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The stratigraphic distribution of Pliocene molluscs from deposits of the northern Peel district in The Netherlands

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Fifteen well-borings in a fault block of the Peel-horst yielded 132 samples of fossil shell-bearing sediment layers. A total of 177 species was identified, of which 88 are gastropods, 86 bivalves and 3 scaphopods. Two biozones could be distinguished, an upper zone, here called the *Cerastoderma edule hostiei* range-zone, and a lower zone, here called the *Pseudamussium gerardi* range-zone. The stratigraphic distribution of the species is shown in table 2, as are the thickness and depth of the zones (table 1). An interzone of 1-2.5 m is present. Two small species, *Semierycina kautskyi* and *Cingula inusitata*, show their greatest concentration here. Table 3 proposes a correlation with the marine Pliocene of Belgium. The Kattendijkien appears to be absent in the area investigated. Glibert (1958) records a number of species from the Belgian part of this deposit and Janssen, Peeters & Van der Slik (1984) deport these from the Dutch beaches and estuaries. Only two of the species not mentioned by the above authors from more recent deposits, have been found in the Peel material, viz., *Pygocardia rustica tumida* and *Philine quadrata*, the latter still occurring in the North Sea.

Key words: Gastropoda, Bivalvia, Scaphopoda, stratigraphy, Pliocene, The Netherlands.

INTRODUCTION

Outcrops of marine Pliocene deposits do not occur in the Netherlands. On the other hand, a large number of Pliocene molluscs is found on the beaches of the province of Zeeland in the SE. of the Netherlands. They have been washed ashore by marine erosion. These specimens were the subject of many publications e.g. of Altena (1937), Altena et al. (1954-1969), Janssen & Van der Slik (1971-1978), and Janssen et al. (1984). However, very little is known about the stratigraphic sequence of Pliocene molluscs in the subsoil of the northern Peel region near the river Meuse, where a neritic facies with a rich fauna is present.

Tesch (1912) reported a number of species from the region Grave-Oss, but was not able to make a more precise study of the stratigraphic distribution of species because of the absence of sufficiently detailed sampling at various depths. Later on the collections of Tesch were revised by Beets (1945) and Heering (1950).

In the present paper the results are reported of a stratigraphical study based on hitherto undescribed material from the northern Peel district.

MATERIAL

A total of 132 samples of sediment with a volume of 350-400 cubic centimetres each were taken from 15 well-borings, 6 of which are located near the village Macharen, 6 near Berghem, and 3 in the town of Oss. All borings are situated on the same fault

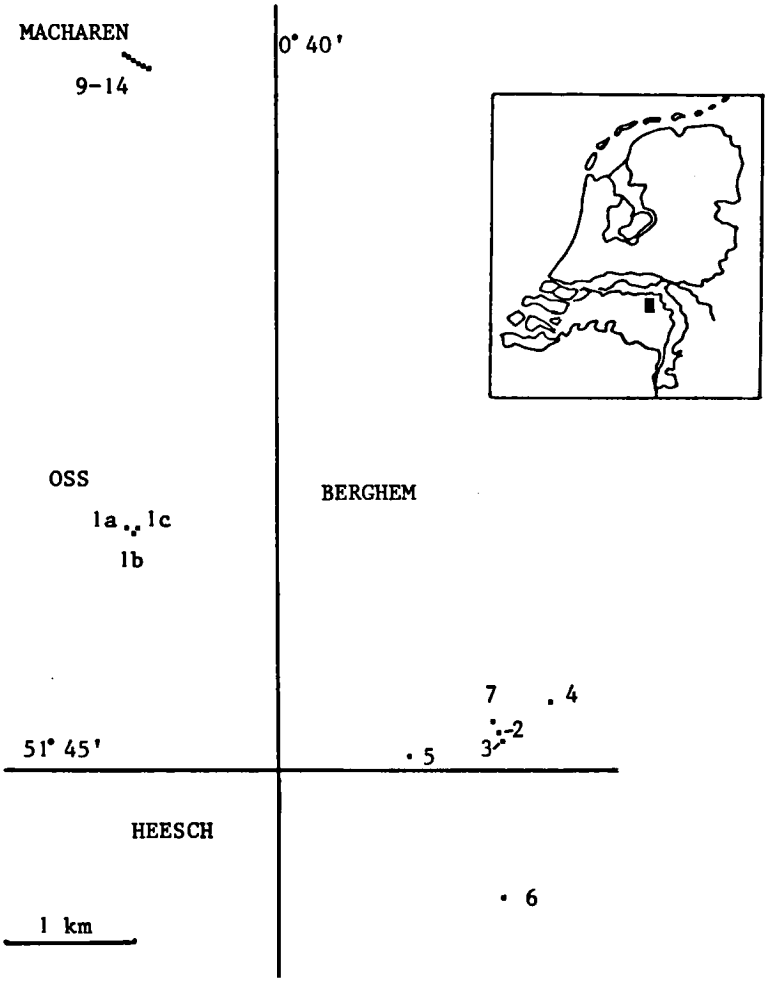

Fig. 1. Study area and boring locations in the northern Peel-horst region of the Netherlands.

block of the Peel-horst. The sediments consist of sand, silty sand, shells and shell fragments. The lower part often contains glauconite grains. The position of the borings is shown in fig. 1.

Complete shells as well as recognizable fragments (the major part) were collected and identified. Sixteen species have been reported earlier as at that time new to the Dutch Pliocene (Van der Burg, 1950, 1952, 1958). All material is kept in the private collection of the present author.

RESULTS

From the samples 177 species were collected, viz. 86 bivalves, 88 gastropods and 3 scaphopods.

Two biozones could easily be distinguished:

— (1) a lower zone characterized by the bivalves *Pseudamussium gerardi* (Nyst, 1835), *Astarte omalii* De la Jonkaire, 1823, and *Astarte fusca basteroti* De la Jonkaire, 1823;

— (2) an upper zone characterized by the bivalves *Cerastoderma edule hostiei* Chavan, 1945, *Spisula inaequilatera* (Nyst, 1845), and the gastropods *Nassarius propinquus* (Sowerby, 1824), *Eulimene terebellata* (Nyst, 1835), and *Littorina suboperta* (Sowerby, 1813).

"Characterized by" in the present case means that the species are common or particularly abundant in their zone and that none of them was found in both zones. Since *Pseudamussium gerardi* and *Cerastoderma edule hostiei* are the most abundant species of those mentioned, they will be used here for the naming of the two biozones. The *C. edule hostiei* range-zone is overlain by fluviatile sand and gravel deposits of Pleistocene age. Below the *P. gerardi* range-zone very dense silt and silty clay deposits almost devoid of macrofossils are present. Whether these deposits are of Pliocene or Miocene age has to be decided on the basis of their microfauna. In one of the Macharen borings a number of valves of the small *Portlandia pygmaea* (Von Münster, 1837) were found at 32 m below the *P. gerardi* range-zone, which points to a Miocene age. Between the two biozones there is a gap (interzone) of 1-2.5 m in which two very small species are found in peak quantities, viz. *Cingula inusitata* (Beets, 1946) and *Semierycina kautskyi* (Glibert, 1945), vide fig. 2. The latter species is occasionally found with the valves united. This all suggests a period of more quiet sedimentation, though no conspicuous lithological differences with the adjacent strata could be observed. The presence of a disconformity between the two biozones cannot be excluded either.

Table 1 gives the approximate thickness and depth of the zones in the three localities. The lower limit of the *P. gerardi* range-zone has not been reached in the borings of Oss.

	Cerastoderma edule hostiei range-zone	*Pseudamussium gerardi* range-zone
Macharen	15 (42-57)	6.5 (59-65.5)
Oss	11.5 (32.5-44)	4 + ? (45-?)
Berghem	9.0 (36-45)	9.5 (47-56.5)

Table 1. Approximate thickness and depth (in brackets) in metres below surface.

In table 2 a list of the species is given together with the zone in which they have been found. The *C. edule hostiei* range-zone correlates well with the Merxemien of Belgium and the *P. gerardi* range-zone correlates with the Scaldisien of that country. A lower part of the Belgian Pliocene, the Kattendijk formation, appears to be absent in the northern Peel district. Of the 26 bivalves mentioned by Janssen et al. (1984) that have been attributed to the Kattendijk formation only, or have their upper limit of occurrence in that formation, only one, *Pygocardia rustica tumida* (Nyst, 1836), was found in the material of the present study. In addition, of the 13 gastropods and bivalves that,

	C	P
GASTROPODA		
Emarginula reticulata Sowerby, 1813	r	-
Lepeta scaldensis Van Regteren Altena, 1954	r	-
Gibbula gelriana Beets, 1946	r	-
Solariella maculata Wood, 1842	-	r
Littorina (*Melaraphe*) *suboperta* (Sowerby, 1813)	c	-
Eulimene terebellata (Nyst, 1835)	c	-
Cingula inusitata (Beets, 1946)	c	r
Rissoa parva interrupta (Adams, 1800)	-	r
Rissoa obsoleta Wood, 1848	-	r
Rissoa curticostata Wood, 1848	-	r
Alvania zetlandica (Montagu, 1815)	r	-
Tornus belgicus (Glibert, 1949)	c	r
Circulus hennei (Glibert, 1952)	r	-
Turritella triplicata (Brocchi, 1814) forma *erthensis* Harmer, 1918	r	-
Turritella triplicata (Brocchi, 1814) forma *incrassata* Sowerby, 1814	r	c
Turritella triplicata (Brocchi, 1814) forma *subangulata* Harmer, 1918	r	-
Turritella tricarinata tricarinata (Brocchi, 1814)	-	r
Turritella tricarinata communis Risso, 1826	-	r
Turritella suttonensis Beets, 1946	-	r
Turritella tornata Brocchi, 1814	-	r
Potamides tricinctus (Brocchi, 1814) forma *icenica* Harmer, 1918	c	-
Potamides tricinctus (Brocchi, 1814)	c	-
Epitonium frondiculum (Wood, 1842)	r	-
Epitonium greenlandicum (Perry, 1811)	-	r
Epitonium clathratulum (Kanmacher, 1798)	-	r
Epitonium (*Acrilloscala*) *geniculatum* (Brocchi, 1814)	-	r
Amaea (*Clathroscala*) *cancellata* (Brocchi, 1814)	-	r
Strombiformis glaber (Da Costa, 1778)	r	r
Capulus ungaricus (Linné, 1758)	r	r
Calyptraea chinensis (Linné, 1758)	c	c
Xenophora deshayesi (Michelloti, 1847)	-	r
Aporrhais pespelicani quadrifidus Da Costa, 1778	-	r
Aporrhais scaldensis Van Regteren Altena, 1954	c	c
Natica multiplicata Wood, 1842	c	r
Polinices catenoides (Wood, 1842)	r	r
Polinices catena (Da Costa, 1778)	r	-
Polinices hemiclausus (Sowerby, 1824) forma *proxima* Wood, 1848	r	-
Polinices cirriformis (Sowerby, 1824)	-	r
Galeodea bicatenata (Sowerby, 1817)	-	r
Trophon muricatus (Montagu, 1803)	-	r
Pyrene (*Mitrella*) *sulcata* (Sowerby, 1823)	-	r
Pyrene (*Mitrella*) *scaldensis* Van Regteren Altena, 1956	r	r
Colus curtus (Jeffreys, 1867)	r	r
Liomesus dalei (Sowerby, 1825)	r	-
Neptunea contraria (Linné, 1771)	r	r
Nassarius (*Hinia*) *consociatus* (Wood, 1848)	c	c
Nassarius (*Hinia*) *propinquus* (Sowerby, 1824)	a	-
Nassarius (*Hinia*) *reticosus* (Sowerby, 1815)	c	c
Nassarius (*Hinia*) *macharensis* Van der Burg, 1958	-	r
Nassarius (*Amyclina*) *labiosus* (Sowerby, 1824)	a	a
Nassarius (*Amyclina*) *lamellilabrus* (Nyst, 1835)	r	c
Dolicholathyrus rothi (Beyerich, 1856)	-	r
Scaphella lamberti (Sowerby, 1816)	r	c
Cancellaria jonkairiana Nyst, 1835	-	r
Admete viridula (Fabricius, 1780)	-	r
Admete gracilenta (Wood, 1872)	r	r
Turris inermis Partsch, 1842	-	r
Turris antwerpiensis (Vincent, 1890)	r	r
Genus spec. nov.[1]	-	r
Clavus modiolus (Cristofori & Jan, 1832)	-	r
Asthenotoma bipunctula (Wood, 1879)	r	-
Moniliopsis neerlandica Beets, 1946	r	-
Mangelia substriolata (Harmer, 1918)	r	r
Mangelia tenuistriata (Bell, 1871)	-	r
Terebra inversa Nyst, 1835	c	c
Terebra canalis Wood, 1848	-	r
Acteon batavus Beets, 1946	-	r
Acteon noae Sowerby, 1822	r	r
Acteon tornatilis (Linné, 1758)	-	r
Ringicula ventricosa (Sowerby, 1824)	-	r
Menestho britannica Bell, 1871	r	-
Chrysallida indistincta (Montagu, 1808)	r	-
Odostomia conoidea (Brocchi, 1814)	c	c
Eulimella laevis (Brown, 1827)	r	r
Turbonilla internodula (Wood, 1848)	-	r
Turbonilla senistriata (Wood, 1879)	r	-
Pyramidella plicosa Brown, 1838	-	c
Rhizorus acuminatus (Bruguière, 1792)	r	c
Retusa subcylindrica (Brown, 1827)	-	r
Cylichna cylindricea (Pennant, 1777)	r	c
Roxania utriculus (Brocchi, 1844)	-	r

	C	P
Scaphander lignarius (Linné, 1758)	r	c
Philine scabra (Müller, 1776)	-	r
Philine quadrata (Wood, 1839)	-	r
Ellobium pyramidale (Sowerby, 1824)	r	r
Ellobium pyramidale striata (Harmer, 1923)	r	-
SCAPHOPODA		
Dentalium sexangulum Gmelin, 1790	-	r
Dentalium rectum Gmelin, 1789	r	-
Dentalium cf. *vulgare* (Da Costa, 1778)	-	r
LAMELLIBRANCHIA		
Leionucula laevigata (Sowerby, 1818)	r	r
Nucula nucleus (Linné, 1758)	c	c
Portlandia pygmaea (von Münster, 1837)	-	r
Yoldia semistriata (Wood, 1840)	c	c
Glycymeris glycymeris variabilis (Sowerby, 1824)	a	r
Glycymeris glycymeris deshayesi (Mayer, 1868)	-	r
Limopsis anomala (Eichwald, 1830)	-	r
Mytilus edulis Linné, 1758	c	-
Atrina fragilis (Pennant, 1777)	-	c
Pecten complanatus Sowerby, 1826	c	c
Lyropecten (Aequipecten) opercularis (Linné, 1758)	a	a
Pseudamussium (Palliolum) tigerinus (Müller, 1776)	-	r
Pseudamussium (Palliolum) gerardi (Nyst, 1835)	-	a
Lima (Limea) loscombi (Sowerby, 1823)	-	r
Lima (Limatula) sulcata (Brown, 1827)	-	r
Pododesmus (Heteranomia) squamula (Linné, 1758)	a	a
Ostrea edulis Linné, 1758	r	-
Astarte obliquata obliquata Sowerby, 1817	c	a
Astarte obliquata burtinea De la Jonkaire, 1823	-	r
Astarte omalii De la Jonkaire, 1823	-	c
Astarte fusca basteroti De la Jonkaire, 1823	-	c
Astarte sulcata (Da Costa, 1778)	-	r
Astarte trigonata Nyst, 1881	-	r
Astarte galeotti (Nyst, 1835)	-	r
Astarte incerta Wood, 1853	c	a
Tridonta montagui (Dillwyn, 1877)	r	r
Goodallia triangularis (Montagu, 1803)	c	c
Digitaria excurrens (Wood, 1853)	-	r
Digitaria digitaria (Linné, 1758)	c	c
Cyclocardia chamaeformis (Sowerby, 1825)	c	-
Cyclocardia orbicularis (Sowerby, 1825)	-	r
Cyclocardia scalaris (Sowerby, 1825)	a	a
Pteromeris corbis (Philippi, 1836)	c	c
Glossus humanus (Linné, 1758)	-	r
Arctica islandica (Linné, 1767)	c	c
Pygocardia rustica rustica (Sowerby, 1818)	r	c
Pygocardia rustica tumida (Nyst, 1836)	-	r
Diplodonta rotundata (Montagu, 1803)	r	-
Felaniella trigonula astartea (Nyst, 1835)	r	c
Lucinoma borealis (Linné, 1767)	c	c
Parvilucinoma scaldensis (Glibert & Van de Poel, 1967)	r	r
Semierycina kautskyi (Glibert, 1945)	a	r
Mysella bidentata (Montagu, 1803)	c	r
Spaniorinus ambiguus (Nyst & Westendorp, 1839)	r	r
Phascoliphila coarctata (Wood, 1851)	-	r
Laevicardium decorticatum (Wood, 1840)	a	r
Cerastoderma edule hostiei (Chavan, 1945)	a	-
Parvicardium papillosum (Poli, 1795)	-	r
Parvicardium scabrum (Philippi, 1844)	-	r
Cardium cf. *fasciatum* (Montagu, 1808)	-	r
Gouldia minima (Montagu, 1803)	r	r
Pitar rudis (Poli, 1795)	-	r
Callista chione (Linné, 1758)	-	r
Dosina exoleta (Linné, 1758)	c	r
Dosinia lupinus lincta (Pulteney, 1799)	r	-
Venus imbricata (Sowerby, 1826)	-	r
Venus cassina (Linné, 1758)	-	r
Timoclea ovata (Pennant, 1777)	a	a
Venerupis rhomboides (Pennant, 1777)	c	r
Venerupis senegalensis (Gmelin, 1791)	r	-
Spisula inaequilatera (Nyst, 1845)	a	-
Spisula elliptica (Brown, 1827)	c	c
Lutraria spec. indet.	-	r
Donax variegatus (Gmelin, 1791)	r	-
Gari fervensis (Gmelin, 1791)	c	-
Albra alba (Wood, 1802)	r	-
Abra prismatica (Montagu, 1803)	-	r
Arcopagia crassa (Pennant, 1778)	r	-
Arcopagia spec. (juv.?)	-	r
Macoma obliqua (Sowerby, 1817)	c	-
Macoma praetenuis (Leathes in Woodward, 1833)	r	-
Angulus donacinus (Linné, 1758)	c	c
Tellina benedeni Nyst & Westendorp, 1839	c	r
Phaxas pellucidus (Pennant, 1777)	c	c
Ensis degrangei Cossmann & Peyrot, 1909	c	c
Ensis cf. *complanatus* Sowerby, 1844	r	-
Hiatella arctica (Linné, 1758)	r	c

	C	P		C	P
Turneria jeffreysi (Winckworth, 1930)	r	r	*Lentidium complanatum* (Sowerby, 1822)	a	c
Panopea faujasi Ménard de la Groye, 1807	r	c	*Mya arenaria* Linné, 1758	c	r
Cyrtodaria angusta (Nyst & Westendorp, 1839)	c	c	*Mya truncata* Linné, 1758	r	-
Corbula gibba (Olivi, 1792)	a	a	*Teredo* spec. (borings in wood)	r	-
			Barnea candida (Linné, 1758)	-	r

[1] This species will be described in due course in the present journal.

Table 2. List of the species of the Peel samples. C = *Cerastoderma edule hostiei* range-zone, P = *Pseudamussium gerardi* range-zone, a = abundant, c = common, r = rare, a dash means absent.

according to Glibert (1958), have their upper limit of occurrence in the Belgian Kattendijk formation or are limited to that formation, only *Philine quadrata* (Wood, 1839) has been found in the Peel material. Although these are in fact negative data, these indicate that the "Sande von Grave-Oss" in the northern Peel region most probably are not equivalent to the Kattendijk formation as has been suggested by Janssen & Van der Mark (1968); at least, this cannot be concluded on the basis of the malacofauna.

In table 3 a correlation is proposed for the marine Pliocene of the northern Peel district with that of Belgium.

Belgium	Northern Peel district
Merxemien	*Cerastoderma edule hostiei* range-zone
Scaldisien	*Pseudamussium gerardi* range-zone
Kattendijkien	hiatus

Table 3. Correlation of the marine Pliocene of the northern Peel district with that of Belgium.

In fig. 2 depth/frequency diagrams of four of the more characteristic species of the Macharen borings are given. One of these, *Semierycina kautskyi*, appears for the first time in the uppermost part of the *P. gerardi* range-zone. As was shown by Janssen & Van der Mark (1969), a number of species, including *S. kautskyi*, have wrongly been reported from the Miocene of Belgium (Glibert, 1958). Therefore this species seems to be a real Pliocene mollusc.

As mentioned before a large number of Pliocene molluscs has been found washed ashore in the province of Zeeland. So far only 12 gastropods and 2 bivalves collected from our samples have not been reported from the Zeeland beaches.

It is often difficult to show that the occurrence of a species is limited to a specific stratum, in particular if, as in our case, the shells have been taken from relatively small samples of borings. However, *Littorina suboperta* and *Eulimene terebellata* are so common in the *C. edule hostiei* range-zone and quite absent in the samples of the *P. gerardi* range-zone, that we can say that most probably the specimens found on the Zeeland shores have been washed up from Merxemien deposits and not from Scaldisien deposits, as was supposed by Altena, Bloklander & Pouderoyen (1954). In a similar way we may deduce from the present study that, in contrast to the supposition of Janssen & Van der Mark (1984), *Astarte omalii* from the Zeeland shores is of Scaldisien origin only, and

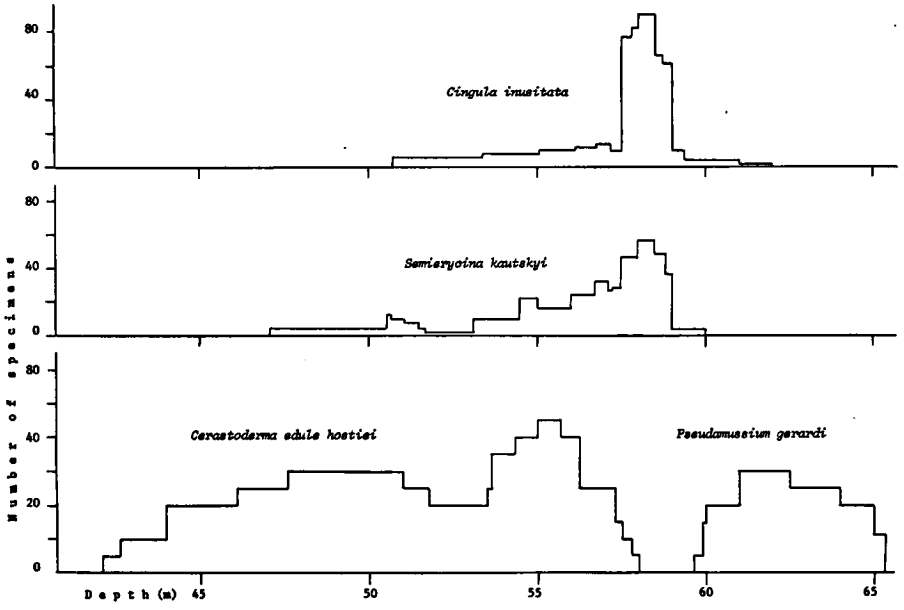

Fig. 2. Depth/frequency diagrams of four species of molluscs in the Macharen borings.

that *C. edule hostiei* is of Merxemien and not of Scaldisien origin. The latter species was also reported from the Belgian Miocene by Glibert (1958). However, as was shown by Janssen & Van der Mark (1969), this was due to inaccurate sampling by his students. It is likely that the reported finding of *C. edule hostiei* in the Belgian Scaldisien is likewise an error. It is sad to see that of the beautiful work of Glibert the stratigraphical part is largely spoiled by inadequate shell collecting.

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SAMENVATTING

De stratigrafische verspreiding van Pliocene mollusken uit afzettingen van het noordelijke Peeldistrict

Van 15 boringen, verricht op een breukschol van de noordelijke Peelhorst (fig. 1), werden 132 monsters van de fossiele schelpenbevattende sedimentlagen genomen en de daarin voorkomende mollusken gedetermineerd. Gevonden werden 177 soorten, waarvan 88 gastropoden, 86 bivalven en 3 scaphopoden.

Twee biozones konden onderscheiden worden, een bovenste, de *Cerastoderma edule hostiei*-range-zone en een onderste, de *Pseudamussium gerardi*-range-zone. De stratigrafische verspreiding van de gevonden soorten is weergegeven in tabel 1, terwijl de dikte en diepte van de zones is vermeld in tabel 2. Een interzone van 1 tot 2½ meter is aanwezig. Juist daar zijn twee kleine soorten, *Semierycina kautskyi* en *Cingula inusitata*, in de grootste concentratie aanwezig (fig. 2).

Een correlatie met het mariene Plioceen van België wordt voorgesteld (tabel 3). De Kattendijk-formatie blijkt in het onderzochte gebied op de noordelijke Peelhorst niet voor te komen. Glibert (1958) noemt een aantal soorten van het Belgisch deel van deze formatie en Janssen, Peeters & Van der Slik (1984) van de Nederlandse stranden en zeegaten. Van het deel der soorten dat door deze auteurs niet uit jongere lagen vermeld wordt, zijn er slechts twee ook in het huidige Peelmateriaal aanwezig, nl. *Pygocardia rustica tumida* en *Philine quadrata*. Bovendien komt laatstgenoemde soort nog in de recente Noordzeefauna voor.