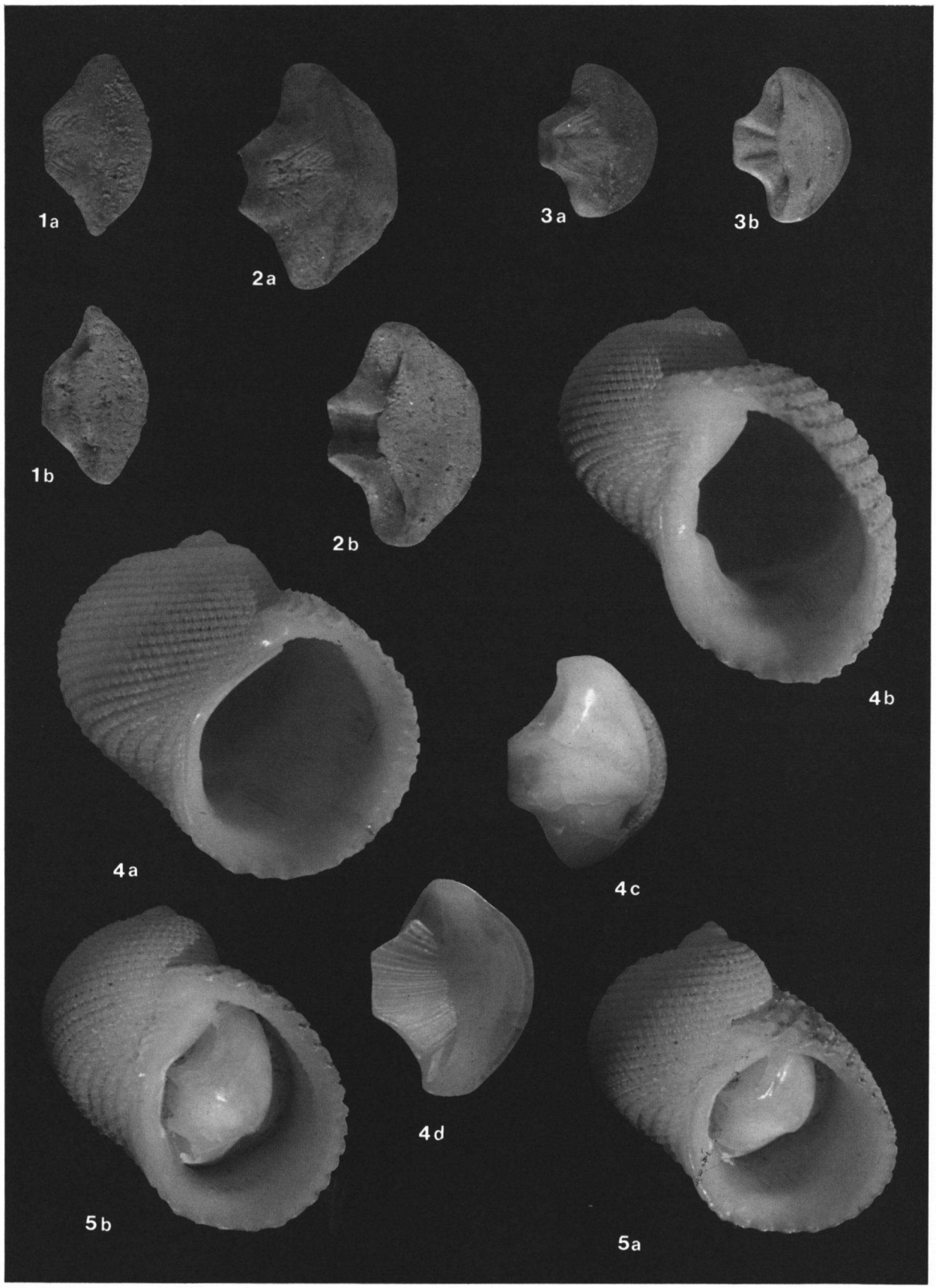
Outer side with a thickened adaxial part, separated by a slightly curved boundary from the somewhat less thick abaxial part. The axial side of the protuberance is thickened most and provided with

Explanation of Plate 2.

Figs 1-3. *Neritopsis* sp., opercula.
Albert Canal section, North of Vroenhoven bridge, West bank near km marks 23.500-23.600, at Riemst, Belgium, lowermost 0.5 m of Geulhem Member (Houthem Formation; Palaeocene, Danian); leg. J.W.M. Jagt, coll. RGM 229 373-229 375.
1a-3a: exterior views; 1b-3b: interior views (heights resp. 8.2, 10.0 and 6.9 mm).

Fig. 4a-d. *Neritopsis radula* (Linné, 1758).
Mauritius, Recent; leg. Frank, 1891, coll. Rijksmuseum van Natuurlijke Historie, Leiden.
4a: shell, straight apertural view (note upper parietal tooth); 4b: dto, oblique apertural view to demonstrate excavated columella; 4c: operculum of same shell, exterior view; 4d: dto, interior view (height of shell 21 mm).

Fig. 5a-b. *Neritopsis radula* (Linné, 1758).
Locality etc. as in Fig. 4.
5a: shell with operculum in situ, straight apertural view; 5b: dto, oblique apertural view (height of shell 18 mm).


1a
2a
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4b
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4c
4d
5b
5a

an oblique and slightly concave squarish field, which was in contact with the shell's columella in the living animal. A furrow runs from the concave squarish field towards the boundary with the less thickened abaxial part of the columella.

Remarks—For a better understanding of the morphology of these opercula illustrations are given (Pl. 2, Figs 4 and 5) of the one and only living representative of the genus *Neritopsis*, *N. radula* (Linné, 1758). In this way inner and outer side of its operculum (Figs 4c and d respectively) can be easily compared with the fossil specimens. Figs 5a-b show the operculum *in situ* in the aperture of the shell, with only the outer side visible. In Fig. 4b the shell is illustrated in an oblique apertural view to show the excavated columella, in which the protuberance of the operculum fits.

Incidentally, the Danian opercula differ only slightly from those of *N. radula*. The excavated inner side of the protuberance in *radula* bears very obvious transverse striae, which are absent in the Danian specimens. Furthermore, the boundary on the outside of the opercula separating the strongly inflated adaxial part from the less thickened abaxial part lies more towards the adaxial side in the Recent species. A further slight difference is the fact that the upper adaxial corner of the *N. radula* opercula is slightly hook-shaped. This hook fits into the furrow between the parietal tooth and the upper apertural margin (Fig. 4a), apparently functioning as a conductor for the operculum. The absence of such a hook in the Danian opercula suggests that the *Neritopsis*-shells had no such parietal tooth and furrow.

Apparently, Jagt (1986) was the first to record opercula of *Neritopsis* from the Early Palaeocene (Danian) deposits in the Maastricht area. However, opercula of this genus were previously reported from Late Cretaceous (Maastrichtian) strata in the same area. Müller (1851, p. 60, pl. 6, fig. 13a-c) described and illustrated, under the denomination *Rhyncholithus buchi* Müller a *Neritopsis* operculum, which he, in view of its peculiar structure so unlike that of cephalopod beaks (rhyncholites), hesitatingly considered to be the upper jaw of a nautiloid buccal apparatus. Müller's specimen was stated to originate from Vetschau near Aachen (F.R.G.): 'Wir fanden das Petrefact in guter Erhaltung bei Vetschau zusammen mit einer Menge kleiner Korallen im Sand.' (Müller, 1851, p. 61).

Binkhorst van den Binkhorst (1873, p. 19, pl. 5c, fig. 4a-d) referred to a single operculum from Lanaye (Belgium, province of Liège) as *Rhyncholithus ? buchii* Müller. This specimen was said to have been collected 'au même endroit où nous avons recueilli l'espèce précédente ...', the preceding species being *Rhyncholithes minimus* Binkhorst, a genuine upper jaw element of a nautiloid cephalopod. The find spot is 'près de Lanaye ... dans une couche de transition entre la craie jaune grossière et la craie grise à silex noirs' (Binkhorst van den Binkhorst, 1873, p. 19). This would imply the upper part of the Gulpen Formation in current lithostratigraphic terminology, and consequently an early Late Maastrichtian age. Judging from the illustrations alone the Maastrichtian specimens resemble the material studied in the present paper so closely that they might belong to the same species indeed.

Binkhorst mentioned that Müller's single specimen of *R. buchi* came from 'une couche à bryozoaires, à Vetschau près d'Aix- la-Chapelle.'. This would suggest that Müller's type specimen is also of Late Maastrichtian age (see also Bosquet, 1860, 1868), since strata of Early Palaeocene (Danian) age have never been reported from the environs of Aachen (see *e.g.* Albers & W.M. Felder, 1979; W.M. Felder, 1975; Vangerow & Schloemer, 1967).

Holzapfel (1887, p. 70) also referred Müller's specimen to the Maastrichtian, and he was the first to note that this alleged cephalopod beak was in fact a *Neritopsis* operculum.

A species only slightly younger than the present material, *Neritopsis multicostata* Briart & Cornet, 1887, is known from the 'Calcaire de Mons' at Mons (Belgium, Mons Basin); for an illustration see Glibert (1973, p. 17, pl. 2, fig. 7). It is, however, impossible to decide whether or not the same taxon is involved, as the Mons species is exclusively known by its shell, opercula have not been reported.

Two species from the Eocene of the Paris Basin, viz. *Neritopsis parisiensis* Deshayes, 1864 and *N. acutispira* Cossmann, 1886 are equally known by their shells only.

Considering that the Early Palaeocene opercula described here certainly look inseparable from those of the underlying Maastrichtian strata and that a direct comparison of the Palaeocene and Eocene species from Belgium and France is impossible we considered it best to describe the material in open nomenclature. Identification is only possible when the shells are known. These have not yet been recorded in literature. If they are ever to be found it is to be expected that the indurated limestone layers in the upper part of the Geulhem Member present the most likely source for Early Palaeocene specimens, although such fossils will always be decalcified and preserved as external and internal moulds.

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