Pteropods (Mollusca, Euthecosomata) from the Early Eocene of Rotterdam (The Netherlands)

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Key words – Mollusca, Gastropoda, Thecosomata, pteropods, The Netherlands, Eocene, Ypresian, biostratigraphy.
A borehole was drilled at Rotterdam in 1955 as a demonstration during the E55 exhibition. Holoplanktonic molluscs (pteropods) were found to be present in the interval 504.5-655.0 m below rotary table (= RT). The upper sample of Middle Eocene (Lutetian) age yielded just a few unidentifiable limacinids. The section between 507.5-607.0 m, of Early Eocene (Ypresian) age, yielded poorly preserved pteropods and demonstrated that the complete interval belongs to pteropod zone 9. Apart from the most abundant species, *Camptoceratops priscus*, which is the index taxon of pteropod zone 9, the section yielded *Heliconoides mercinensis* and *Limacina taylori*, which are known to accompany the index species. Two further limacinid species are described as new to science, viz. *Limacina erasmiana* sp. nov. and *L. guersi* sp. nov., to date not known from elsewhere in the North Sea Basin. The occurrence of *L. pygmaea* in a restricted interval (569.0-574.0 m-RT) is remarkable; it is generally considered to be of Lutetian age, but also is found in the Ypresian of Gan, southwest France. Its occurrence in the E55 section is explained as a 'sea-level related molluscan plankton event', allowing species of oceanic distribution to enter the basin during sea level high stands, as was recently also demonstrated for several Oligocene pteropods.

Contents

Introduction

In 1955, for the second time after World War Two and following the great success of the exhibition Ahoy' 1950, another very large exhibition was organized in Rotterdam to display the post-war revival of society, industry and commerce. The name of this new exhibition was Expo E55 (= Energy 1955) and a large number of participants from all branches of the Dutch community joined this demonstration of recovery.

One of the more spectacular items was a contribution of the Nederlandse Aardolie Maatschappij (N.A.M.) that installed a complete and actively operational oil drill as a demonstration item (Fig. 1). During the E55 exhibition this borehole reached a depth of 1406 m and ended dry in sedimentary rocks of Cretaceous (Aptian) age. After finishing the drilling procedure a γ-log was brought down by N.A.M. from a depth of *c*. 300 m

downwards. Some information on this borehole can also be found on the website NL Olie- en Gasportaal (http://www.nlog.nl).

Samples from this borehole were collected and housed by the 'Geologische Stichting, afdeling Geologische Dienst' at Haarlem, nowadays Nederlands Instituut voor Toegepaste Geowetenschappen TNO (NITG), at Utrecht. The section was continuously cored, resulting in high quality sample material, in which no contamination occurs. The base of Cenozoic sedimentary rocks was found at a depth of 745 m.

Fig. 1. The E55 borehole of Rotterdam. Picture from website http://beeldbank.nationaalarchief.nl/na:col1:dat55564 (courtesy Nationaal Archief Fotocollectie Anefo).

In spite of the high quality of the collected samples, comparatively little scientific research has been executed on this section. Evaluation of the sample material was restricted to a number of internal reports of the Rijks Geologische Dienst, whereas I have been able to find just two formal publications by scientists of that institute referring to this borehole (van Voorthuysen, 1960; van Voorthuysen *et al*., 1972), in which a litho- and/or chronostratigraphical interpretation of the Cenozoic part of the section was given. Internal reports, all restricted to the interval of 0-745 m at the most, touch on a detailed lithological description (Harsveldt, 1955), the heavy-mineral contents (Burger, 1989) and on some further, minor aspects (Doppert, 1977; van Voorthuysen, 1964; Zagwijn, 1961).

Table 1. Stratigraphy of the E55 borehole. Depths in m below rotary table. Modified from website www.nlog.nl.

Depth below surface	chronostratigraphy	lithostratigraphy
0.00-327.00 m	Quaternary	Maassluis Formation
327.00-408.00 m	Pliocene	Oosterhout Formation
408.00-452.00 m	Miocene	Breda Formation
452.00-460.00 m	Oligocene	Rupel Formation, Rupel Clay Member
460.00-507.00 m	Eocene, Lutetian	Dongen Formation, Brussels Sand Member
507.00-703.00 m	Eocene, Ypresian	Dongen Formation, Ieper Clay Member
703.00-745.00 m	Paleocene, Thanetian	Landen Formation, Landen Clay Member
745.00-1112.00 m	Paleocene, Danian	Ommelanden Formation
1112.00-1134.00 m	Cretaceous, Cenomanian	Texel Chalk Formation
1134.00-1214.00 m	Cretaceous, Aptian	Holland Formation, Upper Holland Marl Member
1214.00-1282.00 m	Cretaceous, Aptian	Holland Formation, Middle Holland Shale Member
1282.00-1406.00 m	Cretaceous, Aptian	Holland Formation, Lower Holland Marl Member
1406.00+ m		not penetrated

Brouwer (1968) analysed two samples from this section (725 and 730 m-RT) for their foraminiferal contents and found them to indicate a depositional sea depth exceeding 200 m. Based on van Voorthuysen (1960), Brouwer interpreted these two samples as representing the basal Clays of Ieper (Ypresian), but nowadays that part of the section is recognised as Landen Clay Member of the Landen Formation (Table 1) and their age is considered to be Thanetian. The section was further sampled by Mr Chris King (Bridport, UK) for foraminifera and Dr Etienne Steurbaut (Institut royal des Sciences naturelles de Belgique, Brussels, Belgium) for calcareous nannoplankton (both unpublished).

As a result of various and repeated reorganisations and relocations of the Rijks Geologische Dienst, inclusive of a drastic reduction of scientific research on available sections, the safe keeping of the rather voluminous collection of E 55 cores was endangered in the early 1980s. An agreement was reached between the Dienst and the Rijksmuseum van Geologie en Mineralogie (RGM, nowadays part of the NCB Naturalis) at Leiden. A large quantity of that collection, comprising the Tertiary part of the section, was transported to Leiden, with the purpose of processing the greater part of the samples for macropalaeontological research and, more especially, for holoplanktonic Mollusca.

Abbreviations used: BMNH – The Natural History Museum, London (England); N.A.P. – Normaal Amsterdams Peil; RGM – Department of Geology, NCB Naturalis, Leiden (The Netherlands); LOD – last occurrence datum; RD – Rijks Driehoeksmeting; RT – rotary table.

Stratigraphy and sample processing

The formal E55 borehole number of the Rijks Geologische Dienst is 37H.2-29, NITG number B37H0201, N.A.M. code AHO-E-55. Coordinates are x = -62.986.04, y = -26.531.59 in the old 'Amersfoort' coordinate system, nowadays indicated as RD-coordinates x = 92.014, y = 436.468 (approximately 51° 54′ 49″ N 4° 28′ 20″ E), a location close to the Boymans-van Beuningen Museum, in the centre of the city of Rotterdam. Depths are given in m-RT (m below rotary table = 1.20 m above surface = 0.50 m + N.A.P.). Started 10 May, finished 24 September 1955.

Presently (source: www.nlog.nl) the stratigraphy recognised in the E55 borehole is as given in Table 1, in which the base of the Quaternary, however, is lowered to 327 m (pers. comm. Tom Meijer). For research on holoplanktonic molluscs, 308 samples from the Cenozoic interval (~ 400.00 – 745.00 m below surface), each of them covering 0.50 to 1.50 m core length, were washed on a 300 μm mesh, totalling 294.2 kg. Sample size usually was between 500 and 1500 g. Almost all samples consist of more or less clayey sediment, at first processed with hot water and, after drying, once, sometimes twice followed by treatment with a 10 % solution of hydrogen peroxide. In a small number of cases, samples had to be deep frozen after the first hot water treatment to obtain a clean residue. Residues were often quite substantial, frequently more than half the original sample weight, because of large amounts of dark minerals (glauconite?) and/or pyrite. A quantity of sediment was kept separate from each sample before processing. These small rock samples were returned to the Rijks Geologische Dienst.

Processing of all these samples was laborious and entirely done by Mr. Charles P. Barnard (RGM) at intervals during the years 1987-1990. The sorting procedure of the

Table 2. Range chart of pteropod species in the E55 borehole of Rotterdam.

Depth in m-RT	*Heliconoides mercinensis*	*Limacina erasmiana* sp. nov.	*Limacina guersi* sp. nov.	*Limacina pygmaea*	*Limacina taylori*	Limacinidae sp. 1	Limacinidae sp. indet.	*Camptoceratops priscus*
504.5-505.							5	
507.5-508.5					6			
519.5-520.5		1						1
523.5-524.0							2	1
525.4-526.4					1			
528.0-529.0		1						4
531.0-531.5								2
537.0-537.5								2
537.5-538.0	1							3
538.0-538.5	2							1
539.0-539.5								2
540.5-541.0								3
553.0-554.0	>100							4
555.5-556.0							1	2
556.0-556.5	150		55					20
556.5-557.0	19		5					6
560.0-561.0			3					3
561.0-561.5			1					3
562.0-562.5			1					1
562.5-563.0			1					1
563.0-564.0			6					2
564.0-565.0	6		9					16
565.0-566.0	3		5					9
566.6-567.0	15		1					10
567.0-568.0								4
568.0-569.0	3							2
569.0-570.0	35		32	36		1		45
570.0-571.0	7		22	12				46
571.0-572.0	3	3	25	4				108
572.6-573.0	2		7					2
573.0-574.0	32	1	21	10				44
575.0-576.0								2
576.0-577.0								1
577.0-578.0								4
578.0-579.0					15			8
579.0-580.0					3			17
589.0-590.0					1			3
593.0-594.0	4		3		5			1
595.0-596.0	1							3
599.5-600.0					1			
600.0-601.0	5	1						
603.0-604.0	12							1
608.0-609.0								5
654.0-655.0	1							

voluminous residues, for a large part also done by Mr. Barnard, was quite demoralizing, because of the very restricted fossil contents. In fact, a large number of samples did not yield any macrofossils at all; of the originally 308 samples, only 44 yielded one or more pteropods (Table 2). Furthermore, specimens in fossiliferous samples were commonly of poor quality, being compressed or otherwise damaged by rock pressure or pyrite deterioration, which is not surprising realizing that sample analysis took place over 30 years after collecting. For the present study only holoplanktonic molluscs are considered. The relatively few benthic molluscs and other fossils were returned to the Rijks Geologische Dienst, but are presently housed in RGM.

With the exception of five unrecognizable (base Lutetian) limacinids from sample 504.5 m-RT, pteropods were exclusively present in the Ypresian interval 507-655 m, with the restriction that from the interval 609-655 m just one specimen was recovered. This material is described in more detail below. All specimens are housed in the NCB Naturalis, at Leiden, The Netherlands (RGM registration numbers).

Systematic palaeontology

Here the indication 'clade' is applied as a taxonomic unit above superfamily, instead of the traditional order, suborder, *etc*., indicating that 'recent cladistic analysis has resulted in recognizing a taxon as monophyletic' (Bouchet & Rocroi, 2005, p. 240). Numbers of specimens are given after a slash following the RGM registration number.

Phylum Mollusca Linné, 1758
Class Gastropoda Cuvier, 1797
Clade Thecosomata de Blainville, 1824
Superfamily Limacinoidea Gray, 1847
Family Limacinidae Gray, 1847
Genus *Heliconoides* d'Orbigny, 1834

Type species – *Atlanta inflata* d'Orbigny, 1834 (Recent).

Heliconoides mercinensis (Watelet & Lefèvre, 1885)

Fig. 2.

* 1885 *Spirialis mercinensis* Watelet & Lefèvre, p. 102, pl. 5, fig. 2a-c.
v. 2007 *Heliconoides mercinensis* (Watelet & Lefèvre); Janssen *et al*., p. 163, figs. 7-8 [with extensive synonymy].

Description – The available specimens from this borehole are in general very poorly preserved as internal pyritic moulds, in most cases distorted by rock pressure. Only in the concretion fragment from depth 553-554 m are undisturbed specimens present in internal calcitic mould preservation. One of the larger specimens of this concretion (H = 0.80 mm, W = 1.56 mm) could be isolated (Fig. 2). It agrees in shape with specimens from the Paris Basin Ypresian, as illustrated by Curry (1965) and Cahuzac & Janssen (2010).

Material examined – RGM 569 598/1, 537.5-538 m; RGM 569 600/2, 538-538.5 m; RGM 569 604/ more than 100 specimens in concretion fragment, RGM 569 683/1 (Fig. 2), 553-554 m (donated C. King); RGM 569 608/150, 556-556.5 m; RGM 569 611/19, 556.5-557 m; RGM 569625/6, 564-565 m; RGM 569 628/2, 565-566 m; RGM 569 631/15, 566.6-567 m; RGM 569 635/3, 568-569 m; RGM 569 638/35, 569-570 m; RGM 569 642/7, 570-571 m; RGM 569 646/3, 571-572 m; RGM 569 651/2, 572.6-573 m; RGM 569 654/32, 573-574 m; RGM 569 668/4, 593-594 m; RGM 569 672/1, 595-596 m; RGM 569 675/5, 600-601 m; RGM 569 677/12, 603-604 m (donated C. King); RGM 569 680/1, 654-655 m.

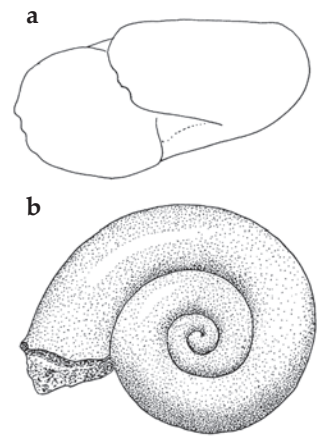


Fig. 2. *Heliconoides mercinensis* (Watelet & Lefèvre, 1885), calcitic internal mould. Rotterdam, E55 borehole, 553-554 m-RT, RGM 569 683. (a) Apertural and (b) apical views. Bar represents 1 mm.

Discussion – *Heliconoides mercinensis* is the oldest pteropod known. Janssen & King (1988) recorded it from pteropod zones 6-8 and the early part of zone 9, which includes the entire Ypresian interval. Janssen *et al*. (2007) found the species in the early Lutetian Lillebaelt Clay Formation in Denmark.

Originally this species was described from the 'Cuisian' (= Ypresian) of the Paris Basin (Mercin is type locality) and it was subsequently recorded from various localities in the North Sea Basin. It is, for instance, a very common species in Ypresian concretions from the London Clay and in similar 'cementstones' from the earliest Eocene Fur Formation, Mo Clay, in Denmark. The concretion fragment from the present borehole (553-554 m) resembles such occurrences closely.

The species is also known (RGM collection) from the Late Paleocene (Tuscahoma Sand Formation, Bear Creek Marls) of Alabama (U.S.A.). *Heliconoides mercinensis* was not recognised in Eocene deposits in North America, as it does not appear in the paper of Hodgkinson *et al*. (1992), but the taxon *Limacina planidorsalis* Hodgkinson *in* Hodgkinson *et al*., 1992 (p. 18, pl. 3, figs. 11-13), found in Early to Middle Eocene of eastern Canadian offshore wells, might very well represent the same species. Curry (1982) mentioned this species also from the very rich Ypresian pteropod assemblage of Gan (southwest France), but that occurrence was redescribed as a new species in Cahuzac & Janssen (2010).

Genus *Limacina* Bosc, 1817

Type species – 'le clio hélicine' = *Limacina helicina* (Phipps, 1774) (Recent).

Limacina erasmiana sp. nov.

Figs. 3-6.

Holotype – RGM 569 649 (Fig. 3a-c).

Type locality – E55 borehole 37H.2-29, Rotterdam, depth 571.0-572.0 m below rotary table.

Stratum typicum – Dongen Formation, Ieper Clay Member (Eocene, Ypresian).

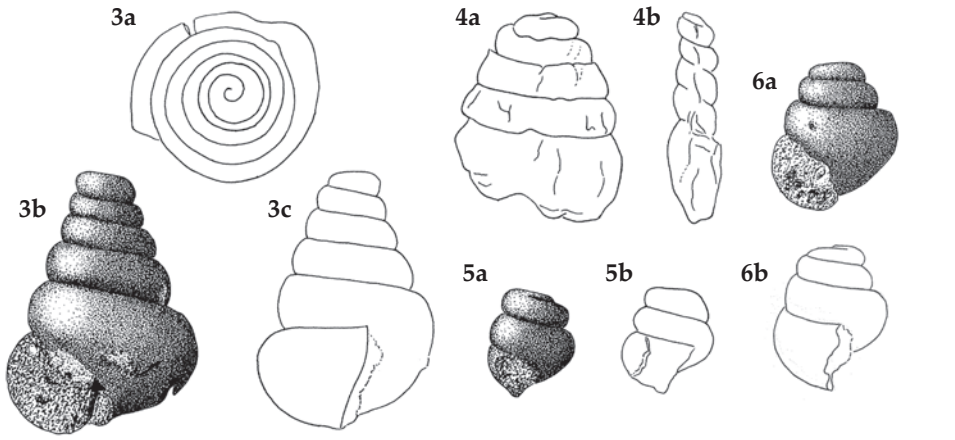
Derivatio nominis – The new species is named after Desiderius Erasmus Roterodamus (1466/1469-1536), humanist and theologian, emblem of the city of Rotterdam.

Paratypes – RGM 569 589/1, 519.5-520.5 m; RGM 569 594/1, 528-529 m; RGM 569 684/1, 560.0-561.0 m (donated C. King); RGM 569 681-682/2 illustrated (Figs. 4, 5), 571-572 m, RGM 569 657/1 (Fig. 6), 573-574 m; RGM 569 676/1, 600-601 m.

Diagnosis – High-conical limacinid with very convex whorls and a blunt apex; aperture circular, no apertural reinforcements present; base of body whorl rounded, perforate.

Description. – The shell is high-conical, 1.35 times higher than wide, with straight tangents and an apical angle of *c*. 40°. There are 5¾ strongly convex whorls, separated by deep sutures. The first 1½ whorl are relatively wide (Fig. 3a) and planispiral, which results in a blunt apex. The aperture is relatively small and circular, occupying four tenths of the shell height and without any apertural reinforcement, positioned slightly oblique with respect to the shell's long axis (Fig. 3c). A narrow umbilicus is present. The holotype is the only fully grown and well-preserved specimen. Its measurements are H 1.32 mm, W 0.98 mm.

Discussion – All paratypes are either juveniles or specimens that have suffered from rock pressure, resulting in completely flattened shells, with a much wider apical angle (Fig. 4).



Figs. 3-6. *Limacina erasmiana* sp. nov., internal pyritic moulds, paratypes unless stated otherwise. All specimens from the E55 borehole at Rotterdam.
Fig. 3. Holotype, 571-572 m-RT, RGM 569 649. (a) Apical, (b) apertural and (c) lateral views.
Fig. 4. Compressed specimen, same depth, RGM 569 682. (a) Dorsal and (b) lateral views.
Fig. 5. Same depth, RGM 569 681. (a) Apertural and (b) lateral views.
Fig. 6. 573-574 m-RT, RGM 569 657. (a) Apertural and (b) lateral views.
Bar represents 1 mm.

The only other species of similar age with a comparatively high spire are *Limacina tutelina* (Curry, 1965), described from the London Clay (Ypresian) of southeast England, and *Altaspiratella bearnensis* (Curry, 1982), from the Ypresian of Gan (southwest France; see Cahuzac & Janssen, 2010) and also known from the North Sea Basin. The former, however, reaches far larger dimensions, has higher and clearly less convex whorls, its first whorl is not planorboid, and the aperture is relatively larger and narrower, not positioned obliquely. *Altaspiratella bearnensis* also has higher whorls, a non-planorboid apical whorl and its base is imperforate. Furthermore, that species has distinctly developed apertural characteristics.

***Limacina guersi* sp. nov.**
Figs. 7, 8.

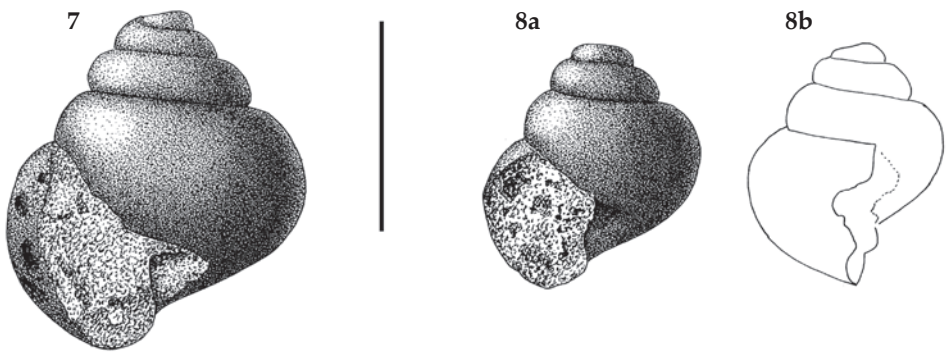
Holotype – RGM 569 685 (Fig. 7).

Type locality – E55 borehole 37H.2-29, Rotterdam, depth 570.0-571.0 m below rotary table.

Stratum typicum – Dongen Formation, Ieper Clay Member (Eocene, Ypresian).

Derivatio nominis – The new species is named after my much appreciated colleague and friend, the late Dr Karl Gürs (1964-2008), in life geologist of the Landesamt für Natur und Umwelt des Landes Schleswig-Holstein (Flintbeck, Germany), who was a co-author in several papers on fossil pteropods.

Paratypes – RGM 569 609, 556-556.5 m; RGM 569 612/5, 556.5-557 m; RGM 569 614/1, 560-561 m; RGM 569 615/1, 560-561 m (donated C. King); RGM 569 617/1, 561-561.5 m; RGM 569.619/1, 562-562.5 m; RGM 569 621, 562.5-563 m; RGM 569 623/6, 563-564 m;



Figs. 7, 8. *Limacina guersi* sp. nov., pyritic internal moulds. Both specimens from the E55 borehole, Rotterdam, 570-571 m-RT.
Fig. 7. Holotype, RGM 569 685, apertural view.
Fig. 8. Paratype, RGM 569 686. (a) Apertural and (b) lateral view.
Bar represents 1 mm.

RGM 569 626/9, 564-565 m; RGM 569 629/5, 565-566 m; RGM 569 632/1, 566.6-567 m; RGM 569 639/32, 569-570 m; RGM 569 643/20, RGM 569 686/1 (Fig. 8), 570-571 m; RGM 569 647/25, 571-572 m; RGM 569 652/7, 572.6-573 m; RGM 569 655/21, 573-574 m; RGM 569 669/3, 593-594 m.

Diagnosis – Limacinid of very regular shape with up to 4¼ very convex whorls and a blunt apex. Aperture circular, slightly more than half the shell height. Base narrowly umbilicated. No apertural reinforcements.

Description – Almost 200 specimens are present, but virtually all of these are in bad condition. More or less well-preserved shells are slightly higher than wide and have up to 4¼ convex whorls of which the first one is almost planispiral, resulting in a blunt apex. The apical angle of the shell is between 70° and 80°, and the tangents along the spire are virtually straight. The aperture occupies somewhat more than half the shell height, its outer margin is regularly circular and the inner lip is invisible. There seem to be no apertural reinforcements, but all specimens are preserved as internal pyritic moulds in which the apertural margin is incompletely preserved. The base of the shell is regularly rounded and has a narrow umbilicus.

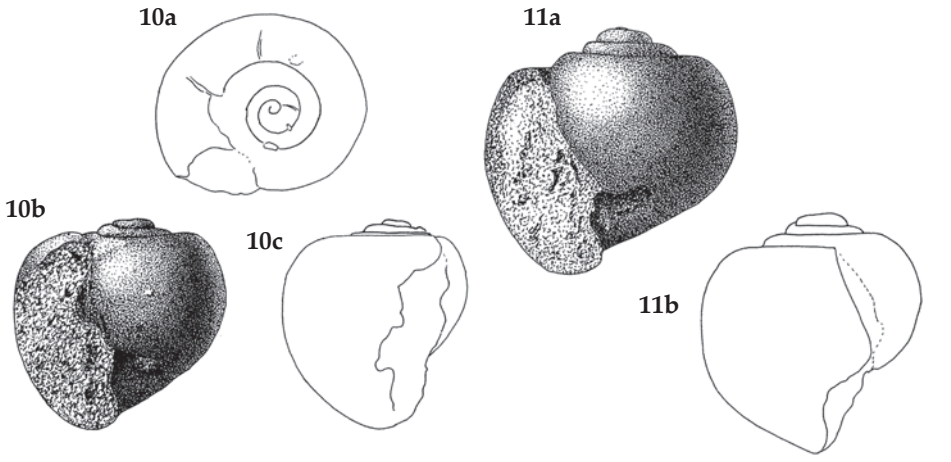
Discussion – Specimens differ from the type material of *Heliconoides nemoris* (Curry, 1965), with which taxon the present material was initially identified, in several respects: specimens reach larger dimensions (largest specimen available, holotype, Fig. 7: H = 1.62 mm; the complete adult holotype of *H. nemoris* reaches just 1.12 mm); have far more convex whorls; and do not show the abapically forward sloping apertural margin. The holotype of *H. nemoris* (see Curry, 1965, fig. 17a-b, *non* 16a-b) is here re-illustrated in Figure 9 for comparison. *Heliconoides nemoris* was described from the Eocene (Bartonian) Upper Bracklesham Beds and was also recorded (Curry, 1965; Cahuzac & Janssen, 2010) from the Priabonian of Biarritz (southwest France). Specimens illustrated from North American Lutetian localities as *Limacina nemoris* by Hodgkinson *et al.* (1992) differ morphologically from *H. nemoris* in not having the blunt apex and absence of apertural reinforcements. From the present new species they differ by a relatively larger body whorl and aperture, and clearly less convex whorls.

Fig. 9. Holotype of *Heliconoides nemoris* (Curry, 1965). Bramshaw (UK, Hampshire), Upper Bracklesham Beds, Shepherd's Gutter Bed (Bartonian), BMNH GG 7100. Bar represents 1 mm.

Limacina pygmaea (Lamarck, 1805)

Figs. 10, 11.

* 1805 Ampullaire pygmée, *Ampullaria* (*pygmaea*) Lamarck, p. 30.
. 1806 Ampullaire pygmée, *Ampullaria pygmæa*; Lamarck, 1806, pl. 61. fig. 6a-b.
v. 1965 *Spiratella pygmaea* (Lamarck); Curry, p. 362, figs. 18a-b, 19.
v. 2010 *Limacina pygmaea* (Lamarck, 1805); Cahuzac & Janssen, pl. 8, figs. 3-5 [with extensive synonymy].



Figs. 10-11. *Limacina pygmaea* (Lamarck, 1805), internal pyritic moulds. E55 borehole, Rotterdam, 571-572 m-RT.
Fig. 10. RGM 569 687. (a) Apical, (b) frontal and (c) lateral views.
Fig. 11. RGM 569 688. (a) Apertural and (b) lateral views.
Bar represents 1 mm.

Description – Shell small, sinistral, naticoid, slightly wider than high to somewhat higher than wide. There are about four whorls in a regular spiral, which may be completely flattened, hardly or not visible in a frontal view, or slightly elevated. Aperture semicircular, apertural margin not reinforced, columella with a clear thickening in the middle. Umbilicus narrow.

Material examined – RGM 569 640/36, 569-570 m; RGM 569 644/12, 570-571 m; RGM 569 648/2, 569 687/1 (Fig. 10), 569 688/1 (Fig. 11), 571-572 m; RGM 569 656/10, 573-574 m.

Discussion – The occurrence of over 60 specimens of *Limacina pygmaea* in this short interval (569-574 m) in the E55 borehole can only be called highly surprising. Curry (1965) and Janssen & King (1988), to name a few, recorded this species exclusively from Lutetian sedimentary rocks and also in the Paris Basin, from where the species was originally introduced, the species is only known from that age.

However, Curry (1982, p. 37, pl. 1, fig. 3a-b), acknowledged by Cahuzac & Janssen (2010, pl. 8, figs. 3-5), found this species in the Ypresian of Gan (southwest France). For the pteropod zonation this fact causes some problems, as pteropod zone 10 (Lutetian) is characterized as a taxon range zone, with *Limacina pygmaea* as index species. The occurrence of that species already in the Ypresian necessitates a new definition of pteropod zone 10. Its lower boundary can now be identified by the LOD of *Camptoceratops priscus* and its upper boundary by the LOD of *L. pygmaea*

Limacina taylori (Curry, 1965)

Figs. 12, 13.

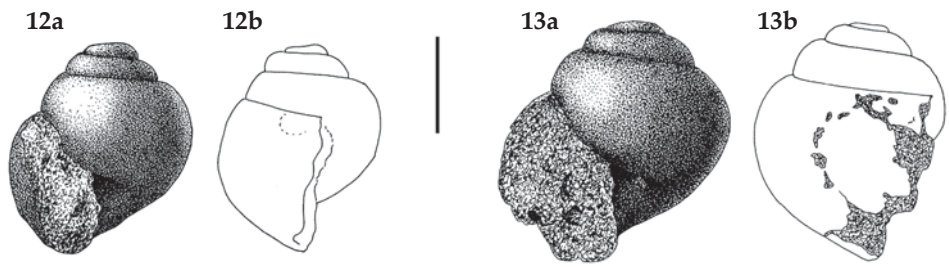
*v 1965 *Spiratella taylori* Curry, p. 363, fig. 21a-b.
? 1992 *Limacina taylori* (Curry); Hodgkinson *et al*., p. 20, pl. 4, fig. 2.

Description – Among the available specimens that are with some doubt identified as *Limacina taylori*, only one is sufficiently well-preserved to be recognised with certainty. That specimen (Fig. 12), of Ypresian age, resembles closely Curry's (1965) drawing of the holotype (redrawn herein as Fig. 13) and also agrees with topotypic material from the type locality (RGM 515 495, donated D. Curry, April 1986). The shell of the E55 specimen is slightly higher than wide (H = 2.24 mm, W = 1.92 mm) and has 3¾ slightly convex whorls. The first whorl is planispiral. The body whorl equals four fifths of the shell height. The elliptical aperture is slightly oblique with respect to the shell's vertical axis, its outer lip is gradually rounded and the inner lip concealed in pyrite. The base of the shell is narrowly perforated.

Material examined – RGM 569 588/? 6, 507.5-508.5 m; RGM 569 593/? 1, 525.4-526.4 m; RGM 569 662/? 14, RGM 569 689/1 (Fig. 12), 578-579 m; RGM 569 664/? 3, 579-580 m, 3 specimens; RGM 569 666/? 1, 589-590 m; RGM 569 670/? 5, 593-594 m; RGM 569 674/? 1, 599.5-600 m.

Discussion – Many of the E55 specimens are so poorly preserved, being deformed or deteriorated, that an identification often is merely wishful thinking. A distinction from the other limacinid species with raised spire has been attempted, but is hardly possible in several cases. Curry (1965) mentioned a shell height of more than 3 mm for this species, which means that the shell illustrated here is not an adult. Still, it is one of the larger E55 limacinid specimens. Janssen & King (1988) recorded *Limacina taylori* from pteropod zones 7 and 8, and the lower part of zone 9.

The specimen illustrated in Hodgkinson *et al*. (1992, pl. 4, fig. 2), has a lower, more globose shell and a wider umbilicus. With a shell height of 1.8 mm at the most it does not reach the size of the North Sea Basin specimens.



Figs. 12, 13. *Limacina taylori* (Curry, 1965), pyritic internal moulds.
Fig. 12. E55 borehole, 578-579 m-RT, RGM 569 689. (a) Apertural and (b) lateral views.
Fig. 13. Holotype, Bognor (UK, Sussex), London Clay (Ypresian), derived from Beetle Bed, BMNH GG 7101. (a) Apertural and (b) lateral views.
Bar represents 1 mm.

Limacinidae sp. 1
Fig. 14.

Description – A single fragment of an apparently rather high spired limacinid. The height of this specimen, no more than a single, rather convex whorl, without the apical whorls present, is just 0.8 mm. Quite peculiar is the high elliptical aperture, situated slightly oblique to the shell's axis. A narrow umbilicus is present.

Material examined – RGM 569 637/1 fragment (Fig. 14), 569-570 m.

Discussion – Initially I identified this specimen as *Altaspiratella bearnensis*, because of its apparently righer high-spired shape, but in that species the base of the shell is imperforate. In the absence of better specimens the identification has to remain on the family level only.

Fig. 14. Limacinidae sp. 1, fragment, apertural view. Borehole E55, Rotterdam, 569-570 m-RT. RGM 569 637. Bar represents 1 mm.

Limacinidae sp. indet.

Material examined – RGM 567 587/5, 504.5-505.5 m; RGM 569 591/2, 523.5-524 m; RGM 569 606/1, 555.5-556.0 m.

Superfamily Cavolinioidea Gray, 1850
Family Creseidae Curry, 1982
Genus *Camptoceratops* Wenz, 1923

Type species – *Camptoceratops priscus* (Godwin-Austen, 1882) (Eocene).

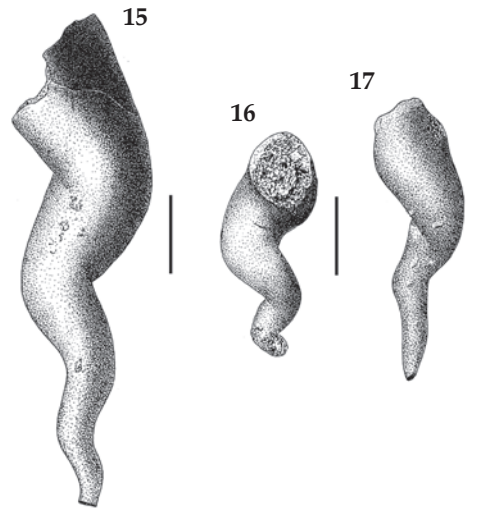
***Camptoceratops priscus* (Godwin-Austen, 1882)**
Figs. 15-17.

*v 1882 *Camptoceras priscum* Godwin-Austen n. sp., p. 220, pl. 5, figs. 1-5.
v. 1882 *Camptoceras priscum* Godwin-Austen var. *obtusum*; Godwin-Austen, p. 220, pl. 5, figs. 6, 7.
v. 1965 *Camptoceratops prisca* (Godwin-Austen); Curry, p. 360, figs. 7-10, pls 16, 17.
v. 2010 *Camptoceratops priscus* (Godwin-Austen); Cahuzac & Janssen, pl. 9, figs. 7-15, pl. 25, figs. 4-6 [with extensive synonymy].

Description – See Curry (1965) and Cahuzac & Janssen (2010).

Material examined – RGM 569 590/1, 519.5-520.5 m; RGM 569 592/1, 523.5-524 m; RGM 569 595/4, 528-529 m; RGM 569 596/2, 531-531.5 m; RGM 569 597/2, 537-537.5 m; RGM 569 599/3, 537.5-538 m; RGM 569 601/1, 538-538.5 m; RGM 569 602/2, 539-539.5 m; RGM 569 603/3, 540.5-541 m; RGM 569 605/4, 553-554 m (donated C. King); RGM 569 607/2, 555.5-556 m; RGM 569 610/20, 556-556.5 m; RGM 569 613/6, 556.5-557 m; RGM 569 616/3, 560-561 m (donated C. King); RGM 569 618/3, 561-561.5 m; RGM 569 620/1, 562-562.5 m; RGM 569 622/1, 562.5-563 m; RGM 569 624/2, 563-564 m; RGM 569 627/16, 564-565 m; RGM 569 630/9, 565-566 m; RGM 569 633/10, 566.6-567 m; RGM 569 634/4,

567-568 m; RGM 569 636/2, 568-569 m; RGM 569 641/45, 569-570 m; RGM 569 645/46, 570-571 m; RGM 569 650/107, RGM 569 690/1 (Fig. 16), 571-572 m; RGM 569 653/1, RGM 569 691/1 (Fig. 17), 572.6-573 m; RGM 569 658/43, RGM 569 692 (Fig. 15), 573-574 m; RGM 569 659/2, 575-576 m; RGM 569 660/1, 576-577 m; RGM 569 661/4, 577-578 m; RGM 569 663/8, 578-579 m; RGM 569 665/17, 579-580 m; RGM 569 667/3, 589-590 m; RGM 569 671/1, 593-594 m; RGM 569 673/3, 595-596 m; RGM 569 678/1, 603-604 m (donated C. King); RGM 569 679/5, 608-609 m.



Figs. 15-17. *Camptoceratops priscus* (Godwin-Austen, 1882) from the E55 borehole, Rotterdam.
Fig. 15. RGM 569 692, 573-574 m-RT, lateral view.
Fig. 16. RGM 569 690, 571.0-572.0 m-RT, apertural view.
Fig. 17. RGM 569 691, 572.6-573.0 m-RT, dorsal view.
Bars represent 1 mm.

Discussion – *Camptoceratops priscus*, apart from a number of North Sea Basin Ypresian localities, is known from the famous Gan locality in southwest France. Furthermore, Janssen *in* Cahuzac & Janssen (2010) considered *Camptoceratops americanus* Garvie, *in* Hodgkinson *et al*., 1992 (p. 25, pl. 7, figs. 13-15), described from the North American Early Eocene, as a synonym of *C. priscus*.

In the E55 borehole this pteropod occurs commonly and even small fragments are easily recognised by their peculiar shape. Three of the better preserved specimens are illustrated here (Figs. 15-17). None of the specimens, all pyritic internal moulds, however, retains the interesting apertural structures or protoconch. These features are excellently visible in specimens from the Ypresian of Gan (southwest France) in shell preservation, described and illustrated in Cahuzac & Janssen, who also re-illustrated the holotype.

Biostratigraphical notes

The creseid pteropod *Camptoceratops priscus* is present in a long range of samples of the E55 section, notably between 519.5 and 604 m, covering almost the complete pteropod bearing part of the section (Table 2) and occurring in several samples with a considerable number of specimens. It is the index species for pteropod zone 9 (Janssen & King, 1988), which is a taxon range zone. Thus, apart from the uppermost sample 504.5-505.5 m (which is dated as Lutetian), at least the interval of 519.5-604 m belongs to pteropod zone 9. Janssen & King (1988, fig. 188) referred to four further pteropod species occurring in zone 9, viz. *Limacina mercinensis*, *L. taylori*, *L. tutelina* and *Euchilotheca succincta* (Defrance, 1828). The first mentioned two are also recognised in the E55 section.

In spite of the poor condition of most specimens, two species are described as new to science, viz. *Limacina erasmiana* sp. nov. and *L. guersi* sp. nov. These give no further information on biostratigraphy, apart from the fact that it is astonishing that they have never been found previously in other sections of Ypresian age in the North Sea Basin.

Limacina pygmaea, until now always considered to be of Lutetian age, occurs quite abundantly in the present Ypresian section in a short interval, viz. 569-574 m. Its existence during the Ypresian is acknowledged, however, by its presence, be it in a small number of specimens, in the Gan assemblage. Such a short term introduction into the North Sea Basin resembles closely the so-called 'sea-level related molluscan plankton events', described from the Oligocene (Rupelian) by Gürs & Janssen (2004) and explained by sea level high stands, allowing oceanic species to temporarily penetrate into the basin.

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References

Blainville, [H.M.D.] de. 1824. Mollusques, Mollusca (Malacoz.). *Dictionnaire des Sciences naturelles*, **32**: 392 pp.

Bosc, [L.A.G.] 1817. Limacine. *Nouveau Dictionnaire d'Histoire naturelle*, **18**: 42.

Bouchet, P. & Rocroi, J.-P. 2005. Classification and nomenclator of gastropod families. *Malacologia*, **47**: 1-397.

Brouwer, J. 1968. The environment of deposition of the Clays of Ieper in The Netherlands. *Mémoire du Bureau de Recherches Géologiques et Minières, Paris*, **58**: 401-404.

Burger, A.W. 1989. *Zware mineralen onderzoek van boring E-55*. Rijks Geologische Dienst, Afdeling Sedimentologie, Sedimentpetrologisch Laboratorium, Rapport **916**: 9 pp. [Unpublished report.]

Cahuzac, B., & Janssen, A.W. 2010. Eocene to Miocene pteropods (Gastropoda, Euthecosomata) from the Aquitaine Basin, southwest France. *Scripta Geologica*, **141**: 1-193.

Curry, D. 1965. The English Palaeogene pteropods. *Proceedings of the Malacological Society of London*, **36**: 357-371.

Curry, D. 1982. Ptéropodes éocènes de la tuilerie de Gan (Pyrénées-Atlantiques) et de quelques autres localités du SW de la France. *Cahiers de Micropaléontologie*, **4** (for 1981): 35-44.

Cuvier, G.[L.C.F.D.] 1797. *Tableau élémentaire de l'histoire naturelle des animaux*. Paris, Baudouin: xvi+710 pp.

Defrance, [....] 1828. *Vaginella*. (Foss.). *Dictionnaire des Sciences naturelles*, **56**: 427.

Doppert, J.W.C. 1977. *De basis van het Kwartair (FA1-FA2 grens) en de basis van de Formatie van Maassluis in de boringen Brielle 37D/134, Hellevoetsluis 1 (N.A.M.) 37D/178, Gaag 1 (N.A.M.) 37B/185, Rotterdam E-55, 37H/201 en De Meern 31G/147*. Rijks Geologische Dienst, Afdeling Microfauna Kaenozoicum, Rapport **1258**: 2 pp. [Unpublished report.]

Godwin-Austen, H.H. 1882. On a fossil species of *Camptoceras*, a freshwater mollusk from the Eocene of Sheerness-on-Sea. *Quarterly Journal of the Geological Society of London*, **38**: 218-221.

Gray, J.E. 1847. A list of the genera of recent Mollusca, their synonyms and types. *Proceedings of the Zoological Society of London*, **15**: 129-219.

Gray, J.E. 1850. *Catalogue of the Mollusca in the collection of the British Museum, 2. Pteropoda.* British Museum and E. Newman, London: iv+45 pp.

Gürs, K., & Janssen, A.W. 2004. Sea-level related molluscan plankton events (Gastropoda, Euthecosomata) during the Rupelian (Early Oligocene) of the North Sea Basin. *Netherlands Journal of Geosciences*, **83**: 199-208.

Harsveldt, H.M. 1955. *Detailed lithological description of the Cenozoic part of the E55 borehole – untitled. Internal report of the Geologische Stichting, afdeling Geologische Dienst. Includes a preliminary chronostratigraphical interpretation by J.H. van Voorthuysen & W.H. Zagwijn*, 23 pp. [Unpublished report.]

Hodgkinson, K.A., Garvie, C.L. & Bé, A.W.H. 1992. Eocene euthecosomatous Pteropoda (Gastropoda) of the Gulf and eastern Coasts of North America. *Bulletins of American Paleontology*, **103** (341): 5-62.

Janssen, A.W., & King, C. 1988. Planktonic molluscs (Pteropods). *In*: R. Vinken *et al*. (eds.), *The Northwest European Tertiary Basin. Results of the International Geological Correlation Programme Project no 124*. Geologisches Jahrbuch, **A100**: 356-368.

Janssen, A.W., Schnetler, K.I. & Heilman-Clausen, C. 2007. Notes on the systematics, morphology and biostratigraphy of fossil holoplanktonic Mollusca, 19. Pteropods (Gastropoda, Euthecosomata) from the Eocene Lillebaelt Clay Formation (Denmark, Jylland). *Basteria*, **71**: 157-168.

Lamarck, [J.B.P.A. de]. 1805-1806. Mémoire sur les fossiles des environs de Paris, comprenant la détermination des espèces qui appartiennent aux animaux marins sans vertèbres, et dont la plupart sont figurées dans la collection des vélins du Muséum, 5. *Annales du Muséum d'Histoire Naturelle de Paris*, **5**: 28-36, 91-98, 179-188, 237-245, 349-357.

Linné, C. 1758. *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis, 1***.** Editio decima, reformata. Salvii, Holmiae: 824 pp.

Orbigny A. d' 1834-1847. *Voyage dans l'Amérique méridionale (le Brésil, la république orientale de l'Uruguay, la république Argentine, la Patagonie, la république du Chili, la république de Bolivia, la république du Pérou), exécuté pendant les années 1826, 1827, 1828, 1829, 1830, 1831, 1832 et 1833*, **5**. Paris, Bertrand & Strasbourg, Levrault: 1-48, 73-128, pls. 1-2, 9-13, 15-16, 56 [1834]; 49-72, 129-176, pls. 3-8, 17-23, 25, 55 [1835]; 177-184, pls. 14, 24, 26-28, 30-32, 34-35, 37, 58 [1836]; 185-376, pls. 38-52, 57 [1837]; pls. 54, 59-66, 68-69 [1839]; 377-424, pls. 53, 67, 70-71 [1840]; 425-488, pls. 72-76, 79-80 [1841]; pls, 83-85 [1842]; 489-728 [1846]; pls. 78-79, 81-82 [1847]. [xliii + 758 pp., 85 plates]. [Publication dates after Sherborn & Griffin, 1934.]

Phipps, C.J. 1774. *A voyage towards the North Pole undertaken by his Majesty's Command 1773*. W. Bowyer & J. Nichols, London: viii+253 pp.

Sherborn, C.D., & Griffin, F.J. 1934. On the dates of publication of the natural history portions of Alcide d'Orbigny's 'Voyage Amérique Meridionale'. *Annals & Magazine of Natural History* (series 10), **13**: 130-134.

Voorthuysen, J.H. van. 1960. De tertiaire en kwartaire ondergrond van Zuidwestnederland. *Geologie en Mijnbouw*, **39**: 579-586.

Voorthuysen, J.H. van. 1964. *Kernboring E55, Rotterdam*. Geologische Dienst, Micropalaeontologisch Laboratorium, Rapport, **531**: 1 p. [Unpublished report.]

Voorthuysen, J.H. van, Toering, K., & Zagwijn, W.H. 1972. The Plio-Pleistocene boundary in the North Sea Basin. Revision of its position in the marine beds. *Geologie en Mijnbouw*, **51**: 627-639.

Watelet, A., & Lefèvre, T. 1885. Note sur des ptéropodes du genre *Spirialis* découverts dans le Bassin de Paris. *Annales de la Société malacologique de Belgique*, **15** (for 1880): 100-103.

Wenz, W. 1923. Zur Systematik tertiärer Land- und Süsswassergastropoden, 5. *Senckenbergiana*, **5**: 116-118.

Zagwijn, W.H. 1961. *Voorlopig verslag van pollenanalytisch onderzoek verricht aan monsters van de boring Ahoy-E55 (Rotterdam).* Geologische Stichting, afdeling Geologische Dienst, Palaeobotanisch Laboratorium, Rapport, **285**: 3 pp. [Unpublished report.]