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# LOWER AND MIDDLE OLIGOCENE DEPOSITS FROM THE DOBERG NEAR BÜNDE (WESTFALIA, F.R.G.) BATHYMETRIC INTERPRETATION OF THE OSTRACOD FAUNA

by

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The ostracods from the Lower and Middle Oligocene deposits at Piepenhagen near Bünde (F.R.G., North Rhine-Westfalia) indicate an increasing water-depth from an upper sublittoral to a bathyneritic environment. This is interpreted as a sea-level rise, resulting in a transgression of the sea in Latdorfian and Rupelian times.

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## SAMENVATTING

Onder- en midden-oligocene afzettingen van de Doberg bij Bünde (Westfalen, Bondsrepubliek Duitsland). Bathymetrische interpretatie van de ostracodenfauna.

De ostracodenfauna uit de onder- en midden-oligocene afzettingen van Piepenhagen bij Bünde (Bondsrepubliek Duitsland, Nordrhein-Westfalen) wijst op een toenemende waterdiepte, van het bovenste sublittoraal tot een bathyneritisch milieu. Dit wordt opgevat als een zeespiegelrijzing, die resulteerde in een transgressie van de zee gedurende het Latdorfien en Rupelien.

## INTRODUCTION

The Lower Oligocene deposits of the Doberg near Bünde (F.R.G., North Rhine-Westfalia) were excellently exposed East of the brickyard Piepenhagen, when the Autobahn (BAB) from Bad Oehnhausen to Osnabrück was built. In 1969, when the excavation had just started, the lowermost beds were accessible during the Oligocene-Excursion 1969. In the following time samples of the whole sequence below the Rupelian clay were taken. These samples were examined by Benedek & Müller (1976) for dinoflagellates and calcareous nannoplankton (fig. 2). The intention of the present paper is to give a view on the distribution of ostracods within the section and to interprete the bathymetric meaning of the ostracod associations. Comparable investigations on the Late Oligocene/Miocene ostracod faunas of NW Germany were published by Uffenorde in 1981 and 1986.

In 1894, a first examination of ostracods from the locality "Brandhorst", also at Bünde, was published by Lienenklaus. A detailed description of the faunas from the localities "Brandhorst", "Vahrenkamp" and "Piepenhagen" was given by Moos in numerous publications (1963-1973). Furthermore ostracods from Bünde were cited in Anderson et al. (1969), Pietrzeniuk (1969), Szczechura (1977) and Gramann (1986). The exact position of the localities mentioned above was given by Gramann (1964: 208-210). None of these publications, however, described the vertical range and distribution of the ostracods within the sequence.

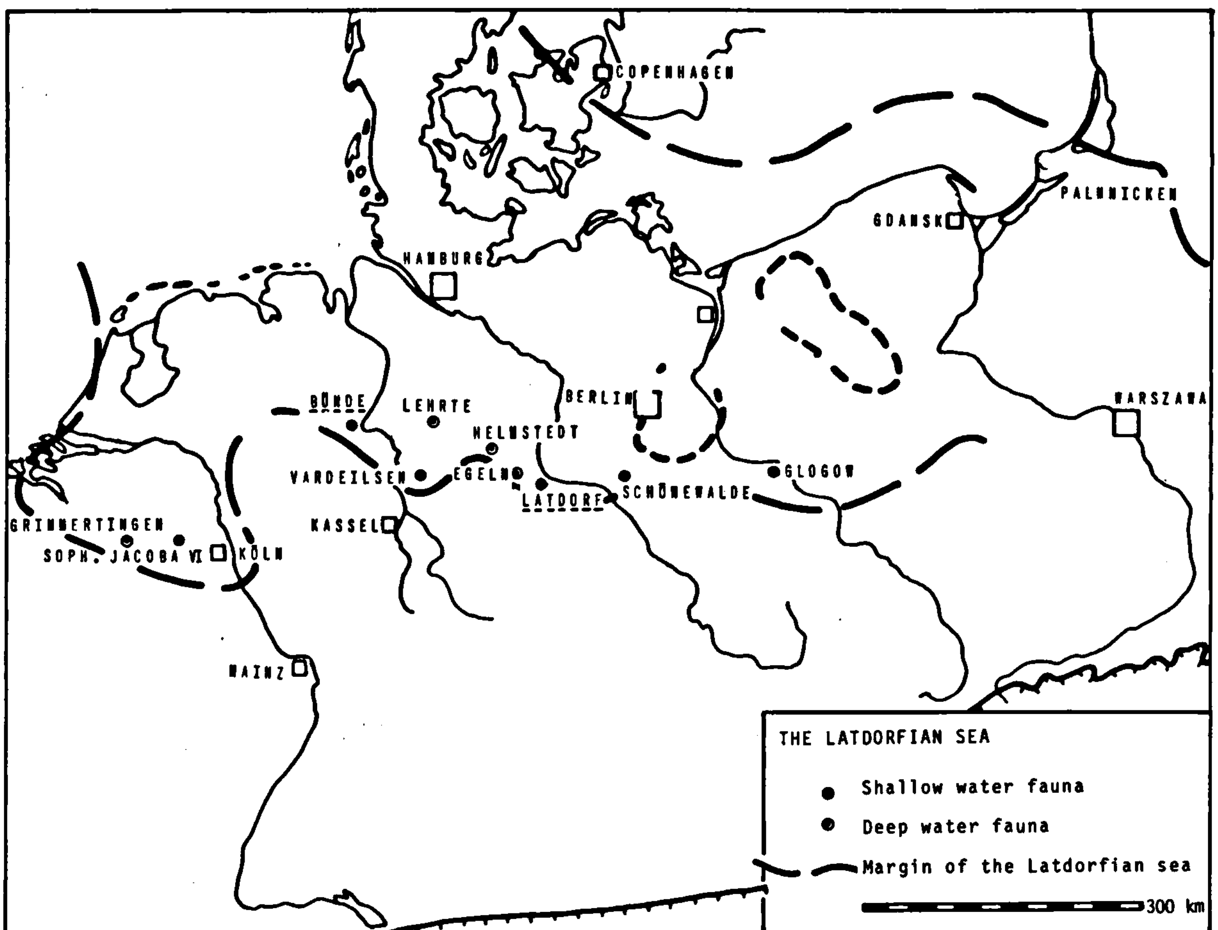



Fig. 1. Location of Bünde and extension of the Latdorfian sea in NW Europe.

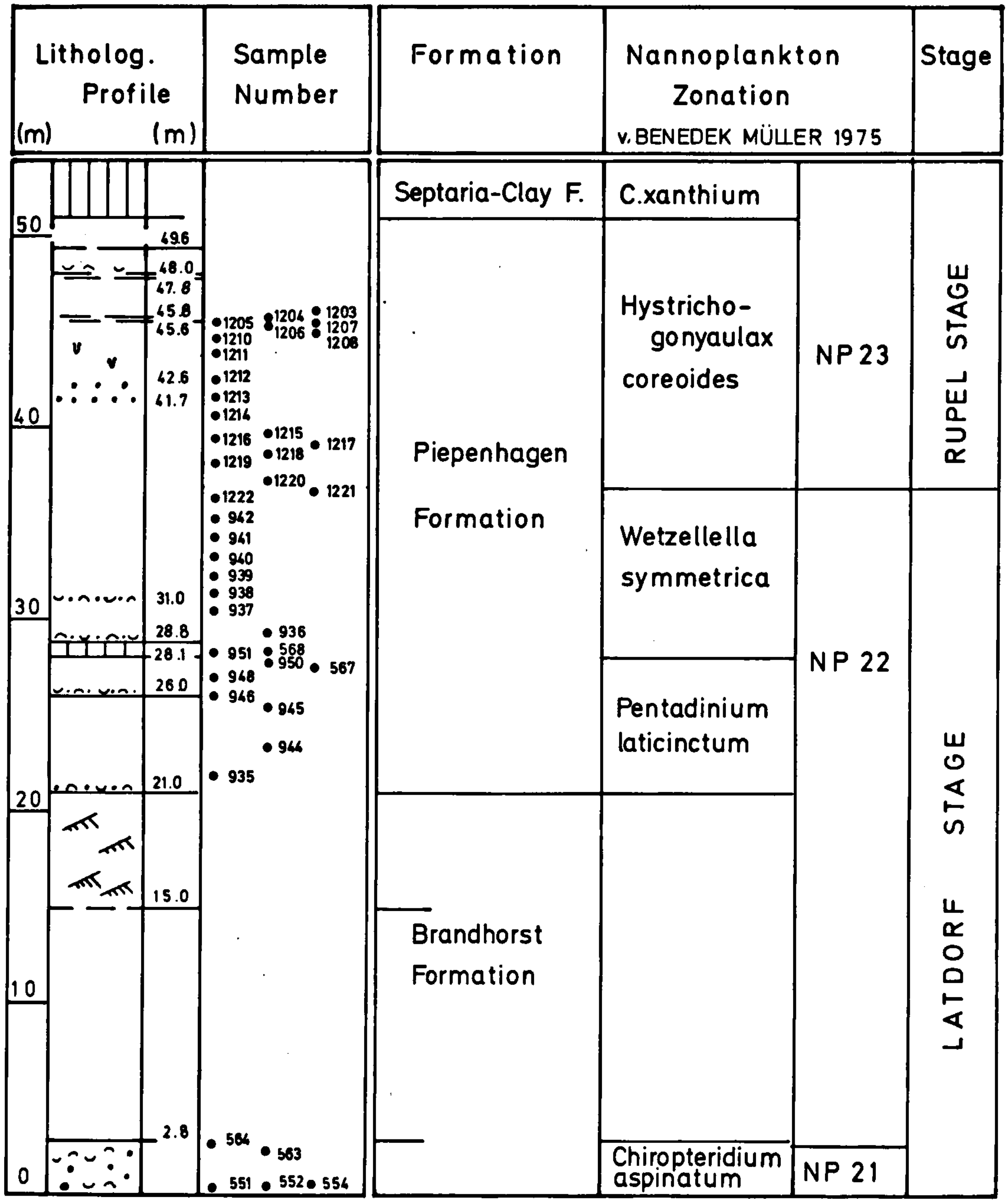



Fig. 2. Lithology and location of samples in the Piepenhagen section, and nannoplankton zonation.

Already in 1866, von Koenen found out that the sandy sequence was overlain by the Middle Oligocene Septaria-clay Formation and contained a mollusc fauna of Early Oligocene character. Müller (1976) described calcareous nannoplankton of zones NP 21, 22 and 23 from my sample collection. She proposed to define the NP 22/NP 23 boundary as the boundary between the Latdorfian and Rupelian stages (fig. 2).

Gramann (in Anderson et al., 1969) was the first to introduce the "Brandhorst Formation" as a formal designation of the fossiliferous sands lying directly on top of the Liassic shales (Gramann, 1986: 419). Kaever & Oekentorp (1970) added the term "Piepenhagen Formation" for the higher part of the sandy sequence. In the present paper these terms are differently used:

Piepenhagen Formation — for the sequence above 21.0 m, up to the Septaria-clay Formation
Brandhorst Formation — from 0.-21.0 m.

## THE DISTRIBUTION OF THE OSTRACODS AND THEIR BATHYMETRIC INTERPRETATION

For an easier orientation the Brandhorst and Piepenhagen formations are subdivided in the horizons A (bottom) to J (top) (fig. 3). The distribution of the species is given in fig. 4.

Horizon A: 0.0-2.8 m = 2.8 m.

The fossiliferous fine-grained basal part of the Brandhorst Formation, which belongs to the nannoplankton zones NP 21 and 22, can be subdivided in four different parts:

Subhorizon A 1: 0.0-1.1 m = 1.1 m: Leguminocythereis-Quadracythere Horizon.

On the altered Liassic shales lies the transgressive basal layer of the Oligocene sea, mean carbonate content 58.2%, containing abundant Foraminifera (*Nummulites, Pararotalia, Asterigerina*) (Grossheide & Trunko, 1965; Gramann, 1964). The genera *Leguminocythereis* and *Quadracythere* (*Hornibrookella*) together represent 79 to 96% of the ostracod fauna. *Bradleya, Schuleridea, Pokornyella, Cnestocythere* and *Hazelina* are present in smaller portions. Both the thick-shelled and sculptured forms and the low number of species and specimens indicate a high-energetic, shallow sea (Szczechura, 1977). Balanids from the intertidal zone are absent. There are practically no elements of biocoenoses below the middle wave base (MWB). The horizon A 1 can be considered a biocoenosis of the upper sublittoral environment.

Subhorizon A 2: 1.1-1.9 m = 0.8 m: Bryozoan Horizon.

The main faunistic feature of this horizon is the bryozoan fauna. Some corals can also be present. This obviously has led to the former signification as "marls". The mean carbonate content equals 32.7%. Nummulites and ostracods are missing. It can be assumed that the Liassic shales or shell-beds of subhorizon A 1 formed the firm basis for the bryozoans. This thanatocoenosis indicates a position in the upper sublittoral environment.

Subhorizon A 3: 1.9-2.6 m = 0.7 m.

The subhorizon A 3 contains the foraminifer genera *Nummulites, Pararotalia, Asterigerina* and *Reussella*, but no ostracods or bryozoans. The carbonate content of sample 563 equals 9.3%.

Subhorizon A 4: 2.6-2.8 m = 0.2 m: Hermanites-Cytheretta Horizon.

In this sample (no. 564, carbonate content 24.7%) which Müller (1976) attributes to the nannoplankton zone NP 22, *Leguminocythereis* and *Quadracythere* form together 25% of the total number of specimens. *Echinocythereis* cf. *scabra, Cytheretta eocaenica* and *Hermanites camelus* appear for the first time and form together 70% of the fauna. *Hazelina indigena* as well as *Schuleridea* (*A.*) *perforata cognata* are remarkably common. *Bradleya*, *Pokornyella* and *Cnestocythere* are missing, as well as representatives of the phytalzone. This fauna indicates upper sublittoral environment.

Horizon B: 2.8-15 m = 12 m.

The homogeneous unfossiliferous sequence of horizon B consists of middle to fine-grained sand and has a thickness of 12 to 15 m. Kaever & Oekentorp (1970: 554) estimated a thickness of some 20 metres. It can be assumed that these sands were deposited under near-shore conditions, respectively in the transition from upper to middle sublittoral environment.

Horizon C: 15-21 m = 6 m.

The greenish fine sands of horizon C are characterized by a trough cross-bedding, which has to be interpreted as migrating dunes. There is no calcareous fauna. Kaever & Oekentorp (1970) mentioned only few and small burrows. This sequence is said to be deposited under conditions of the lower shore-face.

Horizon D: 21-28 m = 7 m.

The mean carbonate content of this horizon equals 17.2%. The ostracod fauna consists of many species and specimens. The main forms are *Bairdia gliberti, Eucytherura macropora* and *Schizocythere buendensis simile*. Besides *Bairdia* there are numerous taxa like *Loxoconcha, Cytheropteron, Xestoleberis, Microcytherura, Propontocypris* and *Paracytheridea*, which used to live on submerged plants (Hartmann, 1975). *Cytherella praesulcata* and *Loxoconcha subovata* are restricted to horizon D. Occasionally specimens of *Pterygocythereis* occur. This fauna originates from the euphotic zone (infralittoral zone). It is located higher than the pterygokline (Liebau, 1980) in the middle sublittoral zone.

According to Liebau the pterygokline corresponds to the storm wave base. Shell layers with small pebbles of Liassic shales at 21 to 26 m in the section can be considered as products of stormy events (tempestites). The fine-grained sand indicates a deep epineritic facies, characterized by undulating water movement.

Horizon E: 28.1-28.8 m = 0.7 m.

The carbonate content of sample nr. 951 is 7.2%. The ostracod fauna (samples nrs 950, 951, 568) shows an intermediate frequency of species and specimens. The characteristic forms are *Pterygocythereis* (4 species), *Cytherella* sp. div., *Eucytherura macropora* and *Schizocythere buendensis simile*. Only few specimens of *Henryhowella asperrima* were found. Ostracods from the phytal zone decrease in importance. *Bairdia* occurs only in a single sample. The upper boundary of the bathymetric distribution of recent *Pterygocythereis* species represents an excellent bathymetric marker: the pterygokline (Liebau, 1980). The mean water-depth of this boundary is approximately 25 to 30 m in epicontinental seas. It coincides with the storm wave base and marks the transition of undulating to stagnant water, i.e. the boundary between middle and lower sublittoral resp. epineritic and infraneritic biofacies.

Horizon F: 28.8-37.0 m = 8.2 m.

Horizon F shows nearly the same characteristic features as horizon D. *Henryhowella asperrima* and *Pterygocythereis* species occur only sporadically in numbers below 5%. In the mainly fine-grained sands, with a mean carbonate content of 15.9%, several shell-layers with coarse sand are intercalated

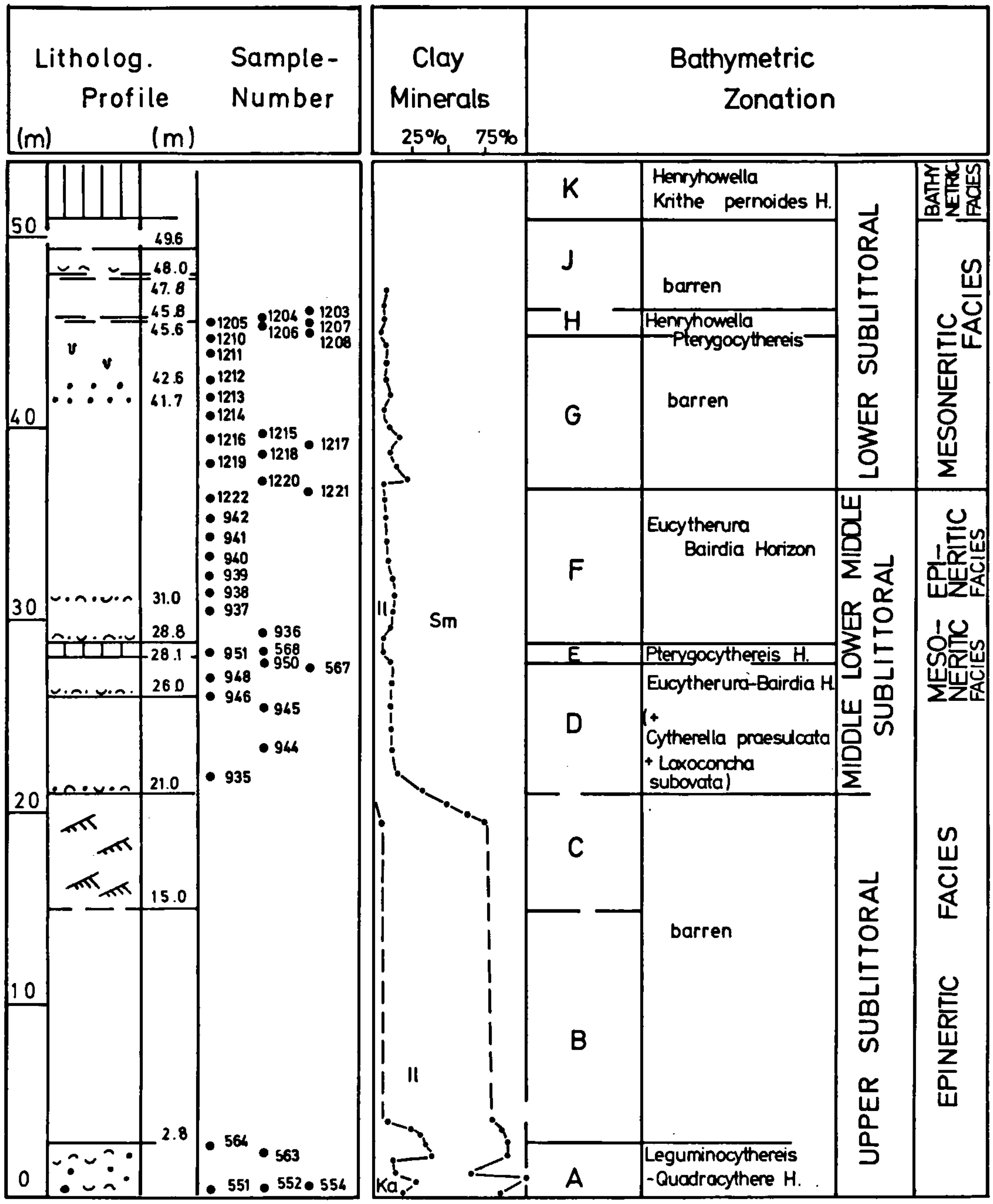
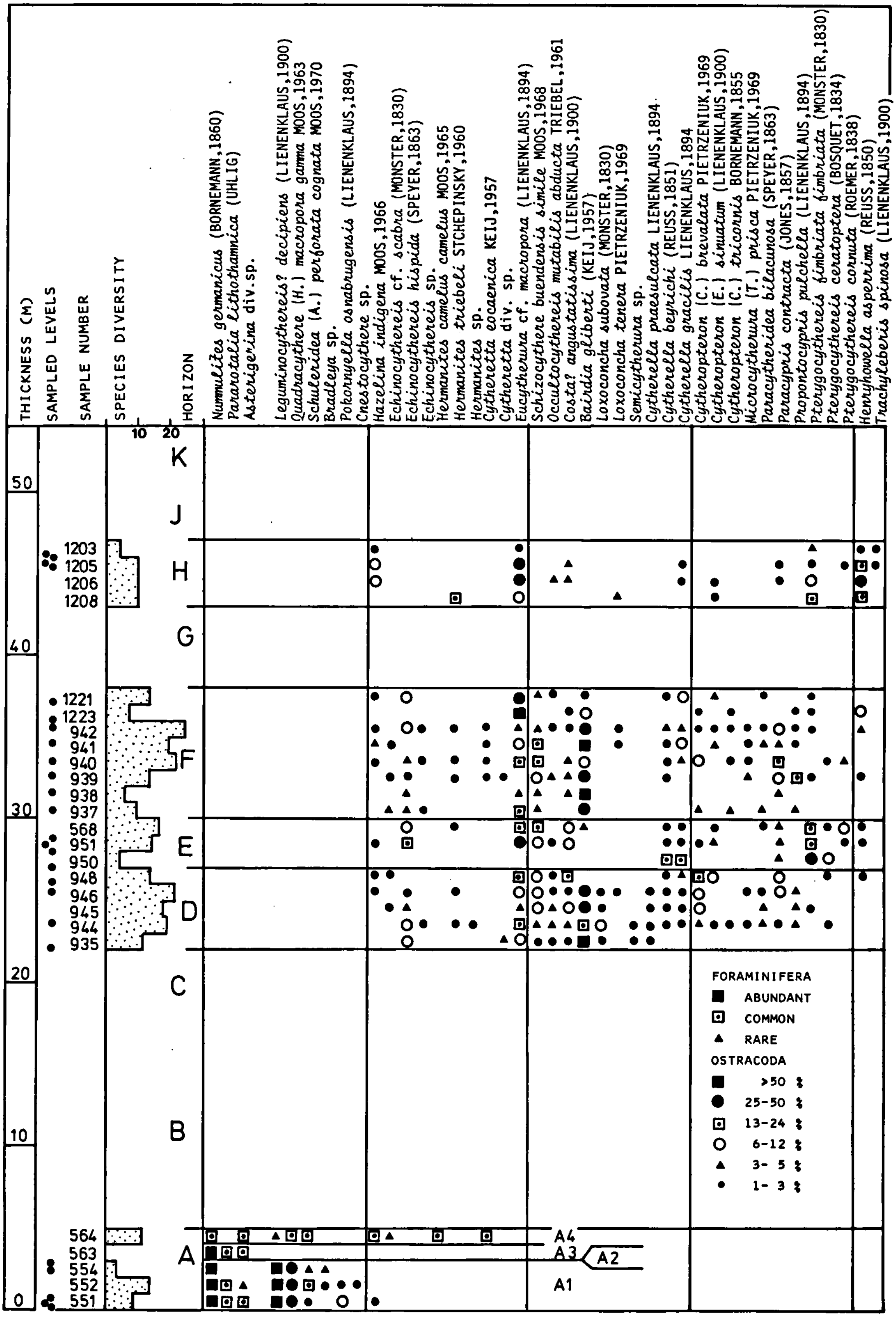



Fig. 3. Lithology and location of samples in the Piepenhagen section, compared with distribution of clay minerals and bathymetric interpretation based on ostracod associations.

Fig. 4. Distribution of Foraminifera and Ostracoda in the Piepenhagen section.


THICKNESS (M)
SAMPLED LEVELS
SAMPLE NUMBER
SPECIES DIVERSITY
10 20
HORIZON
Nummulites germanicus (BORNEMANN,1860)
Pararotalia lithothamnica (UHLIG)
Asterigerina div.sp.
Leguminocythereis? decipiens (LIENENKLAUS,1900)
Quadracythere (H.) macropora gamma MOOS,1963
Schuleridea (A.) perforata cognata MOOS,1970
Bradleya sp.
Pokornyella osnabrugensis (LIENENKLAUS,1894)
Cnestocythere sp.
Hazelina indigena MOOS,1966
Echinocythereis cf. scabra (MÜNSTER,1830)
Echinocythereis hispida (SPEYER,1863)
Echinocythereis sp.
Hermanites camelus MOOS,1965
Hermanites triebeli STCHEPINSKY,1960
Hermanites sp.
Cytheretta eocaenica KEIJ,1957
Cytheretta div. sp.
Eucytherura cf. macropora (LIENENKLAUS,1894)
Schizocythere buendensis simile MOOS,1968
Occultocythereis mutabilis abducta TRIEBEL,1961
Costa? angustatissima (LIENENKLAUS,1900)
Bairdia gliberti (KEIJ,1957)
Loxoconcha subovata (MÜNSTER,1830)
Loxoconcha tenera PIETRZENIUK,1969
Semicytherura sp.
Cytherella praesulcata LIENENKLAUS,1894
Cytherella beyrichi (REUSS,1851)
Cytherella gracilis LIENENKLAUS,1894
Cytheropteron (C.) brevalata PIETRZENIUK,1969
Cytheropteron (E.) sinuatum (LIENENKLAUS,1900)
Cytheropteron (C.) tricornis BORNEMANN,1855
Microcytherura (T.) prisca PIETRZENIUK,1969
Paracytheridea bilacunosa (SPEYER,1863)
Paracypris contracta (JONES,1857)
Propontocypris pulchella (LIENENKLAUS,1894)
Pterygocythereis fimbriata fimbriata (MÜNSTER,1830)
Pterygocythereis ceratoptera (BOSQUET,1834)
Pterygocythereis cornuta (ROEMER,1838)
Henryhowella asperrima (REUSS,1850)
Trachyleberis spinosa (LIENENKLAUS,1900)
50
40
30
20
10
0
K
J
H
G
F
E
D
C
B
A
1203
1205
1206
1208
1221
1223
942
941
940
939
938
937
568
951
950
948
946
945
944
935
564
563
554
552
551
A4
A3
A2
A1
FORAMINIFERA
ABUNDANT
COMMON
RARE
OSTRACODA
>50 %
25-50 %
13-24 %
6-12 %
3- 5 %
1- 3 %

due to the influence of stormy events. The depositional environment lies in the middle sublittoral zone, immediately above the pterygokline resp. storm wave base.

Horizon G: 37-45.5 m = 8.5 m.

Horizon G has a mean carbonate content of 4.8%. It contains no ostracods. In its lower part globigerinids and in the upper part siliceous sponges are frequent. They indicate an increasing influence of the pelagic realm.

Horizon H: 45.5-46.5 m = 1.0 m.

Main species are *Henryhowella asperrima, Pterygocythereis* sp. div. and *Eucytherura macropora*. Only in this level *Trachyleberis spinosa* occurs. The high percentage of *Henryhowella asperrima* indicates that this fauna lived at greater depth in the lower sublittoral zone than the association of horizon F. As specialists of the phytal zone are also missing, this horizon should be placed below the algal chlorokline (Liebau, 1980) into the circa littoral zone. The mean carbonate content of samples nrs 1203, 1205 and 1208 equals 5.8%.

Horizon J: 46.5-51 m = approx. 4.5 m.

This horizon yielded no ostracods. The carbonate content of sample 1202 was found to be less than 1%.

Horizon K: Septaria-clay Formation.

Ostracods of the Septaria-clay Formation are not included in this investigation. Samples from the basal beds of the formation contain no ostracods. It is generally known that the ostracod fauna of the entire Separia-clay Formation contains *Henryhowella asperrima, Krithe pernoides* and also *Pterygocythereis* species. This fauna points to lowermost sublittoral or bathyal environments, resp. to bathyneritic facies (Gramann, 1986; Ritzkowski, 1986).

## THE EARLY OLIGOCENE-MIDDLE OLIGOCENE SEA-LEVEL RISE

The sequence of the ostracod fauna shows a bathymetric tendency. It starts in an upper sublittoral environment, leads to the middle sublittoral zone, reaches lower sublittoral conditions at the level of the pterygokline or storm wave base, and ends in the deep lower sublittoral environment. Only in the Septaria-clay Formation the lowermost part of the lower sublittoral zone respectively the bathyneritic facies can be proven by *Henryhowella asperrima* and *Krithe pernoides* associations.

The reasons for an increase of water-depth cannot be determined definitely by the study of a single section. But the most important reason seems to be a rise of the sea-level. This results in an extension of the marine realm, i.e. the transgression of the Latdorfian sea, which reaches into the Rupelian. This is also reflected by the clay mineral associations (fig. 3), in which kaolinite decreases and smectites become dominant due to a fractionation of clay sedimentation (Bühmann, 1986).

On the basis of the present observations it seems that the sea-level changed continuously without major fluctuations. Füchtbauer (1986: 89, fig. 1), however, marks in the Vail's curve a distinct sea-level fall in the Neuengammer Gassand horizon (lowermost part of NP 23). This level corresponds to horizon G of the Piepenhagen section which contains no ostracods but shows an influence of pelagic conditions by an increased amount of planktonic foraminifers and siliceous sponges. This could be compared to the situation at the southern border of the NW German Albian sea, in which the montmorillonite facies with siliceous sponges, glauconite and phosphorites is explained as the result of a cold water upwelling (Kemper & Zimmerle, 1982).

Ostracods from the localities Brandhorst, Vahrenkamp and Piepenhagen near Bünde represent various bathymetric environments. Due to the definition of the Latdorfian/Rupelian boundary (Benedek & Müller, 1976) they also belong to different stages. Thus their stratigraphical range requires further investigation.

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