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The molluscan fauna of the Eocene Lillebælt Clay, Denmark

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For the first time the molluscan fauna of the latest Ypresian-early Lutetian Lillebælt Clay Formation of Denmark is treated monographically. The assemblage yielded 75 species. Four new species and one new subspecies are introduced, *viz. Astarte filigera treldensis* n. subsp., *Abra madseni* n. sp., *Thracia barsoei* n. sp., *Galeodea anderseni* n. sp. and *Desorinassa tonneseni* n. sp. The molluscan assemblage contains species known from different stratigraphic levels of the British Eocene, where the Lillebælt Clay correlates with the Bracklesham Group, based on micropalaeontological and magnetostratigraphical data. The molluscan fauna suggests water depths during deposition to have ranged from lower sublittoral to upper bathyal, probably 100-300 m.

KEY-WORDS: Mollusca, taxonomy, biostratigraphy, palaeontology, palaeoecology, Lillebælt Clay, Eocene, Denmark, North Sea Basin.

Introduction

Clays and marls were deposited during the Ypresian and Lutetian in most or all of the present Danish land area. At least in some places deposition of similar clays continued into the Late Eocene. The area was covered by the North Sea, and the environment was offshore with deep, probably upper bathyal waters. The clays are of an unusual, extremely fine-grained lithology and represent a hemipelagic sediment type. They have been known since the 19th century as the 'Plastic Clay' (locally also as '*valkeler*', fuller's earth). The clays are exposed in coastal cliffs along the shores of northern Lillebælt, the strait between Jutland and Funen (Fig. 1). They exceed 100 m in thickness, and are now formally named, in ascending order, the Røsnæs Clay Formation, Lillebælt Clay Formation and Søvind Marl Formation (Heilmann-Clausen *et al.*, 1985). The thickest of these formations is the Lillebælt Clay, which form nearly all of the outcrops in the northern Lillebælt area.

The Plastic Clay is very poor in macrofossils, which is why its age was not ascertained for many years. Molluscs are generally poorly preserved, as the original aragonitic shell material in nearly all cases has been dissolved. Internal moulds and impressions are found in sideritic/phosphatic concretions, so in many cases casts of silicone latex must be made. Internal moulds may also be preserved as pyrite, sometimes with the original shell material preserved or replaced by pyrite. The pyritized molluscs can be found on the foreshore together with pyrite-stems of crinoids. Such specimens are difficult to store in collections, due to pyrite disintegration. In the clays rare calcitic bivalves may be found with parts of the shell preserved.

In spite of the rarity of macrofossils, intensive collecting since the 1960s has resulted in much material of mainly washed out specimens, including molluscs. Bonde (1968) gave an account of the material known at that time. The bulk of it was collected on the SE coast of Trelde Næs by the junior author, then a high-school student, and most of his material has been included in the present study. The fauna is preserved as impressions in sideritic/phosphatic concretions, or as pyrite moulds. However, many pyritized specimens have been destroyed by disintegration during the years. Many macrofossils were also collected in these years by the late Henning Lange (Fredericia). Since the 1990s a large number of specimens have been collected washed out on the SE coast of Trelde Næs, mainly in sideritic/phosphatic concretions, especially by Mogens Madsen, Sten Bo Andersen, H. C. Hansen and the late Søren Peter Andersen (all from Fredericia), Ole Barsøe Hansen (Kolding) and Susan Schou Sørensen (Valby).

Thus, the large material from Trelde Næs now available has justified a monographic treatment of the molluscan fauna for taxonomic reasons. Furthermore, a study of the assemblage has yielded important information on the palaeoecology and has formed the basis for comparisons with other Eocene faunas.

Abbreviations

MGUH Geological Museum, type collection, Copenhagen, Denmark.
GM Geological Museum, Copenhagen, Denmark.
NHMUK-G The Natural History Museum, Department of Palaeontology, London, UK.

CHC	Claus Heilmann-Clausen collection, Aarhus, Denmark.
ISL	Kai Ingemann Schnetler collection, Langå, Denmark.
OBK	Ole Barsøe Hansen collection, Kolding, Denmark.
JTK	Jesper and Thomas Hansen collection, Kolding, Denmark.
MMF	Michael Tonnesen collection, Fredericia, Denmark.
SPAF	the late Søren Peter Andersen collection, Fredericia, Denmark.
GPF	Geologisk-Palæontologisk Museum collection, Fredericia, Denmark.
SSV	Susan Schou Sørensen collection, Valby, Denmark.
KPJ	Kolja Petersen collection, Jelling, Denmark.
JFR	Jytte Frederiksen collection, Risskov, Denmark.

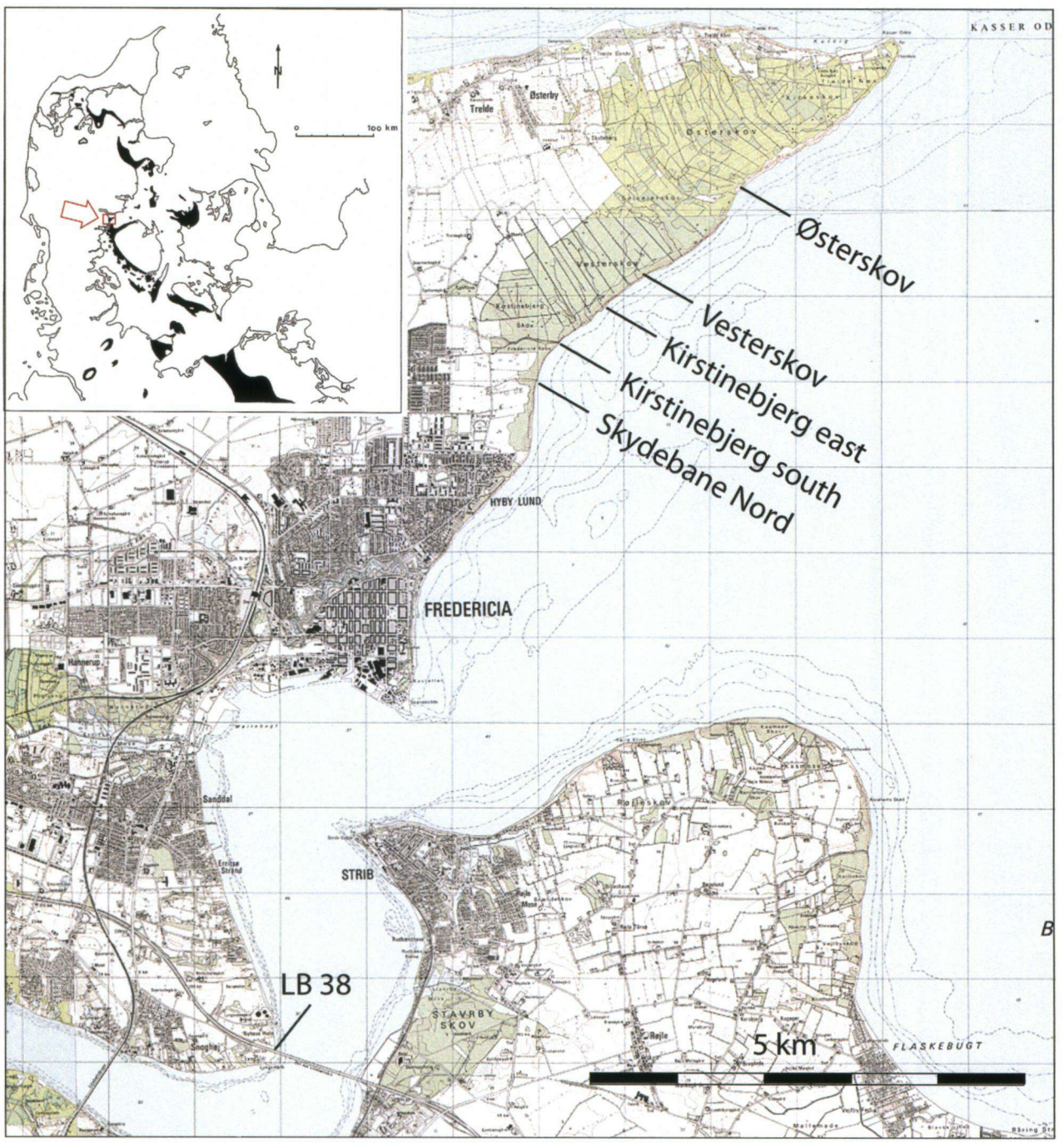

Figure 1. The Trelde Næs peninsula with localities mentioned in the text and in Fig. 2. The position of the LB 38 borehole (GEUS file no. 134.518) is also shown. The inserted map of Denmark and northern Germany shows the position of Trelde Næs (arrow). In black: Eocene subcrop (below Quaternary).

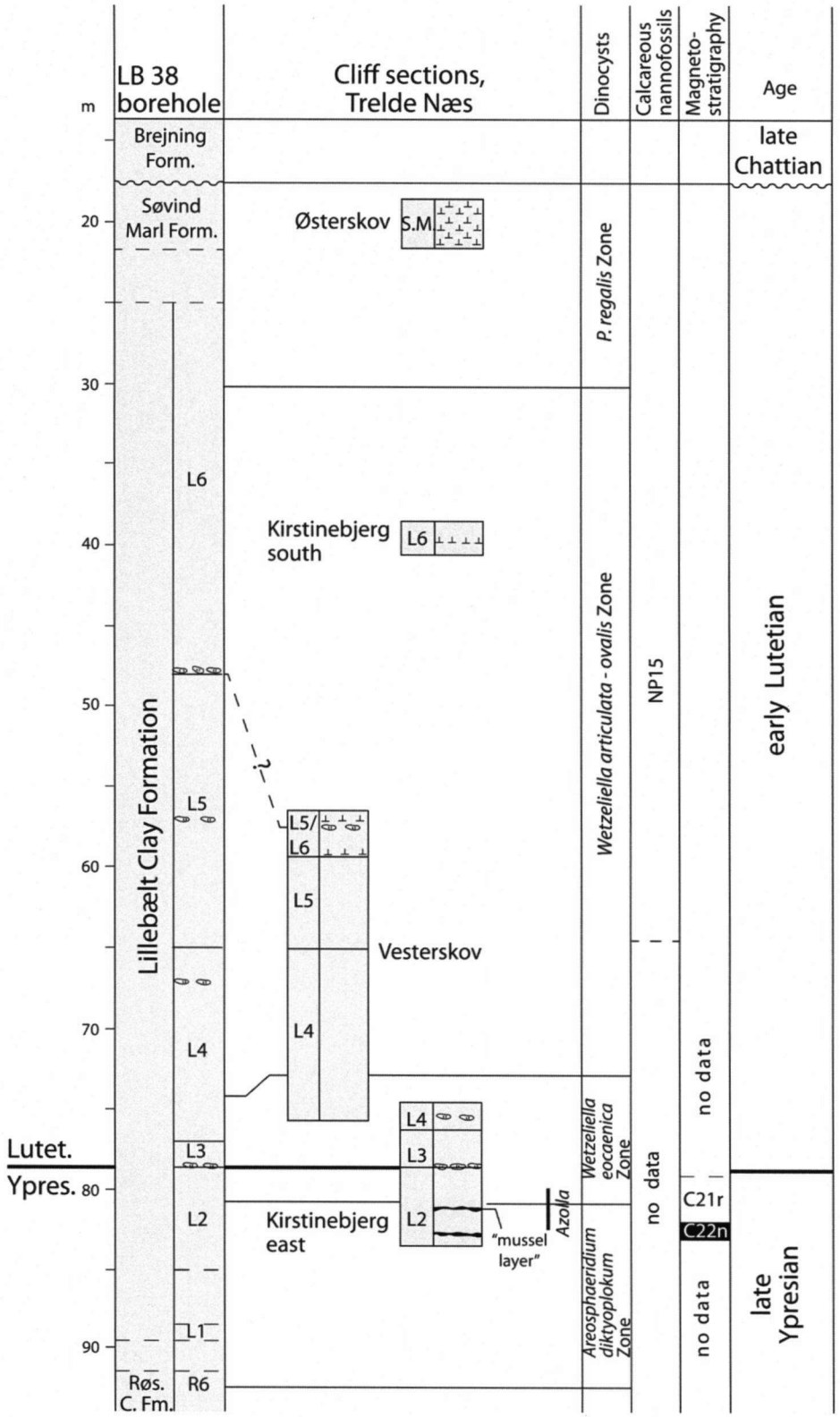

Figure 2. Logged Eocene sections on Trelde Næs and in the LB 38 borehole. All sections drawn to scale. Lithostratigraphy of LB 38 after Dinesen (1965) and Heilmann-Clausen *et al.* (1985). Kirstinebjerg East and Vesterskov after Heilmann-Clausen (1978). Kirstinebjerg South after Heilmann-Clausen *et al.* (1985); this section was not studied for dinocysts. Calcareous nannofossil data after E. Thomsen, Aarhus University (pers. comm. 2011). The dinocyst zones are defined in Heilmann-Clausen (1988). *P. regalis* Zone (new name for the *P. geminatum* Zone) (Heilmann-Clausen & van Simaeys, 2005). Magnetostratigraphy after Heilmann-Clausen & Beyer (in prep.).

Figure 3. The Kirstinebjerg East section exposing beds L2-L4 of the Lillebælt Clay Formation. The reddish interval is Bed L3. The strata form an asymmetrical anticline, here seen in cross section (*i.e.*, photographed in the direction of the fold axis), June 2010. The person is standing at the fold axis, close to the level of the 'mussel layer' of Fig. 2.

The Eocene outcrops on the Trelde Næs peninsula

Late Ypresian and early Lutetian plastic clay crops out extensively on the SE coast of Trelde Næs, between the city of Fredericia and the tip of the peninsula (Fig. 1). Most of the outcrops consist of strata of the Lillebælt Clay Formation, subdivided into 6 regionally distributed, formally described beds, numbered L1 to L6 (Heilmann-Clausen *et al.*, 1985). On Trelde Næs only the beds L2 to L6 are present (Fig. 2). The oldest strata (beds L2-L4) occur in a few semipermanent sea-cliffs up to *c.* 15 m high with glacially intensively folded successions of the strata (Fig. 3). A stratigraphical thickness of 17.5-18 m of this part has been measured (Heilmann-Clausen *et al.*, 1985). The younger beds L5 and L6 are highly smectitic and, due to the strong water-binding capacity of this clay mineral, these beds form no permanent cliff sections. Instead they comprise large, spectacular landslides along most of the 6 km long SE coast of Trelde Næs (Fig. 4). Because of the disturbances the total thickness of beds L5 and L6 is unknown. Heilmann-Clausen *et al.* (1985) logged a thickness of *c.*11 m in sections exposing beds L5 and L6 (Fig. 2), but the total thickness of strata represented in the sliding masses of L5-L6 is probably much thicker, most likely about 40 m, as recorded in the nearby LB 38 borehole (Figs 1 and 2).

A few small outcrops of the Søvind Marl Formation have been logged at Østerskov (Figs 1 and 2) and near the Kirstinebjerg East section (Fig. 1). At the latter locality small temporary exposures of the Late Oligocene Brejning Formation have also been observed (Schnetler, 1985).

Large quantities of sideritic and phosphatic concretions are continuously washed out of the landslides and sea cliffs, and accumulate on the beach. The majority of the concretions are rich in trace fossils but devoid of macrofossils. A small number of the concretions include fossils of invertebrates, mainly molluscs, and vertebrates. Small pyrite concretions, including rare moulds and replacements of body fossils, are likewise washed out of the clay and may accumulate as residual pyrite fields on the beach. Despite the rarity of macrofossils intensive collecting by numerous enthusiasts over many years have brought to light more than a thousand mollusc specimens which have provided the basis for the present description of the assemblage.

Figure 4. Sliding masses of beds L5/L6 northeast of Østerskov section, 2009.

Calcareous nannofossil and dinocyst zonations

The L2-L4 beds are non-calcareous and calcareous nannofossils are only present in a few thin, marly layers in Bed L5 and in more numerous marly layers in Bed L6. The nannofossils suggest that beds L5 and L6 at Trelde Næs belong in NP15 (Lutetian) (Fig. 2), and it is probable that Bed L5 belongs in the lowermost part of that zone (E. Thomsen, Aarhus University, pers. comm., 2011). In the Viborg-1 borehole the lowest samples of the Lillebælt Clay Formation yielding calcareous nannofossils are from topmost L5 and lower L6. They were referred to NP14 by Thiede *et al.* (1980). However, a new study suggests that this interval should instead be included in NP15 (E. Thomsen, pers. comm. in Heilmann-Clausen & van Simaeys, 2005, p. 194).

In contrast to calcareous microfossils, organic-walled dinoflagellate cysts (dinocysts) are abundant and well-preserved in all the Eocene strata on Trelde Næs. In beds L1-L4 dinocysts are essentially the only available tool for biostratigraphy. The first study of the dinocysts was made by Heilmann-Clausen (1978). A number of dinocyst zones of the Lillebælt Clay Formation were defined later (Heilmann-Clausen, 1988) and, based on this, a correlation with northern Germany and Belgium was established (Heilmann-Clausen & Costa, 1989). The correlation with Belgium showed that Bed L1 and the lower part of Bed L2 are of latest Ypresian age and that the Ypresian/Lutetian transition (as then conceived) occurs within Bed L2. An independent study by de Coninck (1991) came to a similar conclusion. However, the recently established GSSP for the base of the Lutetian indicates that the Ypresian/Lutetian boundary (as now formalized) occurs at a slightly higher level (see below).

The *Azolla* event and paleomagnetic data

Spores of the freshwater fern *Azolla* occur in a thin interval in the middle of Bed L2 (Heilmann-Clausen, 1978; Collinson *et al.*, 2010) (Fig. 2). This *Azolla* event forms an important tool for correlation and age determination because it is widespread in the North Sea and Norwegian-Greenland Sea where it occurs in the same position relative to the dinocyst succession (Eldrett *et al.*, 2004; Brinkhuis *et al.*, 2006; Collinson *et al.*, 2010). The *Azolla* event is probably synchronous with a strong bloom of *Azolla* in the Arctic Ocean where episodic freshening of the surface waters allowed the ferns to grow vigorously within the

ocean itself (Brinkhuis *et al.*, 2006). The presence of *Azolla* spores in the Norwegian-Greenland Sea and the North Sea is less well explained. It seems most likely that *Azolla* grew in swamps and lakes NE of the North Sea and the spores were transported to sea by rivers during an important transgression (Heilmann-Clausen *et al.*, 2010).
Recently obtained paleomagnetic data from the Hinge clay pit (Heilmann-Clausen *et al.*, 2010) and Trelde Næs (Beyer & Heilmann-Clausen, unpublished data 2011) show that the Chron C22n/C21r boundary is located within Bed L2 and within the *Azolla* interval (Fig. 2). In the Norwegian-Greenland Sea (Eldrett *et al.*, 2004) the *Azolla* pulse likewise straddles the C22n/C21r boundary, testifying the synchroneity of the event.

The Ypresian/Lutetian boundary

As described above, the Ypresian/Lutetian transition was previously thought to be located in the middle of Bed L2, based on a biostratigraphic correlation to Belgian sections near the original type area for the Lutetian stage (Paris Basin).
A problem for locating the precise position in the Danish succession (and elsewhere) of the Ypresian/Lutetian boundary has been the lack of a precise, internationally agreed definition of the stage boundary. Recently, however, such a definition (a Global Stratotype Section and Point, GSSP) has been established (Molina *et al.*, 2011). The base of the Lutetian is defined at the first occurrence of the calcareous nannofossil *Blackites inflatus* in the Gorrondatxe section in northern Spain (Orue-Extebarria *et al.*, 2006). This level has been chosen to place the Ypresian/Lutetian boundary close to the base of the classical Lutetian deposits (Calcaire Grossier) in the Paris Basin.
Unfortunately, due to the absence of calcareous nannofossils in this part of the Danish succession, the precise position of the Ypresian/Lutetian boundary cannot be recognized using biostratigraphy. However, the GSSP coincides with a significant, and possibly global, maximum flooding surface which is approximately 800 kyr younger than the Chron C22n/C21r boundary (Molina *et al.*, 2011).
A distinctive, burrowed and cemented horizon occurs in all Danish sections within or (as at Trelde Næs) at the base of Bed L3 as described by Heilmann-Clausen *et al.* (1985). The lithology of the horizon suggests that it was formed during a temporary cessation of sediment supply all over the region and therefore represents a condensed interval. Based on estimated sedimentation rates of the lower Lillebælt Clay (Heilmann-Clausen & Beyer, in prep.) it is very likely that this horizon represents the condensed section corresponding to the maximum flooding surface of the Ypresian/Lutetian GSSP (Figs 2, 5).

Provenance of studied molluscs

In situ material – In order to evaluate the provenance of the molluscs studied, which are almost all washed out specimens, first an overview of the few in situ records is given here.

The oldest known mollusc-bearing horizon at Trelde Næs, the 'mussel layer' (Fig. 2), is only a few cm thick and occurs within the *Azolla* interval of Bed L2 (near the top of the *Areosphaeridium diktyoplokum* dinocyst zone); it is of latest Ypresian age. The horizon was found in the Skydebane Nord and Kirstinebjerg East sections where it occurs 15 - 20 cm above the upper of two sapropels. The horizon is lithologically indistinguishable from the mollusc-free strata below and above. During field work by the junior author in the 1960s the density of molluscs was estimated to be 10-15 specimens/m^2 and the layer was named '*muslingelaget*' ('the mussel layer'). Bivalves were the most common, but a few gastropods (including the conical pteropod *Creseis* sp.), a lingulid brachiopod and fish remains were also recovered. The molluscs were preserved with their original shell material, sometimes with precipitation of pyrite. It is notable that a single pyrite mould of a gastropod was also collected from this horizon. The following mollusc taxa are described from this layer: *Propeamussium* sp., *Aviculoperna* cf. *limaeformis*, *Littoriniscala scalarioides* and *Creseis* sp.
A single *Pholadomya virgulosa* preserved in sideritic material was collected in the 1970s by the junior author in a temporary exposure of Bed L5 between Skydebane Nord and Kirstinebjerg South. It is noteworthy that the preservation (paired valves with posterior part missing) is quite similar to the many washed out sideritic moulds of this species.
Scattered pyritized crinoid stems of *Isselicrinus subbasaltiformis* (Miller, 1821), the brachiopod *Terebratulina wardenensis* Elliott, 1955 preserved in original calcitic shell material, and a single bivalve in aragonitic preservation have been recorded in Bed L4 during field work at Vesterskov (Fig. 2).
A slab of clay housed in the Geological Museum in Copenhagen, collected near Fredericia in 1908 (GM 1908.191) includes two specimens of *Aviculoperna* cf. *limaeformis* in similar preservation as in the 'mussel layer' but a dinocyst analysis of the slab (Table 1) suggests that it is probably derived from Bed L4.
Dinesen (1965) recorded macrofossils at various levels in the LB 38 borehole (Fig. 2). They include, in ascending order: a gastropod (at 85.5 m, near the L1/L2 boundary), bivalves? and fish remains (at 82.6 m, in Bed L2, possibly equivalent to the 'mussel layer' at Trelde Næs), a pyritized crinoid (at 76.7 m, close to the L3/L4 boundary), a shell fragment (at 72 m, Bed L4), and a small bivalve (at 60 m, Bed L5).

Washed out material – The *ex situ* material consists of pyrite moulds and of specimens preserved in sideritic/phosphatic concretions. Scattered pyrite accumulations on the foreshore probably wash out from strata in the vicinity. This suggests that part of the material came from the L2-L4 interval, *e.g.* at Skydebane Nord (Fig. 1). Other parts of the pyritized material almost certainly originate from the L5-L6 interval, as indicated by field observations from the outermost part of Trelde Næs where only the L5 and L6 beds occur. On the foreshore of this area a residual

pyrite field was observed in 2007, lying directly on top of clay from the L5-L6 interval. This accumulation included a typical pyritized fossil assemblage consisting predominantly of crinoid stems, and more rarely bivalves and gastropods.
Moulds in washed out sideritic/phosphatic concretions represent the majority of the material studied herein. Dinocysts are common and usually well-preserved in these concretions. In order to identify their provenance, a selection of 11 concretions (10 with molluscs and one with a crab) were examined for their dinocyst contents (Table 1). This made it possible to identify the dinocyst zone and thus the stratigraphic interval from which the concretion was derived. In a similar way dinocysts have previously been used to determine the stratigraphic provenance of concretions from Trelde Næs yielding pteropods (Janssen *et al.*, 2007). As seen from Table 1, ten of the concretions belong in the *Wetzeliella articulata-ovalis* Zone, referring them to the interval upper Bed L4-lower Bed L6, while one belongs in the overlying *Phthanoperidinium regalis* Zone (upper Bed L6-lowermost Søvind Marl Formation).
Similarly, the six previously analysed concretions (Janssen *et al.*, 2007) belong in the *Wetzeliella articulata-ovalis* Zone and are probably derived from Bed L5 or lower part of Bed L6. The top of the *Phthanoperidinium regalis* Zone is of middle Lutetian, mid Chron C20r age (Thomsen *et al.*, in press). It can therefore be concluded that all the washed out sideritic/phosphatic material of the present (and previous) study is derived from higher parts of the strata exposed in the cliffs (upper Bed L4 - lowermost Søvind Marl Form.) and is of early Lutetian age. For comparisons with the numerous studies of molluscs from southern England a correlation to this region is shown in Fig. 5.

Previous work

Gagel (1917) recorded a few molluscs from the plastic clay, including tubes of Teredinidae and the bivalve genus '*Perna*' which has not been found again. The rather extensive material from the collections of the 1960s was studied by Bonde (1968). He published a list of invertebrate fossils known from the Eocene 'plastic clay' and stated that they probably all originated in the Lillebælt Clay. The invertebrates in the material were identified in cooperation with Alfred Rosenkrantz and Søren Floris of the Geological Museum of Copenhagen. In Bonde's account of the molluscs the na-mings of Rosenkrantz were indicated with 'Rkz'. Rosen-krantz also wrote remarks on taxonomy on some of the labels. In other cases additional notes are written on the labels, and apparently part of the material was inspected by C. King in 1972. He compared some species from the plastic clay with species from the British Eocene.

Comparison with SE England

Lithostratigraphic indications as used in the present paper for British occurrences are the traditional namings, as found in the 'classic' literature (mainly Newton, 1891). In the current British lithostratigraphic classification (Fig. 5) (King, 2006) 'London Clay' is now indicated as London Clay Formation in the Thames Group, of Early Eocene (Ypresian) age and subdivided into Divisions A to E, and including a number of formally named members.
The 'Bracklesham Beds', belonging to the Bracklesham Group, are of Early to Middle Eocene (late Ypresian to late Lutetian) age and include the Wittering, Earnley, Marsh Farm and Selsey formations.
The so-called 'Barton Beds' belong in the Middle to Late Eocene (late Lutetian to early Priabonian) Barton Group, subdivided into the Barton Clay and Becton Sand formations.
The 'Headon Beds' are now the Late Eocene (Priabonian) Headon Hill Formation. Of occurrences specified in the older literature the detailed lithostratigraphic origin usually cannot be recognised.

Systematic palaeontology

The systematic arrangement of the bivalves follows that of Moore (1960, 1969) and Beesley *et al.* (1998). The gastropods are arranged in accordance with the family-level classification of Bouchet & Rocroi (2005). The nomenclature of the bivalves is mainly based on Cox *in* Moore (1969) and that of the gastropods follows Cox *in* Moore (1960). A list of mollusc species is given in Table 2.
In several cases the identifications are not completely ascertained. Many species are represented by incomplete or poorly preserved specimens which lack important characteristics of taxonomic value. Furthermore, literature on the North Sea Basin Eocene Mollusca has not been revised recently. The comparison with material in the Natural History Museum (London) has been very important, and the same is true for material obtained from private collections.

Class Bivalvia Linnaeus, 1758
Subclass Protobranchia Pelseneer, 1889
Order Nuculoida Dall, 1889
Superfamily Nuculoidea Gray, 1824
Family Nuculidae Gray, 1824
Genus *Nucula* Lamarck, 1799
Subgenus *Lamellinucula* Schenck, 1944

Nucula (Lamellinucula) minor Deshayes, 1860

Plate 1, fig. 1a-b

*1860 *Nucula minor* Deshayes, p. 823, pl. 64, figs 17-20.
1864 *Nucula minor* Deshayes – Wood, p. 114, pl. 18, fig. 10.
1965a *Nucula (Lamellinucula) minor* Deshayes, 1858 – Glibert & van de Poel, p. 16.

Material and dimensions – Two double-valved specimens were found but imperfectly preserved (OBK 708): an internal mould of a right valve and the exterior impression of the same specimen (OBK 736), and one fragmentary valve (OBK 1005). The illustrated specimen (ex OBK 736) has a length of 14.8 mm and an estimated height of 7 mm.

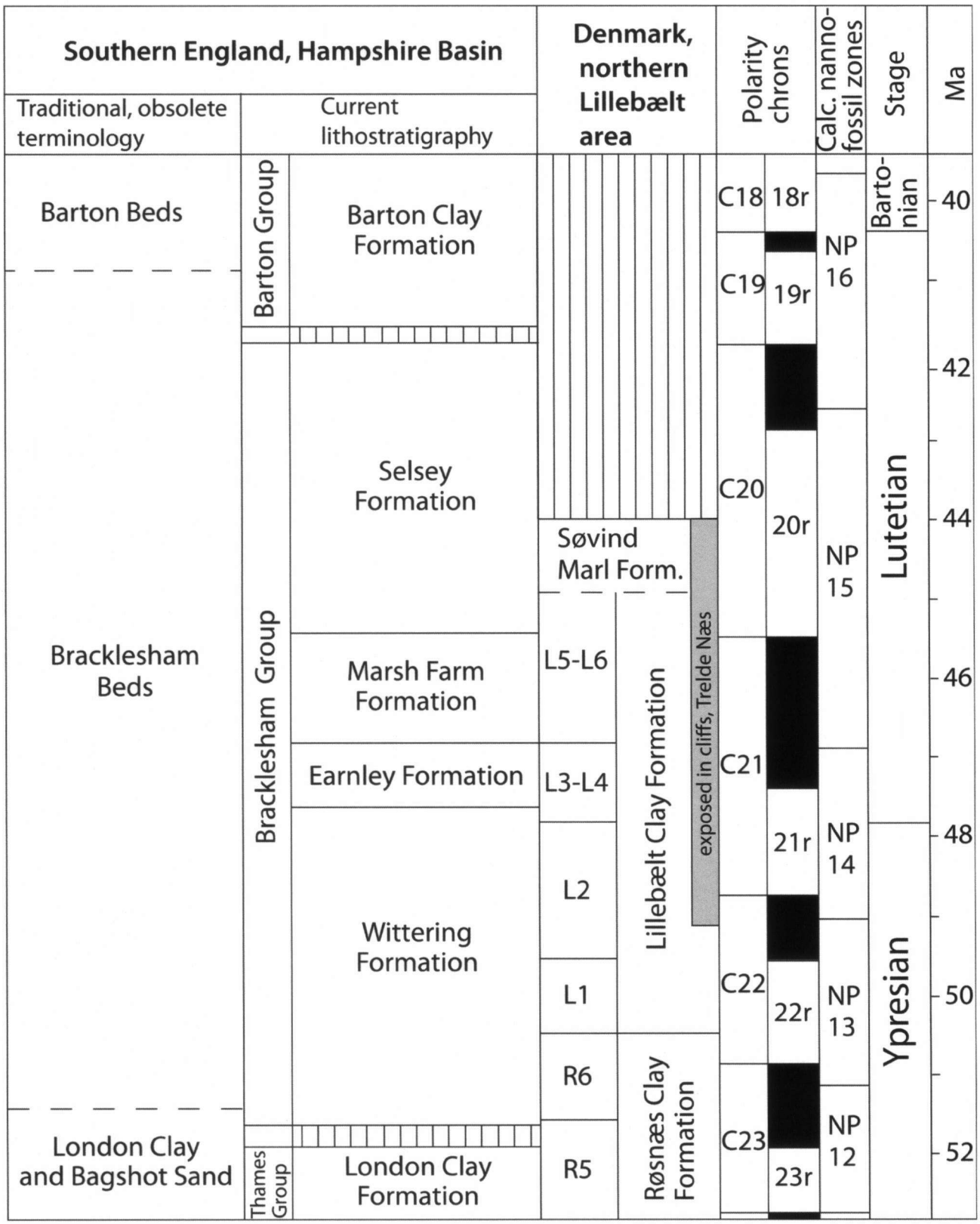

Figure 5. Correlation of the Eocene strata in the northern Lillebælt area with the succession in southern England. For convenience the older English terminology is also shown. Based in part on King (2006) and Payros *et al.* (2009). Only polarity chrons and calcareous nannofossil zones shown in Fig. 2 are identified in Denmark.

No.	Dinocyst prep. No.	Collection id.	Taxon	Dinocyst zone	Probable provenance	Comments
1	2921	OBK 1204	*Pholadomya virgulosa*	*W. articulata-ovalis* Zone, probably lower part	upper Bed L4 - lower Bed L5	presence of *H.-opsis costae*, *W. articulata* cf. *brevicornuta*
2	2922	OBK 1205	*Volutocorbis ambigua*	*P. regalis* Zone	Bed L6 - lowermost Søvind Marl Fm.	
3	2923	OBK 1209	*Cyclocardia subelegans*	*W. articulata-ovalis* Zone, upper part ?	Bed L5 - Bed L6	zone uncertain because of presence of *P.* aff. *regalis*
4	2932	OBK 1043	unidentified gastropod	*W. articulata-ovalis* Zone	upper Bed L4 - lower Bed L6	
5	2933	OBK 1149	*Astarte filigera*	*W. articulata-ovalis* Zone	upper Bed L4 - lower Bed L6	
6	2934	OBK 1312	*Cyclocardia subelegans*	*W. articulata-ovalis* Zone	upper Bed L4 - lower Bed L6	
7	2935	OBK1314	*Cyclocardia subelegans*	*W. articulata-ovalis* Zone, probably lower part	upper Bed L4 - lower Bed L5	presence of *W. articulata brevicornuta*
8	2936	OBK 1280	*Falsiportunites longispinosus* (a crab)	*W. articulata-ovalis* Zone	upper Bed L4 - lower Bed L6	
9	2944	CHC 26-E140	*Atrina affinis*	*W. articulata-ovalis* Zone, lower or middle part	upper Bed L4 - lower Bed L5	presence of *H.-opsis costae*
10	2955	CHC 52-E149	*Pholadomya virgulosa*	*W. articulata-ovalis* Zone, lower or middle part	upper Bed L4 - lower Bed L5	presence of *H.-opsis costae* & *H.-gylon clausenii*
11	2956	CHC 2000-1	*Galeodea striata*	*W. articulata-ovalis* Zone, lower or middle part	upper Bed L4 - lower Bed L5	presence of *H.-opsis costae*, *H.-gylon clausenii* & *W. a. brevicornuta*
12	2954	Geol. Mus. 1908.191 Fredericia	*Aviculopema* cf. *limaeformis*	*W. articulata-ovalis* Zone, lower part	upper Bed L4	
13	2945	CHC unspecified clay sample	*Creseis* sp.	*A. diktyoplokum* Zone	'mussel layer' in Bed L2	

Table 1. Dinocyst zone and provenance of sideritic concretions with molluscs and a crab (no. 8). Also included are two clay samples: (nos. 12, 13) with molluscs from unknown localities.

Description – The shell is small, ovate-triangular with the umbo placed posteriorly. The anterior dorsal margin is slightly convex; the posterior dorsal margin slightly concave. The exterior of the shell has fine but distinct concentric growth-lines. The internal mould (OBK 736) is very well preserved. The umbo is opisthogyrate and there is an angle of *c.* 115° between the anterior and the posterior dorsal margins. The anterior hinge line is regularly convex and has 20 angulated teeth. The posterior row is slightly concave and has 11 teeth. The adductor scars are indistinct, and the pallial line is not preserved. The ventral margin is finely crenulated.

Discussion – Of the *Nucula* species with a crenulated margin *Nucula ampla* (Wood, 1864, p. 108, pl. 18, figs 5a-b, 6a-b), *N. bowerbankii* J.D.C. Sowerby, 1834, *N. dixoni* (Wood, 1864, p. 112, pl. 18, fig. 7a-c), *N. protracta* (Wood, 1864, p. 117, pl. 18, fig. 15), *N. sericea* Wood, 1864 (p. 119, pl. 19, fig. 3). *N. praelongata* Wood, 1864 (Wood 1864, p. 116, pl. 19, fig. 1a-b), *N. tumescens*

(Wood, 1864, p. 121, pl. 18, fig. 1a-c) and *N. wetherellii* J.D.C. Sowerby, 1834 (Wood, 1864, p. 121, pl. 18, fig. 1a-c) all have a smooth exterior. *N. consors* Wood, 1864 (p. 111, pl. 19, fig. 7a-b), *N. curvata* (Wood, 1864, p. 112, pl. 18, fig. 12a-b), *N. similis* J. Sowerby, 1819 (Wood, p. 118, pl. 18, fig. 11a-c) and *N. subtransversa* Nyst, 1845 all have radial ornament on the exterior surface.

Distribution – According to Newton (1891) the species is restricted to the Bracklesham Beds.

Genus *Leionucula* Quenstedt, 1930

***Leionucula proava* (Wood, 1864)**
Plate 1, figs 2-3

*1864 *Nucula proava* Wood, p. 117, pl. 20, fig. 3a-b.

Material and dimensions –The interior of two right valves (OBK 411 and 1064) and a fragmentary left valve (MMF) with the exterior preserved were found. The shell on Pl. 1, fig. 2 has a length of 8.5 mm and a height of 5.3 mm.

Description – The shell is elongate with the umbo placed posteriorly. The anterior dorsal margin is almost straight, while the posterior dorsal margin is distinctly concave, meeting the posterior margin at an obtuse angle. The anterior dorsal margin joins the anterior margin in a regular curve and the anterior margin continues gradually into the long, convex ventral margin. The anterior hinge line has 12 teeth, the posterior eight. The anterior dorsal margin has a length of 5.0 mm; the posterior dorsal margin is 4.1 mm. The margin is smooth. The exterior is smooth except for concentric growth-lines.

Discussion – The specimen is rather close to *Nucula praelonga* Wood, 1864 (p. 115, pl. 19, fig. 4a–b, NHMUK-G 42584) from Barton. This species, however, has a less concave posterior dorsal margin and only 10 and 6 teeth respectively in the anterior and posterior rows of teeth. *Nucula nudata* Wood, 1864 (p. 115, pl. 20, fig. 4a-b, NHMUK-G 42587) from Headon Hill has a convex anterior dorsal margin.
Bonde (1968, p. 149) mentioned poorly preserved nuculids in grey-green clay. In CHC specimen E 130 was labelled 'Pectinid', but is in fact a nuculid and the same is true for E 132.

Superfamily Nuculanoidea H. & A. Adams, 1858
Family Nuculanidae H. & A. Adams, 1858
Genus *Nuculana* Link, 1807

***Nuculana amygdaloides* (J.D.C. Sowerby, 1827)**
Plate 1, figs 4-6

*1827 *Nucula amygdaloides* J.D.C. Sowerby, pl. 554, fig. 4.
1854 *Nucula amygdaloides* Sow. – Morris, p. 217.
1864 *Leda amygdaloides* J. Sowerby – Wood, p. 125, pl. 17, fig. 6a-c.
1891 *Nuculana amygdaloides* (J. de C. Sowerby, 1827) – Newton, p. 27.
1965a *Portlandia (Pseudoportlandia?) amygdaloides* (J. de C. Sowerby, 1827) – Glibert & van de Poel, p. 31.
1968 *Nuculana* sp. – Bonde, p. 149.
1975 *Ledina amygdaloides* (J. de C. Sowerby) – Castell & Cox, pl. 5, figs 5-6.

Material and dimensions – Two complete specimens and 12 valves were found. An internal pyritic mould is present in CHC (E 102). Length up to 23.5 mm, height 13.1 mm.

Description – The shell is rather large and subelliptical. The shells are equivalve, the valve is inequilateral, and the slightly opisthogyrate umbo only projects a little. The length/height ratio is almost 2.0. The anterior dorsal margin is slightly convex, passing gradually into the highly convex anterior margin. The posterior dorsal margin is slightly concave and passes into the posterior margin at an obtuse angle (*c.* 150°). The highly convex posterior margin passes gradually into the slightly convex to almost rectilinear ventral margin, which passes gradually into the anterior margin. The anterior hinge line has about 18 angulated teeth, the posterior about 20. The ligament pit is small, triangular and placed below the umbo. The top angle of the ligament pit is *c.* 45°. The exterior of the shell has a concentric ornament consisting of rather widely spaced furrows. From the umbo to the anterior and posterior corners there are rounded edges. The lunula and area are very indistinct. The interior of the shell is smooth and glossy. The pallial line is situated rather far from the ventral margin and very indistinct. The adductor impressions are also very indistinct. The margin of the shell is sharp and smooth.

Discussion – Bonde (1968, p. 149) referred internal pyritic moulds to the genus *Nuculana* (CHC). The Danish specimens differ slightly by having a thicker shell and a more distinct exterior commarginal ornament.

Distribution – According to Newton (1891) the species is restricted to the London Clay.

Family Yoldiidae Glibert & van de Poel, 1965
Genus *Yoldiella* Verrill & Bush, 1897

***Yoldiella galeottiana* (Nyst, 1845)**
Plate 1, fig. 7

*1845 *Nucula Galeottiana* Nyst, p. 223, pl. 18, fig. 3.
1850 *Nucula serrata* – J. de C. Sowerby *in* Dixon, pp. 93, 170, pl. 2, fig. 9.
1850 *Leda Galeottiana* Nyst – d'Orbigny, p. 378, pl. ii, no. 808.
1858 *Leda Galeottiana* Nyst – Deshayes, p. 830, pl. 66, figs 1-3.
1864 *Leda Galeottiana* Nyst – Wood, p. 126, pl. 17, fig. 2a-b.

1891 *Nuculana Galeottiana* Nyst, 1845 – Newton, p. 27.
1936 *Nuculana Galeottiana* Nyst, 1843 – Glibert, p. 15, fig. 8.
1965a *Nuculana (Saccella) galeottiana* (Nyst, 1843) – Glibert & van de Poel, p. 21.

Material and dimensions – Only the illustrated double-valved specimen was found (MGUH, ex GPF) with the posterior part visible. Estimated length 5.0 mm, height 3.5 mm.

Description – The shell is small, dorso-ventrally depressed and subelliptical, with a depression near the pointed rostrum. From the umbo a distinct and elevated keel runs to the end of the posterior corner. The shell has an ornament of numerous commarginal ribs.

Discussion – This species differs from *Yoldiella minima* by having a more pointed rostrum with a distinct keel.

Distribution – *Yoldiella galeottiana* is known from the Eocene of Belgium (Nyst, 1845) and the Lutetian of France (Deshayes, 1858). Newton (1891) stated that the species occurs in the Barton and Bracklesham Beds although, according to Wood (1864), the species is very rare at Bracklesham.

***Yoldiella minima* (J. Sowerby, 1818)**
Plate 1, figs 8-9

*1818 *Nucula minima* J. Sowerby, pl. 192, fig. 8.
1864 *Leda minima* J. Sowerby – Wood, p. 127, pl. 17, fig. 7a-c.
1891 *Nuculana minima* J. Sowerby, 1818 – Newton, p. 27.
1965a *Nuculana (Saccella) minima* (J. Sowerby, 1818) – Glibert & van de Poel, p. 21.

Material and dimensions – One almost complete specimen (OBK 1355) and one right valve (OBK 1088). Length of MGUH 29716 (Plate 1, fig. 9) is 5.0 mm, height 3.5 mm.

Description – The shell is small and elongately ovate, almost equilateral with a rounded anterior and more pointed posterior end. The umbo is almost orthogyrate and only slightly projecting; it is situated just anterior to the middle of the shell. The shell is moderately convex, especially anteriorly and below the umbo, but more flat on the posterior end with a depression near the rostrum. The anterior dorsal margin is slightly convex, running gradually into the convex anterior margin. The ventral margin is convex and meets the short, almost straight posterior margin at an angle. The posterior dorsal margin is slightly concave. The exterior has commarginal ribs which are strongest below the umbo and almost completely absent near the posterior end. The lunula and area are weakly demarcated. The dental margin is thick, especially the posterior one. The interior is smooth. Adductor scars and pallial line could not be observed. The anterior hinge line is convex and has about 12 acutely angulated teeth. The slightly concave posterior row has about 15 teeth. The ligament pit is very small.

Discussion – The Danish material closely matches the description and illustration by Wood (1864) who wrote that it was somewhat difficult to be sure which species J. Sowerby had described as *Nucula minima*, as there were several rather similar species in the British Eocene.

Distribution – This species is known from the Barton and Bracklesham beds and the London Clay (Wood, 1864; Newton, 1891). *Yoldiella gracilis* (Deshayes, 1858) from the French Eocene is rather similar.

***Yoldiella oblata* (Wood, 1864)**
Plate 1, figs 10-11

*1864 *Leda oblata* Wood, p. 128, pl. 19, fig. 10.
1891 *Nuculana oblata* S.V. Wood – Newton, p. 28.
1992 *Nuculana oblata* (Wood) – Tracey, p. 158.
1997 *Yoldiella oblata* (Wood, 1864) – Jeffery & Tracey, p. 85, pl. 2, figs 7-8.

Material and dimensions – Nine specimens were found (OBK 163, 217, 258, 376, 475, 1077, 1325; 2001/6, MMF 11). Specimen OBK 1077 (Pl. 1, fig. 10) has a length of 4.7 mm and a height of 4.1 mm, specimen MMF 11 (Pl. 1, fig. 11) has a length of 5.5 mm and a height of 4.5 mm.

Description – The shell is small, subelliptical with rounded anterior part and almost rounded posterior part, slightly inequilateral. The umbo is slightly opisthogyrate and situated near the middle of the dorsal margin. The convexity is rather strong, especially anteriorly and below the umbo. The anterior dorsal margin is convex, passing into the convex anterior margin. The posterior dorsal margin is only slightly convex, passing gradually into the slightly convex posterior margin. The ventral margin is evenly convex. The anterior hinge line is convex and has *c.* 17 teeth, while the slightly concave posterior row has *c.* 11. The teeth are rather large and angulated. The exterior of the shell has very fine commarginal ribs. The interior is not sufficiently well preserved to allow a description.

Discussion – The shell is somewhat variable in outline. According to Wood's description the exterior should be smooth and glossy. The Danish material matches the description, but has fine commarginal ribs.

Distribution – According to Newton (1891) the species is restricted to the London Clay.

Subclass Pteriomorphia Beurlen, 1924
Superorder Eupteriomorphia Boss, 1982
Order Arcoida Stoliczka, 1871
Superfamily Limopsoidea Dall, 1895
Family Limopsidae Dall, 1895
Genus *Limopsis* Sassi, 1827
Subgenus *Pectunculina* d'Orbigny, 1843

***Limopsis (Pectunculina)* cf. *scalaris* (J.D.C. Sowerby, 1824)**
Plate 1, fig. 12

Synonymy for the real *Limopsis scalaris*:

*1824 *Pectunculus scalaris* J.D.C. Sowerby, pl. 472, fig. 2.
1854 *Pectunculus scalaris* Sow. – Morris, p. 207.
1891 *Limopsis scalaris* J. de C. Sowerby – Newton, p. 21.
1965a *Limopsis (Pectunculina) scalaris* (J. de C. Sowerby, 1824) – Glibert & van de Poel, p. 73.

Material and dimensions – Only one specimen was found, showing the internal and external moulds of the left valve (OBK 1060), length 2.9 mm, height 2.5 mm.

Description – The outline is rounded ovate. The umbo does not project over the straight dorsal margin. The anterior dorsal margin is a little longer than the posterior. The anterior and posterior margins are convex, running gradually into the convex ventral margin. The hinge has two rows, each with four teeth, of which the middle two are the strongest. The ventral margin has about 30 crenulations. The exterior ornament consists of *c.* 30 radial ribs and weaker commarginal lines.

Discussion – Because of the juvenile state a final identification is not possible.

Distribution – According to Newton (1891) *Limopsis scalaris* is restricted to the Barton Beds.

Order Mytiloida Férussac, 1822
Superfamily Mytiloidea Rafinesque, 1815
Family Mytilidae Rafinesque, 1815
Subfamily Modiolinae Keen, 1958
Genus *Modiolus* Lamarck, 1799

***Modiolus undulatus* (Wood, 1864)**
Plate 1, fig. 13

*1864 *Modiola undulata* Wood, p. 74, pl. 13, fig. 13a-b.

Material and dimensions – One fragmentary right valve (OBK 1003) was found. The height is 14 mm, length 27 mm.

Description – The shell is rather large and elongate-mytiliform, very inaequilateral. The umbonal part is not preserved. The shell is not very inflated. The long dorsal margin is slightly convex and meets the posterior margin at an obtuse angle, to judge from the concentric ornament. The ventral margin is long and slightly concave anteriorly. The commarginal ornament consists of about 10 weak folds of varying strength separated by interspaces of almost equal width.

Discussion – Wood (1864) based this species on fragmentary specimens preserved in septaria. The only Danish specimen matches Wood's description and illustration.

Distribution – Eocene at Harwich and Bawdsey (Wood, 1864).

Superfamily Pinnoidea Leach, 1819
Family Pinnidae Leach, 1819
Genus *Atrina* Gray, 1842

***Atrina affinis* (J. Sowerby, 1821)**
Plate 1, fig. 14

*1821 *Pinna affinis* J. Sowerby, p. 10, pl. 313, fig. 2.
1861 *Pinna affinis* J. Sowerby – Wood, p. 55, pl. 10, fig. 1a-c.
1891 *Pinna affinis* J. Sowerby – Newton, p. 9.
1965b *Atrina affinis* (J. Sowerby) – Glibert & van de Poel, p. 9.
1994 *Atrina affinis* (J. Sowerby) – Pacaud & Marcomini, p. 41.
1997 *Atrina affinis* (J. Sowerby, 1821) – Jeffery & Tracey, p. 86, pl. 3, figs 4-5.

Material and dimensions – Ten incomplete double-valved specimens were collected. The height of the illustrated specimen is 83 mm, the length 115 mm and the transverse diameter about 55 mm.

Description – The shell is large and rather regularly trigonal. The apex is acute. The dorsal margin is almost straight, meeting the long and convex posterior margin at an acute angle. The anterior margin is concave, running gradually into ventral margin. The radial ornament consists of *c.* 18 ribs of varying strength and spacing. Commarginal folds are especially visible near the umbo.

Discussion – Bonde (1968, p. 149) stated that two species of this genus are present in the Lillebælt Clay. In CHC specimen E 137 was labelled *Pinna affinis*, whereas E 140 was identified as *Pinna pyritiformis*? The Danish material matches the illustrations and description by Wood.

Distribution – According to Newton (1891) the species is known from the London Clay.

Order Pterioida Newell, 1965
Suborder Pteriina Newell, 1965
Superfamily Pterioidea Gray, 1847
Family Pteriidae Gray, 1847
Genus *Pteria* Scopoli, 1777

***Pteria* cf. *papyracea* (J.D.C. Sowerby, 1837)**
Plate 1, fig. 15

Synonyms for the real *Pteria papyracea*:

*1837 *Avicula papyracea* J.D.C. Sowerby, p. 136, pl. 8, fig. 16.
1861 *Avicula papyracea* J. Sowerby – Wood, p. 54, pl. 11, fig. 2a-c.
1891 *Avicula papyracea* J. de C. Sowerby – Newton, p. 8.
1997 *'Pteria' papyracea* (J. de C. Sowerby, 1837) – Jeffery & Tracey, p. 86, pl. 3, fig. 3.

Material and dimensions – Two specimens were recorded (OBK 112 and OBK 914).The height of specimen OBK 914 is 18 mm, the length 20 mm.

Description – The rather poor material consists of one almost complete right valve (OBK 112) and a defective double-valved specimen with the greater part of the left valve preserved. The shell is subelliptical with a straight dorsal margin, inaequilateral and almost flat. The prosogyrate umbo projects slightly over the hinge margin and is situated at one fourth of the shell length from the anterior corner of the dorsal margin. The anterior margin is almost straight, but soon becomes convex and runs gradually into the convex ventral margin. The posterior margin is almost straight, meeting the posterior dorsal margin at an angle of *c.* 110°. The anterior auricle is rather small and has five fine commarginal ribs, whereas the posterior auricle is larger and indistinctly demarcated. The ornament consists of about 25 commarginal folds of varying strength. The interior of the shell and hinge characters are not known.

Discussion – The material matches the illustrations and description of Wood.

Distribution – According to Newton (1891) the species is only known from the Eocene London Clay.

Family Bakevelliidae King, 1850
Genus *Aviculoperna* Cossmann, 1887

***Aviculoperna* cf. *limaeformis* (Vincent, 1893)**
Plate 1, fig. 16

1968 *Aviculoperna* sp. – Bonde, p. 150.

Synonymy for the real *Aviculoperna limaeformis*

*1893 *Avicula limaeformis* Vincent, p. 73.
1928 *Aviculoperna limaeformis* – Ravn, p. 71.

Material and dimensions – CHC, two valves; KTF, two double-valved specimens and three single valves; OBK, two valves, one with several juvenile specimens attached. Two specimens, GM 1908.191 in green clay from level L4. Shell height is up to 35 mm, length 42 mm. The illustrated almost complete right valve has a height of 26 mm and a length of 23 mm.

Description – The shell is obliquely ovate, inequilateral and moderately inflated. The umbo is placed well to the anterior end of the straight hinge margin. Both wings are triangular, the anterior one is the smaller. Commarginal growth-lines are present and some specimens also have weak radial ribs. Hinge and interior characters could not be studied on the material available.

Discussion – Ravn (1928, p. 71) referred right valves to *Aviculoperna limaeformis*, but Bonde (1968, p. 149) questioned this assignment as the species from the Belgian Bruxellian is poorly known. The only specimens (Vincent, 1893, p. 73) are a fragment of an adult and a defective juvenile. The fragmentary adult consists of the umbonal part with the anterior auricle partly broken. Bonde mentioned additional Danish specimens, which differ by being more or less oblique and having radial ribs. The Danish material probably contains more than one species.

Order Ostreoida Férussac, 1822
Suborder Pectinina Waller, 1978
Superfamily Pectinoidea Wilkes, 1810
Family Pectinidae Wilkes, 1810
Genus *Propeamussium* Gregorio, 1884

***?Propeamussium* sp.**
Plate 1, figs 17-18

1968 Pectinids - Bonde, p. 148.

Material and dimensions – Only three valves were collected (ex JTK 2001/9, CHC 133 and CHC 134). Shell height of MGUH 29725 (Plate 1, fig. 18) is 5.0 mm, width 4.8 mm.

Description – The shell is small, rounded, almost equilateral and only slightly convex. The ornament on the internal mould of Pl. 1, fig. 18 is of fine concentric growth-lines which are only visible near the ventral margin. The auricles are poorly preserved, but seem to have been relatively large. Specimen E 133 has parts of the shell preserved. The exterior has about 50 fine radial and about 30 commarginal ribs, resulting in a pattern of rectangles having their largest dimension in radial direction. The shell is thin-walled, but there are no traces of internal costae, which are typical of the genus *Propeamussium.*

Discussion – Wood (1864, p. 44, pl. 9, fig. 6a–b) figured specimens of a small *Propeamussium* from Bracklesham as *Pecten squamula* Lamarck, 1806, first described from the Ypresian of the Paris Basin. The Danish specimens seem to be closely related to that species. Bonde (1968, p. 149) mentioned some small, poorly preserved specimens in grey-green clay in the Lillebælt Clay from Trelde Næs. In CHC specimens E 133 and E 134 are labelled *Propeamussium* sp. They originate from level L2.

Superfamily Ostreoidea Rafinesque, 1815
Family Ostreidae Rafinesque, 1815
Genus *Ostrea* Linnaeus, 1758

Ostrea sp.
Plate 1, fig. 19

Material and dimensions – Only one valve was collected (OBK 1099). Its height is 6.5 mm, length 7.9 mm.

Description – The shell is subelliptical and slightly convex. The only ornament consists of *c.* 20 rather weak concentric folds.

Discussion – Because of the poor condition of the specimen a precise identification is not possible. In outline and ornament the specimen resembles *Ostrea velata* (Wood, 1861, pl. 7, fig. 1a-b).

Subclass Heterodonta Neumayr, 1884
Order Veneroida H. & A. Adams, 1856
Superfamily Lucinoidea Fleming, 1828
Family Lucinidae Fleming, 1828

Lucinidae sp. 1
Plate 1, fig. 20

Material and dimensions – Three pyritic internal moulds, OBK 720a, were studied. Shell length is 13.8 mm, height 10.7 mm.

Description – The shell is subelliptical. The umbo is prosocyrt and placed anteriorly to the middle of the dorsal margin. The rather short anterior dorsal margin is concave and meets the short, almost straight anterior margin at an obtuse angle. The anterior margin runs into the highly convex ventral margin almost evenly. In one specimen there is an angulation. The posterior dorsal margin is long and convex and meets the almost straight posterior margin at an obtuse angle. The posterior margin runs into the ventral margin with a slight angulation. No internal characters are preserved. On two shells the commarginal external ornament is partly preserved.

Discussion – This species has an outline resembling that of *Gonimyrtea spinulosa* (Edwards, 1866) from the Barton Beds. A final identification is not possible, as only internal moulds are known.

Lucinidae sp. 2
Plate 1, fig. 21

Material and dimensions – Only one pyritic mould, ex OBK 720b, was found. Shell length is 16.1 mm, height 12.7 mm.

Description – The shell is subelliptical. The umbo is prosocyrt and placed anteriorly to the middle of the dorsal margin. The short anterior dorsal margin is concave and meets the short, almost straight anterior margin at an obtuse angle. The anterior margin runs into the highly convex ventral margin with an angulation. The posterior dorsal margin is long and highly convex, connected with the almost straight posterior margin in a regular curve. The posterior margin runs gradually into the ventral margin. No internal characteristics are preserved. Of two shells the commarginal external ornament is partly visible.

Discussion – The shape resembles that of *Gibbolucina gibbosula* (Lamarck, 1806) from the Barton Beds. Bonde (1968, p. 149) mentioned pyritic internal moulds. Almost all specimens from the 1960s collections are damaged by pyrite disintegration (CHC E 101, E 109, E 121, E 124, E 128).

Family Thyasiridae Dall, 1901
Genus *Thyasira* Leach *in* Lamarck, 1818
Subgenus *Thyasira s.str.*

Thyasira (Thyasira) goodhalli **(J.D.C. Sowerby, 1837)**
Plate 1, fig. 22

*1837 *Cryptodon goodhalli* J.D.C. Sowerby, p. 186, pl. VIII, fig. 7.
1891 *Cryptodon goodhalli* J. de C. Sowerby – Newton, p. 83.

Material and dimensions – One double-valved specimen (OBK 522), of which only the exterior of the right valve is completely visible, and one complete double-valved specimen preserved as an external pyritic mould (OBK 560). Another two single valves are available (OBK 1015 and 1201). Shell height is 5.1 mm, length 5.9 mm.

Description – The shell is small and convex, rounded subtriangular. Two distinct ridges run from the beak to the posterior margin. The beak is placed near the middle of the shell. Except for close-set commarginal growth-lines the exterior of the shell is smooth.

Discussion – The specimen matches the illustration in Castell & Cox (1975, pl. 12, fig. 12).

Distribution – According to Newton (1891) the species is known from the Barton Beds and the London Clay.

Superfamily Chamoidea Lamarck, 1809
Family Chamidae Lamarck, 1809
Genus *Chama* Linnaeus, 1758

Chama **cf.** ***squamosa*** **Solander** ***in*** **Brander, 1766**
Plate 1, fig. 23

Synonymy for the real *Chama squamosa*:

*1766 *Chama squamosa* Solander *in* Brander, p. 36, pl. vii, figs 86, 87.
1822 *Chama squamosa* Solander – J. Sowerby, pl. 348.

1871 *Chama squamosa* Solander, 1766 – Wood, p. 175, pl. 35, fig. 6a-b.
1891 *Chama squamosa* Solander, 1766 – Newton, p. 50.

Material and dimensions – Only one incomplete internal mould was found (OBK 1307). Shell height is 22 mm, length 25 mm.

Description – On the mould rather weak concentric folds are present. The curve of the umbo is strong. No external mould is preserved

Discussion – The outline and traces of a concentric ornament are reminiscent of these characters on *Chama squamosa* from the British Bartonian. The poor preservation, however, prevents a precise identification.

Distribution – According to Newton (1891) *Chama squamosa* is known from the Barton Beds only.

Superfamily Carditoidea Fleming, 1820
Family Carditidae Fleming, 1820
Genus *Cyclocardia* Conrad, 1867

***Cyclocardia subelegans* (Wood, 1871)**
Plate 2, figs 1-2

*1871 *Cardita elegans* var. *subelegans* Wood, p. 146.
1891 *Cardita elegans* var. *subelegans* S.V. Wood – Newton, p. 37.
1996 *Venericardia subelegans* (Wood) – Tracey *et al.*, p. 106, pl. 3, figs 23a-b, 24a-b.

Material and dimensions – Twelve complete specimens and more than 100 single valves are known. The species is commonly found with multiple specimens in a single concretion. Double-valved specimens occur regularly. Height of the specimen illustrated Pl. 2, fig. 1 is 10 mm, its length 9 mm. Pl. 2, fig. 2 has a height of 9.0 and a length of 9.2 mm.

Description – The shell is subcircular with a prosogyrate umbo which is placed near the middle of the shell and projects a little. The exterior has 17-21 axial ribs, which are a little weaker than their interspaces and bear tubercles, which are most distinct near the umbo and on the lateral shell parts. In the hinge tooth 3a is obsolete; 3b bevelled in front, 2 thick, forming a triangle placed almost vertically below the umbo and near the anterior margin, 4b widely divergent from 2, separated from it at the apex. AII is small, provided with a corresponding socket in the right valve. Margins internally have rectangular crenulations, corresponding to the interspaces between the ribs. The pallial line is entire, parallel with the margin.

Discussion – Bonde (1968, p. 149) mentioned poorly preserved pyritic internal moulds. In CHC specimen E 131 is labelled *Venericardia*. Wood (1871, p. 146) considered *subelegans* to be a variety of *Cardita elegans* Lamarck, 1807. This variety was characterised by having sharper and higher ribs. The taxon was considered a distinct species and first illustrated by Tracey *et al.* (1996, p. 106, pl. 3, figs 23a-b, 24a-b).

Distribution – According to Newton (1891) this species is known from the Bracklesham Beds and the Barton Beds.

Family Astartidae Gray, 1840
Genus *Astarte* Sowerby, 1816

Astarte filigera treldensis n. subsp.
Plate 2, figs 3-5

Material and dimensions – Two double-valved and more than 50 isolated valves are known. The specimen illustrated in Pl. 2, fig. 3 has a height of 12.9 mm and a length of 12.0 mm. Pl. 2, fig. 4 has a height of 12.9 mm and a length of 13.8 mm. Pl. 2, fig. 5 (holotype) has a height of 13.5 mm and a length of 15.0 mm.

Type locality – Trelde Næs.

Type strata – Lillebælt Clay, Eocene.

Derivation of name – The species is named after the type locality.

Type material – Holotype: Pl. 2, fig. 5, MGUH 29735, ex OBK 505; paratypes: Pl. 2, fig. 3, MGUH 29733, ex OBK 415: Pl. 2, fig. 4, MGUH 29734, ex OBK 102.

Diagnosis – The new subspecies differs from *Astarte filigera* Wood, 1871 in having a less triangular outline, a much more convex and shorter ventral margin, a highly convex anterior dorsal margin and an almost straight anterior margin. The lateral tooth in the right valve is more convex. The lunula and area on the Danish subspecies are narrower than those of *A. filigera.*

Description – The valves are rather large and thick-shelled, obliquely triangular to subquadrate in outline, truncated posteriorly. The umbo is prosogyrate and projecting, situated anteriorly and perpendicular to the anterior edge. The posterior dorsal margin is concave, considerably shorter than the anterior dorsal margin and runs into the almost straight anterior margin. The posterior margin is highly convex and almost as long as the convex ventral margin. From the umbo to the posterior edge there is a weak ridge which separates the rather flat posterior part of the shell from the more convex anterior part.
The ornament consists of 15-20 strong commarginal ribs, which are wider than their interspaces. A fine commarginal striation is visible on and between the ribs. Lunula and area are well developed, lunula widely lanceolate, area long and narrowly lanceolate. The hinge of the right valve has a central triangular, projecting posterior cardinal tooth (3b) and two deep and narrow pits, of which the anterior is nar-

rower than the obliquely placed posterior pit. Anterior to one pit there is a long, slightly curved lateral tooth. Posteriorly a lateral tooth soon merges with the dorsal margin. The hinge of the left valve has two cardinal teeth (2a and 4a), of the same shape as the pits in the right valve. Posteriorly there is a deep pit for the lateral tooth in the right valve. The interior is smooth; the rather indistinct pallial line is situated rather far from the ventral margin. The adductor impressions are distinct and rather deep, the posterior one more triangular. The ventral margin is crenulated.

Discussion – The Danish species is considered to be a stratigraphical subspecies of *A. filigera* Wood, 1871. Danish specimens differ especially by having different outline. They are less triangular and the ventral margin is much more convex and shorter. The anterior dorsal margin is highly convex, but almost rectilinear in *A. filigera*. The anterior margin is almost straight and connected to the ventral margin with an obtuse angle. It meets the anterior dorsal margin in an almost right angle. The Danish subspecies is more thick-shelled and has a more convex lateral tooth in the right valve. Lunula and area are narrower than in *A. filigera*.

Distribution – According to Newton (1891) *Astarte filigera* is known only from the London Clay. Curry (1965b) stated that *Astarte*, *Thyasira* and other cold water species from the London Clay were absent in the Bracklesham Beds.

Family Crassatellidae Férussac, 1822
Genus *Crassatella* Lamarck, 1799

***Crassatella* cf. *sulcata* (Solander *in* Brander, 1766)**
Plate 3, fig. 6

Synonymy for the real *Crassatella sulcata*:

*1766	*Tellina sulcata* Solander *in* Brander, p. 37, pl. 7, fig. 89.
1822	*Crassatella sulcata* Solander – J. Sowerby, pl. 345, fig. 1.
1871	*Crassatella sulcata* Solander – Wood, p. 170, pl. 18, fig. 11a-c.
1891	*Crassatella sulcata* Solander, 1766 – Newton, p. 33.

Material and dimensions – One internal mould, OBK 651, was found. It has a height of 30 mm and a length of 42 mm.

Description – The shell is elongate-ovate, highly inequilateral with a truncate posterior end. The small prosogyrate umbo is situated behind the middle of the shell. The valves are moderately convex with their strongest convexity anteriorly. The anterior dorsal margin is convex and not separated from the convex anterior margin. The anterior part of the ventral margin is moderately convex, whereas the posterior part is only slightly concave. The posterior margin meets the ventral margin at an acute angle and the posterior dorsal margin in an obtuse angle. The area is elongate-lanceolate, the lunula shorter. No exterior or hinge characteristics are preserved. On the internal mould no adductor scars or pallial line are visible because of the state of preservation.

Discussion – In size and general outline this specimen resembles *Crassatella sulcata* which according to Newton (1891) is restricted to the Barton Beds.

Family Semelidae Stoliczka, 1870
Genus *Abra* Lamarck, 1818

Abra madseni n. sp.
Plate 2, figs 7-8

Material and dimensions – One complete double-valved specimen and more than 120 isolated valves are known. The illustrated holotype has a height of 10.2 mm and a length of 13.9 mm.

Type material – Holotype Pl. 2, fig. 7, MGUH 29737, ex OBK 528; paratype: Pl. 2, fig. 8, MGUH 29738, ex OBK 1062.

Diagnosis – A rather large, subelliptical *Abra* with the umbo only a little behind the middle of the shell. Anterior margin very convex, ventral margin regularly convex and posterior end pointed.

Locus typicus – Trelde Næs.

Stratum typicum -- Lillebælt Clay, Eocene.

Derivatio nominis – The new species is named after Mogens Madsen (Fredericia), who made a large part of the material available for this study.

Description – The shell is rounded elliptical and inequilateral, with the umbo placed a short distance behind the middle of the dorsal margin, and a pointed posterior end. The anterior dorsal margin is convex and runs evenly into the very convex, short anterior margin. The ventral margin is regularly convex and runs gradually into the short posterior margin in an acute angle. The posterior dorsal margin is only slightly convex.
In the hinge of the right valve tooth 3a is small and weak, slender triangular and sharp, directed obliquely forward, separated from 3b by a narrow, deep pit. Tooth 3b is situated directly under the umbo and a little wider than 3a. It is directed obliquely backwards. Behind 3b is the spoon-shaped resilifer, only slightly projecting from the hinge margin. Above the resilifer there is an indistinct resilium for the outer ligament. The anterior dorsal margin has a long, deep and narrow groove for the lateral tooth, while the posterior dorsal margin has a deep, but shorter groove. In the hinge of the left valve cardinal tooth 2 situated in

front of the umbo. This tooth is narrow and small and directed forward. Anterior to 2 there is a deep tooth pit, posteriorly there is a very narrow pit, which is separated from the resilifer by a narrow rib. The plate for the attachment of the outer ligament is more distinct than in the right valve. The anterior dorsal margin has a rather weak lateral tooth, while the lateral tooth on the posterior dorsal margin is shorter.
The pallial line is not very distinct, but has a shallow sinus. The adductor scars are not very distinct. The margin is smooth and sharp. The shell has a glossy surface and very weak commarginal growth-lines are visible.

Discussion – The species differs from the *Abra* species of the Eocene of Britain in being much larger and by its rounded-elliptical outline.

Superfamily Veneroidea Rafinesque, 1815
Family Veneridae Rafinesque, 1815
Genus *Macrocallista* Meek, 1876

Macrocallista sp.
Plate 2, fig. 9a-b

Material and dimensions – One incomplete right valve was found (OBK 272). Its estimated height is 8 mm, estimated length 13 mm.

Description – The shell is rounded ovate. The umbo is only slightly projecting. The anterior dorsal margin is short and slightly convex, running gradually into the convex anterior margin. The posterior dorsal margin is long and only slightly convex, with a gradual transition into the posterior margin. The ventral margin is not preserved, but judging by the commarginal ornament it was regularly convex. The ornament consists of folds of varying strength and interspaces. The unsharply demarcated area is long and narrow; the heart-shaped lunula is separated by a furrow. In the hinge tooth 1a is situated below the umbo. It is triangular and pointed obliquely downwards. Tooth 3a is narrow and separated from 1a by a deep furrow; 3b is separated from 3a by a triangular pit and from the long, sharply demarcated ligament plate by a narrow furrow.

Discussion – The species resembles *Macrocallista laevigata* (Lamarck, 1806) and *M. suberycinoides* (Deshayes, 1824) from the Eocene (Barton and Bracklesham beds) of England. The poor material, however, prevents precise identification.

Genus *Pelecyora* Dall, 1902

Pelecyora sp.
Plate 2, fig. 10

Material and dimensions – One double-valved internal mould (OBK). The specimen is rather worn. Its height is 38 mm, length 41 mm. The diameter of the double-valved specimen is 26 mm.

Description – The shell is rather large and subcircular with rounded anterior and posterior parts. The umbo is prosogyrate and situated almost in the middle of the dorsal margin. The convexity of the shell is rather strong and regular. The anterior dorsal margin is short and slightly convex and runs gradually into the very convex anterior margin. The posterior dorsal margin is longer and slightly convex, connected to the short and almost straight posterior margin with a very obtuse angle. Anterior and posterior margins run gradually into the regularly convex ventral margin. No external characters can be observed except for the long, narrow area and the almost heart-shaped lunula. Hinge characters, pallial line and adductor scars are not preserved.

Discussion – This poor specimen agrees with the genus *Pelecyora* in size and outline. *Pelecyora suborbicularis* (Goldfuss, 1841) has a distribution in Britain from the Barton Beds to the Bembridge Beds, according to Castell & Cox (1975, p. 54). That species is widely distributed in the European Oligocene and Miocene (R. Janssen, 1979, p. 131).

Subclass Anomalodesmata Dall, 1889
Order Pholadomyoida Newell, 1965
Superfamily Pholadomyoidea Gray, 1847
Family Pholadomyidae Gray, 1847
Genus *Pholadomya* J.D.C. Sowerby, 1823
Subgenus *Pholadomya s. str.*

***Pholadomya (Pholadomya) virgulosa* J.D.C. Sowerby, 1844**
Plate 2, fig. 11a-b

*1844	*Pholadomya virgulosa* J.D.C. Sowerby, pl. 630, fig. 1.
1850	*Pholadomya virgulosa* – Dixon, p. 225, pl. 19, fig. 31.
1891	*Pholadomya virgulosa* J. de C. Sowerby – Newton, p. 83.
1968	*Pholadomya* sp. – Bonde, p. 149.
1997	*Pholadomya (Pholadomya) virgulosa* J. de C. Sowerby, 1844 – Jeffery & Tracey, p. 90, pl. 6, fig. 16.

Material and dimensions – This is a very common bivalve in the concretions. Paired valves occur regularly, often with only the anterior part of the shells well-preserved. About 50 specimens were found. The length of the illustrated specimen (OBK 201) is 63.5 mm, its height 42.8 mm. The diameter of the double-valved specimen is 38.2 mm.

Description – The shell is large, rounded triangular but variable in outline, highly inequilateral. The anterior part is rounded and the posterior part is more narrowly acute. The

opisthogyrate umbo is large and rounded and situated anteriorly. The anterior part is highly convex, especially below the umbo. The convexity gradually decreases posteriorly. The anterior dorsal margin is very short and rises forwards, meeting the convex anterior margin at an obtuse angle. The anterior margin drops almost perpendicularly and runs gradually into the slightly convex ventral margin. The posterior dorsal margin is long and distinctly concave, running into the convex posterior margin at an obtuse angle. The dorsal margin is short and slightly convex and meets the ventral margin at an obtuse angle. The sculpture consists of numerous concentric ribs or folds. They are crossed by about 15 weaker radial ribs. The area is large and lanceolate; the lunula is small and indistinctly demarcated.

Remarks – Bonde (1968, p.149) mentioned concretions containing this species. On the label of specimen E 149 in CHC King wrote: 'definitely not *P. margaritacea* J. Sowerby, 1821'. He suggested *P. virgulosa* or *P. dixoni* J.D.C. Sowerby, 1844 for the Danish species. *P. margaritacea* has a more triangular outline with a pointed anterior.

Distribution – According to Newton (1891) *Pholadomya virgulosa* is known from the London Clay.

Family Thraciidae Dall, 1903
Genus *Thracia* J.D.C. Sowerby, 1823
Subgenus *Thracia s. str.*

Thracia (Thracia) barsoei n. sp.
Plate 2, fig. 12a-c

?1891 *Thracia Bartonensis*, Edwards (MS) – Newton, p. 83.

Material and dimensions – Seven specimens are in coll. OBK (OBK 458, 460, 514, 564, 575, 1383 and 1524); KPJ one complete double-valved specimen. A double-valved specimen (holotype, ex OBK 458) has a length of 29 mm, a height of 21 mm and a diameter of 14.4 mm.

Type material – Holotype: Pl. 2, fig. 12a-c, MGUH 29742, ex OBK 458.

Diagnosis – A rather large, almost equivalve *Thracia* with the umbo near the middle of the shell. The length/ height-ratio is *c.* 1.3-1-4. A rather large subtriangular posterior part, demarcated by two ridges, which run from the umbo to the corner of the posterior margin, has a distinct granulation which is also present anteriorly to the demarcating ridge.

Locus typicus – Trelde Næs.

Stratum typicum – Lillebælt Clay, Eocene.

Derivatio nominis – The new species is named after Ole Barsøe Hansen, who collected the holotype and, indeed, most of the material underlying the present study.

Description – The one complete specimen found (OBK 458) is preserved as an external mould in a small concretion. Except for a small part of the left valve the specimen is complete and well preserved. The shell is distinctly longer than high, almost equivalve and has a truncate posterior end. The valves are very convex, especially so the anterior and central parts. The umbo is placed near the middle of the shell, and the beaks of the double-valved shell are touching. The anterior dorsal margin is rather short and slightly convex, passing gradually into the very convex anterior margin. The posterior dorsal margin is rather long and straight and meets the slightly convex posterior margin at an angle of *c.* 120°. The posterior margin drops almost perpendicularly and passes into the ventral margin at an angle of *c.* 120°. The ventral margin is slightly concave posteriorly and convex anteriorly. The shell has rather weak commarginal growth-lines. From the umbo two ridges, running to the corner of the posterior margin, demarcate a posterior part, which has a distinct ornament of close-set granulae. These granulae are united in several places to form concentric lines. On the other part of the shell a much weaker granulation is present, almost invisible anteriorly. The upper ridge demarcates an escutcheon on which growth-lines are present, but no granulation.

Discussion – The specimen differs from other species of *Thracia* from the Eocene of the Paris Basin and Britain. In NHMUK-G (Edwards collection) a specimen from Barton, labelled '*Thracia bartonensis* – Edw. MS' (NHMUK-G 73088) is rather similar to the Danish species. However, the Barton species is relatively longer (L/H 1.6, but only 1.3 in the Danish species) and has a more convex ventral margin and a relatively longer anterior part.

Superfamily Poromyacea Dall, 1886
Family Cuspidariidae Dall, 1886
Genus *Cardiomya* A. Adams, 1864

Cardiomya triradiata **(Wrigley, 1940)**
Plate 2, fig. 13a-c

*1940 *Cuspidaria triradiata* Wrigley, p. 7, figs 5, 6.

Material and dimensions – Only a single specimen was found (MGUH 29743, ex OBK 384). The double-valved specimen has a length of 9.0 mm, a height of 6.5 mm and a diameter of 5.5 mm.

Description – The shell is rather small, droplet-shaped, with a rather short rostrum. The valves are very convex, especially so below the umbones. The ventral and posterior dorsal margins are gradually attenuated into a rostrum. The almost straight anterior dorsal margin gradually runs into the anterior margin which meets the convex ventral margin

in a shallow curve. The ventral margin is gently constricted into the rostrum which has an almost straight ventral margin. The dorsal margin of the rostrum is almost straight. The slightly opisthogyrate umbo projects somewhat over the dorsal margin.
The valves have a regular commarginal ornament consisting of *c.* 40 fine, close-set lines. On the rostrum they bend sharply towards the dorsal margin. The radial ornament consists of almost straight ribs which run from the umbo towards the ventral margin. On the left valve three strong radial ribs run from the umbo to the posterior ventral margin, the posterior two are more widely spaced than the anterior. Posterior to the strong ribs two much weaker ribs are situated near the rostrum, and posteriorly are another six, gradually increasing in strength anteriorly and most prominent near the umbo. On the rostrum two fine radial ribs run towards the posterior end. The right valve has a weaker sculpture, especially the three radial ribs, and posterior to these only one weak spiral is visible. Anterior to the three radial ribs only two very weak ribs are visible. The concentric ribs are also weaker.

Discussion – The specimen from the London Clay, described and illustrated by Wrigley (1940, figs 5-6) seems to be slightly longer than the Danish specimen (height/length ratio 0.64 *viz.* 0.70 in his figs 5 and 6; 0.72 in the specimen from Trelde Næs). The diameter/height-ratio of the specimen, illustrated in his fig. 5, is 0.78, whereas the Danish specimen has a ratio of 0.85. As the range of variability for the species is unknown as yet, we prefer to refer the Danish specimen to *C. triradiata.*

Distribution – London Clay (Wrigley, 1940).

Genus *Cuspidaria* Nardo, 1840

***Cuspidaria inflata* (J.D.C. Sowerby, 1827)**
Plate 2, fig. 14a-b

*1827	*Nucula inflata* J.D.C. Sowerby, p. 103; pl. 554, fig. 2.
1891	*Neæra inflata* J. de C. Sowerby, 1827 – Newton, p. 90.
1940	*Cuspidaia inflata* (J. de C. Sowerby) – Wrigley, p. 6, figs 1–4.

Material and dimensions – One almost complete specimen, preserved as an internal and external mould (MGUH 29744, ex OBK 248) and two external moulds of complete right valves (OBK 638, 738); an almost complete external mould (OBK 978) and an incomplete external mould (OBK 1010). Length of the illustrated specimen 41 mm, height 27 mm and diameter of the double-valved specimen 23 mm.

Description – The shells are large, inequilateral and equivalve. They have a rounded triangular outline and are very convex with a long, straight and narrow rostrum. The opisthogyrate umbones project above the dorsal margins. The slightly convex anterior dorsal margin runs gradually into the convex anterior margin, which meets the ventral margin in a gradual curve. The ventral margin is very convex anteriorly and suddenly constricted into the rostrum, which has an almost rectilinear ventral margin. The dorsal margin of the rostrum is slightly concave and meets the posterior margin of the rostrum at an obtuse angle. The ornament consists of obsolete irregular commarginal ribs which are most prominent near the anterior margin and on the rostrum on which they continue as weak rays. On the internal mould the adductor scars are not visible, and hinge characters are not preserved.

Discussion – The type species of the genus, *C. cuspidata* (Olivi, 1792), seems to be rather similar in outline and ornament. However, the Danish species is closer to *C. inflata* from the British Eocene.

Distribution – According to Newton (1891) the species is known from the London Clay.

Suborder Pholadina H. & A. Adams, 1858
Family Teredinidae Fleming, 1828

Teredinidae gen. et sp. indet.
Plate 3, figs 1-2

Material and dimensions – Numerous teredinid tubes are known, but only two single valves have been found. The height of the illustrated shell is 4.7 mm, its width 4.1 mm. The concretion has a length of 83 mm.

Description – Only external characters of the shell could be observed. The external ornament on the anterior shell-lobe consists of nine coarse ribs separated by distinct furrows on the dorsal part and 20 fine ribs separated by fine furrows on the ventral part. These ribs continue on the anterior part of the median shell-lobe while the posterior part of the median shell-lobe has only weak growth-lines. The posterior shell-lobe has only almost invisible growth-lines. The ribs on the anterior shell-lobe are connected to the longitudinal ribs on the anterior part of the median shell-lobe.

Discussion – Bonde (1968, p. 149) mentioned indeterminate teredinids in pyrite- and baryte-impregnated wood and concretions. Gagel (1917) mentioned teredinids in clay. The state of preservation allows no further identification.

Class Scaphopoda Bronn, 1862
Family Dentaliidae Gray, 1834

Dentaliidae indet.
Plate 3, fig. 3

Material and dimensions – Only one fragment was found. The length of the shell is 2.4 mm and the diameter 1.1 mm.

Description – The shell is smooth and glossy, circular in cross-section and slightly curved, slowly and regularly increasing in diameter. No ornament is visible.

Discussion – The circular outline, regular increase in diameter and the glossy surface show that this is not a teredinid tube. The fragmentary specimen could not be identified.

Class Gastropoda Cuvier, 1797
Subclass Orthogastropoda Ponder & Lindberg, 1995
Superordo Vetigastropoda Salvini-Plawen & Haszprunar, 1987
Superfamily Trochoidea Rafinesque, 1815
Family Solariellidae Powell, 1951
Subfamily Solariellinae Powell, 1951
Genus *Periaulax* Cossmann, 1888

***Periaulax spirata* (Lamarck, 1804)**
Plate 3, figs 4-5

*1804 *Solarium spiratum* Lamarck, p. 54, vélin 15, fig. 8.
1891 *Philippia spirata* (Lamarck) – Newton, p. 221.
1910-13 *Eumargarita (Periaulax) spirata* (Lamarck) – Cossmann & Pissarro, pl. 4, fig. 28-1.
1995 *Solariella (Periaulax) spirata* (Lamarck, 1804) – Le Renard & Pacaud, p. 88.

Material and dimensions – Only six specimens were found (ex MMF 2001/68, OBK 677, 1134, 1188, 1572 and one unnumbered specimen). The shell illustrated in Pl. 3, figs 4 and fig. 6 has a height of 6.6 mm and a width of 8.8 mm. Pl. 3, fig. 5 has a diameter of 6.5 mm.

Description – The species is rather small and conical, height/width-ratio about 1.0. In the largest specimen the protoconch and three teleoconch whorls are preserved which are slightly convex and separated by a distinct suture. The protoconch is worn but seems to have about 1½ whorls. The aperture is not preserved in the available material. On the first teleoconch whorl the presence of three spirals is merely suggested but they gradually weaken. Except for a fine spiral below the adapical suture and a stronger, knob-bearing spiral immediately below it, spiral ornament is absent. The number of knobs is about 30 on each whorl. Radial ornament is only indicated by the prosocline growth lines. The base of the shell is slightly convex and demarcated by a rather distinct spiral, which is not visible on the teleoconch whorls. The demarcating spiral is accompanied by a weaker spiral. The umbilicus is surrounded by a rather distinct carina.

Discussion – The Danish specimens have a weaker spiral ornament than typical *Periaulax spirata*.

Distribution – According to Newton (1891) the species is known from the Bracklesham Beds, the Barton Beds and from the Paris Basin.

Clade Sorbeoconcha Ponder & Lindberg, 1997
Superfamily Cerithioidea Fleming, 1822
Family Potamididae H. & A. Adams, 1854
Genus *Potamides* Brongniart, 1810
Subgenus *Eotympanotonus* Chavan, 1952

***Potamides (Eotympanotonus)* sp.**
Plate 3, fig. 7a-b

Material and dimensions – Only one fragmentary specimen (2001/34) was found. Its height is 12.3 mm, width 10.0 mm. The estimated height when complete is about 22 mm.

Description – The fragmentary shell consists of a little more than the body whorl. The aperture is rounded rectangular with a very short siphonal canal, slightly deflected to the left. The columella is straight; the base of the shell is slightly convex. The whorls are separated by a distinct suture. The spiral ornament consists of three cords that are weaker than their interspaces. Of these, the middle cord is the weakest. The shell wall between the two adapical cords is almost straight, but concave between the middle and abapical spirals. Growth-lines are almost orthocline across the whorl and form about 40 rounded tubercles at the intersections. On the base the growth-lines are prosocyrt with a distinct sinus.

Discussion – *Potamides (Eotympanotonus) conarius* (Bayan, 1873) from the British Barton and Bracklesham beds and the French Bartonian has three spirals, of which the adapical one is the strongest. This spiral has about 20 knobs, while the two weaker spirals have about 40 knobs. As the family Potamididae generally shows a wide range of variability, the Danish specimen may be conspecific with the British and French species.

Remarks – The Recent representatives of Potamididae are generally associated with mangroves (Reid *et al.*, 2008). Many representatives of the family occur in the British Middle and Late Eocene and Oligocene.

Genus *Orthochetus* Cossmann, 1889

***Orthochetus charlesworthi* Wrigley, 1940**
Plate 3, fig. 8

1854 *Cerithium Charlesworthii* Prestwich, p. 412 in part (*nomen nudum*).
1891 *Lovenella Charlesworthii* Prestwich (MS) – Newton, p. 190 (*nomen nudum*).
*1940 *Orthochetus charlesworthi* (Prestwich) – Wrigley, p. 11, figs 11, 12.

Material and dimensions – A single fragmentary specimen (SPA). Its height is 20.5 mm, width 6.9 mm.

Description – The specimen comprises about seven whorls which bear three strong equidistant spiral cords and are separated by a deep suture. The whorls are almost flat but slightly concave between the spirals. The aperture is only partly preserved but is almost rhomboidal in outline. Spiral ornament consists of three strong, rather sharp cords, which are separated by much wider interspaces. The almost flat base is demarcated by a fourth spiral cord, which is considerably weaker. A further five weak spirals are present on the base. The axial ornament consists of slightly prosocline ribs which are much weaker than the spirals. Fine tubercles occur at the intersections with the spirals. There are about 24 axial ribs on the penultimate whorl. Together with the spirals the axial ribs form slightly oblique rectangles.

Remarks – Wrigley (1940, p. 11) stated that the name *charlesworthii* was given by Prestwich (but without a description or illustration) to an extremely rare species from Barton. This species was not known from other localities, but Prestwich confused it with a species from the London Clay, later described as *Orthochetus elongatus* by Wrigley (1940), who restricted the name *charlesworthi* to the species from Barton (Wrigley, 1940, p. 11, figs 11, 12) and designated a neotype (NHMUK-G 72022). Also in Newton (1891) the species is not described or illustrated which makes Wrigley the author of *Orthochetus charlesworthi.*

Discussion – The Danish specimen matches the description and illustration of *Orthochetus charlesworthi* well. *Orthochetus elongatus* Wrigley (1940, p. 12) includes two different species according to Jeffery & Tracey (1997, p. 95). The holotype (1940, fig. 14, NHMUK-G 65549) seems to be a *Cerithiella* species. The Danish species differs from this in having a less distinct suture and slightly prosocline axial ribs. Wrigley (1940, figs 13 and 15) illustrated a specimen with four distinct spirals, of which the abapical one is the strongest.
Cerithiella fowleri Tracey & Todd, 1996 [*nov. nom. pro Cerithium cancellatum* (J.D.C. Sowerby *in* Dixon, 1850)] also has three distinct spirals, of which the abapical two are stronger than the abapical one. The axial ribs are of almost the same strength as the spirals and the suture is deeper than on the Danish specimen. On the base only four spirals are present (specimen from Bracklesham Bay, NHMUK-G 72023).

Distribution – According to Newton (1891) the species is known from the London Clay which was acknowledged by Wrigley (1940).

? *Cerithiella* sp.
Plate 3, fig. 9

Material and dimensions – Only one fragmentary specimen (ex OBK 1171) was found, with a height of 11.7 mm and width of 4.5 mm.

Description – The specimen retains about four spire whorls which are separated by a rather distinct suture. The spiral ornament consists of four cords, of which the middle two are the strongest. The adapical spiral is rather weak and placed a little distance from the suture. The middle two are of almost the same strength and separated by a slightly wider space. The lowest spiral is weak and placed immediately above the abapical suture. Between the spirals the whorl is slightly concave. The axial sculpture consists of orthocline to slightly opisthocline ribs which are much weaker than the spirals. At the intersections with the spirals rather strong tubercles occur. There are about 20 axial ribs on the penultimate whorl. Together with the spirals the axial ribs form slightly oblique rectangles.

Discussion – The incomplete specimen prevents a safe assignment to the genus *Cerithiella*. It differs from *Orthochetus charlesworthi* by the much coarser spirals and tubercles and the position of the spirals.

Family Cerithiopsidae H. & A. Adams, 1853
Subfamily Cerithiopsinae H. & A. Adams, 1853
Genus *Cerithiopsis* Forbes & Hanley, 1851

Cerithiopsis sp.
Plate 3, fig. 10

Material and dimensions – Only one fragmentary specimen (ex OBK 576) was found, height 3.5 mm, width 2.1 mm.

Description – The shell is narrowly turriculate. The last whorl is *c.* two fifths of the total shell height. The aperture seems to have been ovate and rather small. The fragmentary specimen has three and a half whorls preserved. The whorls are convex with distinct spirals which have slightly concave interspaces, and are separated by a deep suture. There are four spirals, much narrower than their interspaces, and the middle two (2 & 3) are stronger than the others and placed near midwhorl. Under the adapical suture the whorl has a narrow, flat part, demarcated by spiral 1. Spiral 4 is situated closely below spiral 3. Immediately above the abapical suture there is a fifth weak spiral, which is covered by the following whorl. The axial ornament consists of *c.* 30 opisthocyrt to orthocline ribs, which are much narrower than their interspaces. Small tubercles occur at the intersections with the spirals. The spiral and axial elements form a cancellate ornament. Both the labrum and the end of the canal are missing. The smooth base is almost flat.

Discussion – As protoconch and apertural characteristics are missing, the generic position is uncertain. However, the outline and ornament is similar to species of the genus *Cerithiopsis* Forbes & Hanley.

Family Epitoniidae Berry, 1910
Genus *Foratiscala* de Boury, 1887

***Foratiscala* aff. *newtoni* de Boury, 1890**
Plate 3, fig. 11

Synonymy for the real *Foratiscala newtoni*:

1827 *Scalaria reticulata* J.C.D Sowerby, pl. 577, fig. 4 (*non* Solander).
1890 *Foratiscala Newtoni* de Boury, p. 140.
1891 *Foratiscala Newtoni* de Boury (MS) – Newton, p. 215.
1891 *Foratiscala Newtoni* de Boury, 1890 – Newton, p. 297.

Material and dimensions – One almost complete (OBK 1429) and two fragmentary specimens (OBK 1429 and 1492) were found. The height of the former is *c.* 23 mm, width 10 mm. The largest fragmentary specimen is *c.* 15 mm, width *c.* 9 mm.

Description – The almost complete specimen consists of a little more than eight whorls which are highly convex and separated by a deep suture. The spiral ornament consists of about 10 fine cords with secondary threads inserted. The adapical three spirals are weaker than the others. The spirals are crossed by an estimated 30 or more finer prosocline axial ribs on each whorl. The spirals and axial ribs together result in a cancellate pattern of rectangles having their largest dimension in a spiral direction. At the intersections with the spirals the axial ribs are slightly crimped.

Discussion – The species demonstrates a certain similarity to *Foratiscala newtoni* de Boury, 1890, which is present in the English Bracklesham Beds and in the Paris Basin.

Genus *Tenuiscala* de Boury, 1887

***Tenuiscala* sp.**
Plate 3, fig. 14

Material and dimensions – One incomplete specimen (OBK 1609) was found. Its height is 16.3 mm, width 4.0 mm.

Description – The specimen consists of the impression of eight spire whorls, which are convex and separated by a deep suture. The spiral ornament consists of five primary cords, of which the abapical delimits the base and is covered by the following whorl. The four visible spirals are of almost the same strength and spirals 2 & 3 are a little more widely spaced than the others. Secondary spirals are intercalated, firstly between spirals 2 and 3 and later between all spirals and between the suture and the adapical and abapical suture. On the last whorl there are four fine spirals below the adapical suture and the first primary spiral. On the flat base the strong demarcating spiral cord is prominent and six spiral threads, separated by fine furrows, are visible. The axial ribs are opisthocline and weaker than their interspaces. On the last whorl there are about 20 ribs. The axial ribs are weaker than the spirals. Small tubercles occur at the intersections with the spirals.

Discussion – The incomplete specimen prevents a final identification. *Tenuiscala munieri* (de Raincourt, 1870) has only 14 axial ribs which are considerably stronger, and only four primary spirals.

Genus *Littoriniscala* de Boury, 1887

***Littoriniscala scalarioides* (J.D.C. Sowerby *in* Dixon, 1850)**
Plate 3, fig. 13

*1850 *Turritella scalarioides* Dixon, p. 227, pl. 15, fig. 10.
1891 *Littoriniscala scalarioides* (J. de C. Sowerby, 1850) – Edwards, p. 215.
1984 *Littoriniscala scalarioides* (J. de C. Sowerby *in* Dixon, 1850) – Cooper, p. 7.
1997 *Littoriniscala scalarioides* (J. de C. Sowerby *in* Dixon 1850) – Jeffery & Tracey, p. 95, pl. 9, fig. 16.

Material and dimensions – Two specimens were found preserved as pyritic metamorphs (CHC, specimens E 102 and E 110). The height of the illustrated specimen is 15.4 mm, width 8.2 mm.

Description – The largest specimen comprises 3¾ middle whorls and the body whorl. The shell is narrowly turriculate, about 1.8 times taller than wide. The whorls are highly convex and separated by a deep suture. The body whorl is half the total shell height, the aperture about one third. Spiral ornament begins with five cords, which are almost equidistant, and soon secondary spirals are intercalated. On the body whorl there are three weak spiral cords adapically and two generations of secondary spirals in between the primary cords. The axial ornament consists of fine prosocline ribs, meeting the suture at an angle of about 75°. The base is slightly convex and demarcated by a rather weak spiral cord. It has about 10 weaker spirals towards the pseudumbilicus. The aperture is ovate (the labrum is broken) and there is a narrow umbilicus behind the oblique columella.

Discussion – The specimen was labelled *Mathildia sororcula* Wrigley, 1940 by Bonde, while Rosenkrantz suggested that it was a cerithiid. King in 1972 suggested on the label that it was a determinable epitoniid. The two Danish specimens match the description and illustrations of *Littoriniscala scalarioides*. A specimen from Highgate Archway (Wetherell collection, NHMUK-G 69287) has about 10 almost equal spiral ribs on the teleoconch whorls. *Acrilla wetherelli* (Edwards *in* Lowry *et al.*, 1866) has a similar number of spirals and axial ribs, but the axial ribs are prolonged adapically beyond the suture and the base is distinctly angulated.

Distribution – According to Newton (1891) the species is

known from the London Clay.

Epitoniidae gen. et sp. indet.
Plate 3, fig. 12

Material and dimensions – One fragmentary specimen (OBK 1001) was found, with a height of *c.* 10 mm and width of *c.* 7 mm.

Description – The specimen consists of the impression of three spire whorls, which are convex and separated by a deep suture. The spiral ornament consists of about 10 threads, with secondary spirals intercalated. These spirals are crossed by an estimated 30 stronger, almost orthocline axial ribs per whorl. Below the suture the axial ribs first bend backwards. The spirals and axial ribs together result in a cancellate pattern.

Discussion – The species differs from *Foratiscala* sp. (see above) in having stronger, orthocline axial ribs.

Superfamily Stromboidea Rafinesque, 1812
Family Aporrhaidae Gray, 1850
Subfamily Aporrhainae Gray, 1850
Genus *Aporrhais* da Costa, 1778

***Aporrhais sowerbii* (Fleming, 1828)**
Plate 3, fig. 15

1822 *Rostellaria parkinsoni* J. Sowerby, p. 69, pl. 349, figs 1, 3, 4 (*partim*).
*1828 *Rostellaria sowerbii* Fleming, p. 360.
1829 *Rostellaria sowerbii* Mantell, p. 203.
1840 *Rostellaria sowerbyi* – J. de C. Sowerby, p. 9.
1891 *Aporrhais sowerbii* Mantell, 1835 – Newton, p. 97.
1938 *Aporrhais sowerbii* (Mantell, 1829) – Wrigley, p. 79, figs 42, 43, 45, 46, 49.

Material and dimensions – One fragmentary specimen, ex MMF 2003/21 with height of 10.5 mm, width 14.1 mm.

Description – The fragmentary shell consists of 2½ whorls. The protoconch and the anterior part of the shell are missing. The whorls are convex and separated by a distinct suture. The labrum has a digitation, which reaches to the adapical suture of the penultimate whorl. The spiral ornament consists of 12 threads above the carina and two strong cords below it. The penultimate whorl has about 20 opisthocline axial ribs, the body whorl about 16 ribs, which form tubercles on the carina.

Remarks – According to Wrigley (1938, p. 79) J. Sowerby included Eocene (London Clay) and Cretaceous specimens under the name *Rostellaria parkinsoni*. Obviously also for this reason Fleming (1828) and Mantell (1829) both introduced the new name *Rostellaria sowerbii* for the London Clay species and restricted *Rostellaria parkinsoni* to the Cretaceous species. J.D.C. Sowerby (1840, p. 9) emended the species name to *sowerbyi* in the index, although this was unjustified as the original spelling was based on the latinised form of Sowerby *i.e.* Sowerbius, and was therefore not an inadvertent error. The paper by Fleming (1828) seems to have been overlooked, as Mantell in later papers was considered the author of this species.

Discussion – The specimen seems to fall within the range of the highly variable *Aporrhais sowerbii*. Wrigley (1938) recognized four forms, of which the Danish specimen comes closest to *Aporrhais sowerbii* f. *constricta* Wrigley, 1938 (see his fig. 43).

Distribution – According to Newton (1891) *Aporrhais sowerbii* is widely distributed in the London Clay.

Family Strombidae Rafinesque, 1815
Genus *Tibia* Röding, 1798

***Tibia sublucida* (Edwards *in* Lowry *et al.*, 1866)**
Plate 3, fig. 16

1850 *Rostellaria lucida* J.D.C. Sowerby *in* Dixon, pp. 105, 187; pl. 5, fig. 21 (*non Rostellaria lucida* J. Sowerby, 1815).
*1866 *Rostellaria sublucida* Edwards *in* Lowry *et al.*, pl. 3.
1938 *Tibia sublucida* (F.E. Edwards) – Wrigley, p. 63; pl. 4, figs 5, 6, 7, 8.
1968 *Tibia* sp. – Bonde, p. 149.

Material and dimensions – The shell is common. More than 60 external moulds were found, mostly in OBK, but also in GPF and JFR. The specimen illustrated in Pl. 3, fig. 16 has a height of 30 mm.

Description – The shell is rather large and narrowly fusiform, more than twice as high as wide.
The protoconch consists of five highly convex whorls, which are smooth and separated by deep sutures. On the last protoconch whorl fine, almost orthocline riblets occur. The transition to the teleoconch is gradual. The teleoconch of the largest specimen found consists of about five convex whorls which are separated by distinct sutures. The last whorl is about 0.4 of the total shell height, the aperture about 0.3 of the total shell height. The aperture is relatively small and obliquely ovate. The labrum runs into the paries at an angle of about 45°. The columella is smooth and almost straight. As all specimens are immature, the characters of the rostrum and the labrum are not preserved, but the rostrum seems to be almost straight. The spiral ornament consists of 12-16 fine spiral bands, which are separated by much narrower spiral furrows. The spiral bands are of almost the same strength and undulate across the axial ribs. On the last two whorls, the two adapical spiral bands become stronger and a little more spaced than the other spiral bands, thus forming a subsutural band. The axial ribs are almost orthocline and most prominent on the first teleoconch whorls, but gradually they decrease in

strength. On the last whorl they are almost absent. The number of axial ribs is 20-25.

Discussion – The Danish material differs only slightly from British specimens of *Tibia sublucida* of which the protoconch and teleoconch whorls are more convex and the number of axial ribs is lower (British examples have about 30). The axial ribs are weaker than their interspaces and the spirals are visible on the axial ribs, whereas they are only visible in the interspaces in *T. sublucida*. The aperture is wider and seems to be less suddenly constricted into the rostrum. Specimens of *T. sublucida* in the collections of the Natural History Museum, London show a wide range of variation, for which reason we have assigned the Danish material to this species. *Tibia lucida* (J. Sowerby, 1815) has a lower number of axial ribs (12-16), a more slender outline and varices. Bonde (1968, p. 149) suggested a possible identification with a *Tibia* from the London Clay.

Distribution – According to Wrigley (1938) the species is widely distributed in the London Clay and is typically present in the Bracklesham Beds.

Tibia sp. 1
Plate 3, figs 17, 19a-b

Material and dimensions – Ten specimens were found. The shell illustrated in Pl. 3, fig. 17 has a height of 22 mm and a width of 10 mm, Pl. 3, fig. 19a-b has an estimated height of 27 mm and a width of 11 mm.

Description – The shell is rather large and narrowly fusiform, about 2.5 times higher than wide. The protoconch is not preserved on the specimens available. The teleoconch of the largest specimen found consists of almost four flat whorls, which are separated by rather distinct sutures. The last whorl is about two fifths of the total shell-height, the aperture about three tenths of the total shell-height. The aperture is relatively small and obliquely ovate. The labrum runs into the parietal wall at an angle of about 45°. The columella is smooth and almost straight. The callus is rather thin, and spiral folds on the columella are visible through the callus. As all specimens are immature, the characters of the rostrum and the labrum are not preserved, but the rostrum seems to be almost straight. The spiral ornament consists of seven clear primary spiral ribs, which are fine and separated by much wider interspaces. The two adapical spirals are very close-set and form a sutural band. The distances between the spirals are not equal; 2 & 3 are more widely spaced than 3 & 4; spirals 4 & 5 are the most widely spaced, while 5 & 6 have the same interspace as 3 & 4. Spirals 6 & 7 are close-set. On the last two whorls secondary spiral ribs are intercalated and they are of almost the same strength as the primary cords and separated by narrow furrows. The total number of spirals is about 23. They are almost invisible on the middle part of the whorl and more prominent on the base. The axial ribs are opisthocline to almost orthocline, only visible on the early teleoconch whorls as they gradually decrease in strength. On the last whorls they are absent, and only growth-lines are visible. The number of axial ribs is 20–25.

Discussion – This species differs from *Tibia sublucida* by its flat whorls, the considerably higher number of spirals and the weak axial ornament. Wrigley (1938, p. 65, fig. 26) established '*Tibia*' *enigmatica*, based on a single defective specimen from the Bracklesham Beds. That species has flat whorls, about 14 axial ribs on the first middle whorls and about 11 spirals. On the ultimate whorls both sculptural elements become obsolete, especially the axial ribs, which are completely absent on the body whorl. The Danish species seems to be related.

Tibia sp. 2
Plate 3, fig. 18a-b

Material and dimensions – Only one specimen (ex OBK 1514). Its height is 5 mm (estimated), width is 2.8 mm.

Description – A single juvenile specimen was found, consisting of the well-preserved protoconch and the first teleoconch whorl. The shell is fusiform, about twice as high as wide. The protoconch consists of almost five whorls, of which the first is moderately convex and the rest are slightly convex to almost flat. The nucleus is not preserved. The first whorls are smooth and on the last half whorl 10 fine spirals occur, separated by narrower interspaces. The transition to the teleoconch is gradual and indicated by the appearence of axial folds. The teleoconch whorl is slightly convex and has a spiral ornament of about 10 threads, which are the continuation of the spirals on the protoconch. The adapical five spirals are more close-set than the other spirals and they remain rather distinct, whereas the spirals on the abapical half of the whorl soon fade out. On the convex base seven rather distinct spirals are present. The axial sculpture consists of 16 folds which are slightly opisthocline and most prominent adapically. The last whorl is more than half, the aperture about three tenths of the total shell-height. The aperture is relatively small and obliquely ovate. The labrum is broken. The columella is smooth and almost straight with a thin callus and the short canal is slightly turned to the left.

Discussion – This juvenile specimen differs from *T. sublucida* by having a different protoconch. In *T. sublucida* the protoconch is much narrower (apical angle about 45° instead of 60°) and the axial ribs are present from the last protoconch whorl. *T. sublucida* has much more convex protoconch whorls and rather distinct axial ribs on the last half protoconch whorl. *Tibia* sp. 2 resembles *Tibia* sp. 1 with its flat whorls, weak spirals and axial ribs, but has a higher number of primary spirals. '*Tibia*' *enigmatica*, discussed above, has a similar number of spiral threads and weak axial ribs and may be closely related.

Family Xenophoridae Troschel, 1852.

Genus *Xenophora* G. Fischer, 1807

***Xenophora schroeteri* (Gmelin, 1791)**
Plate 4, fig. 1a-c

*1791 *Trochus Schroeteri* Gmelin, p. 3575, n. 56.
1804 *Trochus agglutinans* Lamarck, p. 51.
1806 *Trochus agglutinans* Lamarck, pl. 7, fig. 8.
1864 *Xenophora agglutinans* Lamarck – Deshayes, p. 964.
1891 *Xenophora agglutinans* Lamarck, 1804 and 1806 – Newton, p. 218.
1910-13 *Xenophora agglutinans* Lamarck, 1804 – Cossmann & Pissarro, pl. 12, fig. 69-3.
1975 *Xenophora agglutinans* (Lamarck, 1804) – Castell & Cox, pl. 17, fig. 10.

Material and dimensions – Only seven specimens were found (ISL OBK 1107, OBK 1260, OBK 1275, MMF 14 and SSV). Specimen OBK 1275 has a height of 19 mm and a width of 32 mm. The largest specimen (MMF 12) has a height of 22 mm and a width of 46.3 mm.

Description – The shell is rather large and low-spired, conical with a flat to slightly convex base. The height/width ratio is about 0.6. The angle of the apex is about 110°. The protoconch was studied on a juvenile specimen. It has about three smooth and convex whorls which are separated by a distinct suture. The terminal ¼ whorl has nine fine spiral ribs which are crossed by five almost orthocline axial ribs. The whorls of the teleoconch are slightly convex and separated by a distinct suture. The spirals on the protoconch continue on the first half whorl but then they disappear except for two spirals situated immediately above the abapical suture. Opisthocline growth-lines are visible. A concretion in ISL contains two specimens, of which one has three foraminifers attached and the other has two foraminifers and several serpulids. The aperture is rather narrow and the anterior margin is situated at the level of the base, so the aperture is not visible when viewed anteriorly. The base has a distinct umbilicus. Near the umbilicus there are three spirals, whereas the spirals and growth-lines on the base are very weak. In collection SSV a remarkable specimen has five tubes of a serpulid attached.

Discussion – The Danish material matches specimens from the British and French Eocene. In literature the species is mostly known as *X. agglutinans* (Lamarck, 1806).

Distribution – The species has a wide distribution in the British Eocene (Newton, 1891) and is well-known from the French Eocene.

Family Ovulidae Fleming, 1822
Genus *Eocypraea* Cossmann, 1903

***Eocypraea* cf. *oviformis* (J. Sowerby, 1812)**
Plate 4, figs 2a-b, 3a-b; Plate 7, fig. 17a-c

Synonymy for the real *Eocypraea oviformis*:

*1812 *Cypraea oviformis* J. Sowerby, pl. 4, lower figures.
1854 *Cypraea oviformis* Sowerby – Edwards, p. 128, pl 16, fig. 1a-i.
1891 *Cypraea oviformis* J. Sowerby – Newton, p. 99.
1968 *Sphaerocypraea bowerbankii* – Bonde, p. 150.

Material and dimensions – One specimen, preserved as a pyritic internal mould and one specimen, preserved as an internal mould in a sidertic/phosphatic concretion, both specimens leg. C. Heilmann-Clausen (CHC E 60). Ten specimens, preserved as internal moulds in clay-iron stone (OBK 63, 195, 419, 724, 826, 827, 828, 1061 and 1574). One internal mould (SSV). An external mould of a juvenile specimen (MTF). The height of the shell in Pl. 4, fig. 2 is 24 mm, width 20 mm. The height of that in Pl. 4, fig. 3 is 46 mm, width 30 mm. Height/width-ratio is 1.2-1.5. The height of Pl. 7, fig. 17a-c is 39.7 mm, width 32.4 mm

Description – The shell is rather large and globose. No external moulds of adult specimens have been found. A juvenile specimen (MTF) has a rather distinct spiral ornament. The aperture is rather narrow and widens anteriorly. The large specimen in CHC shows numerous regular teeth on the labrum.

Discussion – In general outline and aperture the Danish specimens resemble *Eocypraea oviformis* and *Sphaerocypraea globularis*. Bonde (1968) referred the two specimens in CHC to *S. bowerbankii* (J.D.C. Sowerby, 1850). On the label Bonde later has written that the pyritic specimen comes closer to *E. oviformis* or *Sphaerocypraea alata*. In my opinion the pyritic specimen comes very close to *E. oviformis*, whereas the other specimen in CHC seems to come closer to *S. globularis* and *S. bowerbankii*. As only more or less well-preserved internal moulds have been found, it seems most reasonable for the time being to assign all specimens to *Eocypraea* cf. *oviformis*. Better material may make possible a subdivision.

Distribution – According to Newton (1891) *Eocypraea oviformis* is known from the London Clay.

Superfamily Ampullinoidea Cossmann, 1919
Family Ampullinidae Cossmann, 1919
Genus *Globularia* Swainson, 1840

***Globularia* cf. *patuloides* (Cossmann & Pissarro, 1902)**
Pl. 4, fig. 4

1968 Naticidae – Bonde, p. 150 (*partim*).

Synonymy for the real *Globularia patuloides*:

1901 *Ampullina mutabilis* – Cossmann & Pissarro, p. 220 (*non* Solander, 1766).
*1902 *Ampullina patuloides* Cossmann & Pissarro, p. 106.

1909 *Ampullina mutabilis* – Cossmann & Pissarro, pl. 11, fig. 64-25 (*non* Solander, 1766).
1933 *Globularia patula* form *brabantica* Glibert, p. 40, pl. 2, fig.11.
1946 *Globularia patula* (Lamarck) form *brabantica* Glibert – Wrigley, p. 90, fig.7.
2007 *Globularia patula brabantica* Glibert, 1933 – Pacaud, p. 37.

Material and dimensions – Only one pyritic internal mould was found (CHC E 104). Its estimated height is about 26 mm, the width 25 mm.

Description – The shell is almost as wide as high and has a very low apex. The last whorl equals 90 % of the total shell height, the aperture 75%. The protoconch is not preserved, the teleoconch whorls rapidly increase in diameter. The whorls are convex and separated by a deep suture. The aperture is semicircular and the columella is almost straight. The umbilicus is rather wide and the rim, demarcating the callus, is distinct.

Discussion – The incomplete pyritic internal mould prevents a final identification, but in general outline the specimen matches the description and illustration of *Globularia patula* (Lamarck, 1804) forma *brabantica* (Glibert, 1933) of Wrigley (1946). Wrigley also described and illustrated 11 species of *Globularia* from the English Eocene. *Globularia sigaretina* (Lamarck, 1804) has a similar outline, but a minute umbilicus, *G. patula* (Lamarck, 1804) *s.str.* has a higher apex and the whorls are more shouldered, *G. bognorensis* Wrigley, 1946 is more high-spired and has very shallow sutures. *Globularia adurni* Wrigley, 1946 and *G. splendida* (Deshayes, 1864) also have shouldered whorls. *G. solentina* Wrigley, 1946 is shouldered and has a canaliculate suture. *G. parisiensis* (d'Orbigny, 1850) is higher spired. *Globularia parisiensis* f. *macrophala* Wrigley, 1946 has a very wide umbilicus. *Globularia grossa* (Deshayes, 1864) and *G. grossa* f. *harrisi* (Cossmann, 1889) are high-spired. *Globularia navalium* Wrigley, 1946 has the highest convexity on the upper part of the whorl and *G. sphaerica* (Deshayes, 1824) has adpressed whorls. Pacaud (2007) stated that *brabantica* is a junior synonym of *patuloides*.

Distribution – According to Wrigley (1946) the species is known from the Bracklesham and the Barton beds. The species is furthermore known from the Bruxellian of Belgium and from the Bartonian of the Paris Basin.

Family Naticidae Gray, 1840
Genus *Euspira* Agassiz, 1838

***Euspira* cf. *glaucinoides* (J. Sowerby, 1812)**
Plate 4, fig. 5

1968 Naticidae – Bonde, p. 150 (*partim*).

Synonymy for the real *Euspira glaucinoides*:

*1812 *Natica glaucinoides* J. Sowerby, p. 19, pl. 5, upper figure.
1891 *Natica labellata* Lamarck, 1804 – Newton, p. 239 (*non* Lamarck).
1948 *Euspira glaucinoides* (J. Sowerby, 1812) – Wrigley, p. 14, figs 14, 15.

Material and dimensions – Five specimens: CHC E 112 (two specimens), OBK, three specimens. The height of the illustrated specimen is 9.0 mm and its width is 9.4 mm.

Description – All specimens except E 112 are fragmentary and represent low spired naticids, but no specimens have aperture and umbilicus preserved. Final interpretations are thus not possible. The illustrated specimen E 112 is a pyritic internal mould which has the apertural and umbilical characteristics rather well-preserved.

Discussion – Bonde (1968, p. 150) presumed there were two species present in the Danish material, both known from the Eocene of England. Specimen CHC E 104 is labelled *Globularia* cf. *patula* (Lamarck, 1804) and E 112 as *Euspira* cf. *glaucinoides* (J. Sowerby, 1812). We accept this latter identification.

Genus *Sinum* Röding, 1798

***Sinum clathratum* (Gmelin, 1791)**
Plate 4, fig. 7

*1791 *Nerita clathrata* Gmelin, p. 3675, number 21.
1823 *Sigaretus canaliculatus* J.D.C. Sowerby, p. 115, pl. 384.
1833 *Sigaretus canaliculatus* Sowerby – Deshayes, p. 182, pl. 22, figs 13, 14.
1850 *Sigaretus canaliculatus* – J. de C. Sowerby *in* Dixon, pl. 5, fig. 9.
1866 *Sigaretus canaliculatus* – Edwards *in* Lowry *et al.*, pl. 3.
1910 *Sigaretus clathratus* (Gmelin) – Cossmann & Pissarro, pl. 10, fig. 62-1.
1933 *Sigaretus clathratus* Gmelin sp. 1791 – Glibert, p. 37, pl. 2, fig. 9.
1938 *Sigaretus (Sigaretus) clathratus* Gmelin sp. 1791 – Glibert, p. 76, pl. 2, fig. 14.
1938 *Sinum clathratum* (Gmelin) – Wrigley, p. 22, figs 44, 45, 46.

Material and dimensions – One specimen, OBK 1157, with height of 6.7 mm and width of 6.6 mm.

Description – The only specimen found consists of the protoconch and 0.75 teleoconch whorls. The base and the aperture are not preserved. The protoconch consists of 2½ smooth whorls which are separated by a distinct suture. The nucleus is small and the first protoconch whorl is planispiral and only slowly increases in diameter, whereas the

terminal whorl increases in diameter rapidly. The transition to the teleoconch is sharp and marked by a growth-line and the sudden appearance of the spiral ornament. The teleoconch whorl quickly increases in height and is separated by a distinct suture. The adapical margin of the labrum is preserved and sharp. The spiral ornament consists of numerous fine spirals, separated by finer furrows. The spirals are crinkled by slight deflections in crossing the growth-lines, which are slightly prosocline.

Discussion – The incomplete specimen is considered to be *Sinum clathratum* (Gmelin, 1791).

Distribution – The species is known from the Bracklesham Beds and the Barton Beds in England (Wrigley, 1938). According to Glibert (1938) the species has been recorded from the Paris Basin (Lutetian and Bartonian) and is also known from the Belgian Bruxellian (Glibert, 1933) and Wemmelian (Glibert, 1938).

Naticidae indet.
Plate 4, fig. 6a-b

Material and dimensions – One specimen is available (ex SPAF), with height 28.7 mm and width 22.9 mm, preserved as a pyritic internal mould with parts of the shell preserved.

Description – The specimen is rather large and naticoid-shaped. The protoconch and apex are not preserved and the specimen has the last whorl and about two spire whorls preserved. The whorls are highly convex and rapidly increase in diameter. They are separated by a canaliculated suture which is almost horizontal. The last whorl occupies 90% of the total shell height, the aperture 75%. The aperture is wide and ovate and the umbilicus is wide. The base is convex but as the aperture widens the base of the last half-whorl is concave.

Discussion – The species differs from English Eocene Naticidae by the shape of the aperture. The state of preservation prevents further identification.

Family Cassidae Latreille, 1825
Genus *Galeodea* Link, 1805

Galeodea anderseni n. sp.
Plate 4, figs 8-10

Material and dimensions – This species is one of the most common larger gastropods in the Lillebælt Clay. More than 60 specimens are known, but many are internal moulds. A few rather complete external moulds allow the following description. Height of the holotype illustrated in Pl. 4, fig. 8 is 41.4mm, the width 31.5 mm.

Type material – Holotype Pl. 4, Fig. 8, MGUH 29770, ex GPF; paratypes: Pl. 4, Fig. 9, MGUH 29771, ex GPF; Pl. 4, Fig. 10, MGUH 29772, ex GPF.

Diagnosis – *Galeodea* with one row of prominent tubercles situated adapically, no distinct varices, a weak callus and no internal knobs on the labrum.

Derivatio nominis – The species is named after Mr Sten Bo Andersen (Fredericia, Denmark), who during many years has collected a large quantity of material at Trelde Næs.

Locus typicus – Trelde Næs.

Stratum typicum – Lillebælt Clay, Eocene.

Description – The shell is large, ovoid and rather thin-walled. The height/width ratio is about 1.4. The protoconch is not preserved on the specimens available. The teleoconch consists of about five whorls on the largest specimen found. The last whorl is about 0.8 of the total shell-height, the aperture almost 0.7 of the total shell-height. The whorls are carinated, and the knob-bearing carina is situated near the middle of the whorls. The adapical part of the whorl is flat to slightly concave, and the abapical part is slightly convex. The last whorl is moderately convex below the periphery and is suddenly constricted into the siphonal canal, which is turned backwards and deeply excavated. The labrum is not completely preserved on any specimen, but it has a rather weak varix and is flattened. It is not possible to state the number of denticles on the internal side of the labrum. The callus is thin and widely distributed on the parietal wall and on the columella, and it has a free margin posteriorly which partly covers the transition from the base into the neck of the canal, resulting in a small pseudumbilicus. No specimen shows clearly the number of denticles or folds on the columella.
The spiral ornament begins with eight primary spiral cords, of which the first four are above the carina, spirals 5 & 6 form the carina, and two more are placed abapically. The spirals are flat and thread-like, and the adapical spirals 2 & 4 are weaker than 1 & 3, whereas the abapical spirals are of almost the same strength. The adapical spiral of the carina is the strongest of all. On the following whorls secondary spirals are intercalated in the interspaces, and numerous spirals are present on the last whorl and on the convex base. The axial sculpture consists of numerous fine riblets, and knobs appear on the carina, having their largest dimension in the directions of the spirals. Their number is about 20 on the last whorl. The growth-lines are prosocline on the adapical part of the whorl, but almost orthocline on the abapical part of the whorl. Old apertures are not very distinct, but can be observed on some specimens.

Discussion – According to Bonde (1968) the Lillebælt Clay contains several species of the genus *Galeodea*, including *G. gallica* Wrigley, 1934 and *G. bullata* (T. Brown, 1839) known from the London Clay. The material studied comes closest to '*Cassis*' *striata* J. Sowerby, 1812 from the Eocene London Clay of England (see Wrigley,

1934, p. 116, figs 22-23). However, the Danish specimens differ by having a more weakly developed callus. On the English species the callus is thicker and more wide-spread with a sharper margin. The characteristic tubercles on the internal side of the labrum could not be observed on the Danish specimens which lack the distinct varices of the English species. The outline of the spire is less convex and the knobs on the shoulder are stronger. For these reasons we prefer to establish a new species.

Genus *Mambrinia* Gardner, 1939

***Mambrinia* cf. *nodosa* (Solander *in* Brander, 1766)**
Plate 5, fig. 4

Synonymy for the real *Mambrinia nodosa*:

*1766 *Buccinum nodosum* Solander *in* Brander, p. 43, fig. 131.
1850 *Cassidaria nodosa* Solander, 1766 – Dixon, p. 105, 120; pl. 5, figs 3-4; pl. 7, fig. 43; pl. 15, fig. 8.
1891 *Cassis nodosa* Solander, 1766 – Newton, p. 105.
1934 *Galeodea nodosa* (Solander) – Wrigley, p. 120, figs 31-32.
1934 *Galeodea nodosa* (Solander) form *funicincta* (Edwards MS) – Wrigley, p. 120, fig. 31.

Material and dimensions – One pyritic internal mould (OBK 734) was found. The specimen has a height of 27 mm and a width of 24 mm.

Description – The specimen comprises 2½ convex whorls. No apertural features are preserved. The last whorl comprises about 2/3 of the total shell-height. On the spire whorls one knob-bearing spiral is situated on the middle of the whorl, while another weaker knob-bearing spiral is situated immediately above the suture. The knobs are large and rounded. On the middle whorl there are 14 knobs. The last whorl bears three knob-bearing spirals, of which the adapical one is stronger than the other two. The knobs are not placed above each other. On the base of the last spire whorl there are a further six spirals.

Discussion – This species is more high-spired than *Mambrinia nodosa* and also resembles *Galeodea gallica* Wrigley, 1934 (see Wrigley, 1934, p. 123, figs 21, 25).

Distribution – According to Newton (1891) *Mambrinia nodosa* is present in the Barton Beds, Bracklesham Beds and London Clay.

Superfamily Ficoidea Meek, 1864
Family Ficidae Meek, 1864
Genus *Priscoficus* Conrad, 1866

***Priscoficus* cf. *eocenica* (Wrigley, 1929)**
Plate 5, figs 1-3, 7

Synonymy for the real *Priscoficus eocenica*:

*1929 *Ficus eocenica* n. sp. – Wrigley, p. 238, figs 4-6.

Material and dimensions – Two defective specimens (OBK 601 and 1571). The height of OBK 601 (Pl. 5, fig. 3) is 63 mm, width 31 mm. OBK 1571 (Pl. 5, figs 1-2) has an estimated height of at least 70 mm and a width of 42 mm.

Description – Specimen OBK 601 consists of the impression of one side of the last whorl and the aperture. Specimen OBK 1571 consists of the internal mould of the apex and last whorl and parts of the teleoconch, preserved as impressions. The protoconch and some of the first teleoconch whorls are missing. The shell is large and pear-shaped, with a relatively high apex and angulated whorls. The aperture is wide and ovate and the columella is sinuous, anteriorly deflected to the left. The whorl is slightly angular because of the two keels and separated by a slightly undulating suture. The part of the whorl above the adapical keel is almost straight and between the two keels the whorl is almost perpendicular. On the slightly concave base there are five further spirals, of which the abapical one is the strongest. Between the keels there are five spirals and weaker secondary spirals. On the keels there are rather weak tubercles. On the spire whorls the adapical keel is situated almost at the middle of the whorl and has fine tubercles. On the adapical part there are about seven fine spirals and on the abapical part there are seven more spirals. The number of axial ribs is about 25-30. They are opisthocline, meeting the adapical suture at an angle of 110° and the carina at an angle of about 75°. On the abapical part they are almost orthocline to slightly opisthocyrt. Fine tubercles occur at the intersections with the carina.

Discussion – *Priscoficus eocenica* (Wrigley, 1929) from the London Clay is less slender and has a somewhat lower apex, but is rather similar in general outline, size and ornament (see Wrigley, 1929, p. 238, figs 4, 5a-b, 6). *Priscoficus smithi* (J.D.C. Sowerby, 1827) has a narrower aperture and a lower number of strong tubercles (see Wrigley, 1929, figs 1a-b, 2a-b). The present species differs from *Fulgoroficus* cf. *multiformis*, described below, in having much weaker axial ribs.

Distribution – According to Wrigley (1929) *Priscoficus eocenica* is known from the London Clay.

Genus *Fulgoroficus* Sacco, 1890

***Fulgoroficus* cf. *multiformis* (Wrigley, 1929)**
Plate 5, figs 5-6

Synonymy of the real *Fulgoroficus multiformis*:

*1929 *Ficus multiformis* Wrigley, p. 241, figs 15, 16a-b, 17, 18, 20, 21.

Material and dimensions – Two juvenile shells (ex MMK 3 and 4). Pl. 5, fig. 5 has a height of 6.3 mm and a width of 5.2 mm.

Description – The juvenile specimen consists of the protoconch and about 1½ teleoconch whorls. The protoconch consists of two convex, smooth whorls, separated by a deep suture. The nucleus is small and depressed and the first protoconch whorl is planspiral. After two whorls fine prosocline axial ribs cross six fine spirals. They become orthocline to opisthocline and number about 20 on each teleoconch whorl. The spirals and the axial ribs are of almost the same strength, resulting in a cancellate rectangular ornament. The aperture is wide and the columella is straight. The fragmentary specimen consists of one side of two teleoconch whorls on which three almost equidistant keels are developed.

Discussion – The specimens agree quite well with the description by Wrigley (1929), but because of incomplete preservation a final identification is not possible.

Distribution – According to Wrigley (1929) the species occurs in the London Clay.

Infraordo Neogastropoda Wenz, 1938
Superfamily Buccinoidea Rafinesque, 1815
Family Buccinidae Rafinesque, 1815
Subfamily Buccininae Rafinesque, 1815

***Eocantharus morrisii* (Edwards *in* Lowry *et al.*, 1866)**
Plate 5, figs 8-9

*1866 *Pisania morrisii* Edwards *in* Lowry *et al.*, pl. 4.
1891 *Pisania morrisii* Edwards (MS) – Newton, p. 161.
1949 *Pollia londini* (Wrigley) – Wrigley, p. 15.
1949 *Pollia* sp. – Wrigley, p. 15.
1963 *Cantharus (Eocantharus) morrisii* (Edwards) – Glibert, p. 78.
1965 *Pollia morrisii* (Edwards) – Curry & King, p. 34.
1997 *Cantharus (Eocantharus) morrisii* (Edwards *in* Lowry *et al.*, 1866) – Jeffery & Tracey, p. 96, pl. 10, figs 7-8.

Material and dimensions – Six specimens, GPF 2001/44, OBK 462, OBK 906, OBK 1158 (two specimens) and OBK 1494. The shell illustrated in Pl. 5, fig. 8 has a height of 10.8 mm and a width of 5.3 mm. Pl. 5, fig. 9 is 11.5 mm high and 5.0 mm. wide.

Description – The shell is fusiform, about 2.5 times higher than wide. Specimen 2001/44 consists of the protoconch and four spire whorls. The protoconch is multispiral and broadly conical, consisting of about 2½ convex whorls, which are separated by deep sutures. The nucleus and the sculpture of the protoconch whorls are not preserved. The largest specimen has a little more than three teleoconch whorls, which are moderately convex and separated by a deep, slightly undulating suture. The last whorl is 0.6 of the total shell height, the aperture and canal about 0.4. The aperture, base and canal are preserved on one of the two specimens of OBK 1158. The aperture is ovate and constricted into a narrow canal of the same length. The canal is deflected to the left. The labrum is sharp, but on the internal side there are 11 knobs a short distance in from the margin of the labrum. The columella is sinuous and smooth with a rather well defined callus. The spiral ornament consists of eight primary spirals, which are separated by interspaces of almost the same width. On the later whorls secondary spiral ribs are intercalated, especially between the adapical spirals. The adapical spirals are weaker than the abapical ones which undulate across the axial ribs. Growth-lines are rather distinct and opisthocyrt. The axial sculpture consists of 12–16 ribs, which are wider than their interspaces. The axial ribs are orthocline to slightly opisthocline.

Discussion – The Danish material matches the descriptions and figures of this species from the English Eocene. *Eocantharus lavatus* (J.D.C. Sowerby, 1823) differs particularly by the spiral ornament. Between the main spirals this species has four fine spirals, absent in Danish examples of *E. morrisii.*

Family Nassariidae Iredale, 1916
Genus *Desorinassa* Nuttall & Cooper, 1973

Desorinassa tonneseni n. sp.
Plate 5, figs 10, 12

Material and dimensions – Two juvenile specimens in concretion OBK 1276 and *c.* 25 specimens in concretion OBK 1521.The height of the specimen illustrated in Pl. 5, fig. 10 is 5.6 mm, the width 3.7 mm. The largest specimen (Pl. 5, fig. 12) has a height of 8.5 mm.

Type material – Holotype Pl. 5, fig. 12, MGUH 29784, ex OBK 1521; paratype Pl. 5, fig. 10, MGUH 29782, ex OBK 1276.

Diagnosis – A small *Desorinassa* with a spiral ornament of 7-8 weak spiral bands, no subsutural platform and slightly convex whorls. The canal is very short and the labrum is smooth and slightly thickened.

Locus typicus – Trelde Næs.

Stratum typicum – Lillebælt Clay, Eocene.

Derivatio nominis – The species is named after Michael Tonnesen of Fredericia, who made material in his collection available to us.

Description – The shell is small, ovate-conical and about 1.5 times as high as wide. The last whorl is 0.8 of the total shell-height, the aperture about 0.5. The largest specimen

has an apex, consisting of three whorls, and the last whorl preserved. The whorls are slightly convex and separated by a rather distinct suture. The aperture is relatively wide and ovate and the very short canal is situated near the end of the columella and is almost spout-like. The labrum is smooth, prosocline and slightly thickened. It runs in a regular curve into the end of the canal, with its deepest point below the columella. The columella is concave and short, ending before the deepest point of the aperture, and has a thickened columellar plait towards the canal. The callus is well defined and there is a small umbilicus. A weak ridge is visible on the apical side of the fasciole. The spiral ornament consists of 9-10 very weak and low spiral bands, which are more or less visible and separated by very fine furrows. The adapical spiral is stronger than the other spirals and separated from the following spiral by a wider furrow. The convex base has further 14 spiral bands. There is no axial sculpture, but very fine, prosocline growth-lines may be observed, having the same shape as the labrum.

Discussion – The new species comes rather close to *Desorinassa desori* (Deshayes, 1865), which is the type species of *Desorinassa*. The Danish species differs from the type species by having a more prominent spiral ornament, no subsutural platform and a much shorter canal, and it is considerably smaller. *Desorinassa acies* (Watelet, 1853) and *Desorinassa ovata* (Deshayes, 1835) from the Ypresian of the Paris Basin both have a spiral ornament similar to the Danish species but are larger. The former is relatively more slender and the latter has a subsutural platform. *Desorinassa williamsi* Nuttall & Cooper, 1973 from the English Ypresian is larger and almost smooth. The genus *Desorinassa* is mainly distributed in the Thanetian of France and England and the Ypresian of France (Nuttall & Cooper, 1973).

Family Fasciolariidae Gray, 1853
Subfamily Fusininae Wrigley, 1927
Genus *Fusinus* Rafinesque, 1815

***Fusinus unicarinatus* (Deshayes, 1835)**
Plate 5, fig. 11

*1835 *Fusus unicarinatus* Deshayes, p. 515, pl. 57, figs 11-12.
1850 *Fusus unicarinatus* Deshayes – Dixon, p. 104, pl. 7, fig. 25.
1891 *Fusus unicarinatus* Deshayes – Newton, p. 153.
1927 *Fusus unicarinatus* Deshayes – Wrigley, p. 217, fig. 1.

Material and dimensions – One fragmentary specimen (ex OBK 146). The height of the apical fragment is 20 mm, the width 8 mm, estimated height about 30 mm.

Description – The shell lacks the body whorl, aperture and canal, but has the apex and protoconch rather well preserved. The shell is slender. The protoconch consists of two whorls, which are convex, separated by a deep suture and quickly increasing in diameter. The remaining teleoconch consists of almost eight whorls, which are highly convex and separated by a deep suture. The whorls are carinated, because of a strong spiral rib, situated on the middle of the whorl. This rib divides the whorl into a straight to slightly concave adapical part and a convex abapical part. The spiral ornament consists of six primary spirals, of which the top three are weak and situated on the adapical part of the whorl. Spirals 2 & 3 are more close-set. On the sixth teleoconch whorl a weak secondary spiral is inserted between spirals 1 & 2. The abapical three spirals are stronger and regularly placed on the convex part of the whorl. They decrease in strength abapically. The axial ribs run from one suture to the other and are almost orthocline. They number about 12, and are wider than their interspaces and not sharply demarcated. On the adapical part they are very weak. Rounded tubercles occur at the intersections with the spiral ornament, having their largest dimension in a spiral direction. The growth-lines are opisthocyrt.

Discussion – The Danish specimen is considered to be *Fusinus unicarinatus* (Deshayes, 1835) although it differs slightly by having four spiral ribs adapically instead of five.

Distribution – According to Wrigley (1927) the species is present in the London Clay and Bracklesham Beds.

Genus *Clavilithes* Swainson, 1840

***Clavilithes* cf. *intermedius* Wrigley, 1927**
Plate 5, fig. 12

1968 Buccinid species – Bonde, p. 150.

Synonymy for the real *Clavilithes intermedius*:

*1927 *Clavilithes intermedius* Wrigley, p. 228, fig. 13.

Material and dimensions – One fragmentary specimen (ex CHC) with height 58 mm and estimated height when complete 75 mm, the width is 28 mm.

Description – Only one defective specimen is known. It lacks the protoconch and the first teleoconch whorls, and the canal and the labrum are defective. The shell is large and fusiform, almost three times higher than wide. The last whorl is about 0.6 of the estimated shell-height, the aperture and canal about 0.4. One side of the last 3½ teleoconch whorls is preserved. The whorls are convex and separated by a deep suture. The aperture is oval and suddenly constricted into the long, narrow and almost straight canal. Posteriorly it runs into the paries at an acute angle with a small spout. The labrum is broken; a well-defined callus is present on the inner lip. The spiral ornament consists of several rather weak bands on the adapical part of the whorl and four stronger bands on the abapical part.

Secondary spirals are inserted on the later whorls. An axial ornament of about ten broad, weak folds is present on the first teleoconch whorls but gradually disappears on later whorls. Opisthocyrt growth-lines are visible.

Discussion – Bonde (1968, p.149) mentioned a large high spired buccinid gastropod, which is the specimen described here. Of the species described from the English Eocene *C. intermedius* Wrigley, 1927 (p. 228, fig. 13) seems to be closest, or even conspecific. *Clavilithes rugosus* (Lamarck, 1803) (see Cossmann & Pissarro, 1907, pl. 40, fig.198-9) has more angulated whorls and sharper axial ribs. *Clavilithes dameriacensis* (Deshayes, 1864) (see Cossmann & Pissarro, 1907, pl. 41, fig.198-8) also comes close to the Danish species.

Distribution – According to Wrigley (1927) the species is present in the Bracklesham Beds.

Genus *Daphnobela* Cossmann, 1896

***Daphnobela juncea* (Solander *in* Brander, 1766)**
Plate 6, figs 1-2

*1766	*Murex junceus* Solander *in* Brander, p. 17, pl. 1, fig. 26.
1822	*Buccinum junceum* Solander – J. Sowerby, pl. 375, fig. 1.
1850	*Buccinum junceum* Solander, 1766 – Dixon, p. 100, pl. 7, fig. 47.
1860	*Metula juncea* – Edwards, pl. 33, fig. 10a-c.
1891	*Metula juncea* Solander, 1766 – Newton, p. 164.
1997	*Daphnobela juncea* (Solander *in* Brander, 1766) – Jeffery & Tracey, p. 96, pl. 10, figs 15-16.

Material and dimensions – Nine specimens were found. The material consists of two almost complete specimens, three apices, one last whorl showing the aperture, and one specimen showing the rear part of the last whorl and aperture and two incomplete specimens (OBK, MMF). The shell illustrated in Pl. 6, fig. 1 has a height of 15.6 mm and a width of 5.1 mm. Pl. 6, fig. 2 is 9.5 mm high and 3.2 mm wide.

Description - The shell is rather small, fusiform and slender, about three times as high as wide. The protoconch is not completely preserved but seems to be paucispiral, consisting of about two smooth whorls. The teleoconch consists of up to six whorls, the last whorl isabout 0.3 of the total shell height, the aperture about 0.2 of the total shell height. The rather narrow aperture is oval, passing into the short canal. The smooth columella is almost straight; the labrum is partly broken but is slightly thickened. The teleoconch whorls are relatively high and constricted anteriorly. They have their largest width one quarter whorl below the adapical suture,where a distinct carina is situated, dividing the whorl into a slightly concave adapical part with weak spiral ornament and a slightly convex abapical part with distinct spiral ornament. The whorls are divided by deep sutures which are almost canaliculate because of the constricted abapical part of the whorl. On the adapical part of the whorl about five very weak spiral riblets are present, on the abapical part there are 15 spiral ribs, stronger than their interspaces. There is no axial sculpture, but slightly opisthocline growth-lines are visible, having a very shallow sinus on the adapical part of the whorl.

Discussion – Specimens from Denmark are more slender than the British ones, but match other features quite well.

Distribution – According to Newton (1891) the species is present in the Barton Beds, Bracklesham Beds and London Clay.

Family Volutidae Rafinesque, 1815
Genus *Volutocorbis* Newton, 1906

***Volutocorbis* cf. *ambigua* (Solander *in* Brander, 1766)**
Plate 6, figs 3-4

1968	*Volutocorbis* sp. – Bonde, p. 150.

Synonymy for the real *Volutocorbis ambigua*:

*1766	*Strombus ambigua* Solander *in* Brander, p. 32, pl. 5, fig. 69.
1823	*Voluta ambigua* Solander – J.D.C. Sowerby, pl. 399, fig. 1.
1854	*Voluta ambigua* Solander, 1766 – Edwards, p. 150, pl. 19, fig. 4a-b.
1891	*Voluta ambigua* Solander, 1766 – Newton, p. 132.

Material and dimensions – This species is rather common and is found as pyritic internal moulds or external impressions. More than 100 specimens were collected. The height of the specimen illustrated in Pl. 6, fig. 3 is 43 mm, its width 25 mm. The height of the shell in Pl. 6, fig. 4 is 25 mm. The largest specimen found has an estimated height of 65 mm and a width of 32 mm.

Description – The shell is rather large, ovoid-conical and rather solid. The protoconch is not very well preserved but is multispiral and has about three smooth whorls separated by a distinct suture. The transition to the teleoconch is indistinct. The largest specimen consists of almost five teleoconch whorls, which are convex and separated by a deep suture. The last whorl is about 0.7 of the total shell height, the aperture 0.5. The aperture is ovate and passes anteriorly into a narrow and short canal which is slightly deflected to the left. The labrum is broken and the columella has two distinct folds. The spiral ornament consists of flat spiral bands, separated by narrow spiral grooves. The axial sculpture consists of 12-14 distinct ribs which are almost orthocline.

Discussion – Danish specimens come close to *V. ambigua* but differ slightly by having a higher apex and more dis-

tinct sutures, by being less slender and having sharper axial ribs. As *V. ambigua* shows a wide range of variation, the Danish specimens may still be referred to this species. *V. lima* (J.D.C. Sowerby, 1823) has more convex whorls, a canaliculated suture and knobs at the intersections between the spirals and the axial ribs. The number of axial ribs is higher.

Distribution – According to Newton (1891) *Volutocorbis ambigua* is restricted to the Barton Beds.

Volutidae indet.
Plate 6, fig. 5

Material and dimensions – One specimen (OBK 224) with height 10.4 mm, and width 4.3 mm.

Description – The only specimen found consists of about three teleoconch whorls. The shell is slender and almost biconical, about 2.5 times higher than wide. The protoconch and the apertural features are not preserved. The whorls are slightly convex and separated by a rather distinct suture. The last whorl is about 0.7 of the total shell height. Judging by the neck the canal seems to have been rather long and narrow. The spiral ornament begins with three primary spiral threads of which the adapical is weaker than the other two and situated near the suture. The two abapical spirals are more close-set and situated near the middle of the whorl. On the following whorl a weaker spiral appears below the adapical suture and a another weak spiral above the abapical suture. The three primary spirals remain stronger than the others. On the last whorl and the convex base 10 spirals are present, and on the neck of the canal there are 6 further spirals. Axial sculpture is absent, but numerous, slightly prosocline growth-lines are visible on and between the spirals.

Discussion – The genus *Longoconcha* Stephenson, 1941 has some resemblance, but as the aperture and columella characters are not preserved, a final determination is impossible. However, *Longoconcha* is restricted to the Cretaceous (Saul & Squires, 2008).

Superfamily Conoidea Fleming, 1822
Family Conidae Fleming, 1822
Coninae Fleming, 1822
Genus *Hemiconus* Cossmann, 1889

Hemiconus sp.
Plate 6, fig. 6

1968 Conidae – Bonde, p. 150.

Material and dimensions – One pyritic external mould (CHC) with the ornament preserved, height 17.6 mm, width 9.0 mm.

Description – The protoconch and part of the first teleoconch whorl are missing. The shell is biconical, the height/width-ratio about 1.9. The specimen has four teleoconch whorls, which are strongly carinated and separated by a distinct suture. The last whorl is about 0.75 of the total shell-height, the aperture 0.5. The aperture is narrow and has almost parallel sides. The labrum is missing. The carina is situated above the middle of the whorl and divides the whorl into a flat adapical part and an almost straight abapical part, which drops almost perpendicularly. The adapical part of the whorl is smooth and the abapical part has about five weak spiral bands. The slightly convex base has numerous fine spiral bands. The axial sculpture consists of weak ribs and growth-lines with the sinus on the carina. Below the carina the growth-lines are prosocyrt. The number of axial ribs is 16. Strong tubercles occur at the intersection with the carina.

Discussion – The Danish species differs from *Hemiconus concinnus* (J. Sowerby, 1821) by having the keel situated above the middle of the whorl. The adapical part of the whorl is concave and below the keel the whorl is almost perpendicular on the Danish specimen which also has a slightly lower number of nodules and no spirals on the adapical part of the whorl. Bonde (1968, p. 150) referred this specimen to an unspecified London Clay species.

Subfamily Clathurellinae H. & A. Adams, 1858
Genus *Bathytoma* Harris & Burrows, 1891

***Bathytoma turbida* (Solander *in* Brander, 1766)**
Plate 6, fig. 7a-b

*1766 *Murex turbidus* Solander *in* Brander, p. 10, pl. 2, fig. 31.
1816 *Pleurotoma colon* J. Sowerby, pl. 146, figs 7-8.
1843 *Pleurotoma cataphracta* Brocchi – Morris, p. 157 (*non* Brocchi).
1843 *Pleurotoma turbida* – Morris, p. 157.
1860 *Pleurotoma turbida* Solander – Edwards, p. 311, pl. 32, fig. 2a-c.
1891 *Pleurotoma turbida* Solander, 1766 – Newton, p. 126.
1975 *Bathytoma turbida* (Solander) – Castell & Cox, pl. 26, figs 16-17.

Material and dimensions – One fragmentary specimen (ex ISL 2001/64), one complete juvenile specimen (OBK 421) and an incomplete juvenile specimen (OBK 870) were found. The estimated height of the illustrated specimen is about 34 mm, the width 13 mm.

Description – The shell is rather large and slender, oblong-ovate-fusiform. The height/width ratio is about 2.5; the last whorl is 0.8 of the total shell height, the aperture 0.5. The protoconch is badly preserved on the complete juvenile specimen, but is multispiral and conical with about three convex whorls. The transition to the teleoconch is not determinable. The complete juvenile specimen consists of five teleoconch whorls, which are separated by a distinct

suture. The first teleoconch whorls are relatively low, later becoming higher. The aperture is oblong ovate, passing into the rather short and almost straight canal. The labrum is broken; the inner lip is well defined and the columella is smooth with an indistinct oblique fold.
The whorls have a depressed zone above the middle of the whorl and a subsutural band. The spiral ornament on the first teleoconch whorl has a rather distinct spiral under the adapical suture and secondary spirals are intercalated on the younger whorls. A carina consisting of three spirals is situated a little under the middle of the whorl. Immediately over the abapical suture a rather distinct spiral appears and one further spiral appears on the later whorls. In the concave part of the whorl there are about three finer spirals. The abapical two thirds of the whorl are convex with a blunt carina below the middle of the whorl. This carina is formed by three spiral cords on the first teleoconch whorls. Below the carina there are up to six spirals of which the two abapical ones are stronger than the others. The convex base and the neck of the canal have strong spirals. Secondary weaker spirals are intercalated. The axial ribs form distinct tubercles where they meet the spirals. On the first teleoconch whorl there are 30 fine tubercles below the adapical suture. Growth-lines are rather distinct, having their sinus on the middle of the carina.

Discussion – We compared the Danish specimens with examples from the Barton Beds of England. They match these specimens, as well as descriptions and illustrations in the literature.

Distribution – According to Newton (1891) the species is restricted to the Barton Beds.

Family Clavatulidae Gray, 1853
Genus *Orthosurcula* Casey, 1904

***Orthosurcula crassa* (Edwards, 1857)**
Plate 6, fig. 8

*1857 *Pleurotoma crassa* Edwards, p. 212, pl. 26, fig. 1a-d.
1891 *Pleurotoma crassa* Edwards, 1856 – Newton, p. 107.
1984 *Turricula crassa* (Edwards, 1856) – Cooper, p. 8.
1997 *Turricula (Orthosurcula) crassa* (Edwards, 1857) – Jeffery & Tracey, p. 98.

Material and dimensions – One specimen (OBK 1287) with an estimated height if complete of *c.* 65 mm and a width of 23 mm.

Description – The only available specimen has almost three whorls completely preserved. The last whorl is 0.7 of the estimated shell-height, the aperture more than half the estimated shell height. The whorls are very convex with a well developed subsutural band and a broad carina preserved on the first of the teleoconch whorls. The whorls have a concave ramp between the adapical sutural band and the carina. Beneath the carina the whorl is regularly convex. The whorls are separated by a deep suture. The aperture is elongate-ovate, basally constricted into a presumably long, straight siphonal canal. The labrum is broken and the columella is straight, with a well defined callus.
On the subsutural band there are three distinct spiral threads, of which the lower two are the strongest. On the concave part of the whorl there are five fine spirals and on the carina three strong spirals. Below the carina there is one rather distinct spiral, later two and secondary spirals are inserted on the following whorls. On the last two teleoconch whorls the carina fades away, resulting in an ornament of almost equal spirals below the concave part of the whorl. The convex base and the neck of the canal have a similar ornament. The axial sculpture is most visible on the subsutural band, where it causes 30-40 rather distinct tubercles. On the first teleoconch whorl there are knobs on the spirals of the carina, but they soon fade out. The growth-lines are distinct. They are prosocyrt under the adapical suture and have a rather deep sinus on the middle of the concave part of the whorl, where they cause a fine granulation of the spirals. Below the carina they are prosocyrt.

Discussion – Our specimen is considered to be conspecific with *Orthosurcula crassa* (Edwards, 1857, pl. 26, fig. 1a-d). *Orthosurcula rostrata* (Solander *in* Brander, 1766) (Edwards, pl. 26, fig. 8a-c) is also related, but is more elongate and has a finer ornament.

Distribution – According to Newton (1891) the species is restricted to the London Clay.

***Orthosurcula planetica* (Edwards, 1857)**
Plate 6, fig. 9

*1857 *Pleurotoma planetica* Edwards, p. 212, pl. 26, fig. 3.
1891 *Pleurotoma planetica* Edwards, 1856 – Newton, p. 109.
1997 *Turricula (Orthosurcula) planetica* (Edwards, 1857) – Jeffery & Tracey, p. 98.

Dimensions and material – Only two defective specimens are known (OBK 482 and 1371). Height of the latter is 19 mm, width 8 mm.

Description – Specimen OBK 1371 has almost one side completely preserved whereas OBK 482 consists of part of the penultimate whorl and half of the body whorl. The aperture and the siphonal canal are preserved except for the labrum which is broken. The shell is fusiform and has angulated whorls, caused by two strong spirals which are situated near the abapical suture. The adapical part of the whorl is slightly concave. The base is almost flat and constricted into the narrow canal which is of almost the same length as the aperture. The aperture is ovate and narrow, passing into the canal.
The spiral ornament is well preserved and covers the

adapical flat part of the whorls. Near the adapical suture are two rather weak spirals with small tubercles. Below these are nine fine spiral threads, abapically increasing in strength. About five rather strong spirals increase in strength towards the two strong peripheral cords. On the base and the neck of the canal there are 10 spirals decreasing abapically in strength and fine secondary spirals are seen between them. Except for fine growth-lines and the apical tubercles the shell has no axial sculpture. The growth-lines have a rather deep sinus placed on the middle of the nine fine spirals.

Distribution – According to Newton (1891) this species is restricted to the Bracklesham Beds.

Orthosurcula cf. ***teretrium crebrilinea*** **(Edwards, 1857)**
Plate 6, fig. 11, 12

Synonymy for the real *Orthosurcula teretrium crebrilinea*:

*1860	*Pleurotoma teretrium* var. *crebrilinea* Edwards, p. 210, pl. 30, fig. 8f.
1891	*Pleurotoma teretrium* var. *crebrilinea* Edwards, 1856 – Newton, p. 112.
1997	*Turricula (Orthosurcula) teretrium crebrilinea* (Edwards, 1857) – Jeffery & Tracey, p. 98, pl. 11, fig. 6.

Dimensions and material – Two specimens, preserved as an internal pyritized mould and an external mould of an incomplete specimen, were found (MMF, OBK 873). The estimated height of Pl. 6, fig. 11 is *c.* 24.5 mm, its width is 9.2 mm.

Description – The largest specimen has the impression of the body whorl and part of the penultimate whorl preserved. The last whorl is 0.6 of the estimated height, the aperture 0.5. The whorls are angular and divided into a slightly concave adapical part and a moderately convex abapical part. The base is slowly and evenly constricted into a rather long and almost straight canal. The callus is thin and rather indistinctly defined. The labrum is missing and the basal spirals are visible through the thin callus on the columella. The spiral ornament on the adapical part of the whorl consists of about 10 fine threads of which the adapical four are granulated by the growth-lines. On the abapical part of the whorl there are about 12 spirals and the base and the neck of the canal have a similar ornament. Secondary spirals are intercalated. About 16 weak opisthocline axial ribs are visible on the penultimate whorl and they gradually disappear on the body whorl. The growth lines are rather distinct, having their deep sinus on the 7th spiral thread on the adapical concave part of the whorl. On the body whorl they are flexuous.

Distribution – According to Newton (1891) this species is restricted to the London Clay.

Orthosurcula sp.
Plate 6, fig. 10

Dimensions and material – MTF, one incomplete specimen, preserved as a pyrite cast with remnants of the shell; two internal pyritic moulds (SPAF); three external moulds (OBK 390, 802, 862).The height of the illustrated specimen is 22.1 mm, its width 12.0 mm. Estimated height *c.* 30 mm.

Description – The figured specimen consists of almost five teleoconch whorls. The protoconch is missing. The shell is fusiform, about 2.5 times as high as wide. The last whorl is half the shell height, the aperture about one quarter. The labrum and the end of the canal are also missing. The aperture is ovate, evenly constricted towards the apparently short canal. The columella is slightly concave and smooth. The teleoconch whorls are convex with a weak shoulder and are separated by a deep suture. The adapical part of the whorl is almost flat. The spiral ornament consists of two fine threads immediately below the adapical suture and five more on the middle of the flat shoulder. Under the flat part of the whorl there are about 15 spirals separated by narrower interspaces. The convex base has a similar ornament. The axial sculpture consists of about 16 indistinct ribs which are opisthocline on the abapical part of the whorl. On the base they fade out. The growth-lines are prominent and cause a fine granulation of the subsutural spirals and those on the flat part of the whorl. Below the suture they are prosocline and meet the suture at an angle of 45°. They have a moderately deep sinus on the middle of the flat part of the whorl and run in an opisthocline curve across the abapical part of the whorl, having the shape of the axial ribs.

Discussion – Related species are *Crenaturricula macilenta* (Edwards, 1857, pl. 26, fig. 13a-b) and *Orthosurcula sulculosa* (Edwards, 1857, pl. 27, fig. 2a-c).

Superfamily Cancellarioidea Forbes & Hanley, 1851
Family Cancellariidae Forbes & Hanley, 1851
Subfamily Cancellariinae Forbes & Hanley, 1851
Genus *Cancellaria* Lamarck, 1799
Subgenus *Merica* H. & A. Adams, 1854

Cancellaria (Merica) evulsa **(Solander *in* Brander, 1766)**
Plate 6, fig. 13a-b

*1766	*Buccinum evulsum* Solander *in* Brander, p. 13, fig. 14.
1822	*Cancellaria evulsa* – J. Sowerby, p. 84, pl. 361, figs 2-4.
1835	*Cancellaria evulsa* Solander – Deshayes, pl. 79, figs 27-28.
1850	*Cancellaria evulsa* Solander – Dixon, p. 103, pl. 7, fig. 40.
1891	*Cancellaria evulsa* Solander, 1766 – Newton, p. 170.
1935	*Bonellitia evulsa* (Solander) – Wrigley, p. 364, figs 12-13, 44.
1975	*Bonellitia evulsa* (Solander) – Castell & Cox, pl. 26, fig. 7.

Dimensions and material – Just a single adult specimen, retaining its body whorl with the aperture preserved, was found. Two further juvenile specimens may be conspecific.The estimated height is 28 mm, the width 14 mm.

Description – The only adult specimen has a spiral ornament consisting of about 10 cords with secondary threads intercalated. The axial ribs are strongly prosocline. The aperture is ovate, running into the short canal, which has an adaxial spout. The columella has three rather strong folds of which the abapical one joins the margin to the siphonal canal. There is a weak callus.

Discussion – We refer this incomplete specimen to *Cancellaria evulsa*, because it is similar to the description and illustrations in Wrigley (1935).

Distribution – This species had a wide stratigraphical distribution during Eocene and Oligocene times in the North Sea Basin.

Clade Heterobranchia
Superfamily Acteonoidea d'Orbigny, 1843
Family Actaeonidae d'Orbigny, 1843
Subfamily Acteoninae d'Orbigny, 1843
Genus *Tornatellaea* Conrad, 1860

***Tornatellaea simulata* (Solander *in* Brander, 1766)**
Plate 7, figs 3, 4, 5a-b

*1766	*Bulla simulata* Solander *in* Brander, p. 29, pl. 4, fig. 61.
1817	*Avicula simulata* Solander, 1766 – J. Sowerby, pl. 163, figs 5-8.
1850	*Actaeon simulatus*? – Dixon, pp. 98, 119, 227; pl. 14, fig. 25.
1891	*Solidula simulata* Solander, 1766 – Newton, p. 261.
1968	*Tornatellaea* sp. – Bonde, p. 150.
1975	*Tornatellaea simulata* (Solander) – Castell & Cox, pl. 27, fig. 5.
1997	*Tornatellaea simulata* (Solander *in* Brander, 1766) – Jeffery & Tracey, p. 103, pl. 14, fig. 10.

Dimensions and material – Six pyritic moulds (SPAF, MTF, JTH), some of them with the shell partly preserved. Two external moulds of the apex are also available (OBK). Height of the illustrated specimen on Pl. 7, figs 5a-b is 18.0 mm, width 12.4 mm.

Description – The shell is ovoid-conical, with a height/width ratio of about 1.5. The last whorl is almost 0.8 of the total shell height, the aperture about 0.6. The protoconch is only preserved on two juvenile specimens (Pl. 7, Figs 3-4). The shell has about three teleoconch whorls which are moderately convex and separated by a deep suture. The aperture is rather wide and ovate. The labrum is broken on all specimens available and the straight columella has two strong folds. The spiral ornament consists of five flat bands. The two adapical spiral bands are wider than the three abapical spirals which are almost equal in strength. The spiral bands are separated by narrow furrows. On the convex base there are a further 11 spiral bands. Weak growth-lines are visible in between the spirals.

Discussion – The Danish material comes close to British examples of *Tornatellaea simulata* which are, however, more slender (height/width ratio almost 2.0) and the growth-lines are more prominent. As *T. simulata* shows a wide range of variability and the Danish specimens are rather poorly preserved, they are considered conspecific.

Distribution – According to Newton (1891) the species is present in the Barton Beds, Bracklesham Beds and London Clay.

Superfamily Mathildoidea Dall, 1889
Family Mathildidae Dall, 1889
Genus *Mathilda* Semper, 1866

***Mathilda* sp.**
Plate 7, fig. 1

Dimensions and material – Only one fragmentary specimen was found (ex ISL). Height of the fragment is 5.1 mm, width 4.0 mm.

Description – The only available specimen consists of the impression of two teleoconch whorls. The whorls are moderately convex and separated by a deep suture. The spiral ornament consists of five strong cords, separated by wider interspaces. Weaker secondary spirals are intercalated. Spirals 2, 3 & 4, counted from the adapical suture, are the strongest. The axial sculpture consists of about 35 almost orthocline ribs which are weaker than the spirals and separated by wider interspaces. The spirals and the axial ribs cause a cancellation of the whorls.

Discussion – *Mathilda sororcula* Wrigley, 1940 (p. 10, fig. 17) has a rather similar ornament but seems to have more convex whorls.

Superfamily Pyramidelloidea Gray, 1840
Family Pyramidellidae Gray, 1840
Subfamily Turbonillinae Bronn, 1849
Genus *Turbonilla* Risso, 1826

***Turbonilla* sp.**
Pl. 7, Fig. 2

Dimensions and material – Only one fragmentary specimen (ex GPF4). Its height is 2.7 mm, width 1.2 mm.

Description – The specimen consists of about three whorls which are moderately convex and separated by a deep suture. The only sculpture is of 12-14 axial ribs which are orthocline to slightly opisthocline and of almost the same

strength as their interspaces. The base is convex and smooth.

Discussion – The poor material excludes an identification.

Order Thecosomata de Blainville, 1824
Superfamily Cavolinioidea Gray, 1850
Family Limacinidae Gray, 1850
Genus *Heliconoides* d'Orbigny, 1834

***Heliconoides lillebaeltensis* A.W. Janssen *in* Janssen *et al.*, 2007**
Plate 7, figs 6-7

2007 *Heliconoides lillebaeltensis* A.W. Janssen *in* Janssen *et al.*, p. 161, figs 3-8, 12-13.

Dimensions and material – More than 200 specimens were recovered from several concretions.The height of the specimen illustrated in Pl. 7, fig. 7 is 2.1 mm.

Description – See Janssen *et al.* (2007).

Remarks – This species is characterised by an elevated spira and an externally reinforced apertural margin. It co-occurs with *H. mercinensis* in many concretions.

Distribution – The species is only known from the Lillebælt Clay of Denmark.

***Heliconoides mercinensis* (Watelet & Lefèvre, 1885)**
Plate 7, Fig. 8

1874 *Planorbis* ikke ulig *Pl. vortes* men maaske en *Valvatina* – Mørch, p. 279.
*1885 *Spirialis mercinensis* Watelet & Lefèvre, p. 102, pl. 5, fig. 2a-c.
1907 *Valvatina raphistoma* Stolley – Ravn, p. 368.
1913 *Valvatina merciniensis* (*sic*!) (Watelet & Lefèvre) – Cossmann & Pissarro, pl. 60, ptéropodes 2-2.
1965a *Spiratella mercinensis* (Watelet & Lefèvre, 1885) – Curry, p. 366, figs 15a-b, 16.
1997 *Spiratella mercinensis* (Watelet & Lefèvre, 1880) – Jeffery & Tracey, p. 104, pl. 15, fig. 1.
2007 *Heliconoides mercinensis* (Watelet & Lefèvre, 1885) – A.W. Janssen *in* Janssen *et al.*, p. 163, figs 7-8.

Dimensions and material – More than 100 specimens are known from several concretions.The diameter of the illustrated specimen is 2.1 mm.

Description – See Janssen *et al.* (2007).

Discussion – The sinistral shell is planorboid and thus easily distinguished from the two other pteropods. Apertural reinforcements are not preserved, but the characteristic shape allows a sound identification.

Distribution – The species is recorded from the Fur Formation (Ypresian) of Denmark (Mørch, 1874; Ravn, 1907), from the Ypresian London Clay in England, from the Ypresian of Belgium and the Ypresian of the Paris Basin. It has also been recorded from the Late Paleocene of Alabama, U.S.A. (Janssen *et al.*, 2007). It is the oldest pteropod species known.

Genus *Limacina* Bosc, 1817

***Limacina pygmaea* (Lamarck, 1804)**
Plate 7, fig. 9

1965a *Spiratella pygmaea* (Lamarck, 1804) – Curry, p. 362, figs 18a-b, 19 (with further synonymy).
2007 *Limacina pygmaea* (Lamarck, 1805) – A.W. Janssen *in* Janssen *et al.*, p. 165, fig. 11.

Dimensions and material – Only one specimen is known (OBK 1072). Shell height is 1.0 mm.

Description – The shell has a very low spira, considerably lower than the accompanying specimens of *Heliconoides lillebaeltensis*. The aperture is not visible.

Distribution – According to Janssen *et al.*, (2007) the species is known from the Eocene (Lutetian) of the Paris and North Sea basins.

Superfamily Cavolinioidea Gray, 1850
Family Cavoliniidae Gray, 1850
Subfamily Creseinae Curry, 1982
Genus *Creseis* Rang, 1828

***Creseis* sp.**
Plate 7, figs 10-11

Dimensions and material – Twenty eight specimens were found (CHC 139), all originating from the L2 level. Height of the illustrated specimen is 4.9 mm, width 1.9 mm. A fragmentary specimen has a height of 5.0 mm and a width of 2.3 mm. The estimated height when complete is *c.* 8 mm.

Description – All specimens are depressed and have only parts of the very thin and fragile shell preserved. A vertical line is visible on all specimens, most probably just a crack in the shell wall. A single specimen (Pl. 7, fig 12) differs by a less slender outline and might belong to another species

Discussion – The poor state of preservation prevents a final identification.

Class Cephalopoda Cuvier, 1795
Subclass Nautiloida Agassiz, 1847
Order Nautilida Agassiz, 1847

Superfamily Nautiloidea de Blainville, 1825
Family Hercoglossidae Spath, 1927
Genus *Cimomia* Conrad, 1866

***Cimomia imperialis* (J. Sowerby, 1812)**
Plate 7, figs 13-14

*1812 *Nautilus imperialis* J. Sowerby, pl. 1 (upper and right hand figures).
1835 *Nautilus Lamarcki* Deshayes, p. 767, pl. c, fig. 1.
1843 *Nautilus imperialis* J. Sowerby – Sowerby, pl. 627, fig. 4.
1849 *Nautilus imperialis* J. Sowerby – Edwards, p. 47, pl. 5.
1850 *Nautilus imperialis* J. Sowerby – Dixon, pp. 109, 120, 228.
1865 *Nautilus Lamarcki* Deshayes, p. 625.
1891 *Nautilus imperialis* J. Sowerby – Foord, p. 321.
1891 *Nautilus imperialis* J. Sowerby –Newton, p. 290.
1949 *Nautilus imperialis* J. Sowerby – Wrigley, p. 16.
1968 *Cimomia* cf. *imperialis* – Bonde, p. 150.
1997 *Cimomia imperialis* (J. Sowerby, 1812) – Jeffery & Tracey, p. 104, pl. 15, figs 7- 8.

Dimensions and material – More than 10 more or less defective specimens were found (OBK, GPF, CHC).The largest dimensions of the specimens illustrated in Pl. 7, fig. 13 and 14 respectively are 77 mm and is 85 mm.

Description – The shell is large, estimated diameter when complete about 20 cm, globose and rather narrow in ventral view. The aperture is subelliptical. The septa are concave and have a gentle undulation on each side with broad dorsal lobes which are inflected towards the axis. The growth-lines are reflected backwards in a rather deep narrow wave. The umbilicus is narrow and deep.

Discussion – The Danish specimens match the descriptions and illustrations in literature.

Distribution – According to Newton (1891) the species is known from the Barton and Bracklesham beds.

Family Aturiidae Chapmann, 1857
Genus *Aturia* Bronn, 1838

***Aturia ziczac* (J. Sowerby, 1812)**
Plate 7, fig. 1

*1812 *Nautilus ziczac* J. Sowerby, p. 9, pl. 1, fig. 3.
1835 *Nautilus ziczac* J. Sowerby – Deshayes, p. 765, pl. c, figs 2-3.
1849 *Aturia ziczac* J. Sowerby – Edwards, p. 52, pl. 9, fig. 1a-h.
1850 *Aturia ziczac* J. Sowerby – Dixon, pp. 110, 194, pl. 8, fig. 19.
1865 *Aturia ziczac* J. Sowerby – Deshayes, p. 628.
1891 *Aturia ziczac* J. Sowerby – Foord, p. 342, 344, fig. 74a, b.
1891 *Aturia ziczac* J. Sowerby – Newton, p. 292.

Dimensions and material – One specimen with a diameter of 35 mm (GPF).
Description – The specimen is preserved as an internal pyrite cast. The smooth and ventricose shell has a closed umbilicus and concave septa. The lateral lobes are narrow and pointed and the dorsal lobes are strongly curved. The siphuncle is large.

Discussion – The specimen matches the illustrations in literature.

Distribution – *Aturia ziczac* had a wide geographical distribution. It has been recorded from Eocene and Oligocene deposits in England, France, Belgium, and Germany. According to Newton (1891) the species is known in Britain from the London Clay and Bracklesham Beds.

Comparison with English Eocene faunas

The molluscan fauna of the British Eocene has been described by numerous authors. Newton (1891) gave a summary of the species in the Edwards collection, with the stratigraphical ranges of the species. Curry (1965b) gave a survey of the Palaeogene beds of SE England and stated the number of species in the English Eocene beds. However, it may be concluded that a modern revision is strongly needed; several species appear to be undescribed (J. Todd, pers. comm., 2004).
The London Clay is of Early Eocene (Ypresian) age (cf. Fig. 5) and has a uniform lithology of fine grained clay. Curry (1965b) concluded that it was deposited at some distance from land, in a sea without strong currents. He suggested a water depth of 100-200 fathoms (180-360 m). However, a somewhat shallower, inner to mid-neritic environment was suggested by King (2006). He also interpreted the bivalve genera *Thyasira*, *Arctica* and *Astarte* as indicators of deep water, as their recent representatives all have a predominantly boreal distribution.
The Bracklesham Beds are of latest Ypresian-late Middle Lutetian age, more or less synchronous with the Lillebælt Clay (Fig. 5). The Bracklesham Beds contain a rich molluscan fauna of about 500 species indicating changed condition of deposition compared to the London Clay (Curry, 1965b). Representatives of attached bivalves such as *Chama, Arca, Spondylus* and *Plicatula* appear, indicating shallow, clear water. Other new genera suggesting very warm water occur: *Conus, Mitra, Oliva* and *Marginella.* Cold water indicators (*Arctica, Astarte, Thyasira* and *Aporrhais*) from the London Clay are absent in the Bracklesham fauna.
The Barton Beds of late Middle Eocene (Bartonian) age (Fig. 5) consist of marine sands and clays with a molluscan fauna of about 500 species, indicating a shallow sea, cooler than that of the Bracklesham Beds.
A comparison with the known stratigraphical ranges of the British species shows that the Danish fauna has 28 species in common with the older London Clay, 19 with the more or less synchronous Bracklesham Beds and 15 with the younger Barton Beds (Table 3). Thus the affinity to the

London Clay is the greatest. A possible explanation is that the London Clay was deposited in deep water whereas the Bracklesham and Barton Beds originated in more shallow waters. Some species from the London Clay may have survived in the Lutetian deep water environment in Denmark. Most Danish molluscs originate from L4 and L5, which are referred to the Lutetian Stage, but molluscs from Bed L2 (Ypresian Stage) have also been found. The figures may be distorted in view of the fact that several species from the Lillebælt Clay are only tentatively identified to species level. Furthermore, the stratigraphic ranges of the British species have not been updated recently.

State of preservation, palaeoenvironment

Some mollusc species occur abundantly. In Table 2 one valve of a bivalve is counted as ½.

Only the more common species are listed in Table 4, with their palaeoecological significance.

The frequent bivalve species all belong to the infauna and are frequently found with both valves united, especially so *Atrina affinis, Pholadomya virgulosa, Cyclocardia subelegans* and a lucinid species. All bivalve species indicate a soft seabed and calm water. The genera *Astarte* and *Abra* suggest a rather low water temperature, probably due to deep water. Teredinidae and *Aviculoperna* cf. *limaeformis* indicate sunken driftwood, just like the single specimen of *Ostrea* sp.

Among the common gastropods the genus *Galeodea* is an echinivore, but surprisingly only a few echinoids have been found. *Tibia* species are detritivores and *Eocypraea* cf. *oviformis* a herbivore. The rather rare turrids are vermivores, like the more common *Tornatellaea simulata.*

A remarkable occurrence is *Potamides* sp., as the representatives of the family Potamididae are generally associated with mangroves, thus indicating near-shore conditions and a tropical climate. Yet the only specimen found may have been transported with sunken driftwood.

The very abundant pteropods and frequent nautiloids indicate fully marine conditions with connection to the ocean. Other mollusc species are very rare, many only known as single specimens. In many concretions molluscs seem to be concentrated, probably by current, *e.g. Cyclocardia subelegans, Tibia sublucida* and *Heliconoides* spp.

The genera *Eocypraea, Ficus* and *Volutocorbis* and the nautilioids all indicate warm water, whereas the common bivalve species *Astarte filigera treldensis* and *Abra madseni* suggest colder water.

The diversity of the mollusc fauna is rather low, as compared to the British Barton and Bracklesham Beds, which both have molluscan faunas of about 500 species. The rather poor Danish molluscan fauna of the Lillebælt Clay, as well as the dominant species, indicate water depths of about 100-300 m. The dominant species are all full grown, indicating good conditions for these species.

Among the non-molluscan invertebrates several species of Anthozoa are rather frequent, indicating an oxygen-rich environment and current. The serpulids are represented by numerous specimens of *Rotularia bognoriensis* (Mantell, 1822) and the brachiopod *Terebratulina wardenensis* Elliott, 1955 is rather frequent. Isolated pyrite stems of the crinoid *Isselicrinus subbasaltiformis* (Miller, 1821) are frequently found washed out of the clay and are also recorded in situ in Bed L4 (cf. above) but only one specimen has been found in a concretion. A few plates of asteroids have been found. Numerous concretions containing decapods have been found, representing nine species (Collins & Jakobsen, 2003). Frequently these concretions also contain many specimens of the pteropod *Heliconoides*. Vertebrates include sharks, teleosts, turtles and birds (Hoch, 1975; Heilmann-Clausen, 2006; Bonde *et al.*, 2008). Four teleost species represented by otoliths have been recorded (Schwarzhans, 2007). According to his paper the otoliths indicate deep water.

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Nr	Species	Number of specimens
1	*Nucula minor* Deshayes, 1860	2/1, 2/2
2	*Leionucula proava* (Wood, 1864)	3/2
3	*Nuculana amygdaloides* (J.D.C. Sowerby, 1827)	2/1, 12/2
4	*Yoldiella galeottiana* (Nyst, 1845)	1/1
5	*Yoldiella minima* (J. Sowerby, 1818)	1/1, 1/2
6	*Yoldiella oblata* (Wood, 1864)	9/2
7	*Limopsis (Pectunculina)* cf. *scalaris* (J.D.C. Sowerby, 1824)	1/2
8	*Modiolus undulatus* Wood, 1864	1/2
9	*Atrina affinis* (J. Sowerby, 1821)	10/1
10	*Pteria* cf. *papyracea* (J.D.C. Sowerby, 1837)	2/2
11	*Aviculoperna* cf. *limaeformis* (Vincent, 1893)	2/1, 10/2
12	*?Propeamussium* sp.	3/2
13	*Ostrea* sp.	1/2
14	Lucinidae sp. 1	3/1
15	Lucinidae sp. 2	1/1
16	*Thyasira (Thyasira) goodhalli* (J.D.C. Sowerby, 1837)	2/1, 2/2
17	*Chama* cf. *squamosa* Solander *in* Brander, 1766	1/2
18	*Cyclocardia subelegans* (Wood, 1871)	12/1, 102/2
19	*Astarte filigera treldensis* n. subsp.	2/1, > 50/2
20	*Crassatella* cf. *sulcata* (Solander *in* Brander, 1766)	1/1
21	*Abra madseni* n. sp.	1/1, 120/2
22	*Macrocallista* sp.	1/2
23	*Pelecyora* sp.	1/1
24	*Pholadomya (Pholadomya) virgulosa* J.D.C. Sowerby, 1844	> 50/1
25	*Thracia (Thracia) barsoei* n. sp.	8/1
26	*Cardiomya triradiata* (Wrigley, 1940)	1/1
27	*Cuspidaria inflata* (J.D.C. Sowerby, 1827)	1/1, 4/2
28	Teredinidae, gen. et sp. indet.	2/2, numerous tubes
29	Dentaliidae indet.	1
30	*Periaulax spirata* (Lamarck, 1804)	6
31	*Potamides (Eotympanotonus)* sp.	1
32	*Orthochetus charlesworthi* Wrigley, 1940	1
33	? *Cerithiella* sp.	1
34	*Cerithiopsis* sp.	1
35	*Foratiscala* aff. *newtoni* de Boury, 1890,	3
36	*Tenuiscala* sp.	1
37	*Littoriniscala scalarioides* (J.D.C. Sowerby *in* Dixon, 1850)	1
38	Epitoniidae gen. et sp. indet.	1
39	*Aporrhais sowerbii* (Fleming, 1828)	1
40	*Tibia sublucida* (Edwards *in* Lowry *et al.*, 1866)	> 50
41	*Tibia* sp. 1	10
42	*Tibia* sp. 2	1
43	*Xenophora schroeteri* (Gmelin, 1791)	7
44	*Eocypraea* cf. *oviformis* (J. Sowerby, 1812)	13
45	*Globularia* cf. *patuloides* (Cossmann & Pissarro, 1902).	1
46	*Euspira* cf. *glaucinoides* (J. Sowerby, 1812)	5
47	*Sinum clathratum* (Gmelin, 1791)	1
48	Naticidae indet.	1
49	*Galeodea anderseni* n. sp.	> 50
50	*Mambrinia* cf. *nodosa* (Solander *in* Brander, 1766)	1
51	*Priscoficus* cf. *eocenica* (Wrigley, 1929).	2
52	*Fulgoroficus* cf. *multiformis* (Wrigley, 1929)	3
53	*Eocantharus morrisii* (Edwards *in* Lowry *et al*, 1866)	6
54	*Desorinassa tonneseni* n. sp.	27
55	*Fusinus unicarinatus* (Deshayes, 1835)	1
56	*Clavilithes* cf. *intermedius* Wrigley, 1927	1
57	*Daphnobela juncea* (Solander *in* Brander, 1766)	7
58	*Volutocorbis* cf. *ambigua* (Solander *in* Brander, 1766)	103
59	Volutidae indet.	1
60	*Hemiconus* sp.	1
61	*Bathytoma turbida* (Solander *in* Brander, 1766)	3

62	*Orthosurcula crassa* (Edwards, 1857)	1
63	*Orthosurcula planetica* (Edwards, 1857)	2
64	*Orthosurcula* cf. *teretrium crebrilinea* (Edwards, 1857)	3
65	*Orthosurcula* sp.	6
66	*Cancellaria (Merica) evulsa* (Solander *in* Brander, 1766)	1 + 2?
67	*Tornatellaea simulata* (Solander *in* Brander, 1766)	1
68	*Mathilda* sp.	1
69	*Turbonilla* sp.	1
70	*Heliconoides lillebaeltensis* A.W. Janssen *in* Janssen *et al.*, 2007	> 200
71	*Heliconoides mercinensis* (Watelet & Lefèvre, 1885)	> 100
72	*Limacina pygmaea* (Lamarck, 1804)	1
73	*Creseis* sp.	28
74	*Cimomia imperialis* (J. Sowerby, 1812)	10
75	*Aturia ziczac* (J. Sowerby, 1812)	1

Table 2. List of mollusc species from the Eocene Lillebælt Clay and the number of specimens.

Nr	Species	1	2	3
1	*Nucula minor* Deshayes, 1860		*	
2	*Leionucula proava* (Wood, 1864)	*		
3	*Nuculana amygdaloides* (J.D.C. Sowerby, 1827)	*		
4	*Yoldiella galeottiana* (Nyst, 1845)		*	*
5	*Yoldiella minima* (J. Sowerby, 1818)	*	*	*
6	*Yoldiella oblata* (Wood, 1864)	*		
7	*Limopsis (Pectunculina)* cf. *scalaris* (J.D.C. Sowerby, 1824)	(*)		
8	*Modiolus undulatus* Wood, 1864	*		
9	*Atrina affinis* (J. Sowerby, 1821)	*		
10	*Pteria* cf. *papyracea* (J.D.C. Sowerby, 1837)	(*)		
11	*Aviculoperna* cf. *limaeformis* (Vincent, 1893)			
12	?*Propeamussium* sp.			
13	*Ostrea* sp.			
14	Lucinidae sp. 1			
15	Lucinidae sp. 2			
16	*Thyasira (Thyasira) goodhalli* (J.D.C. Sowerby, 1837)	*		*
17	*Chama* cf. *squamosa* Solander *in* Brander, 1766	(*)		
18	*Cyclocardia subelegans* (Wood, 1871)		*	*
19	*Astarte* (s. lat.) *filigera treldensis* n. subsp.			
20	*Crassatella* cf. *sulcata* (Solander *in* Brander, 1766)			(*)
21	*Abra madseni* n. sp.			
22	*Macrocallista* sp.			
23	*Pelecyora* sp.			
24	*Pholadomya (Pholadomya) virgulosa* J.D.C. Sowerby, 1844	*		
25	*Thracia (Thracia)barsoei* n. sp.			
26	*Cardiomya triradiata* (Wrigley, 1940)	*		
27	*Cuspidaria inflata* (J.D.C. Sowerby, 1827)	*		
28	Teredinidae, gen. et sp. indet.			
29	Dentaliidae indet.			
30	*Periaulax spirata* (Lamarck, 1804)		*	*
31	*Potamides (Eotympanotonus)* sp.			
32	*Orthochetus charlesworthi* Wrigley, 1940			*
33	?*Cerithiella* sp.			
34	*Cerithiopsis* sp.			
35	*Foratiscala* aff. *newtoni* de Boury, 1890,		*	
36	*Tenuiscala* sp.			
37	*Littoriniscala scalarioides* (J.D.C. Sowerby *in* Dixon, 1850)	*		
38	Epitoniidae gen. et sp. indet.			
39	*Aporrhais sowerbii* (Fleming, 1828)	*		
40	*Tibia sublucida* (Edwards *in* Lowry *et al.*, 1866)		*	
41	*Tibia* sp. 1			
42	*Tibia* sp. 2			

43	*Xenophora schroeteri* (Gmelin, 1791)		*	*
44	*Eocypraea* cf. *oviformis* (J. Sowerby, 1812)	(*)		
45	*Globularia* cf. *patuloides* (Cossmann & Pissarro, 1902).		(*)	(*)
46	*Euspira* cf. *glaucinoides* (J. Sowerby, 1812)			
47	*Sinum clathratum* (Gmelin, 1791)	*	*	*
48	Naticidae indet.			
49	*Galeodea anderseni* n. sp.			
50	*Mambrinia* cf. *nodosa* (Solander *in* Brander, 1766)	*	*	*
51	*Priscoficus* cf. *eocenica* (Wrigley, 1929).	(*)		
52	*Fulgoroficus* cf. *multiformis* (Wrigley, 1929)			
53	*Eocantharus morrisii* (Edwards *in* Lowry *et al.*, 1866)	*		
54	*Desorinassa tonneseni* n. sp.			
55	*Fusinus unicarinatus* (Deshayes, 1835)	*	*	
56	*Clavilithes* cf. *intermedius* Wrigley, 1927		(*)	
57	*Daphnobela juncea* (Solander *in* Brander, 1766)	*	*	*
58	*Volutocorbis* cf. *ambigua* (Solander *in* Brander, 1766)			*
59	Volutidae indet.			
60	*Hemiconus* sp.			
61	*Bathytoma turbida* (Solander *in* Brander, 1766)			*
62	*Orthosurcula crassa* (Edwards, 1857)	(*)		
63	*Orthosurcula planetica* (Edwards, 1857)		*	
64	*Orthosurcula* cf. *teretrium crebrilinea* (Edwards, 1857)	(*)		
65	*Orthosurcula* sp.			
66	*Cancellaria (Merica) evulsa* (Solander *in* Brander, 1766)		*	*
67	*Tornatellaea simulata* (Solander *in* Brander, 1766)	*	*	*
68	*Mathilda* sp.			
69	*Turbonilla* sp.			
70	*Heliconoides lillebaeltensis* A.W. Janssen *in* Janssen *et al.*, 2007			
71	*Heliconoides mercinensis* (Watelet & Lefèvre, 1885)	*		
72	*Limacina pygmaea* (Lamarck, 1804)		*	
73	*Creseis* sp.			
74	*Cimomia imperialis* (J. Sowerby, 1812)	*	*	
75	*Aturia ziczac* (J. Sowerby, 1812)	*	*	
	Total number of species	28	19	15

Table 3. Stratigraphical range in SE England of the molluscs of the Lillebælt Clay, based mainly on Newton (1891). 1. London Clay; 2. Bracklesham Beds; 3. Barton Beds. Incompletely identified occurrences are between brackets.

Species	**number**	**palaeoecology (after Jeffery & Tracey, 1997)**
Heliconoides lillebaeltensis	> 200	pelagic herbivorous ciliary-feeder
Volutocorbis cf. *ambigua*	> 100	molluscivore
Heliconoides mercinensis	> 100	pelagic herbivorous ciliary-feeder
Pholadomya virgulosa	> 70	infaunal suspension feeder
Abra madseni n. sp.	> 60	infaunal deposit feeder
Galeodea anderseni n. sp.	> 60	echinivore
Tibia sublucida	> 60	detritivore
Cyclocardia subelegans	> 50	infaunal suspension feeder
Astarte filigera treldensis n. subsp.	> 25	infaunal suspension feeder
Desorinassa tonneseni n. sp.	27	carnivorous
Cimomia imperialis	> 10	free-swimming predator
Lucinidae indet. sp. 1 + sp. 2	> 10	infaunal chemosymbiont
Aviculoperna cf. *limaeformis*	> 10	epifaunal suspension feeder
Teredinidae indet.	> 10	wood-boring xylophage and suspension feeder
Eocypraea cf. *oviformis*	> 10	herbivore
Atrina affinis	10	semi-infaunal suspension feeder
Tibia sp. 1	10	detritivore
Daphnobela juncea	9	carnivorous
Nuculana amygdaloides	8	infaunal deposit feeder
Thracia barsoei n. sp.	8	infaunal suspension feeder

Tornatellaea simulata	8	infaunal vermivore
Periaulax spirata	6	epifaunal
Cuspidaria inflata	5	carnivorous
Bathytoma turbida	3	vermivore

Table 4. Frequent mollusc species of the Eocene Lillebælt Clay and their palaeoecological indications.

References

Beesley, P.I., Ross, G.J.B. & Wells, A. (eds) 1998. *Mollusca: The southern synthesis. Fauna of Australia* 5. Melbourne (CSIRO Publishing), i-xvi, 1-563 (5A); i-viii, 565-1234 (5b).

Bonde, N. 1968. Nyligt fundne fossiler fra det 'plastiske ler'. *Meddelelser fra Dansk Geologisk Forening* 18, 148–151.

Bonde, N., Andersen, S., Hald, N. & Jakobsen, S.L. 2008. *Danekræ - Danmarks bedste fossiler*. København (Gyldendal), 225 pp.

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

Boury, E. de 1890. Observations sur quelques Scalidae du Bassin de Paris et description d'une espèce nouvelle. *Journal de Conchyliologie* 38, 139-143.

Brander, G. 1766. *Fossilia Hantoniensia collecta et in Musæo Brittanico deposita*. Londini, 43 pp.

Brinkhuis, H., Schouten, S., Collinson, M.E. *et al.* (22 authors) 2006. Episodic fresh surface waters in the Eocene Arctic Ocean. *Nature* 441, 606–609.

Castell, C.F. & Cox, L.R. 1975. *British Caenozoic fossils*; 5th edition. London [British Museum (Natural History)], vi + 132 pp.

Cleevely, R.J. 1974. The Sowerbys, the Mineral Conchology, and their fossil collection. *Journal of the Society for the Bibliography of Natural History* 6, 373-568.

Collins, J.H.S. & Jakobsen, S.L. 2003. New crabs (Crustacea, Decapods) from the Eocene (Ypresian/Lutetian) Lillebælt Clay Formation of Jutland, Denmark. *Bulletin of the Mizunami Fossil Museum* 30, 63-96.

Collinson, M.E., Barke, J., Burg, J. van der, Konijnenburg-van Cittert, J.H.A. van, Heilmann-Clausen, C., Howard, L.E. & Brinkhuis, H. 2010. Did a single species of Eocene *Azolla* spread from the Arctic Basin to the southern North Sea? *Review of Palaeobotany and Palynology* 159, 152-165.

Coninck, J. de 1991. Ypresian organic-walled phytoplankton in the Belgian Basin and adjacent areas. *In*: Dupuis, C., Coninck, J. de & Steurbaut, E. (eds). The Ypresian stratotype. *Bulletin de la Société belge de Géologie* 97 (1988), 287-319.

Cooper, J. 1984. A review of the London Clay (Eocene) Mollusca of the cliffs and shore of the Isle of Sheppey, Kent, England. *Tertiary Research* 6, 5-9.

Cossmann, M. & Pissarro, G. 1901. Faune éocénique du Cotentin 3.*Bulletin de la Société Géologique de Normandie* 18-20, 27-181.

Cossmann, M. & Pissarro, G. 1907-1913. *Iconographie complète des coquilles fossiles de l'Éocène des environs de Paris* 2. *Scaphopodes, gastropodes, brachiopodes, céphalopodes & supplément*. Paris (Cossmann), 20 pp., 65 pls.

Curry, D. 1965a. The English Palaeogene pteropods. *Proceedings of the Malacological Society of London* 76, 357-371.

Curry, D. 1965b. The Palaeogene beds of South-East England. *Proceedings of the Malacological Society of London* 76, 151-173.

Curry. D. & King, C. 1965. The Eocene succession at Lower Swanwick Brickyard, Hampshire. *Proceedings of the Geologists' Association* 76, 29-35.

Deshayes, G.-P. 1833. *Description des coquilles fossiles des environs de Paris* 2(30-36). Paris (Levrault), 291-429; atlas 2, pls 41-61.

Deshayes, G.-P. 1835. *Description des coquilles fossiles des environs de Paris* 3(40-45) Paris (Levrault), 495-780; atlas 2, pls 79-106.

Deshayes, G.-P. 1856. *Description des coquilles fossiles des environs de Paris* 1(1, 3, 5). Paris (Baillière), 1-80; atlas 1, pls 1-10.

Deshayes, G.-P. 1858. *Description des animaux sans vertèbres découverts dans le Bassin de Paris* 2(45-50). Paris (Baillière), 393-704; atlas 1, pls 50-87.

Deshayes, G.-P. 1860. *Description des animaux sans vertèbres découverts dans le Bassin de Paris* 1(19-20). Paris (Baillière), 705-912.

Deshayes, G.-P. 1864. *Description des animaux sans vertèbres decouverts dans le bassin de Paris* 2(39-40). Paris (Baillière), 921-968.

Deshayes, G.-P. 1865. *Description des animaux sans vertèbres decouverts dans le bassin de Paris* 3(45-50). Paris (Baillière), 201-668; atlas 2, pls 86-107.

Dinesen, A. 1965. *Boringen LB 38 på Lyngs Odde*. Copenhagen (GEUS), 83 pp. (unpublished report).

Dixon, F. 1850. *The geology and fossils of the Tertiary and Cretaceous formations of Sussex*. London (Longman, Brown, Green & Longmans), xvi + 423 pp. (descriptions of the shells by J.D.C. Sowerby).

Eldrett, J.S., Harding, I.C., Firth, J.V. & Roberts, A.P. 2004. Magnetostratigraphic calibration of Eocene-Oligocene dinoflagellate cyst biostratigraphy from the Norwegian-Greenland Sea. *Marine Micropaleontology* 204, 91-127.

Edwards, F.E. 1855-1861. A monograph of the Eocene Mollusca, or descriptions of shells from the older Tertiaries of England, 3. Prosobranchiata *Palaeontographical Society, (Monographs)*, London. 1, 123-180 (1855); 2, 181-240 (1857); 3, 241-332, (1861).

Fleming, J. 1828. *History of British animals, exhibiting the descriptive characters and systematical arrangement of the genera and species of quadrupeds, birds, reptiles, fishes, mollusca, and radiata of the united kingdom; including the indigenous, extirpated, and extinct kinds, together with periodical and occasional visitants*. Edinburgh (Bell & Bradfute) & London (J. Duncan), i-xxii, 1-565.

Foord, A.H. 1891. *Catalogue of the fossil cephalopods in the British Museum (Natural History)* 2. *Containing the remainder of the suborder Nautiloidea, consisting of the families Lituitidae, Trochoceratidae, and Nautilidae, with a supplement*. London [British Museum (Natural History)], 303 pp.

Gagel, C. 1917. Ein neuer Fossilfund im dänischen Untereocän. *Jahrbuch der Königlichen Preussischen Geologischen Landesanstalt* 37, 60-63.

Glibert, M. 1933. Monographie de la faune malacologique du Bruxellien des environs de Bruxelles. *Mémoires du Musée Royal d'Histoire Naturelle de Belgique* 53, 1-213.

Glibert, M. 1938. Faune malacologique des Sables de Wemmel, 2. Gastropodes, scaphopodes, cephalopodes. *Mémoires du Musée Royal d'Histoire Naturelle de Belgique* 85, 1-190.

Glibert, M. & Poel, L. van de 1965a. Les Bivalvia fossiles du Cénozoïque étranger des collections de l'Institut Royal des Sciences Naturelles de Belgique, 1. Palaeotaxodontida et Eutaxodontida. *Mémoires du Musée Royal d'Histoire Naturelle de Belgique*, 2(77), 1-112.

Glibert, M. & Poel, L. van de 1965b. Les Bivalvia fossiles du Cénozoïque étranger des collections de l'Institut Royal des Sciences Naturelles de Belgique, 2. Pteroconchida, Colloconchida et Isofilibranchida). *Mémoires du Musée Royal d'Histoire Naturelle de Belgique* 2(78), 1-105.

Gmelin, J.F. 1791. *Caroli a Linné Systema Naturae, Editio XIII, aucta reformata. Classis VI: Vermes* 1(6). Lipsiae (Georg Emanuel Beer), 3021-3910.

Heilmann-Clausen, C. 1978. *Undersøgelse af den fossile dinofla-*

gellatflora i 'Plastisk Ler' fra det nordlige lillebæltområde. Aarhus (Geologisk Institut, Aarhus Universitet), 99 pp. (unpublished thesis).

Heilmann-Clausen, C. 1988. The Danish Subbasin, Paleogene dinoflagellates. *In*: R. Vinken *et al.* (eds). The Northwest European Tertiary Basin. Results of the International Geological Correlation Programme Project no 124. *Geologisches Jahrbuch* A 100, 339-343.

Heilmann-Clausen, C., 2006. Koralrev og lerhav (excl. Danien). *In*: Larsen, G. (ed.). *Naturen i Danmark, Geologien.* København (Gyldendal), 181-186, 191-226.

Heilmann-Clausen, C. & Beyer, C. in prep. The Ypresian/Lutetian boundary in Denmark.

Heilmann-Clausen, C., Beyer, C. & Snowball, I. 2010. Stratigraphy and paleoenvironment of the Danish Eocene *Azolla* event. *Geophysical Research Abstracts* 12, 1 p. (EGU 2010-12095).

Heilmann-Clausen, C. & Costa, L.I. 1989. Dinoflagellate zonation of the uppermost Paleocene? to Lower Miocene in the Wursterheide research well, NW Germany. *Geologisches Jahrbuch* A 111, 431-521.

Heilmann-Clausen, C., Nielsen, O.B. & Gersner, F. 1985. Lithostratigraphy and depositional environments in the Upper Paleocene and Eocene of Denmark. *Bulletin of the Geological Society of Denmark* 33, 287–323.

Hoch, E. 1975. Amniote remains from the eastern part of the Lower Eocene North Sea Basin. *Colloque International C.N.R.S.*, Paris, no. 218, 543-562.

Heilmann-Clausen, C. & Simaeys, S. van 2005. Dinoflagellate cysts from the Middle Eocene to ?lowermost Oligocene succession in the Kysing research borehole, central Danish Basin. *Palynology* 29,143-204.

Janssen, A.W., Schnetler, K.I. & Heilmann-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.

Janssen, R. 1979. Revision der Bivalvia des Oberoligozäns (Chattium, Kasseler Meeressand). *Geologische Abhandlungen Hessen* 78, 181 pp., 4 pls.

Jeffery, P. & Tracey, S. 1997. The Early Eocene London Clay Formation mollusc fauna of the former Bursledon Brickworks, Lower Swanwick, Hampshire. *Tertiary Research* 17, 75-137.

King, C. 2006. Paleogene and Neogene: uplift and a cooling climate. *In*: Brenchley, P.J. & Rawson, P.F. (eds). *The geology of England and Wales,* 2nd edition. London (Geological Society of London), 395-427.

Lamarck, J.B. 1804. Mémoires sur les fossiles des environs de Paris 4. *Annales du Muséum d'Histoire Naturelle* 5, 237-245, 339-357.28-36, 91-98, 179-188, 237-245, 339-357.

Lamarck, J.B. 1806. Mémoires sur les fossiles des environs de Paris 6. *Annales du Muséum d'Histoire Naturelle* 7, 53-62, 130-139, 231-244, pls 5-7.

Le Renard, J. & Pacaud, J.-M. 1995. Révision des mollusques paléogénes du Bassin de Paris 2. Liste des références primaries des espèces. *Cossmanniana* 3, 65-132.

Lowry, J.W, Etheridge, R. & Edwards, F.E. 1866. *Chart of the characteristic British Tertiary fossils, stratigraphically arranged.* London (Tennant & Stanford), 4 pp.

Mantell, G. 1822. The fossils of the South Downs, or illustrations of the geology of Sussex. London (Lupton Relfe), xiv + 327 pp.

Mantell, G. 1829. A tabular arrangement of the organic remains of the County of Sussex. *Transactions of the Geological Society of London* 2(3)1, 311 pp.

Molina, E., Alegret, L., Apellaniz, E., Bernaola, G., Caballero, F., Dinarès-Turell, J., Hardenbol, J., Heilmann-Clausen, C., Larrasoaña, J.C., Luterbacher, H., Monechi, S., Ortiz, S., Orue-Etxebarria, X., Payros, A., Pujalte, V., Rodríguez-Tovar, F.J., Tori, F., Tosquella, J. & Uchman, A. 2011. The Global Stratotype Section and Point (GSSP) for the base of the Lutetian Stage at the Gorrondatxe section, Spain. *Episodes* 34, 86-108.

Mørch, O.A.L. 1874. Forsteningerne i Tertiærlagene i Danmark. *Meddelelse paa det 11te skandinaviske Naturforskermøde i Kjøbenhavn*, 274-298.

Moore, R.C. (ed.) 1960. *Treatise on invertebrate paleontology* 1. *Mollusca* 1. Lawrence, (Geological Society of America & University of Kansas), i-xxxviii, 1-952.

Moore, R.C. (ed.) 1969. *Treatise on invertebrate paleontology* 1. *Mollusca* 6, *Bivalvia.* Lawrence (Geological Society of America & University of Kansas), i-xiii, 1-351.

Morris, J. 1843. *A catalogue of British fossils; comprising all the genera and species hitherto described; with reference to their geological distributions and to the localities in which they have been found.* London (Morris), 393 pp.

Morris, J. 1854. *A catalogue of British fossils; comprising all the genera and species hitherto described; with reference to their geological distributions and to the localities in which they have been found,* 2nd edition. London (Morris), 372 pp.

Newton, R.B. 1891. *Systematic list of the Frederick E. Edwards collection of British Oligocene and Eocene Mollusca in the British Museum (Natural History).* London [British Museum (Natural History)], 365 pp.

Nuttall, C.P. & Cooper, J. 1973. A review of some English Palaeogene Nassariidae, formerly referred to *Cominella. Bulletin of the British Museum (Natural History), Geology* 23, 179–219.

Nyst, P.H. 1845. *Description des coquilles et polypiers fossiles des terrains tertiaires de la Belgique.* Bruxelles (Nyst). 675 pp.

Orbigny, A. d' 1850. Prodrome de paléontologie stratigraphique universelle des animaux mollusques et rayonnées, faisant suite au cours élémentaire de paléontologie et de géologie stratigraphiques 2. Paris (Masson), 428 pp.

Orue-Extebarria, X., Payros, A., Bernaola, G., Dinares-Turell, J., Tosquella, J., Apellaniz, E. & Caballero, F., 2006. A field guide to the Ypresian/Lutetian boundary at the Gorrondatxe beach section (Basque Country, W Pyrenees). *Mid-conference excursion guidebook of the International Meeting on Climate and Biota of the Early Paleogene University of the Basque Country, Bilbao, Spain,* 1-15.

Pacaud J.-M. 2007. Nouveautés nomenclaturales et taxinomiques introduites par Alcide d'Orbigny dans le Prodrome (1850, 1852) pour les espèces du Paléocène et de l'Éocène. *Geodiversitas* 29, 17-85.

Pacaud, J.-M. & Marcomini, J.-L. 1994. Présence d'*Atrina affinis* (Sowerby, 1821) (Mollusca: Bivalvia: Pinnidae), espèce de l'Eocène anglais, dans l'Auversien du Bassin de Paris. *Cossmanniana* 3, 41-44.

Prestwich, J. 1854. On the thickness of the London Clay; on the relative position of the fossiliferous beds of Sheppey, Highgate, Harwich, Newnham, Bognor, &c, and on the probable occurrence of the Bagshot Sands in the Isle of Sheppey. *The Quarterly Journal of the Geological Society of London* 1, 401-419.

Ravn, J.P.J. 1907. Molluskfaunaen i Jyllands Tertiæraflejringer.

Det Kongelige Danske Videnskabernes Selskabs Skrifter 3, 217-384.

Ravn, J.P.J. 1928. Tertiær. *In*: Nordmann, V. (ed.). Oversigt over Danmarks Geologi. *Danmarks Geologiske Undersøgelse* 4, 64 pp.

Reid, D.G., Ryal, P., Lozouet, P., Glaubrecht, M. & Williams, S.T. 2008. Mudwhelks and mangroves: the evolutionary history of an ecological association (Gastropoda: Potamididae). *Molecular Phylogenetics and Evolution* 47, 680-699.

Saul, L.R., & Squires, R.L. 2008. Volutiderminae (Gastropoda: Volutidae) of Coniacian throught Maastrichtian age from the North American Pacific slope. *Journal of Paleontology* 82, 213–237.

Schnetler, K. I. 1985. Two new Upper Oligocene gastropods from the North Sea Basin. *Bulletin of the Geological Society of Denmark* 34, 199-204.

Schwarzhans, W. 2007. Otoliths from casts from the Eocene Lillebælt Clay Formation of Trelde Næs near Fredericia (Denmark), with remarks on the diet of stomatopods. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* 246/1, 69-81.

Solander, D.C. *in* Brander, G., see Brander.

Sowerby, J. 1812-1822. *The mineral conchology of Great Britain; or coloured figures and descriptions of those remains of testaceous animals or shells, which have been preserved at various times and depths in the earth* 1-4. London (Sowerby), 1(1-18), 1-214, pls 1-102, 1812-1815; 2(19-35), 1-239, pls 103-203, 1815-1818; 3(36-53), 1-186, pls 204-306, 1818-1821; 4(54-65), 1-14, pls 307-377, 1821-1822 (dates of publication of the various issues, cited according to Cleevely, 1974).

Sowerby, J.D.C. 1822-1846. *The mineral conchology of Great Britain; or coloured figures and descriptions of those remains of testaceous animals or shells, which have been preserved at various times and depths in the earth* 4-7. London (Sowerby), 4(66-70), 105-151, pls 378-407, 1822-1823; 5(71-96), 1-171, pls 408-503, 1823-1825; 6(87-105), 1-239, pls 504-609, 1826-1829; 7(106-113), 1-80, pls 610-648, 1840-1846 (dates of publication of the various issues, cited according to Cleevely, 1974).

Thiede, J., Nielsen, O.B. & Perch-Nielsen, K. 1980. Lithofacies, mineralogy and biostratigraphy of Eocene sediments in northern Denmark (Deep Test Viborg 1). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* 160, 149-172.

Thomsen, E., Abrahamsen, N., Heilmann-Clausen, C., King, C. & Nielsen, O.B. in press. Middle Eocene to Early Oligocene development in the eastern North Sea Basin: biostratigraphy, magnetostratigraphy and paleoenvironment of the Kysing-4 borehole, Denmark. *Palaeogeography, Palaeoclimatology, Palaeoecology.*

Tracey, S. 1992. A review of the Early Eocene molluscs of Bognor Regis (Hampshire Basin), England. *Tertiary Research* 13, 155-175.

Tracey, S. & Todd, J. A. 1996. Nomenclatural changes for some Bracklesham Group gastropods. *Tertiary Research*, 16, 41-54.

Tracey, S., Todd, J.A., Le Renard, J., King, C. & Goodchild, M.1996. Distribution of Mollusca in units S1 to S9 of the Selsey Formation (middle Lutetian), Selsey Peninsula, West Sussex. *Tertiary Research* 16, 97-139.

Vincent, G. 1893. Note préliminaire sur les *Avicula*. Contribution à la paléontologie des terrains éocénes de la Belgique. *Société Royale Malacologique de Belgique, Bulletin des Séances 1893*, lxiii-lxxiv.

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(1880), 100-103.

Wood, S.V. 1861-1871. A monograph of the Eocene Mollusca, or, descriptions of shells from the older Tertiaries of England. 1(1-3). Bivalves. *Palaeontographical Society (Monographs)*, 1-182.

Wrigley, A. 1925. Notes on English Eocene Mollusca, with descriptions of new species. *Proceedings of the Malacological Society* 16, 232-248.

Wrigley, A. 1927. Notes on English Eocene Mollusca, with descriptions of new species 2. The Fusinidae. *Proceedings of the Malacological Society* 17, 216-249.

Wrigley, A. 1929. Notes on English Eocene Mollusca, with descriptions of new species 3. *Ficus*. *Proceedings of the Malacological Society* 18, 235-251.

Wrigley, A. 1934. English Eocene and Oligocene Cassididae, with notes on the nomenclature and morphology of the family. *Proceedings of the Malacological Society* 21, 108-130.

Wrigley, A. 1935. English Eocene and Oligocene Cancellariidae. *Proceedings of the Malacological Society* 21, 356-381.

Wrigley, A. 1938. English Eocene and Oligocene Strombidae and Aporrhaidae. *Proceedings of the Malacological Society* 23, 61-88.

Wrigley, A. 1940. Some Eocene Mollusca, with descriptions of new species. *Proceedings of the Malacological Society* 24, 6-18.

Wrigley, A. 1946. English Oligocene and Eocene Ampullinids. *Proceedings of the Malacological Society* 27, 88-104.

Wrigley, A. 1948. English Eocene and Oligocene Naticidae. *Proceedings of the Malacological Society* 28, 10-30.

Wrigley, A. 1949. The London Clay at Lower Swanwick, Hampshire. Appendix, 13-19. *In*: Thomas, H.D. & Davies, A.G. (eds). The Prosobranch *Rhabdopleura* in the English Eocene. *Bulletin of the British Museum (Natural History) (Geology)* 1, 1-29.

Plate 1.

1a-b. *Nucula (Lamellinucula) minor* Deshayes, 1860. a) internal mould of right valve, b) silicone latex cast of same specimen, external view. MGUH 29708, ex OBK 736. Length 14.8 mm.

2. *Leionucula proava* (Wood, 1864). Silicone latex cast of right valve, internal view. MGUH 29709, ex OBK 411. Length 8.5 mm.

3. *Leionucula proava* (Wood, 1864). Silicone latex cast of fragmentary double-valved specimen, external view of left valve. MGUH 29710, ex MMF. Estimated length when complete 8.0 mm.

4. *Nuculana amygdaloides* (J.D.C. Sowerby, 1821). Silicone latex cast, internal view. MGUH 29711, ex ISL. Length 23.5 mm.

5. *Nuculana amygdaloides* (J.D.C. Sowerby, 1821). Concretion, internal view. MGUH 29712, ex OBK 477. Length 21.9 mm.

6. *Nuculana amygdaloides* (J.D.C. Sowerby, 1821). Silicone latex cast, external view. MGUH 29713, ex OBK 415. Length 9.9 mm.

7. *Yoldiella galeottiana* (Nyst, 1844). 2001/7. Silicone latex cast of double-valved specimen, external view. MGUH 29714, ex GPF. Estimated length when complete 5.0 mm.

8. *Yoldiella minima* (J. Sowerby, 1818). Silicone latex cast of right valve, internal view. MGUH 29715, ex OBK 1355. Length 4.8 mm.

9a-b. *Yoldiella minima* (J. Sowerby, 1818). Silicone latex cast, a) external, b) internal view of right valve. MGUH 29716, ex OBK 435. Length 5.0 mm.

10. *Yoldiella oblata* (Wood, 1864). Silicone latex cast of right valve, internal view. MGUH 29717, ex OBK 1077. Length 4.7 mm.

11. *Yoldiella oblata* (Wood, 1864). Silicone latex cast, internal mould of right valve. MGUH 29718, ex MMF. Length 5.5 mm.

12. *Limopsis (Pectunculina)* cf. *scalaris* (J.D.C. Sowerby, 1824). Concretion, internal mould of left valve. MGUH 29719, ex OBK 1060. Length 2.9 mm.

13. *Modiolus undulatus* (Wood), 1864. Silicone latex cast of right valve, external view. MGUH 29720, ex OBK 1003. Length 27.0 mm.

14. *Atrina affinis* (J. Sowerby, 1821). Concretion, internal mould with part of the ornament preserved, external view. MGUH 29721, ex OBK. Length 115 mm.

15. *Pteria* cf. *papyracea* (J.D.C. Sowerby, 1837). Silicone latex cast of right valve, external view. MGUH 29722, ex OBK 914. Length 20.0 mm.

16. *Aviculoperna* cf. *limaeformis* (Vincent, 1893). Silicone latex cast, external view of two specimens. MGUH 29723, original in MTF. Length 23.0 mm.

17. ?*Propeamussium* sp. Slab of clay with shell partly preserved, external view. MGUH 29724, ex CHC 133. Length 4.8 mm.

18. ?*Propeamussium* sp. Silicone latex cast, internal view. MGHU 29725, ex JTH. Length 4.7 mm.

19. *Ostrea* sp. Silicone latex cast, external view. MGUH 29726, ex OBK 1099. Length 7.9 mm.

20. Lucinidae sp. 1. Pyritized internal mould. MGUH 29727, ex OBK 720a. Length 13.8 mm.

21. Lucinidae sp. 2. Pyritized internal mould. MGUH 29728, ex OBK 720b. Length 16.1 mm.

22. *Thyasira (Thyasira) goodhalli* (J.D.C. Sowerby, 1837). Silicone latex cast of right valve, external view. MGUH 29729, ex OBK 522. Length 5.9 mm.

23. *Chama* cf. *squamosa* Solander *in* Brander, 1766. Concretion, internal mould. MGUH 29730, ex OBK 1307. Length 25.0 mm.

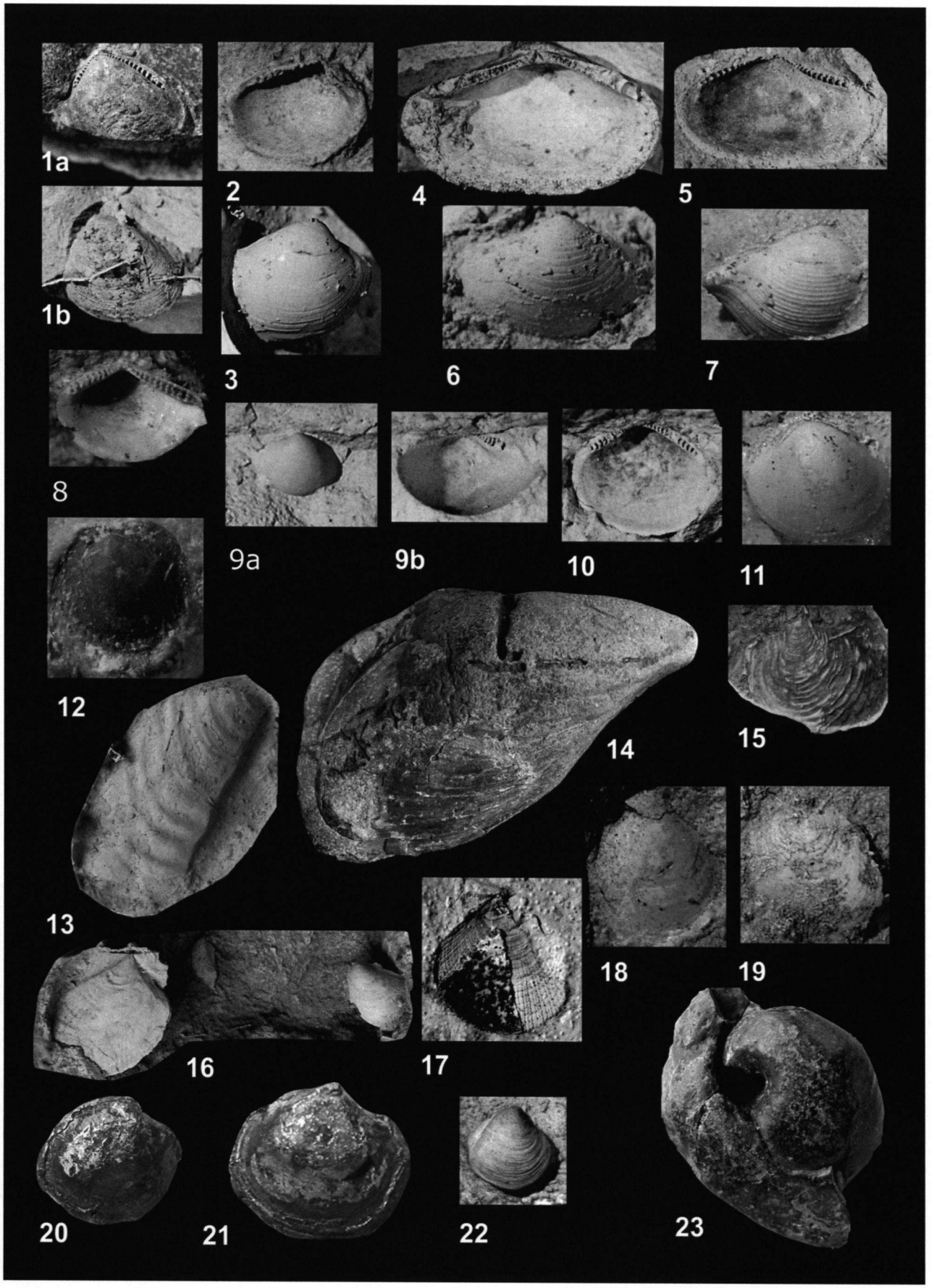

Plate 1.

Plate 2.

1. *Cyclocardia subelegans* (Wood, 1871). Silicone latex cast, internal view. MGUH 29731, ex OBK 428. Length 9 mm.
2. *Cyclocardia subelegans* (Wood, 1871). Silicone latex cast, internal view. MGUH 29732, ex OBK 3. Length 9.2 mm.
3. *Astarte filigera treldensis* n. subsp. Silicone latex cast, external view. Paratype, MGUH 29733, ex OBK 415. Length 12.9 mm.
4. *Astarte filigera treldensis* n. subsp. Silicone latex cast, hinge area. Paratype, MGUH 29734, ex OBK 102. Length 13.8 mm.
5. *Astarte filigera treldensis* n. subsp. Silicone latex cast, internal view. Holotype, MGUH 29735, ex OBK 505. Length 15.0 mm.
6. *Crassatella* cf. *sulcata* (Solander *in* Brander, 1766). Concretion, internal mould. MGUH 29736, ex OBK 651. Length 42.0 mm.
7. *Abra madseni* n. sp. Silicone latex cast, internal view. Holotype, MGUH 29737, ex OBK 528. Length 13.9 mm.
8. *Abra madseni* n. sp. Silicone latex cast, external view. Paratype, MGUH 29738, ex OBK 1062. Length 10.0 mm.

9a-b. *Macrocallista* sp. Silicone latex cast, a) hinge area, b) external view. MGUH 29739, ex OBK 272. Estimated length when complete 13 mm.

10. *Pelecyora* sp. Concretion, internal mould. MGUH 29740, ex OBK 281. Length 41 mm.

11a-b. *Pholadomya (Pholadomya) virgulosa* J.D.C. Sowerby, 1844. Concretion, a) external view of right valve, b) umbonal view. MGUH 29741, ex OBK 201. Length 63.5 mm.

12a-c. *Thracia (Thracia) barsoei* n. sp. Silicone latex cast, a) external view of left valve, b) external of right valve, c) umbonal view. Holotype MGUH 29742, ex OBK 458. Length 29 mm.

13a-c. *Cardiomya triradiata* (Wrigley, 1940). Silicone latex cast, a) external view of left valve, b) umbonal view, c) external view of right valve. MGUH 29743, ex OBK 384. Length 9.0 mm.

14a-b. *Cuspidaria inflata* (J.D.C. Sowerby, 1827). Silicone latex cast, a) external view of left valve, b) umbonal view. MGUH 29744, ex OBK 248. Length 41 mm.

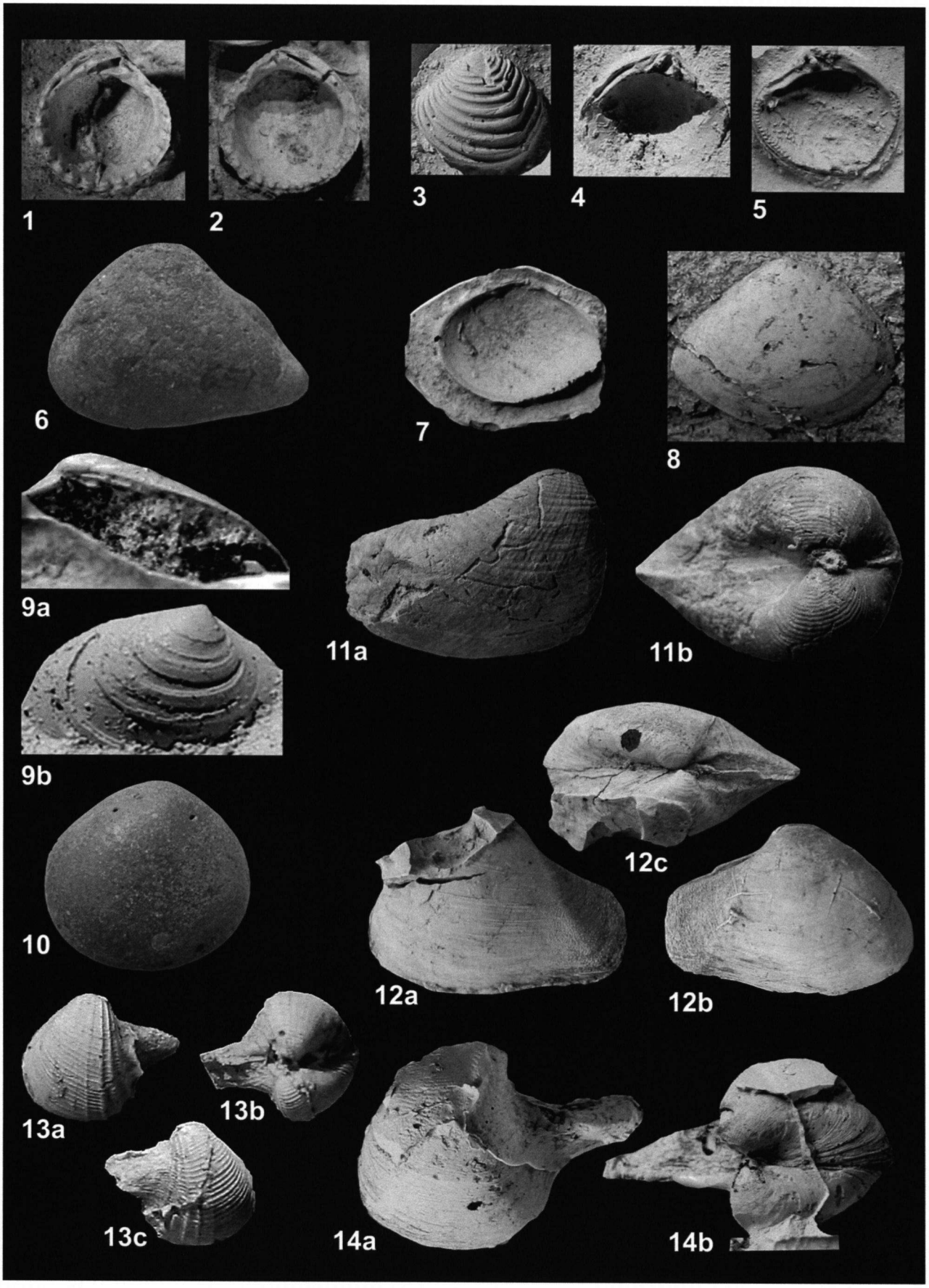

Plate 2.

Plate 3.

1. Teredinidae, gen. et sp. indet. Silicone latex cast of right valve. MGUH 29745, ex MMF. Length 4.7 mm.
2. Teredinidae, gen. et sp. indet. Concretion. MGUH 29746, ex ISL. Length 83 mm.
3. Dentaliidae indet. MGUH 29747, ex OBK 1540. Silicone latex cast. Length 2.4 mm, diameter 1.1 mm.
4. *Periaulax spirata* (Lamarck, 1804). Silicone latex cast, dorsal view. MGUH 29748, ex OBK 1134. Height 6.6 mm.
5. *Periaulax spirata* (Lamarck, 1804). Silicone latex cast, apical view. MGUH 29749, ex ISL. Diameter 6.5 mm.
6. *Periaulax spirata* (Lamarck, 1804). Silicone latex cast, umbilical view. MGUH 29748, ex OBK 1134. Diameter 5.4 mm.

7a-b. *Potamides (Eotympanotonus)* sp. Silicone latex cast, a) apertural, b) dorsal view. MGUH 29750, ex ISL. Height 12.3 mm., estimated height when complete 22 mm.

8. *Orthochetus charlesworthi* Wrigley, 1940. Silicone latex cast, lateral view. MGUH 29751, ex Coll. SPAF. Height 20.5 mm.
9. *Cerithiopsis* sp. MGUH 29753, ex OBK 576. Silicone latex cast, middle whorls. Height of fragment 3.5 mm.
10. ?*Cerithiella* sp. MGUH 29752, ex OBK 1171. Silicone latex cast, middle whorls. Height of fragment 11.7 mm.
11. *Foratiscala* sp. aff. *newtoni* de Boury, 1890. Silicone latex cast, middle whorls. MGUH 29754, ex OBK 237. Height 15 mm.
12. Scalidae gen. et sp. indet. Concretion, internal view of middle whorls. MGUH 29755, ex OBK 1001. Height 10 mm.
13. *Littoriniscala scalarioides* (J.D.C. Sowerby *in* Dixon, 1850). Pyritized internal mould. MGUH 29756, ex CHC 102. Height 15.4 mm.
14. *Tenuiscala* sp. Silicone latex cast, dorsal view. MGUH 29757, ex OBK 1609. Height 16.3 mm.
15. *Aporrhais sowerbii* (Fleming, 1828). Silicone latex cast, dorsal view. MGUH 29758, ex MMF 21. Height 10.5 mm.
16. *Tibia sublucida* (Edwards *in* Lowry *et al*, 1866). Silicone latex cast, apertural view. MGUH 29759, ex GPF. Height 30 mm.
17. *Tibia* sp. 1. Silicone latex cast, apertural view. MGUH 29760, ex OBK 871. Height 22 mm.

18a-b. *Tibia* sp. 2. Silicone latex cast, a) dorsal, b) apertural view. MGUH 29761, ex OBK 1514. 4.0 mm.

19a-b. *Tibia* sp. 1. Silicone latex cast, a) apertural, b) dorsal view. MGUH 29762, ex OBK 228. Height 27.0 mm.

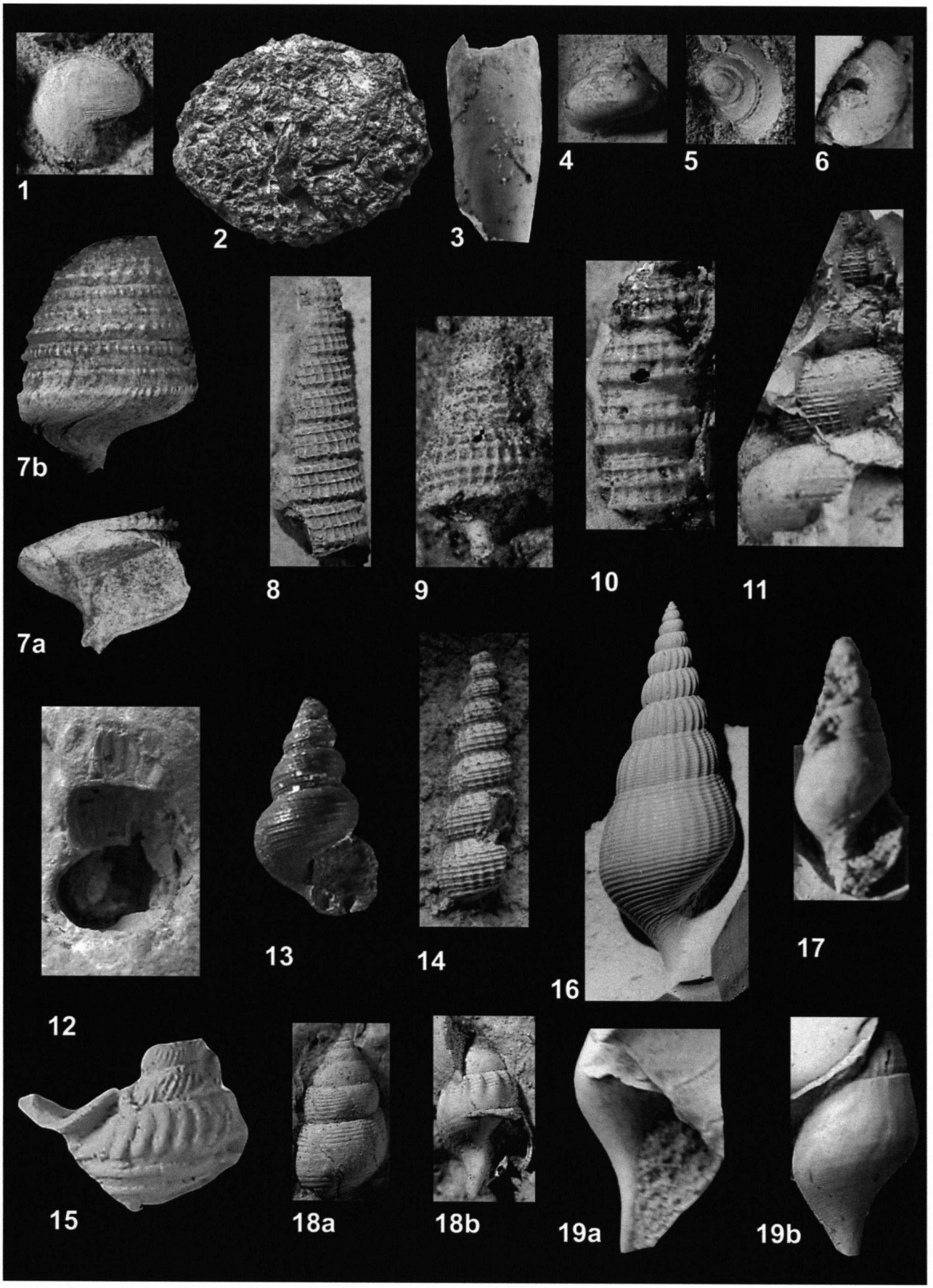

Plate 3.

Plate 4.

1a-c. *Xenophora schroeteri* (Gmelin, 1791). a) apical, b) umbilical, c) apertural view. Pyritized internal mould. MGUH 29763, ex OBK 1275. Height 19 mm.

2a-b. *Eocypraea* cf. *oviformis* (J. Sowerby, 1812). a) apertural, b) dorsal view. Pyritized internal mould. MGUH 29764, ex CHC E 60. Height 24 mm.

3a-d. *Eocypraea* cf. *oviformis* (J. Sowerby, 1812). a) apertural, b) dorsal, c) umbilical, d) apical view. Concretion. MGUH 29765, ex CHC E 60. Height 46 mm.

4. *Globularia* cf. *patuloides* (Cossmann & Pissarro, 1902). Pyritized internal mould, apertural view. MGUH 29766, ex CHC E 104. Height 26 mm.

5. *Euspira* cf. *glaucinoides* (J. Sowerby, 1812). Pyritized internal mould, apertural view. MGUH 29767, ex CHC E 112. Height 9.0 mm.

6. Naticidae indet. Pyritized internal mould with remnants of the shell, apertural view. MGUH 29768, ex SPAF. Height 28.7 mm.

7. *Sinum clathratum* (Gmelin, 1791). Silicone latex cast, dorsal view. MGUH 29769, ex OBK 1157. Height 6.7 mm.

8. *Galeodea anderseni* n. sp. Silicone latex cast, apertural view. Holotype, MGUH 29770, ex GPF. Height 44.0 mm.

9. *Galeodea anderseni* n. sp. Silicone latex cast, dorsal view. Paratype, MGUH 29771, ex GPF. Height 41.7 mm.

10. *Galeodea anderseni* n. sp. Silicone latex cast, lateral view. Paratype, MGUH 29772, ex GPF. Height 36.7 mm.

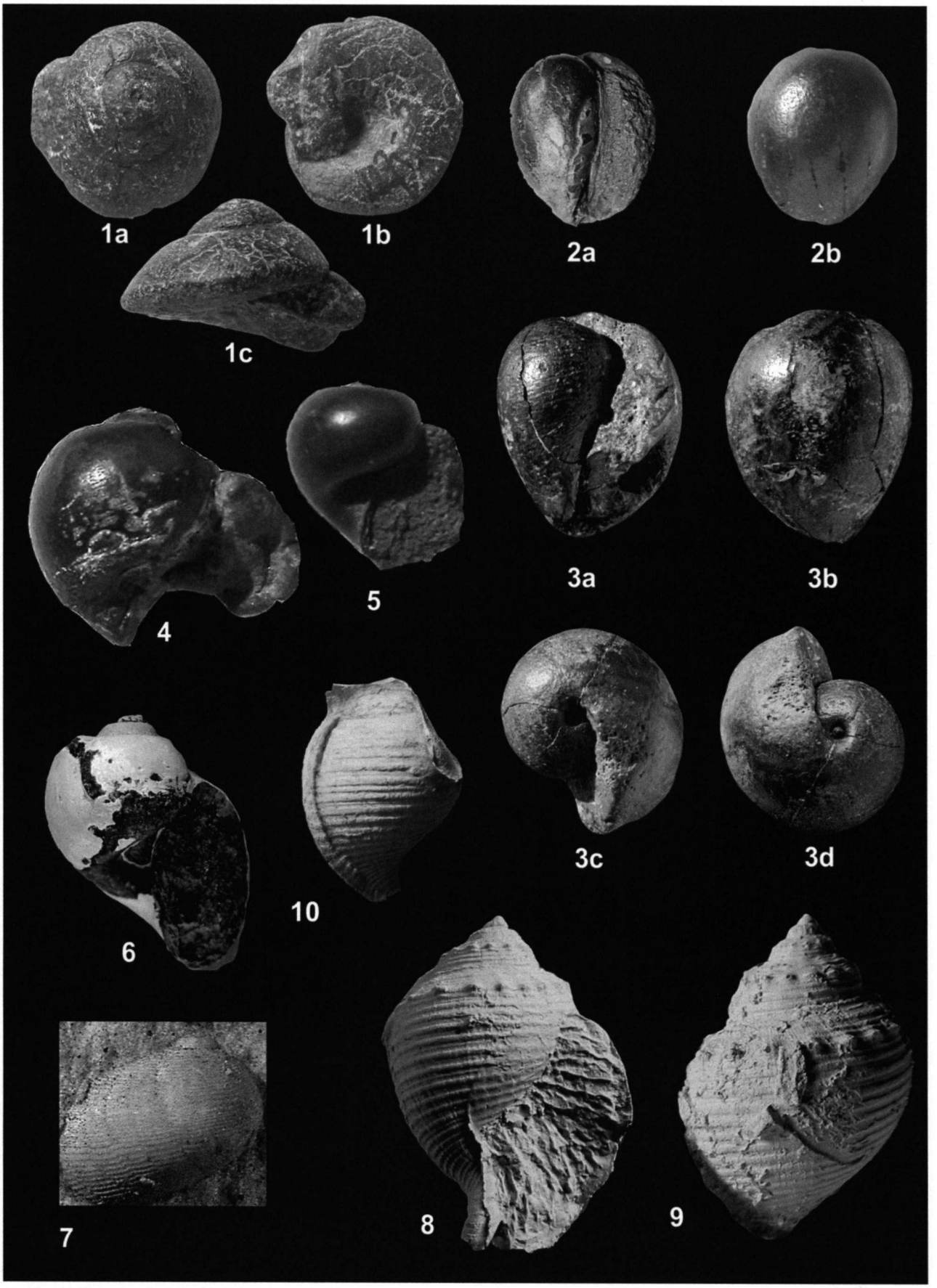

Plate 4.

Plate 5.

1. *Priscoficus* cf. *eocenica* (Wrigley, 1929). Concretion with internal mould, dorsal view. MGUH 29773, ex OBK 1571. Estimated height when complete 63 mm.

2a-b. *Priscoficus* cf. *eocenica* (Wrigley, 1929). a) middle whorls, b) apical shell part. Silicone latex casts of external mould. MGUH 29774, ex OBK 1571.

3. *Priscoficus* cf. *eocenica* (Wrigley, 1929). Silicone latex cast, apertural view. MGUH 29775, ex OBK 601. Height 63 mm.
4. *Mambrinia* cf. *nodosa* (Solander *in* Brander, 1766). Pyritized internal mould. MGUH 29776, ex OBK 734. Height 27 mm.
5. *Fulgoroficus* cf. *multiformis* (Wrigley, 1929). Silicone latex cast, lateral view. MGUH 29777, ex MMF 3. Height 6.3 mm.
6. *Fulgoroficus* cf. *multiformis* (Wrigley, 1929). Silicone latex cast, apertural view. MGUH 29778, ex MMF 4. Height 9.0 mm.
7. *Priscoficus* cf. *eocenica* (Wrigley, 1929). Silicone latex cast, dorsal view. MGUH 29779, ex OBK 71. Height 14.1 mm.
8. *Eocantharus morrisii* (Edwards *in* Lowry, 1866). Silicone latex cast of two specimens, lateral and apertural views. MGUH 29780, ex OBK 1158. Height of largest specimen 10.8 mm.
9. *Fusinus unicarinatus* (Deshayes, 1835). Silicone latex cast, apical shell part. MGUH 29781, ex OBK 146. Height 20 mm, estimated height when complete 30 mm.
10. *Desorinassa jutensis* n. sp. Silicone latex cast, apertural view. Paratype, MGUH 29782, ex OBK 1276. Height 5.6 mm.
11. *Eocantharus morrisii* (Edwards *in* Lowry, 1866). Silicone latex cast, dorsal view. MGUH 29783, ex OBK 462. Height 11.5 mm.
12. *Desorinassa jutensis* n. sp. Silicone latex cast, apertural view. Holotype, MGUH 29784, ex OBK 1521. Height 8.9 mm.
13. *Clavilithes* cf. *intermedius* Wrigley, 1927. Silicone latex cast, apertural view. MGUH 29785, ex CHC. Height 75 mm.

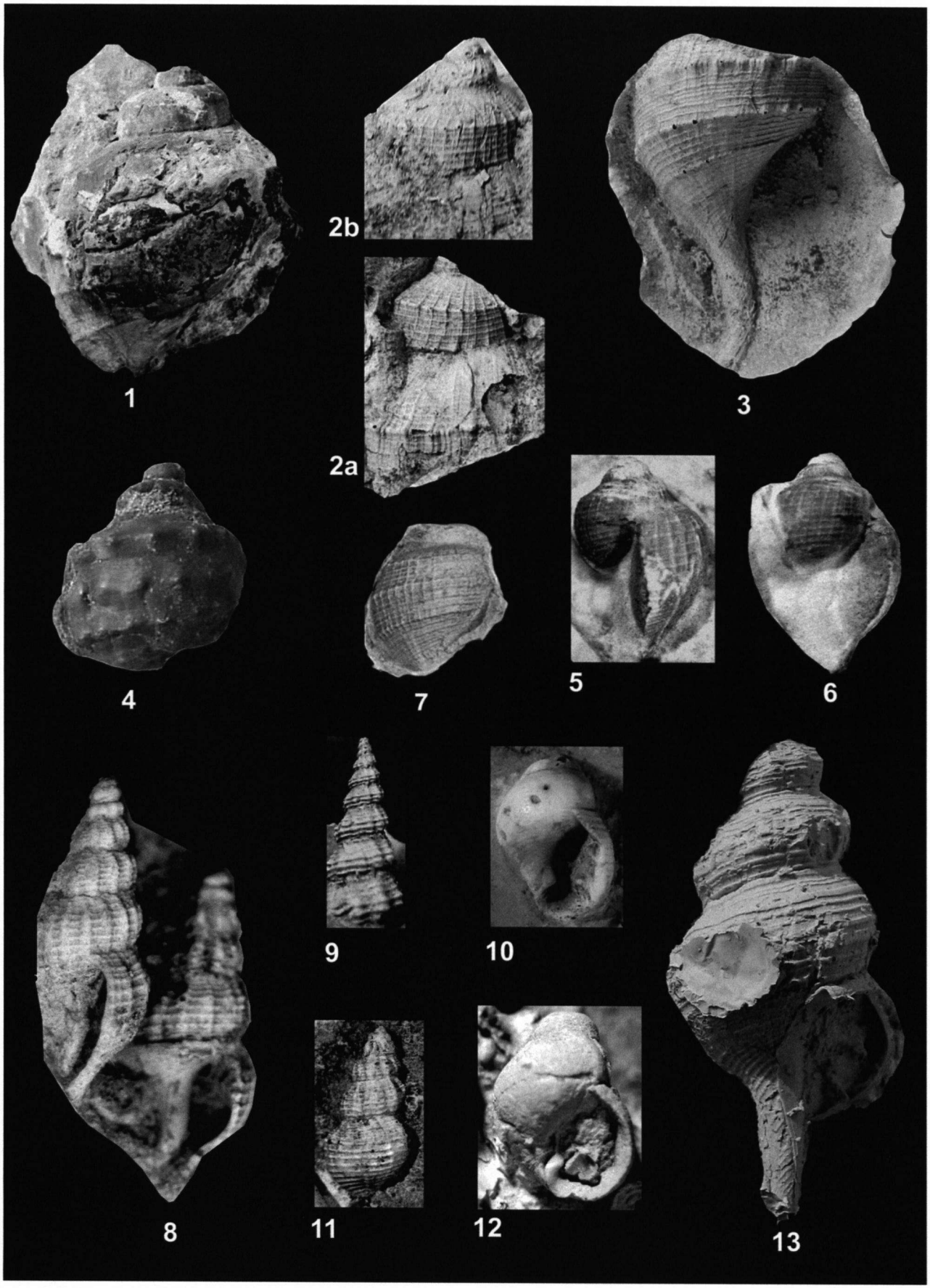

Plate 5.

Plate 6.

1. *Daphnobela juncea* (Solander *in* Brander, 1766). Silicone latex cast, oblique apertural view. MGUH 29786, ex OBK 391. Height 15.6 mm.
2. *Daphnobela juncea* (Solander *in* Brander, 1766). Silicone latex cast, dorsal view. MGUH 29787, ex GPF. Height 9.5 mm.
3. *Volutocorbis* cf. *ambigua* (Solander *in* Brander, 1766). Silicone latex cast, apertural view. MGUH 29788, ex GPF. Height 43 mm.
4. *Volutocorbis* cf. *ambigua* (Solander *in* Brander, 1766). Silicone latex cast, oblique apertural view. MGUH 29789, ex GPF. Height 25 mm.
5. Volutidae indet. Silicone latex cast, dorsal view. MGUH 29790, ex OBK 224. Height 10.4 mm.
6. *Hemiconus* sp. Pyritized internal mould, apertural view. MGUH 29791, ex CHC. Height 17.6 mm.

7a-b. *Bathytoma turbida* (Solander *in* Brander, 1766). Silicone latex cast, a) oblique apertural, b) lateral view. MGUH 29792, ex ISL. Estimated height when complete 34 mm.

8. *Orthosurcula crassa* (Edwards, 1857). Silicone latex cast, apertural view. MGUH 29793, ex OBK 1287. Estimated height when complete 65 mm.
9. *Orthosurcula planetica* (Edwards, 1857). Silicone latex cast, apertural view. MGUH 29794, ex OBK 482. Height of fragment 12 mm.
10. *Orthosurcula* sp. Pyritized internal mould with parts of the shell preserved, dorsal view. MGUH 29795, ex MTF. Height 22.1 mm.
11. *Orthosurcula* cf. *teretrium crebrilinea* (Edwards, 1857). Pyritized internal mould, apertural view. MGUH 29796, ex SPAF. Height 24.5 mm.
12. *Orthosurcula* cf. *teretrium crebrilinea* (Edwards, 1857). Silicone latex cast, dorsal view. MGUH 29797, ex MMF. Height 16.6 mm.

13a-b. *Cancellaria (Merica) evulsa* (Solander *in* Brander, 1766). Silicone latex cast, a) apertural, b) lateral view. MGUH 29798, ex GPF. Estimated height when complete 28 mm.

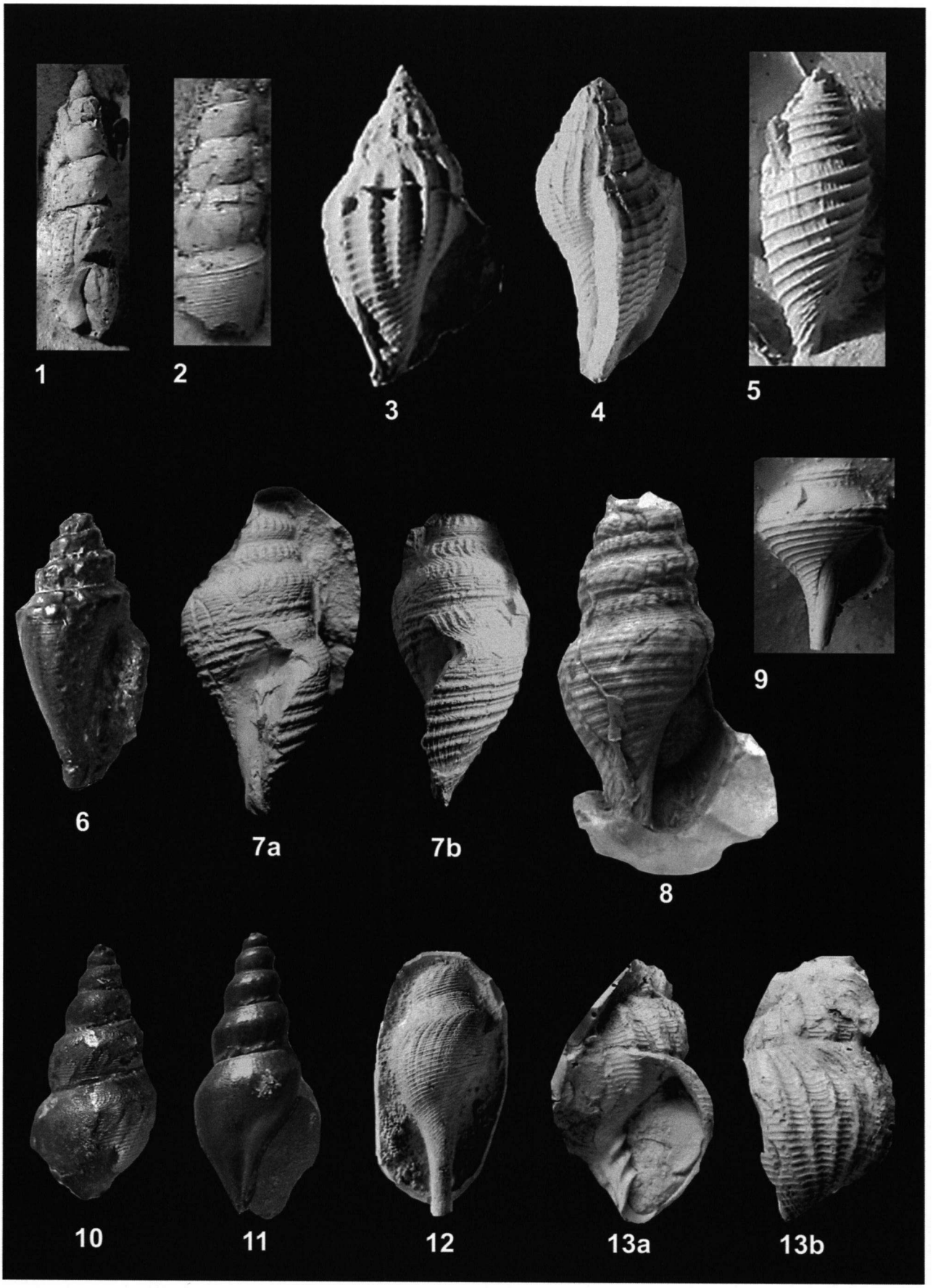

Plate 6.

Plate 7.

1. *Mathilda* sp. Silicone latex cast, apertural shell part, dorsal view. MGUH 29798, ex ISL. Height of fragment 5.1 mm.
2. *Turbonilla* sp. Silicone latex cast, dorsal view. MGUH 29799, ex GPF. Height 2.7 mm.
3. *Tornatellaea simulata* (Solander *in* Brander, 1766). Silicone latex cast, dorsal view. MGUH 29800, ex OBK 293. Height 3.4 mm.
4. *Tornatellaea simulata* (Solander *in* Brander, 1766). Silicone latex cast, apertural view. MGUH 29801, ex GPF. Height 4.1 mm.

5a-b. *Tornatellaea simulata* (Solander *in* Brander, 1766). Pyritized internal mould with parts of the shell preserved, a) apertural, b) dorsal view. MGUH 29802, ex SPAF. Height 18 mm.

6. *Heliconoides lillebaeltensis* A.W. Janssen *in* Janssen *et al.*, 2007. Silicone latex cast. Holotype and 13 paratypes. Length of cast 10.5 mm. MGUH 28735, ex OBK 229.
7. *Heliconoides lillebaeltensis* A.W. Janssen *in* Janssen *et al.*, 2007. Silicone latex cast, apertural view. Holotype, MGUH 28735, ex OBK 229. Height 2.1 mm.
8. *Heliconoides mercinensis* (Watelet & Lefèvre, 1885). Silicone latex cast, apical view. MGUH 28738, ex OBK 868. Diameter 2.1 mm.
9. *Limacina pygmaea* (Lamarck, 1804). Silicone latex cast, apertural view. MGUH 28739, ex OBK 1072. Height 1.0 mm.
10. *Creseis* sp. CHC. Slab of clay, specimen with shell partly preserved. MGUH 29803, ex CHC. Height of specimen 4.9 mm.
11. *Creseis* sp. MGUH 29804, ex CHC. Slab of clay with *c.* 15 specimens. Width of slab 19 mm.
12. *Creseis* sp. Slab of clay, specimen with shell partly preserved. MGUH 29805, ex CHC. Height of specimen 4.9 mm.
13. *Cimomia imperialis* (J. Sowerby, 1812). Concretion. MGUH 29806, ex OBK 1581. Fragmentary specimen, length 77 mm.
14. *Cimomia imperialis* (J. Sowerby, 1812). Concretion, apertural view of fragmentary specimen. MGUH 29807, ex OBK. Width 85 mm.
15. *Aturia ziczac* (J. Sowerby, 1812). Pyritized internal mould, lateral view. GPF. Height 35 mm.

16a-c. *Eocypraea* cf. *oviformis* (J. Sowerby, 1812). a) apertural, b) dorsal, c) apical view. SSV. Height 39.7 mm.

17a-b. *Xenophora schroeteri* (Gmelin, 1791). Concretion. a) apical view; b) attached tube of serpulid. SSV. Diameter 37.3 mm., length of serpulid 4.5 mm.

(Figures 6-9 after Janssen *et al.*, 2007)

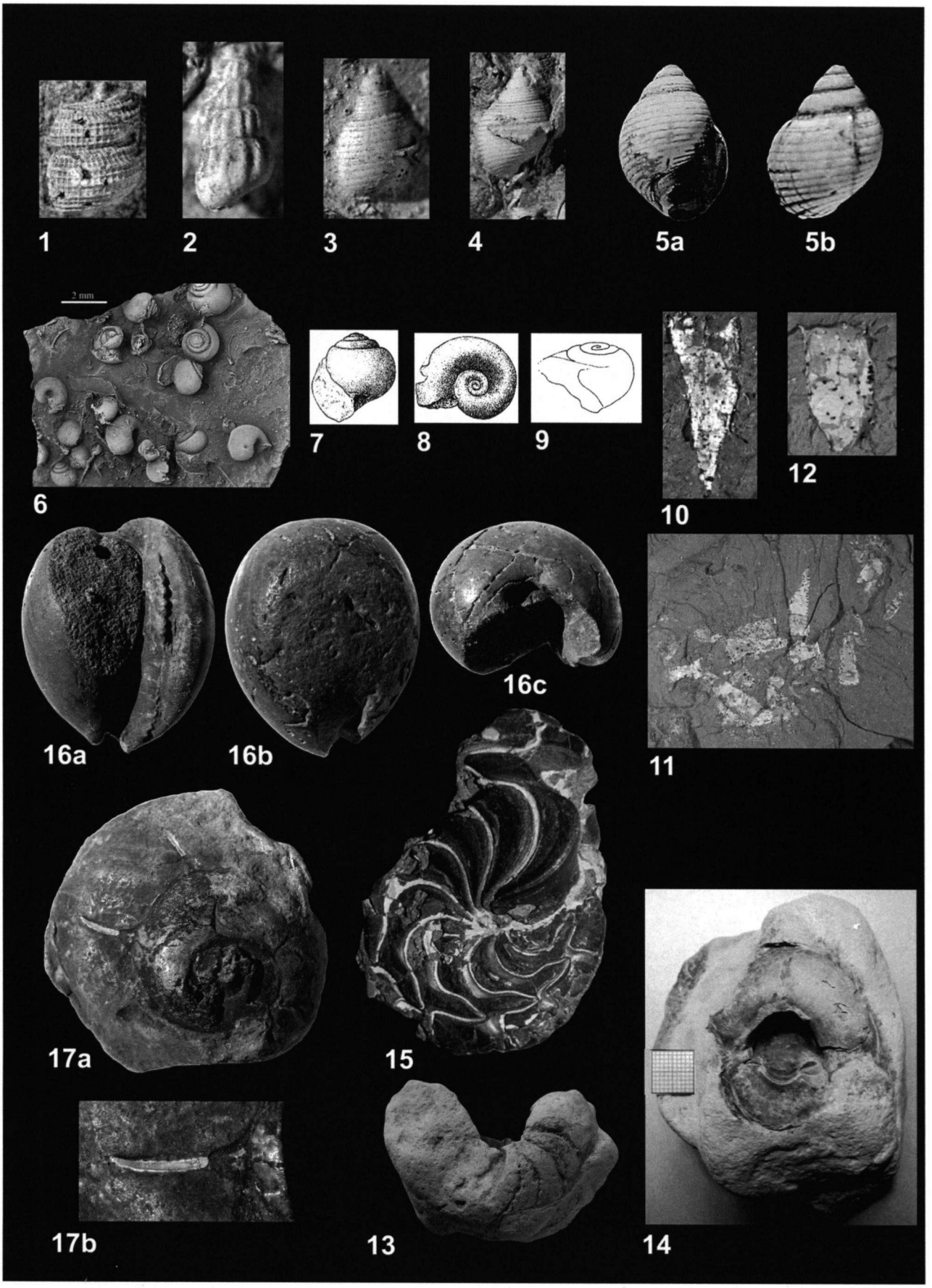

Plate 7.