Revision of the gastropod family Pseudolividae from the Paleocene of West Greenland and Denmark

JEAN-MICHEL PACAUD & KAI INGEMANN SCHNETLER

Pacaud, J.-M. & Schnetler, K. I. 1999–12–20: Revision of the gastropod family Pseudolividae from the Paleocene of West Greenland and Denmark. *Bulletin of the Geological Society of Denmark*, Vol. 46, pp. 53–67. Copenhagen.

The Paleocene deposits on the Nuussuaq peninsula (West Greenland) contain three new species belonging to the family Pseudolividae de Gregorio, 1880. *Popenoeum lacunosum* sp. nov., *Pseudoliva praetermissa* sp. nov. and *Fusulculus nanapullus* sp. nov. are described. The species *Fusulculus koeneni* (Ravn, 1939) from the Paleocene (Selandian) of Denmark is revised, a lectotype is designated and new figures are published. *Pseudoliva (Fusopsis) canalifera* Ravn, 1939 is excluded from the Pseudolividae and *Fusopsis* is considered to be a subjective junior synonym of *Suessionia* Cossmann, 1889, and therefore reassigned to the family Buccinidae Rafinesque, 1815.

Key words: Gastropods, Pseudolividae, new species, Paleocene, West Greenland, Denmark.

J.-M. Pacaud, Laboratoire de Paleontologie, Muséum National d'Histoire Naturelle, 8 rue de Buffon, F- 75005 Paris, France. K.I. Schnetler, Fuglebakken 14, Stevnstrup, DK-8870 Langå, Denmark. *12 October 1998.*

The fossil representatives of the family Pseudolividae de Gregorio, 1880 have recently been the subject of several studies in France (Villatte 1970, Pacaud 1998), the United States of America (Zinsmeister 1983; Squires 1989; Squires, Zinsmeister & Paredes-Mejía 1989; Vermeij & De Vries 1997) and Japan (Kase 1990). These studies have prompted an increasing interest in this family. During a revision of Pseudolividae taxa from the Cretaceous to the Paleocene, one of us (Pacaud 1998) has restudied material of the genus *Pseudoliva* from Nuussuaq (West Greenland), housed in the Geological Museum of Copenhagen; three new species are described.

The recognition of new species of the family Pseudolividae from the Paleocene of Greenland has required revision of the species *Pseudoliva koeneni* Ravn, 1939 and *Pseudoliva (Fusopsis) canalifera* Ravn, 1939 from the Selandian (Paleocene) of Denmark. *Pseudoliva* sp. from the Danian of Sweden is only represented by an internal mould.

Geological setting and stratigraphy

The geological setting of the West Greenland continental margin has recently been described by Dam & Sønderholm (1994) and Nøhr-Hansen & Dam (1997). This margin was developed during the late Mesozoic to early Cenozoic in connection with the opening of the Labrador Sea; a complex of linked basins extended from the Labrador Sea to the Baffin Bay. The sedimentary succession in West Greenland is the onshore extension of this basin and about 2.5 km lower Cretaceous (Albian) to Paleocene rocks are exposed.

Kollmann & Peel (1983) described the geological setting of the Nuussuaq peninsula, based on Henderson et al. (1976). Exposures of lower Cretaceous to Paleocene sediments occur in the valleys Auvfarrsuaq – Agatdalen in central Nuussuaq, Tunorssuaq and Itivdle in NW Nuussuaq, and along the south and north coasts (Fig. 1). The sediments are overlain by Tertiary basalts with intrusives.

The upper Cretaceous to Paleocene sediments on the Nuussuaq peninsula are assigned to the Kangilia and the Agatdalen formations. Previously the Kangilia Formation was assigned to the mid – late Danian and the Agatdal Formation to mid Paleocene (Kollmann & Peel 1983). These formations have been described by Rosenkrantz (1970), Koch (1959, 1963), Hansen (1970), Henderson et al. (1976) and Croxton (1980). Nøhr-Hansen & Dam (1997), based on palynological studies of the sedimentary succession at Annertuneq on the northern coast of the Nuussuaq, placed the Cretaceous-Paleocene boundary within the Fossil Wood

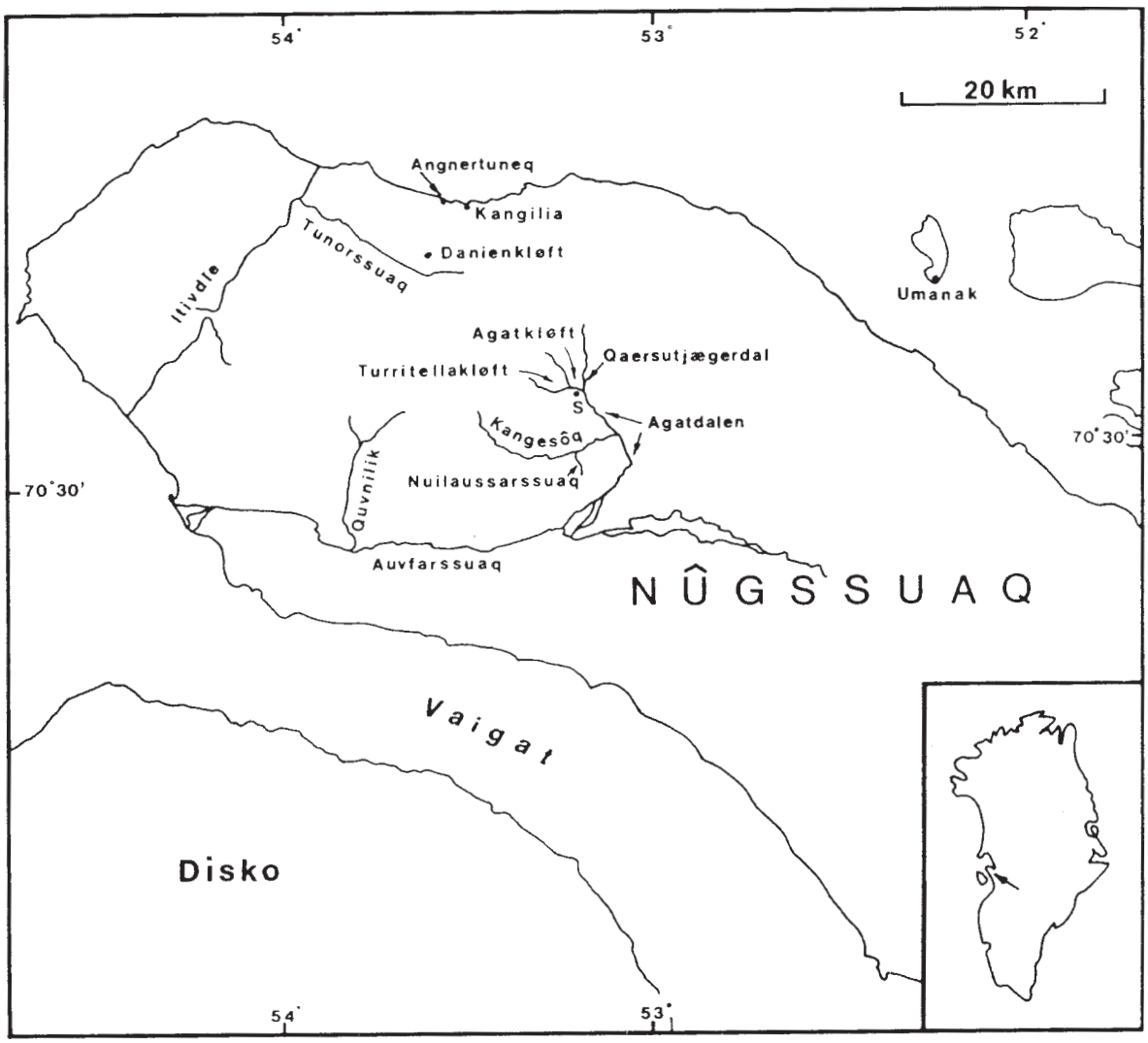


Fig. 1. Localities in the Nuussuaq peninsula. S marks the Sonja lens. Reproduced from Kollmann & Peel 1983 (p. 7, fig. 1).

Member of the Kangilia Formation. The Oyster Ammonite Conglomerate in the Kangilia Formation in central Nuussuaq is reworked, as the matrix contains bivalves characteristic of the Thyasira Member. According to Dam & Sønderholm (1994) the Kangilia Formation on the north coast of Nuussuaq is correlated with the upper Maastrichtian to lower Selandian, and the Agatdal Formation with the Selandian. Nøhr-Hansen & Dam (1997) suggested that the sediments were deposited during a latest Maastrichtian regression followed by early Danian transgression. The stratigraphy of the sediments of the Nuussuaq peninsula is shown in Figure 2.

The fauna

The Paleocene deposits of the Nuussuaq peninsula have yielded a rich assemblage of molluscs, collected by the late Professor A. Rosenkrantz on 18 expeditions in the years between 1938 and 1968. Rosenkrantz (1970) published a part of this material and Kollmann & Peel (1983) have completed the list of gastropods by this author and gave additional systematical observations. The catalogue of Kollmann & Peel illustrates 257 gastropod species in open nomenclature from the localities Turritellakløft, Agatkløft, Qaersutjægerdal, Angnertuneq, Danienkløft, Kangilia, Kangesoq, Nuilaussarssuaq, Quvnilik and Tunorssuaq (Fig. 1). The Sonja lens in the Turritellakløft yielded a rich gastropod fauna (228 species).

Kollmann & Peel (1983) discussed in detail the gas-

tropod fauna and stated that the fauna from the Kangilia Formation was derived from a single environment, whereas the fauna of the overlying Agatdal Formation originated from a mixture of environments. A number of specimens are worn thus demonstrating signs of transport, and the composition of the fauna indicates that the gastropods originate from a variety of ecological niches. Kollmann & Peel concluded that the present juxtaposition of the molluscs in the Agatdal Formation was mainly due to transport from different biocoenoses into a deeper part of the basin.

Abbreviations

Specimens in the Type Collection of the Geological Museum have the prefix MGUH. Specimens that are not figured carry the accession numbers of the museum with prefix GM. Material in the collections of the Geological Survey of Greenland and Denmark (GEUS) is indicated with GEUS.

Systematic Palaeontology

Class Gastropoda Cuvier, 1797
Order Caenogastropoda Cox, 1959
Suborder Neogastropoda Thiele, 1929
Superfamily Muricoidea Rafinesque, 1815
Family Pseudolividae de Gregorio, 1880

Genus *Popenoeum* Squires, 1989

Type species. – *Popenoeum maritinum* Squires, Zinsmeister & Paredes-Mejía, 1989 by original designation.

Popenoeum lacunosum sp. nov.
Pl. 1, Figs 1–4.

1970 *Pseudoliva* aff. *robusta* Briart & Cornet, Rosenkrantz, p. 441.
1972 *Pseudoliva canaliculata* sensu Gorbach non Briart & Cornet, p. 106, pl. 16, fig. 6.
1983 *Pseudoliva* sp. 1 Kollmann & Peel, pp. 85–86 (partim), figs 190A–B (non figs 190C–D).
1989 *Popenoeum* nov. sp. aff. *maritimus* Squires, Zinsmeister & Paredes-Mejía, p. 213.
1998 *Sulcobuccinum* sp. aff. *maritinum* (Squires, Zinsmeister & Paredes-Mejía), Vermeij, pp. 82–83.
1998 *Popenoeum* sp. Pacaud, p.10, fig. 17.

Type locality. – Sonja lens, east of Turritellakløft, central Nuussuaq.

Type stratum. – Sonja Member of the Agatdal Formation, Paleocene.

Derivation of name. – With reference to the adapical depression on the last whorl.

Holotype. – Pl. 1, Fig. 1A–B, MGUH 15810.

Paratypes. – Pl. 1, Fig. 2A–B, MGUH 25056 (ex GM 1977.164); Pl. 1, Fig. 3A–B, MGUH 25057 (ex GM 1977.175); Pl. 1, Fig. 4, MGUH 25058 (ex GM 1977.153).

Diagnosis. – A large and globose *Popenoeum* with a slight depression on the adapical part of the whorl. The radial ribs lack spines on their shoulder.

Material. – The peninsula of Nuussuaq: Turritellakløft, conglomerate with *Cucullaea:* 1 specimen (GM 1977.146), 2 specimens (GM 1977.148). Conglomerate with *Turritella:* 1 specimen (GM 1977.145), 1 specimen (GM 1977.147), 1 specimen (GM 1977.150), 2 specimens (GM 1977.152), 1 specimen (GM 1977. 154), 4 specimens (GM 1977.155), 3 specimens (GM 1977.156), 3 specimens (GM 1977.157), 7 specimens (GM 1977.158), 9 specimens (GM 1977.159), 1 specimen (GM 1977.165), 1 specimen (GM 1977.167), 1 specimen (GM 1977.174). Quarsutjægerdal: 1 specimen (GM 1977.149), 2 specimens (GM 1977.151). Agatkløft: 5 specimens (GM 1977.153), 2 specimens (GM 1977.163), 1 internal mould (GM 1977.162). Inkerman, the peninsula of Crimea (Gorbach, 1972).

Measurements. – The holotype has a height of 45 mm and a width of 32 mm. The paratypes have these dimensions: Height 48 mm and width 30 mm (MGUH 25056, ex GM 1977.164); height 47 mm and width 30 mm (MGUH 25057, ex GM 1977.175); height 9.5 mm and width 5.1 mm (MGUH 20058, ex GM 1977.153).

Description. – Shell large and globose, consisting of five teleoconch whorls, which are separated by canaliculate sutures. The protoconch is smooth and globose, consisting of 1½ whorls. The spire is high and gradate. The last whorl is very large and convex, the height equals 3/4 of the total shell height. The spiral ornamentation consists of fine and narrowly spaced threads on the first teleoconch whorls, and on the last whorl they become strong bands, which run across the radial ribs. The radial sculpture consists of 10 distinct, flexuous ribs, which reach the dorsal furrow, where they disappear. The dorsal pseudolivid furrow is narrow and deep. The prominent part of the radial ribs is on the middle of the adapical zone of the last whorl, which has a slight depression; the radial ribs reach the adapical suture, without bearing spines on the shoulder. The aperture is ovale-elongate and equals about 2/3 of the total shell height, adapically constricted and at the abapical angle strongly constricted into a short, narrow and deep siphonal canal. The pseudumbilicus is narrow, generally covered by the

labial callus, and demarcated towards the base by an arced, flat and carinated spiral band. The columella is concave, smooth and flat and ending in a bend simulating an anterior columellar fold. The columellar callus is well demarcated and only a little extended on the base. The labrum is not thickened, prosocline in lateral view and regularly convex in outline with internally a labial tooth at the height of the dorsal furrow. Growth lines are distinct.

Discussion. – The genus *Popenoeum* Squires, 1989 is characterised by a well developed spire, gradate whorls, distinctly canaliculated sutures, a radial sculpture resulting in small knobs on the shoulder of each whorl, a spiral ornamentation consisting of fine or strong bands and finally by a dorsal furrow, which is deep. The new species described here matches these characters completely, for which reasons we refer it to the genus *Popenoeum*.

On *Popenoeum lacunosum* the most prominent part of the radial ribs is at the middle of the whorl, the adapical zone shows almost knobs. The radial ribs are far from forming a row of knobs, but they have a tendency of becoming indistinct before they reach the adapical suture and only show a thickening on the shoulder of the whorl. In fact the adapical zone on the last whorl is marked by a depression. We have never observed this character on any other species of the genus *Popenoeum*.

Squires, Zinsmeister & Paredes-Mejía (1989) have placed this species close to *Popenoeum maritinum* from the Paleocene of the United States and Mexico, the type species of the genus *Popenoeum*. This species differs from *P. lacunosum* by having a more pyriform outline, radial ribs with nodules on the shoulder of the whorl and a more canaliculate suture. *Popenoeum maritinum* is more closely related to the widely distributed species *P. ambiguum* (Binkhorst, 1861) from the lower Paleocene, a species which recently has been discussed in detail (Pacaud 1998).

The radial sculpture of *P. primum* (Defrance, 1827) from the Paleocene is quite different from the radial sculpture of *P. lacunosum*. It consists of two rows of nodules and no clear ribs; one of the rows is situated near the suture and has a suggestion of spines. A depression is situated between the two rows of nodules, but this depression cannot be compared to the depression on *P. lacunosum*. However, populations without the adapical row of nodules exist, especially in the Paleocene of the Pyrenees and on Crimea. These specimens always differ from *P. lacunosum* by the absence of true radial ribs and by having a coronation under the suture.

Popenoeum bajaense Squires, Zinsmeister & Paredes-Mejía, 1989 from the Thanetian of Mesa San Carlos in Mexico is closely related to *P. lacunosum*, but the Mexican species has a more cylindrical outline, similar to the outline of *P. primum*. The radial sculpture on the last whorl consists of finer ribs, which are distinctly more nodular on the shoulder.

Popenoeum zitteli (Pethö in Zittel, 1882), described by Pethö (1906, p. 169, pl. 10, figs 1–2) from the Maastrichtian of Petrovaradin in Hungary and Sainte-Alvère in France (Termier, 1954) is the species closest related to *P. lacunosum*. The Hungarian species has almost the same dimensions and the ornamentation is rather similar, but the Hungarian species has always more prominent radial ribs and their number is also higher (18 instead of 10), and they continue right to the suture, without any change in curvature.

Popenoeum sp. (Darragh, 1997) from the Paleocene of Australia is also closely related to *P. lacunosum*. It differs by having smaller dimensions, a radial sculpture consisting of sinuous ribs which continue to the suture, without any change in their curvature.

The specimen from the Danian of Inkerman on the Crimea peninsula was illustrated by Gorbach (1972, p. 106, pl. 16, fig. 6) and referred to *Pseudoliva canaliculata* Briart & Cornet, 1877, but the Crimean specimen differs from the species of the Danian of Belgium discussed below. The species from the Belgian Danian, renamed *P. briarti* (Vincent, 1928) differs markedly from the Crimean specimen by having a more slender outline, a higher apex and higher whorls, weaker radial ribs, cut by less sharp spirals, which form larger bands. In fact the specimen figured by Gorbach in all features is identical with the new species. The last whorl has the same convexity and a similar depression, strong radial ribs cut by strong and numerous spiral bands. We therefore consider *Pseudoliva canaliculata* sensu Gorbach non Briart & Cornet to be conspecific with the new species and consequently refer the Crimean species to *P. lacunosum*.

Genus *Pseudoliva* Swainson, 1840

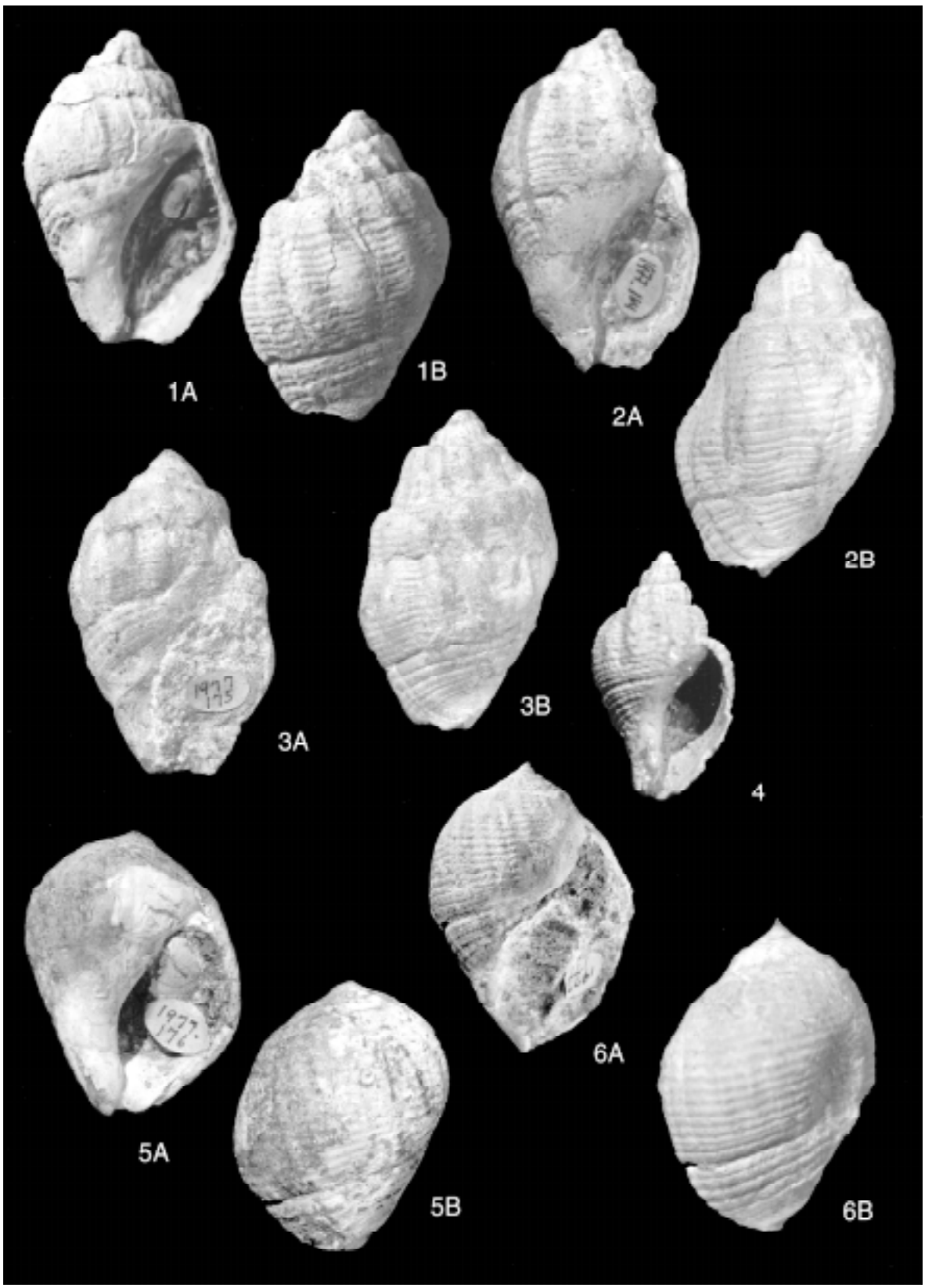
Type species. – *Buccinum crassum* Gmelin, 1791 (= *Buccinum plumbeum* Dillwyn, 1817) by original designation.

Synonymy. – *Sulcobuccinum* d'Orbigny, 1850

Type species. – *Buccinum fissuratum* Deshayes, 1835 by subsequent designation (Vermeij, 1998).

Plate 1

Fig. 1A–B. *Popenoeum lacunosum* sp. nov. Holotype, × 1.2, MGUH 15810. Sonja lens. Fig. 2A–B. *Popenoeum lacunosum* sp. nov. Paratype, ×1.2, MGUH 25056 (ex GM 1977.164). Turritellakløft. Fig. 3A–B. *Popenoeum lacunosum* sp. nov. Paratype, ×1.2, MGUH 25057 (ex GM 1977. 175). Turritellakløft. Fig. 4. *Popenoeum lacunosum* sp. nov. Paratype, ×5, MGUH 25058 (ex GM 1977.153). Sonja lens. Fig. 5A–B. *Pseudoliva praetermissa* sp. nov. Holotype, × 1.6, MGUH 25059 (ex GM 1977.176). Sonja lens. Fig. 6A–B. *Pseudoliva praetermissa* sp. nov. Paratype, ×1.3, MGUH 25060 (ex GM 1977.177). Sonja lens.


1A
1B
2A
2B
3A
3B
4
5A
5B
6A
6B

Pseudoliva praetermissa sp. nov.

Pl.1, Figs 5–6; Pl. 2, Figs 1–2.

1970 *Pseudoliva* sp. Rosenkrantz, p. 441.
1983 *Pseudoliva* sp. 1 Kollmann & Peel, pp. 85–86 (partim), figs 190C–D (non 190A–B).
1989 *Popenoeum* nov. sp. aff. *maritimus* Squires, Zinsmeister & Paredes-Mejía, p. 213.
1998 *Pseudoliva* sp. Pacaud, p. 11–12, fig. 19.

Type locality. – Sonja lens, east of Turritellakløft, central Nuussuaq.

Type strata. – Sonja Member of the Agatdal Formation, Paleocene.

Derivation of name. – praetermissa (Latin) = forgotten, overlooked. This new species was hitherto confused with *Popenoeum lacunosum*, described above.

Holotype. – Pl. 1, Fig. 5A–B, MGUH 25059 (ex GM 1977.176).

Paratypes. – Pl. 1, Fig. 6A–B, MGUH 25060 (ex GM 1977.177); Pl. 2, Fig. 1, MGUH 25061; Pl. 2, Fig. 2A–B, MGUH 15811 (ex GM 1977.177).

Diagnosis. – A large and pyriforme *Pseudoliva* with a stronger spiral ornamentation and flexuous growth folds.

Material. – Turritellakløft, conglomerate with *Turritella:* 2 specimens (GM 1977.157), 1 specimen (GM 1977.159), 1 specimen (GM 1977.168), 1 specimen (GM 1977.169), 1 specimen (GM 1977.170), 1 specimen (GM 1977.172), 1 specimen (GM 1977.173), 5 specimens (GM 1977.178), 1 specimen (GM 1977. 179), 2 specimens (GM 1977.183).

Agatkløft: 192 specimens (GM 1977.153), 1 specimen (found in GM 1977.182).

Measurements. – The holotype has a height of of 34 mm and a width of 26 mm. MGUH 25060 has a height of 41 mm and a width of 29 mm, and MGUH 15811 a height of 20 mm and a width of 14mm.

Description. – Shell large and pyriform with four adult whorls, separated by linear sutures. The protoconch has 1½ smooth and globose whorls. The spire is conical and short. The last whorl is large and globose and almost occupies the total shell height. The spiral ornamentation consists of wide bands which overrun the radial ribs. The radial sculpture consists of a varying number of ribs (from 15 to 24). The radial ribs become weaker and change to flexuous growth folds on the adult specimens. The dorsal pseudolivid furrow is narrow and deep. The aperture is ovate-elongate and equals more than 2/3 of the total shell height. Adapically the labrum meets the columellar wall in an acute angle and the aperture is strongly constricted into a short, narrow and deep siphonal canal at the abapical edge. The pseudumbilicus is narrow, generally covered by the labial callus, and demarcated from the base by an arched, flat and carinated spiral band. The columella is strongly concave, smooth and flat and has a knob simulating an anterior columellar fold. The callus on the columella is only a little extended on the base and indistinctly demarcated. The labrum is not thickened and has a prosocline direction in lateral view, a convex outline and it is marked internally by a labial tooth at the height of the dorsal furrow.

Discussion. – This species was considered by Kollmann & Peel (1983) to be a juvenile of *Popenoeum lacunosum*, described above, the study of the very numerous specimens has demonstrated that the smaller form represented a different species. We have studied numerous ontogenetic stages and especially the specimen 1977.173, an adult specimen, which has larger dimensions than those of *Popenoeum lacunosum,* but has the same characters as the smaller specimen figured by Kollmann & Peel (fig. 190C–D). The shells of adult specimens of *Pseudoliva praetermissa* are consistantly large and pyriform and differ markedly from adult specimens of *Popenoeum lacunosum*. The two species thus are not conspecific.

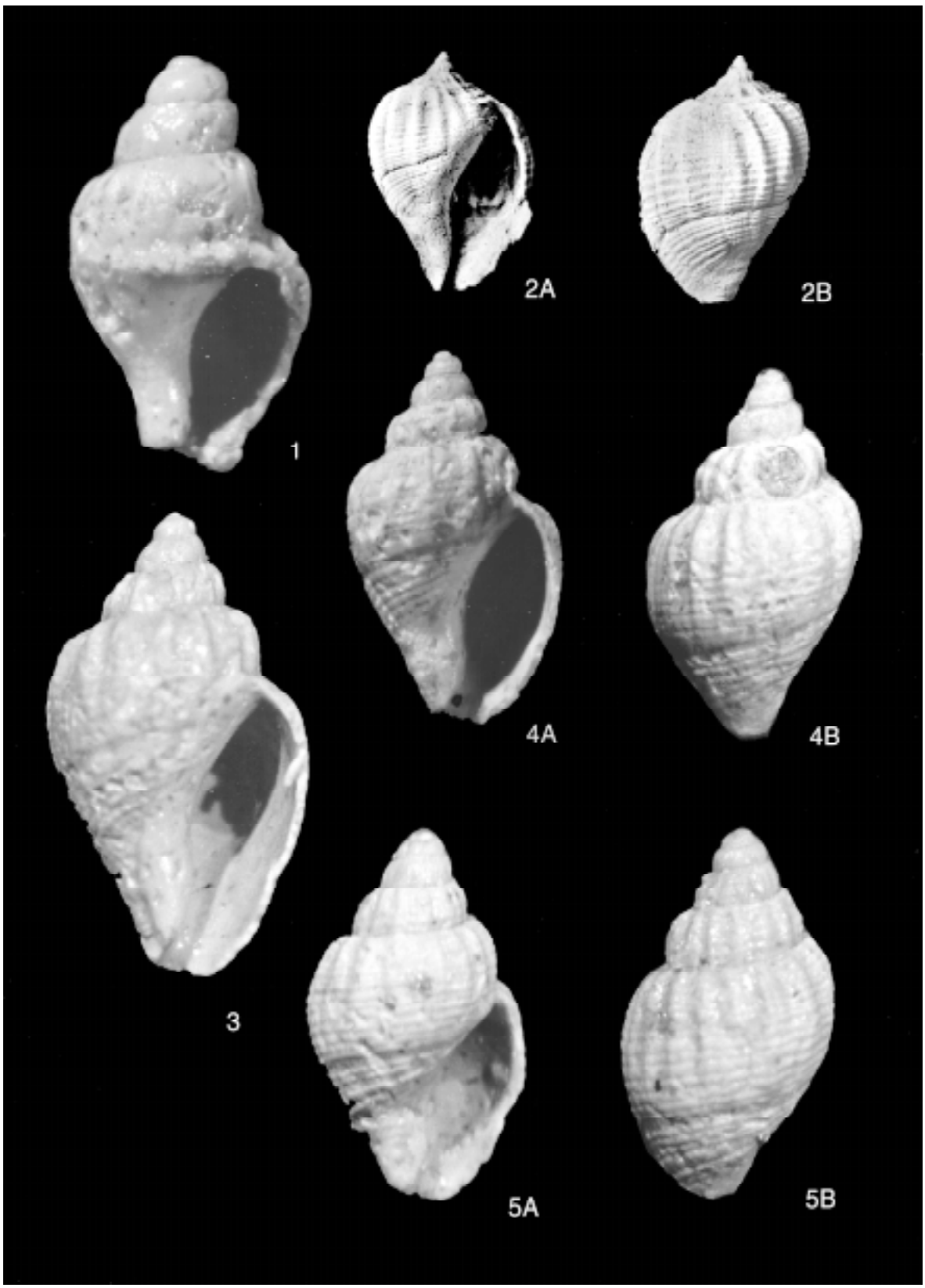
The adult specimens of *P. praetermissa* generally are rather poorly preserved and details of the ornamentation are thus not observable. For this reason we have also designated as paratype an immature specimen (MGUH 15811), which demonstrates details in sculpture and ornamentation better than the holotype and the other paratype (MGUH 25060). MGUH 15811 is also a typical representative of the new species, since the bulk of material consists of juvenile and immature specimens (192 specimens from Agatkløft, GM 1977.153).

The specimen figured by Kollmann & Peel (1983, fig. 190C-D) is immature and is similar to *Pseudoliva fissurata* (Deshayes, 1835) from the Thanetian of the Anglo-Paris Basin. The species from Greenland sometimes has more distinct radial ribs and a stronger marked spiral ornamentation.

The strength of the radial ribs on *Pseudoliva curvicostata* Briart & Cornet, 1871 from the Danian of

→

Plate 2
Fig. 1. *Pseudoliva praetermissa* sp. nov. Protoconch × 30, MGUH 25061 (ex GM 1977.153). Sonja lens. Fig. 2A–B. *Pseudoliva praetermissa* sp. nov. Paratype × 2, immature specimen. MGUH 15811. Sonja lens. Fig. 3. *Fusulculus nanapullus* sp. nov. Holotype × 15, MGUH 25062 (ex GM 1977.153). Sonja lens. Fig. 4A–B. *Fusulculus nanapullus* sp. nov. Paratype × 15, MGUH 15812. Sonja lens. Fig. 5A–B. *Fusulculus nanapullus* sp. nov. Paratype × 15, MGUH 25063 (ex GM 1977.153). Sonja lens.


2A
2B
1
4A
4B
3
5A
5B

Age	Formation	North Nuussuaq	Thickness	Central Nuussuaq	Thickness
Paleocene (Selandian)	Agatdal Fm	Sandstone	20 m	Abraham Mb Andreas Mb Turritella/ Sonja Mb	12 m 25 m 5 m
Late Maastrichtian to Paleocene (Selandian)	Kangilia Fm	Propeamussium Mb Thyasira Mb Fossil wood Mb Conglomerate Mb	100 m 34 m 425 m 50 m	Propeamussium Mb Thyasira Mb Oyster-ammonite Mb	75 m 5 m

Fig. 2. Stratigraphy of the late Maastrichtian to early Paleocene deposits of the Nuussuaq peninsula. Compiled after Kollmann & Peel (1983), Dam & Sønderholm (1994) and Nøhr-Hansen & Dam (1997).

Mons, Belgium is also rather similar to those of *P. praetermissa*, but the dorsal furrow on the Belgian species is replaced by a scar-like furrow and the spiral ornamentation consists of finer and more close-set spirals. *Pseudoliva elisae* Briart & Cornet, 1871, another species from the Danian of Mons, has similarly inflated whorls, but differs from *P. praetermissa* by having radial ribs, which do not reach the suture, and a flat dorsal scar-like furrow.

Pseudoliva praetermissa is similar to the juvenile stage of *Popenoeum ambiguum* (Brinkhorst, 1861) but differs from this species by having linear, not canaliculate sutures and a more pronounced spiral ornamentation.

Genus *Fusulculus* Bouchet & Vermeij, 1998

Type species. – *Fusulculus crenatus* Bouchet & Vermeij, 1998 by original designation.

Remarks. – The new species, described below, belongs to a group of species of relatively small fusiforme Pseudolividae (maximum height 18.4 mm) with a relatively high spire, a subsutural, concave ramp on the last whorl, a radial sculpture appearing at the adapical suture and gradually disappearing abapically and an almost invisible dorsal furrow. There are numerous species of Pseudolividae which we refer to the genus *Fusulculus* (see Pacaud, 1998). Some species, which have less distinct characters, have been assigned to the Conidae, e.g. *Conorbis macnairyensis* Wade, 1917 from the Maastrichtian (Ripley Formation) of Tennessee (USA), now assigned to the genus *Cryptoconus* (see Sohl, 1964) and *Etallonia prisca* Deshayes, 1862 from the Thanetian of the Paris Basin, now assigned to the genus *Oenopota* (see Glibert, 1962). This species, however, is a genuine *Fusulculus*, closely related to *F. koeneni* (Ravn, 1939) from the Selandian of Denmark, described below. Other species, which we assign to the genus *Fusulculus*, are *F. multinodulosus* (Vermeij, 1998) from the Danian of Mons, Belgium, *F. rosenkrantzi* (Traub, 1979) from the Thanetian of Austria, *F. antiquus* (Vincent, 1878) from the Thanetian (Landénien) of Belgium, *F. nodulosus* (Beyrich, 1854) and *F. pusillus* (Beyrich, 1854) from the Eocene Lattorfian (= Priabonien) of Germany and the Eocene of Great Britain. The new assignment of *Conorbis macnairyensis* Wade, 1917 to the genus *Fusulculus* places the origin of the group to the Upper Cretaceous. A study of the fossil species of this group, for the greater part demonstrating a stratigraphic occurrence restricted to the Paleocene, is in progress (Pacaud).

Fusulculus nanapullus sp. nov.
Pl. 2, Figs 3–5.

1983 *Pseudoliva* sp. 2, Kollmann & Peel, p. 86, fig. 191.
1998 *Fusulculus* sp., Pacaud, p. 12.

Type locality. – Sonja lens, east of Turritellakløft, central Nuussuaq.

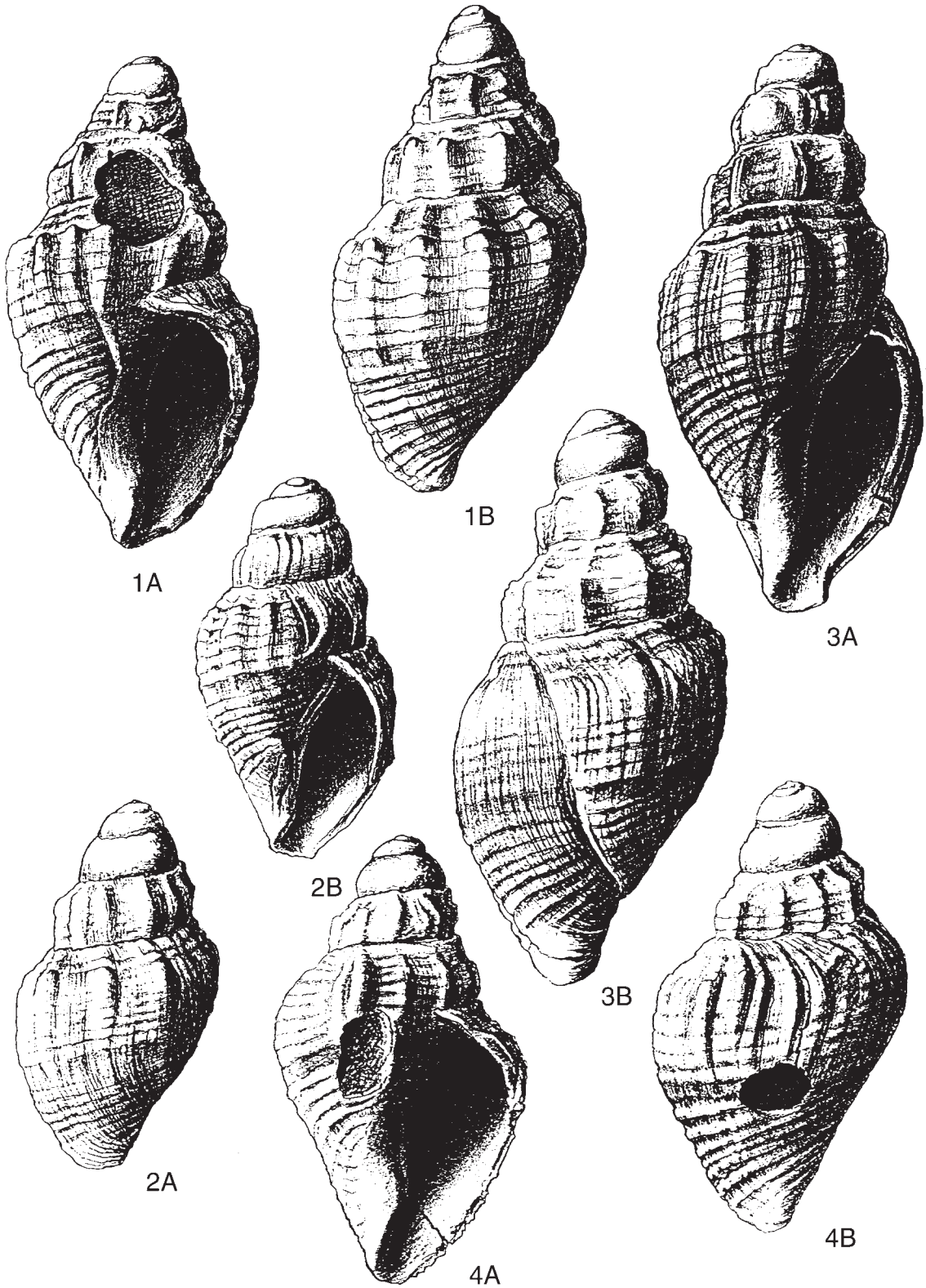
Type strata. – Sonja Member of the Agatdal Formation, Paleocene.

Derivation of name. – nana (Greek) = small, pullus (Latin) = pretty.

Holotype. – Pl. 2, Fig. 3, MGUH 25062 (ex GM 1977.153).

Paratypes. – Pl. 2, Fig. 4A–B, MGUH 15812; Pl. 2, Fig. 5A–B, MGUH 25063.

Plate 3
Morphological variation of *Fusulculus koeneni* (Ravn, 1939). Reproduced after drawings in the Rosenkrantz files in the Geological Museum, the University of Copenhagen. Fig. 1A–B. *Fusulculus koeneni* (Ravn, 1939). Lectotype × 15, MGUH 821. Vestre Gasværk.Fig. 2A–B. *Fusulculus koeneni* (Ravn, 1939). MGUH 25064, × 15. Kongedyb I. Fig. 3A–B. *Fusulculus koeneni* (Ravn, 1939). MGUH 25065, × 15. Kongedyb I Fig. 4A–B. *Fusulculus koeneni* (Ravn, 1939). MGUH 3754, × 15. Vestre Gasværk. Figured by Ravn (1939, pl. 2, figs 4a–b).


1A
1B
3A
2B
3B
2A
4A
4B

Diagnosis. – A short, small and conical pseudolivid species.

Material. – Agatkløft: 24 specimens (GM 1977.153). Turritellakløft and Qaersutjægerdal (Kollmann & Peel, 1983).

Measurements. – The holotype has a height of 5 mm and a width of 3 mm.

Description. – Shell small, short and conical. The protoconch consists of 2½ smooth and almost flat whorls. The teleoconch consists of three convex whorls, separated by deep sutures. The last whorl equals half the total shell height. The spiral ornamentation consists of narrowly spaced spiral threads which overrun the radial ribs. The radial sculpture consists of 14–16 ribs. The dorsal pseudolivid furrow is plane and very indistinct. The aperture is ovate-elongate and constricted abapically into a narrow and deep siphonal notch. The pseudumbilicus is narrow, generally covered by the labial callus, and demarcated exteriorly from the base by an arched, flat and exteriorly carinated spiral band. The columella is incurved, smooth and flattened and has a terminal knob, simulating a columellar fold. There is no callus on the columella. The labrum is not thickened, orthocline in lateral view and regularly convex in outline.

Discussion. – *Fusulculus nanapullus* demonstrates a similarity with *F. koeneni* from the Selandian of Denmark, especially with the lectotype from Vestre Gasværk (Pl. 3, Fig. 1A–B, MGUH 821), but differs, however, in the absence of a adapical carina on the last whorl and by having a less slender outline. *F. nanapullus* also is close to specimens of *Fusulculus* sp. from the British Ypresian (London Clay), by Jeffery & Tracey (1997) considered these to be juvenile specimens of *Pseudoliva laudunensis* (Defrance, 1826). However, *F. nanapullus* cannot be considered as the juvenile stage of *Pseudoliva praetermissa* as we have compared specimens of that species through numerous growth stages. A comparison of specimens of comparable size, an adult *F. nanapullus* and a juvenile *P. praetermissa*, demonstrates that the last whorl on *P. praetermissa* is more conical (allready pyriform as the adult shell of the same species) and the width is slightly less. The number of radial ribs is about the same at a similar place on the two species (15–17).

Fusulculus koeneni (Ravn, 1939)

Pl. 3, Figs 1–4; Pl. 4, Figs 1–3.

1885 *Pseudoliva pusilla* von Koenen non Beyrich, 1854, pp. 20–21, pl. 11, figs 16a–d.
1897 *Pseudoliva pusilla* sensu von Koenen, Grönwall, p. 66.
1904 *Pseudoliva pusilla* sensu von Koenen, Grönwall, p. 34.
1920 *Pseudoliva pusilla* sensu von Koenen, Rosenkrantz, p. 8.
1939 *Pseudoliva koeneni* Ravn, 1939, pp. 75–76, pl. 2, figs 4a–b.
1960 *Pseudoliva (s. str.) koeneni* Ravn, Glibert, p. 7.
1973 *Pseudoliva (s.str.) koeneni* Ravn, Glibert, p. 73.
1975 *Pseudoliva* sp. Anderson, p. 153, pl. 15, fig. 13.
1979 *Pseudoliva koeneni* Ravn, Traub, p. 111.
1997 *Pseudoliva (Buccinorbis) koeneni* Ravn, Darragh, p. 81.
1998 *Sulcobuccinum koeneni* (Ravn), Vermeij, p. 81.
1998 *Fusulculus koeneni* (Ravn), Pacaud, p. 11.

Type locality. – Vestre Gasværk, Copenhagen, Denmark.

Type stratum. – Lellinge Greensand, Selandian, Paleocene.

Type material. – Lectotype (herein designated): Pl. 3, Fig. 1A–B, MGUH 821.

Material. – Vestre Gasværk VI: 535 specimens (GM). Vestre Gasværk VII: 1128 specimens (MGUH). Sundkrogen, leg. Rosenkrantz: 1390 specimens (GM). Sundkrogen, leg. Harder: 2433 specimens (GEUS); Sundkrogen, leg Harder: 2 specimens (Pacaud colln. No. P26342); 20 specimens (Schnetler colln.). Sundkrogen, leg. Ødum 1920: 3 specimens (GEUS); 2 specimens (Schnetler colln.). Kongedyb I: 1019 specimens (GM). Kongedyb II: 248 specimens (GM). Prøvesten: 117 specimens (GM). Ratheim, Germany: (Anderson, 1975).

Measurements. – The lectotype has a height of 4.9 mm and a width of 2.6 mm.

Description. – The shell is small, slender and conical, the maximum width equals half the total shell height. The protoconch consists of three smooth and convex whorls, separated by distinct sutures. The nucleus is more or less depressed. On many specimens the entire protoconch is relatively low and conical, with more indistinct sutures. The transition into the teleoconch is indicated by close-set radial, orthocline riblets. The teleoconch consists of three very convex whorls with a rather prominent sutural ramp, separated by deep and linear sutures. On the teleoconch a depression under the adapical suture is present, while the abapical part of the whorl is almost plane and vertical. The spiral ornamentation of the teleoconch consists of four to seven spiral bands. On the adapical depression one or two close-set, not very prominent bands and three to five weak, almost united bands are visible. The abapical bands are the most prominent. The last whorl,

which occupies two thirds of the total shell height, has a further spiral band as continuation of the suture. The dorsal pseudolivid furrow is flat, very indistinct and scar-likel, but especially visible by its darker colour, distinctly different from the lighter colour of the shell and also indicated by a sudden inflexion of the growth lines. Below the dorsal furrow ten spirals in decreasing strength and distance towards the end of the canal. The radial sculpture consists of 10–15 rather strong , almost straight ribs. On the last whorl the radial ribs gradually get weaker and disappear. The radial ribs have nodules developed on the adapical spiral band, projecting on the sutural ramp. The aperture is oval-elongate and equals about 0.6 of the total shell height. Abapically the aperture is constricted into a relatively wide and short siphonal canal. The columella is strongly concave and smooth. The columellar callus is thick and well demarcated. The labrum is thin and almost orthocline in lateral view, regularly convex in outline and has internally a slight incurvation.

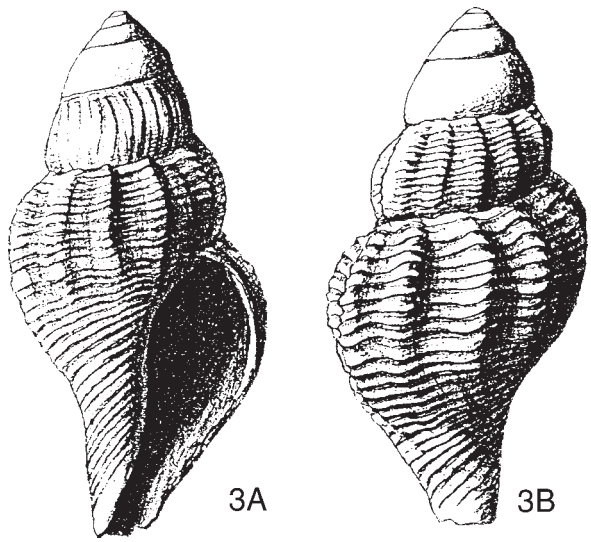


Fig. 3. *Suessionia canalifera* (Ravn, 1939). × 19. Holotype, MGUH 3785. Reproduced after drawings in the Rosenkrantz files of the Geological Museum, the University of Copenhagen.

Discussion. – The greater part of the very abundant material of this species consists of juvenile specimens and demonstrates a considerabel variation (Pl. 3, Figs 1–4). Ravn (1939) stated that the adapical carina on the last whorl was more or less well developed and that specimens with a weak carina had only a weak subsutural spiral. He also stated that the number of radial ribs varied from 10 to 15 and the shell was more ore less slender in outline.

The study of numerous specimens of *Fusulculus koeneni* demonstrates a dorsal, scar-like hardly marked furrow, which is very different from the deep furrow on *Popenoeum lacunosum* and *Pseudoliva praetermissa*. We have compared juvenile specimens of these two species with species of *F. koeneni*. *F. koeneni* shows a resemblance to *F. nanapullus*, but differs from this species by having an adapical carina on the last whorl. *F. rosenkrantzi* (Traub, 1979) from the Thanetian of Kroisbach in Austria is very closely related to *F. koeneni*, but differs by having a more prolonged shell and a more weak radial sculpture.

The specimen in open nomenclature from the Danian of Ratheim (Germany), figured by Anderson (1975) seems to belong to *F. koeneni* by having a slender shell and distinct adapical spiral bands, suggesting the typical carina of *F. koeneni*.

Remarks. – Von Koenen (1885) established this species sub nomina *Pseudoliva pusillus*, but this name is preoccupied by a species of the Lattorfian of Germany. He figured two specimens (figs 16a–b = MGUH 820 and figs 16c–d = MGUH 821), but designated no holotype. A study of the type material in the Geological Museum of Copenhagen by Schnetler confirmed the observation by Rosenkrantz (unpublished notes in the files of the Geological Museum of Copenhagen) that the specimen MGUH 821 was the best of the two syntypes figured by von Koenen. We therefore designate this specimen as the lectotype for *Fusulculus koeneni* (Ravn, 1939).

Ravn (1939, pl. 2, figs 4a–b) figured a smaller specimen and his figures are not very satisfying. We illustrate the best adult specimen, an immature specimen and a protoconch from Sundkrogen (leg. Harder) and the lectotype after drawings in the files of the Geological Museum of Copenhagen (the Rosenkrantz files of drawings).

Family Buccinidae Rafinesque, 1815

Genus *Suessionia* Cossmann, 1889

Type species. – *Fusus exigua* Deshayes, 1835 by original designation.

Synonymy. – *Fusopsis* Ravn, 1939

Type species. – *Pseudoliva (Fusopsis) canalifera* Ravn, 1939 by monotypy.

Suessionia canalifera (Ravn, 1939)

Pl. 4, Figs 4–5, Fig. 3A–B

1939 *Pseudoliva (Fusopsis) canalifera* Ravn, 1939, p. 76, pl. 3, figs 4a–b.
1998 *Fusopsis canalifera* (Ravn), Vermeij, p. 80.
1998 *Suessionia canalifera* (Ravn), Pacaud, p. 11, fig. 20.

Type locality. – Sundkrogen, the Harbour of Copenhagen, excavation 1920.

Type strata. – Lellinge Greensand, Selandian, Paleocene.

Holotype. – Fig. 3A–B, MGUH 3785, leg. Rosenkrantz 1920.

Material. – Sundkrogen, 1 specimen, Pl. 4, Fig. 4, MGUH 25069, leg. Harder 1920; 1 specimen, Pl. 4, Fig. 5, MGUH 25070, leg. Harder 1920. Sundkrogen, leg. Harder: 12 specimens (GEUS). Sundkrogen, leg. Rosenkrantz: 7 specimens (GM).

Measurements. – The holotype has a height of 3.5 mm and a width of 1.8 mm.

Description. – The shell is very small, slender and fusiform. The width almost equals the total shell height. The protoconch is multispiral, consisting of four smooth whorls, which are separated by rather distinct sutures. The nucleus is very small and orthostroph and the following three protoconch whorls are increasing regularly in diameter. The terminal protoconch whorl is rapidly increasing in height. The transition into the teleoconch is indicated by the appearance of a spiral ornamentation and three close-set radial riblets. The teleoconch consists of two convex whorls which are separated by deep and undulating sutures, caused by a small subsutural band. The last whorl comprises a little more than two thirds of the total shell height. The base is convex. The radial sculpture consists of 11 rather strong, almost orthocline ribs. The spiral ornamentation consists of 10 spiral narrowly spaced riblets. On the last whorl the space between the two adapical spiral bands is wider, and abapically the radial ribs gradually disappear. The base and the neck of the canal have about 20 very fine, close-set spiral riblets. The growth lines are relatively distinct. The aperture is ovale and equals half the total shell height. The columella is smooth and concave. The callus is thin. The canal is well developed but rather short, strongly bent backwards, truncated and slightly notched. The labrum is thin and orthocline.

Remarks. – Ravn (1939, p. 76) introduced *Fusopsis* as a subgenus of *Pseudoliva* in his description of this species , without giving a diagnosis. He furthermore suggested that *Pseudoliva koeneni* could represent a transition between *Fusopsis* and *Pseudoliva (s. str.).* Vermeij (1998), proposing *Fusopsis* as an independent genus of the family Pseudolividae, emphazises the similarity between *Fusopsis* and the genus *Benthobia* Dall, 1889, the only other Pseudolivid genus having a multispiral protoconch and he suggested a possible synonymy of the two genera.

In fact, the study of several specimens of *Pseudoliva (Fusopsis) canalifera* demonstrate these characters: A fusiform shell with a multispiral, conical protoconch with a very small and orthostroph nucleus, a prolonged and slightly notched canal, no dorsal furrow, typical for the family Pseudolividae. These characters place the species in the family Buccinidae. The study demonstrated inclusion in the genus *Suessionia* Cossmann, 1889 (see Gougerot & Le Renard, 1983). A comparison with two specimens of *Suessionia exigua* (Deshayes, 1835), the type species of *Suessionia*, from the Cuisian of Liancourt-Saint-Pierre (Oise, France) (Pl. 4, Figs 6–7) completely confirmed the assignment of *Pseudoliva (Fusopsis) canalifera* to the genus *Suessionia*. The assignment of this species to the Pseudolividae is based on Ravn's interpretation of the wider spiral furrow on the last whorl as the dorsal pseudolivid furrow. As mentioned above this furrow is only a wider space between two spirals, a character present in many representatives of the Buccinidae, especially *S. exigua*. This character is completely visible on shells of larger dimensions, e.g. *Cantharus (Pollia) vasseuri copolygona* (Pezant, 1908) from the Eocene of the Paris Basin.

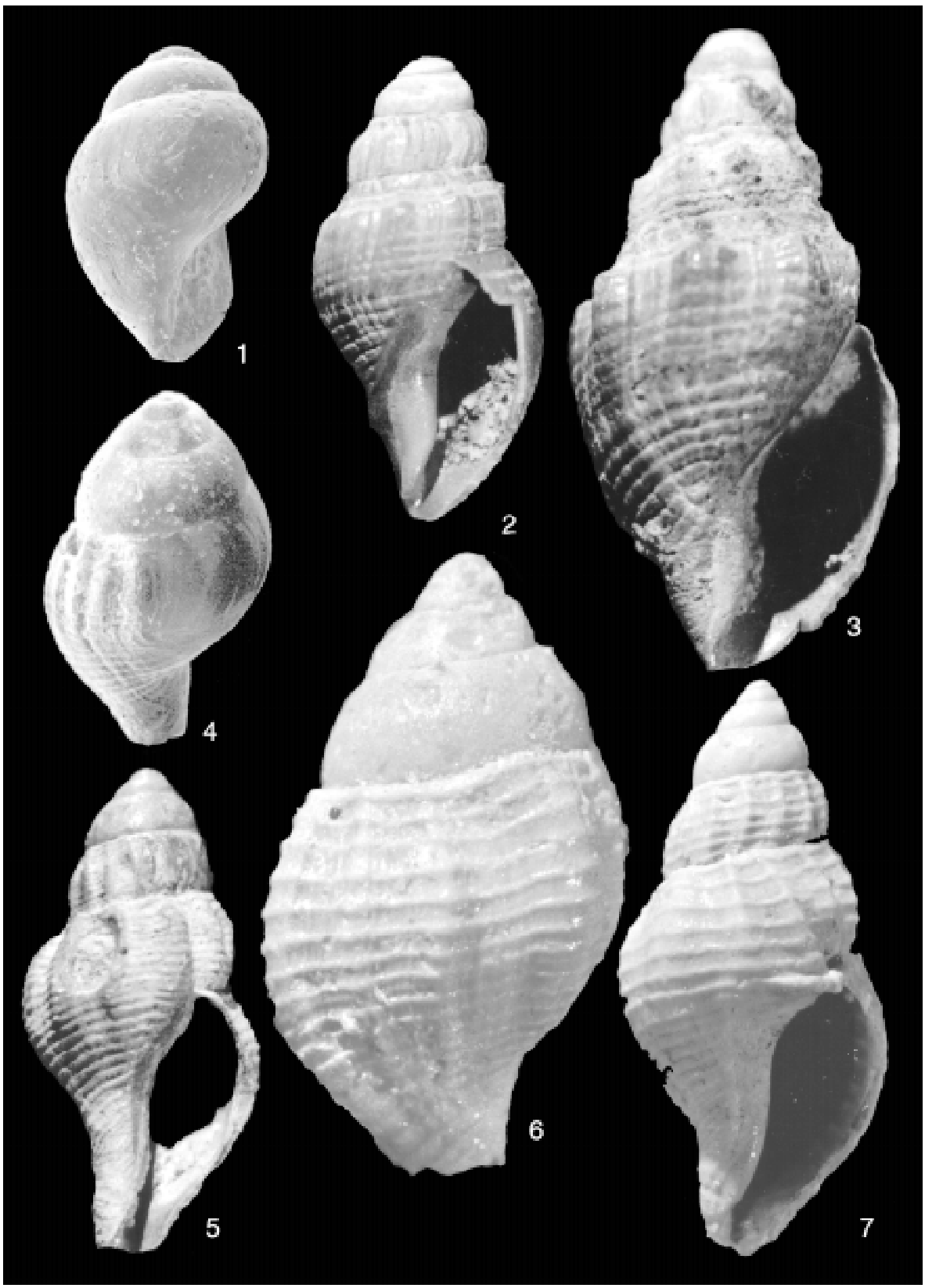
As all the characters of *Pseudoliva (Fusopsis) canalifera* Ravn, 1939 lead us to an assignment to the genus *Suessionia*, thus the family Buccinidae, we consequently exclude this species from the Pseudolividae. Furthermore we consider the genus *Fusopsis* as a junior synonym of *Suessionia* Cossmann, 1889, and thus the genus *Fusopsis* cannot be maintained.

Suessionia densestriata (von Koenen, 1885) from the same locality differs from *S. canalifera* by having a higher number of radial ribs and stronger spiral bands, resulting in granulated radial ribs. The specimens from the Paleocene of Bochotnica (near Pulawy, Poland), by Krach (1981) referred to *S. densestriata* seem to be conspecific with this species. They differ from *S. canalifera* in having a stronger sculpture. *S. iuvavica* Traub, 1979 from the Paleocene (see Traub & Werner, 1993) of Kroisbach and Oiching (near Salzburg, Austria) is very closely related to *S. canalifera.* The Austrian species however differs from *S. canalifera* in having a larger size, a less conical protoconch, granulated radial ribs on the first teleoconch whorl, a

→

Plate 4

Fig. 1. *Fusulculus koeneni* (Ravn, 1939). Protoconch × 35. MGUH 25066 (leg. Harder 1920). Sundkrogen. Fig. 2. *Fusulculus koeneni* (Ravn, 1939). × 20. MGUH 25067 (leg. Harder 1920). Sundkrogen. Fig. 3. *Fusulculus koeneni* (Ravn, 1939). × 22. MGUH 25068 (leg. Harder 1920). Sundkrogen. Fig. 4. *Suessionia canalifera* (Ravn, 1939). Protoconch × 30. MGUH 25069 (leg.Harder 1920). Sundkrogen. Fig. 5. *Suessionia canalifera* (Ravn, 1939). × 20. MGUH 25070 (leg. Harder 1920). Sundkrogen. Fig. 6. *Suessionia exigua* (Deshayes, 1835). Protoconch × 33. From the Cuisian of Liancourt-Saint-Pierre (Oise, France), Pacaud colln. Fig. 7. *Suessionia exigua* (Deshayes, 1835). × 20. From the Cuisian of Liancourt-Saint-Pierre (Oise, France), Pacaud colln.


1
2
3
4
5
6
7

stronger and sharper spiral ornamentation and finally by having 9–10 internal lirae on the labrum.

We illustrate the holotype of *Suessionia canalifera* after drawings in the files of the Geological Museum, the University of Copenhagen. Furthermore a juvenile and an adult specimen are figured.

Dansk sammendrag

Fra Paleocænet på Nuussuaq halvøen (Vestgrønland) opstilles tre nye arter, tilhørende familien Pseudolividae de Gregorio, 1880: *Popenoeum lacunosum* sp. nov., *Pseudoliva praetermissa* sp. nov. and *Fusulculus nanapullus* sp. nov.

Fra det danske Selandien (Lellinge Grønsand) er to arter af Ravn (1939) tidligere henført til Pseudolividae, og disse to arter er revideret. *Pseudoliva koeneni* Ravn, 1939 henføres til slægten *Fusulculus* Bouchet & Vermeij, 1998 og tilhører således stadig Pseudolividae, og en lectotype foreslås. *Pseudoliva (Fusopsis) canalifera* Ravn, 1939 er fjernet fra familien Pseudolividae, da *Fusopsis* Ravn, 1939 anses for et synonym for *Suessionia* Cossmann, 1889, og denne art henføres således til familien Buccinidae Rafinesque, 1815.

Acknowledgments

We thank Pierre Lozouet (MNHN-Paris) for information. Sten Lennart Jakobsen, Geological Museum of Copenhagen kindly made the material from Greenland available to us and photographed the holotype of *Popenoeum lacunosum* and the paratype of *Pseudoliva praetermissa*. We thank the Geological Museum for allowing us to publish the drawings of *Fusulculus koeneni* and *Suessionia canalifera* from the files of the museum. We thank GEUS (the Geological Survey of Greenland and Denmark) for giving us access to the Harder collection from Sundkrogen. Søren Bo Andersen, Geological Institute, University of Aarhus, Denmark kindly carried out the greater part of the photograpical work, and Erik Thomsen, Geological Institute, University of Aarhus kindly made the scanning electron pictures. David Harper, Geological Museum of Copenhagen and Heinz Kollmann, Naturhistorisch Museum, Vienna is thanked for critically reading of the manuscript.

References

Anderson, H.-J. 1975: Die Fauna der paläocänen Hückelhovener Schichten aus dem Schacht Sophia Jacoba 6 (Erkelenzer Horst, Niederrheinische Bucht). Geologica et Paleontologica 6, 141–171.

Beyrich, E. 1854: Die Conchylien des Norddeutschen Tertiärgebirges. Zeitschrift den Deutschen Geologischen Gesellschaft 2/3, 83–176.

Binkhorst van den Binkhorst, J.T 1861: Monographie des Gastéropodes et des Céphalopodes de la craie supérieure du Limburg, suivie d'une description de quelques espèces de crustacés du même dépôt crétacé. Bruxelles (Muquardt), Maastricht (Müller Fréres), 83 pp.

Bouchet, P. & Vermeij, G.J. 1998: Two New Deep-Water Pseudolividae (Neogastropoda) from the South-West Pacific. The Nautilus 111 (2), 47–52.

Briart, A. & Cornet, F.L. 1871: Description des Fossiles du calcaire grossier de Mons. Partie 1: Gastéropodes. Mémoires Couronnés et Mémoires des Savant Etrangers, Académie Royale des Sciences des Lettres et des Beaux-Arts de Belgique 36, 1870 (published 1871), i–viii, 1–76.

Briart, A. & Cornet, F.L. 1877: Description des Fossiles du calcaire grossier de Mons, Partie 3: supplément aux premières parties. Mémoires couronnés et Mémoires des Savant Etrangers, académie Royale des sciences, des Lettres et des Beaux-Arts de Belgique 43, i–viii, 1–73.

Cossmann, M. 1889: Catalogue Illustré des Coquilles fossiles de l'Eocène des Environs de Paris (4 ème fascicule). Annales de la Société Royale Malacologique de Belgique 24, 3–385.

Croxton, C.A. 1980: Aquilapollenites from the Late Cretaceous. Paleocene (?) of central West Greenland. Rapport Grønlands Geologiske Undersøgelse 101, 5–27.

Darragh, T.A. 1997: Gastropoda, Scaphopoda and new Bivalvia of the Paleocene Pebble Point Formation, Victoria, Australia. Proceedings of the Royal Society of Victoria 109 (1), 57–108.

Defrance, F. 1827: in Levrault (ed.): Dictionnaire des sciences Naturelles, Strasbourg (Levrault) 51, 534 pp.

Deshayes, G.P. 1835: Description des coquilles fossiles des environs de Paris. Tome II, Livraisons 40–45, in 4, 495–780, Atlas II, pls 79–106. Paris (Levrault).

Deshayes, G.P. 1862: Description des Animaux sans vertèbres découverts dans le bassin de Paris. Tome II, Livraisons 29–32, in 4, 433–640, Atlas II, pls 27–39. Paris (Ballière).

Glibert, M. 1960: Les Volutacea fossiles du Cénozoïque étranger des collections de l'Institut Royal des Sciences Naturelles de Belgique. Mémoires de l'Institut Royal des Sciences Naturelles de Belgique. 2 ème série, (61), 109 pp.

Glibert, M. 1962: Les Mesogastropoda fossiles du Cénozoïque étranger des collections de l'Institut Royal des Sciences Naturelle de Belgique. Mémoires de l'Institut Royal des Sciences Naturelles de Belgique 173, 116 pp.

Glibert, M. 1973: Révision des Gastropoda du Danien et du Montenien du calcaire de Mons. Mémoires de l'Institut Royal des sciences Naturelles de Belgique 173, 116 pp.

Gorbach; L.P. 1972: Stratigraphie et faune des Mollusques du Paléocène inférieur de Crimée. Institut des Ressources minèrales d'URSS, 115 pp. (In Russian).

Gougerot, L. & Le Renard, J. 1983: Clefs de détermination des petites espèces de Gastéropo des de l'Eocéne du Bassin parisien. XXII: les genres *Coptochetus* et *Suessionia* Cossmann. Cahiers des Naturalistes, Bulletin des Naturalistes Parisiens, nouvelle série 39 (1), 1–9.

Grönwall, K.A. 1897: Block af Paleocän från Köpenhamn. Meddelelser fra Dansk Geologisk Forening 4, 53–72.

Grönwall, K.A. 1904: Forsteningsførende Blokke fra Langeland, Sydfyn og Ærø samt Bemærkninger om de ældre Tertiærdannelser i det baltiske Omraade. Danmarks Geologiske Undersøgelse 15, 62 pp.
Hägg, R. 1947: Die Mollusken und Brachiopoden der Schwedischen Kreide. Das Kristian- stadgebiet. Sveriges Geologiska Undersökning C 485, 143 pp.
Hansen, H.J. 1970: Danian foraminifera from Nûgssuaq, West Greenland. Grønlands Geologiske Undersøgelse 93, 132 pp.
Henderson, G., Rosenkrantz, A. & Schiener, E.J. 1976: Cretaceous-Tertiary sedimentary rocks of West Greenland. In Escher, A. & Watt, W.S. (eds): Geology of Greenland. Geological Survey of Greenland, 341–362.
Jeffery, P. & Tracey, S. 1997: The Early Eocene London Clay Formation mollusc fauna of the former Bursledon Brickworks, Lower Swanwick, Hampshire. Tertiary Research 17 (3–4), 75–137.
Kase, T. 1990: Late Cretaceous Gastropods from the Izumi Group of southwest Japan. Journal of Paleontology 64 (4), 563–578.
von Koenen, A. 1885: Ueber eine Palaeocäne Fauna von Kopenhagen. Abhandlungen der Königlichen Gesellschaft der Wissenschaften zu Göttingen 32, 128 pp.
Kollmann, H & Peel, J.S. 1983: Paleocene gastropods from Nûgssuaq, West Greenland. Bulletin Grønlands Geologiske Undersøgelse 146, 115 pp.
Koch, B.E. 1959: Contribution to the stratigraphy of the non-marine Tertiary deposits on the south coast of the Nûgssuaq peninsula, northwest Greenland with remarks on the fossil flora. Bulletin Grønlands Geologiske Undersøgelse 22, 100 pp.
Koch, B.E. 1963: Fossil plants from the Lower Paleocene of the Agatdalen (Angmartussut) area, central Nûgssuaq peninsula, northwest Greenland. Bulletin Grønlands Geologiske Undersøgel se 38, 120 pp.
Krach, W. 1981: Paleocene Fauna and Stratigraphy of the middle Vistula River, Poland. Studia Geologica Polonica 71, 180 pp. (in Polish).
Nøhr-Hansen, H. & Dam, G. 1997: Palynology and sedimentology across a new marine Cretaceous-Tertiary boundary section on Nuussuaq, West Greenland. Geology 25 (9), 851-854.
Pacaud, J.-M. 1998: Nouvelles données sur le genre *Popenoeum* (Mollusca, Pseudolividae). Remarques taxonomiques sur une espèce ubiquiste du Paléocène inférieur, *Popenoeum ambiguum* (Binkhorst, 1861: *Pyrula*), nov. comb. Cossmanniana 5 (1–2), 1–28.
Pethö, J. in Zittel, K.A. 1882: Handbuch der Palaeontologie, Palaezoologie, 2: Mollusca und Arthropoda. München und Leipzig, 893 pp.
Pethö, J. 1906: Die Kreide (Hypersenon) Fauna des Peterwardeiner (Pétrovárader) Gebirges (Fruska Gora). Palaeontographica 52, 57–331.
Pezant, A. 1908: Mollusques fossiles de Monnevilles (Oise). La Feuille des Jeunes Naturalistes, Paris 4 ème série, no. 451, 132–138; no. 452, 158–161; no. 453, 173–178; no. 454, 192–202; no. 455, 224–229.
Ravn, J.P.J. 1939: Etudes sur les Mollusques du Paléocène de Copenhague. Det Kongelige Danske Videnskabernes Selskab. Biologiske Skrifter 1 (1), 103 pp.
Rosenkrantz, A. 1920: En ny københavnsk Lokalitet for forsteningsførende Paleocæn. Meddelelser fra Dansk Geologisk Forening 5, 1–10.
Rosenkrantz, A. 1970: Marine Upper Cretaceous and lowermost Tertiary deposits in West Greenland. Meddelelser fra Dansk Geologisk Forening 19, 406–453.
Sohl, N.F. 1964: Neogastropoda, Opisthobranchia and Basommatophora from the Ripley, Owl Creek, and Prairie Bluff Formations. United States Geological Survey, Professional Paper 331–B, 153–344.
Squires, R.L. 1989: A new Pseudolivine gastropod genus from the lower Tertiary of North America. Journal of Paleontology 63 (1), 38–47.
Squires, Zinsmeister, W.J. & Paredes-Mejía, L.M. 1989: *Popenoeum*, new Pseudolivine gastropod genus: Widespread and most diversified during the Paleocene. Journal of Paleontology 63 (2), 212–217.
Termier, G. 1954: Gastéropodes du Cretacé supérieur dans le Sud-Ouest de la France (Groupe 2). Bulletin de la Société d'Histoire naturelle de Toulouse, 89, 323–382.
Traub, F. 1979: Weitere Paleozän-Gastropoden aus dem Helvetikum des Haunsberges nördlich von Salzburg. Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Historische Geologie 19, 93–123.
Traub, F. & Werner, W. 1993: Biostratigraphische Einstufung der Gastropoden aus dem Paleozän (Tertiär) des Haunsberges (N Salzburg, Austria) anhand der internationalen Plankton-Foraminiferen-Zonierung. Zitteliana 20, 369–378.
Vermeij, G.J. & de Vries, T.J. 1997: Taxonomic remarks on Cenozoic Pseudolivid Gastropods from South America. The Veliger 40 (1), 23–28.
Vermeij, G.J. 1998: Generic Revision of the Neogastropod Family Pseudolividae. The Nautilus 111 (2), 53–84.
Villatte, J. 1970: Deux Olividae identiques: *Pseudoliva prima* (Defrance) et *Pseudoliva poursanensis* Doncieux. Bulletin de la Societé d'Histoire Naturelle de Toulouse 106 (1–2), 22–27.
Vincent, G. 1878: Description de la faune de l'étage Landénien inférieur de Belgique. Annales de la Societé Royale Malacologique de Belgique 11, 111–160.
Vincent, E. 1928: Observations sur lec couches montiennes traversées au Puits no 2 du Charbonnage d'Eyden, près de Maaseyck (Limbourg). Bulletin de l'Académie Royale de Belgique, classe des Sciences 14 (1/2), 554–568.
Wade, B. 1917: New and Little known Gastropoda from the Upper Cretaceous of Tennessee. Proceedings of the Philadelphia Academy of Natural Science 69, 280–304.
Wade, B. 1926: The fauna of the Ripley Formation on Coon Creek, Tennessee. United States Geological Survey, Professional Paper 137, 1–272.
Zinsmeister, W.J. 1983: New Late Paleocene molluscs from the Simi Hills, Ventura County, California. Journal of Paleotology 57, 1282–1303.