A STUDY OF MARINE MIOCENE FAUNAS IN THE "ACHTERHOEK" (NETHERLANDS, PROVINCE OF GELDERLAND), PART 2 [1])

by E. F. de Vogel, Leiden

Summary

The material upon which this study is based belongs to the Reinbek formation, and is present in the collections of the Rijksmuseum van Geologie en Mineralogie, Leiden. Of each sample a counting-list of the molluscs is given; of these the features they have in common are given in general account. Three groups of borings can be distinguished with regards to the species content in the basal layers; especially the graph of Astarte radiata in the basal part of the boring is important. Probably these groups have a correlation with differences in habitat. The different sediments belong to one sedimentation cycle; the gradual decline of the basin caused a gradual change in the species content. A thanatocoenosis that is found in the more western borings at the base, is present in the eastern borings higher in the section. One can recognize formations that are distinguished by other authors on the base of molluscs, but these do not appear to be separated by boundaries in the species content. The soft concretions in situ are linked to a certain thanatocoenosis, but the 50% clay - 50% sand boundary appears to vary. The miocene sea must have extended farther eastwards; there are still some miocene deposits left in places with salt-dome activity. Species typical for the "Hemmoor Stufe" are also found in sediments of the Laag van Ticheloven; the sediments of the former formation are here regarded as a shellow water facies of the Reinbek Stufe. The most important species, which can be used to characterise the thanatocoenosis, are, from the base to the top: Hiatella arctica, Astarte radiata, Spisula spec., and Limopsis aurita.

Samenvatting

Van de getelde monsters van verschillende boringen in de Achterhoek worden complete tellijsten gegeven. Behalve van enkele soorten die in hoge aantallen voorkomen worden ook grafieken van de verdeling over gastropoden en bivalven gegeven. In één boring, waarvan het ene gedeelte verbuisd werd uitgevoerd met de puls, en het andere gedeelte onverbuisf d.m.v. spoelboren, werden tussen de monsters geen verschillen gevonden die veroorzaakt konden zijn door het verschil in boormethode. Tellingen gebaseerd op 500 exemplaren geven goede resultaten bij het vergelijken van verschillende boringen. Routinetellingen voor het snel vaststellen van de aard van de fauna van nieuw verkregen monsters kunnen worden uitgevoerd door van twee opeenvolgende monsters 100 exemplaren te tellen, waarbij de diameter van het materiaal niet kleiner hoeft te zijn dan 2 mm. Uit de gegevens van de tellijsten werd een basis-overzich samengesteld. Algemene gegevens betreffende de molluskeninhoud worden vermeld naast de soorten die op bepaalde diepten het hoogste maximum bereiken. Er worden geen biofacies benoemd omdat deze omgrensd moeten worden, waarbij dan grenzen gelegd worden die gebaseerd zijn op slechts één soort. De resultaten worden vergeleken met andere onderzoekingen, waarbij blijkt dat vroeger onderscheiden formaties overeen komen met bepaalde thanatocoeno-

[1]) I am indebted to Mr. E. Melis, Leiden, for explaining to me the statistic backgrounds and concequences of the second part of this study. To Miss E. Bavelaar, Leiden, my thanks are due for the typing of the manuscript.

sen, maar deze zijn niet begrensd. De karakterisering door de auteurs van deze formaties wordt voor sommige gevallen becritiseerd. Bij onderling vergelijken van de boringen blijkt dat deze gerangschikt kunnen worden in drie groepen, die gekarakteriseerd worden door de soortensamenstelling in de basale lagen. Het verloop van de grafiek van Astarte radiata is een goede indicator hiervoor. Verschillende bijzonderheden worden bij elke boring vermeld. Het optreden en verdwijnen in de sectie van Haustator eryna en Hinia schroederi wordt besproken, dit zijn de enige "Hemmoor-soorten" die in "Hemmoor-afzettingen" in dit gebied aangetroffen werden bij dit onderzoek. Deze bleken eveneens voor te komen in sedimenten van het Ticheloven type. De condities die in de miocene zee heersten worden behandeld, het moet een tamelijk rustig milieu geweest zijn. De soortensamenstelling varieert in de verschillende boringen t.o.v. de 50% klei - 50% zand grens. Dit in tegenstelling tot het optreden van zachte concreties in situ, die gebonden zijn aan een bepaalde thanatocoenose. De basislagen van de verschillende groepen boringen worden in verband gebracht met verschillen in milieu, waarbij de meer zandige lagen ondieper water vertegenwoordigen dan de lagen met fijner sediment. Er wordt geconcludeerd dat deze verschillende lagen slechts één transgressie vertegenwoordigen, wat ondersteund wordt door een fauna van haaientanden, zowel van verspoelde als niet verspoelde exemplaren. Na het overstromen van dit gebied, wat snel moet hebben plaats gevonden, trad een geleidelijke daling van de bodem op. Hierdoor wordt de thanatocoenose, die in westelijke boringen aan de basis ligt, in de meer oostelijke boringen (dus meer naar de rand van het bekken) hoger in de sectie gevonden. Boven de afzettingen van het "Hemmoor" en Ticheloven type wordt een gewijzigde haaienfauna gevonden, zodat aangenomen kan worden dat een verbinding met andere zeeën is ontstaan tijdens deze afzetting. Dit blijkt geen invloed te hebben op de molluskenfauna, daar geen nieuwe vormen optreden en de grafieken van de verschillende soorten geen gecorreleerde afwijkingen vertonen. Een onbekend gedeelte ten oosten van het onderzochte gebied moet bedekt geweest zijn met miocene afzettingen, die door erosie nu vrijwel zijn verdwenen, behalve boven sommige zoutpeilers, die in de ondergrond aanwezig zijn. De indeling in stratigrafische eenheden wordt behandeld, er wordt voorgesteld de naam "Hemmoor Stufe" niet meer te gebruiken, daar deze een ondiepwater-facies is van de Reinbek Stufe. De belangrijkste soorten in relatie tot de lithologische eenheden worden genoemd, te weten, beginnende bij de basis: Hiatella arctica, Astarte radiata, Spisula spec. en Limopsis aurita.

GENERAL NOTES TO THE COUNTING-LISTS AND GRAPHS

Horizontally on the first line, the total number of the specimens present in the sample are given. More than 500 specimens have never been counted, but in samples with less than 500 specimens all have been counted. On the second line, the percentage represented by one specimen is indicated. The third line mentions the percentage of gastropod and scaphopod specimens in relation to the total number of counted specimens (for the sake of brevity hereafter called: percentage of gastropod specimens). The percentage of the bivalve specimens is not given, but can be found in the graphs. The following two lines give the number of gastropod and scaphopod species together (hereafter called: number of gastropod species), and the number of bivalve species. These data have been included together in one graph.

Below these general figures follows the complete list of molluscan species found in the samples. Of each of the species the percentage of the specimens to the total number of specimens in the sample is given. Some species are always given in open nomenclature, even if the speciesname could be determined, because these species are usually very fragmentary or corroded (e. g. Actaeon, Turbonilla). Sometimes only the name of the genus can be found for specimens of genera that usually can be recognized on specific level, due to bad preservation (e. g. juvenile specimens of Hinia). These specimens are given in open nomenclature. Sometimes only the name of the family can be decided upon (e. g. Turridae), whilst others are in such a poor condition that the only observation that can be made is whether they are remains of bivalves or of gastropods.

Some of the species, those that are present in considerable numbers and that also show interesting features, are given in graphs. These graphs are composed as follows: on the vertical axis the depth from where the sample is derived is indicated; and on the horizontal axis the percentage of the species is given. This method of presentation is, in contrast to the graphs by Janssen (1967). As I want to compare the different borings, and as the depth of the samples is a given factor to which the percentages of the different species are determined, I think this way of presenting the results makes these easier to interprete, as in this way the variation in the occurrance of a species in the section is given. The percentage of the given species is drawn in the middle of the intervals on the vertical axis. These dots are connected by a line representing, more or less, the real increase and decrease of the percentage of that species in that section. When the samples contain less than 200 specimens, the figures become less reliable, as is clearly demonstrated in the graphs of the Aalten boring. In this case, the percentages are connected by a dotted line.

The lithological features of the samples were investigated by Mr. M. van den Bosch (not published), who located the place of the 50% clay - 50% sand boundary. This depth is drawn in in the graphs and must be regarded as a rough approximation, as the lithological changes are slow and gradual. This boundary is regarded as existing just between two samples, while in reality it must be situated either in the overlying, or in the underlying sample. The smaller the intervals, the more correctly the exact place of this boundary can be estimated.

The counting lists are printed in a separate appendix, distributed together with this issue of the "Mededelingen". The graphs are printed on loose sheets (see inner side of back cover).

GENERAL FEATURES OF THE BORINGS

To get a clearer view of the variations that are present in the various borings, it is useful to give an account of the general features that can be composed from the information of the various borings, and in which the most important species must be included. In the sections there is a certain speciessequence, that is not only due to the change in time, but also to a change in ecological circumstances, the latter obviously being the more important. In these sequences no boundaries can be recognized, consequently these results cannot be fully compared with the results found by Cadée (1968), as he only recognizes boundaries and does not indicate small changes within the mentioned zones.

At the base we find maximum numbers of Hiatella arctica, the number of gastropod species is usually very high in comparison with the number of bivalve species; the gastropod specimens can be more than 50% of the total number of specimens, and the samples are very rich in molluscs. In the overlying layers the content of molluscs is still rather high but less than in the stratum with Hiatella. The gastropod and bivalve species show a decrease, the former decreasing rapidly, the latter more gradual and slower. The same tendency can be observed when the number of gastropod specimens is regarded. In this higher layer the most important species is Astarte radiata. Some of the species of the underlying layer are absent here. Somewhat higher still, Astarte radiata decreases and a high maximum of Spisula spec. is found. The same tendencies as in the underlying layers, with regards to the gastropod and bivalve species as well as specimens, are encountered; these are continued in the overlying layers where Limopsis aurita has its maximum. Here the number of gastropod species, as well as specimens, is very low and the number of bivalve species, as well as specimens, is low, but not descending to such a small number as found for the gastropods. The overlying layers do not contain signifecant numbers of molluscs.

Each bank with a maximum of a certain species has a specific species content, as can be seen in the counting lists. These other species, however, can usually also be found in the overlying, as well as in the underlying layers. It is hard to distinguish any bio-stratigraphical units; in doing so boundaries are made where they do not occur, as there is not even one species restricted to such a unit. Moreover, it is difficult to define gradual changing sequences. Therefore, I only want to mention those species with a clear, high maximum, without giving thse species more importance than other species that have a somewhat lower maximum, because these species would

interfere with a classification based on the first mentioned species. This does not mean that the mentioned species cannot be used for correlating a certain sample to a certain thanatocoenosis.
The maxima of some of these species can be estimated in the field without counting, e. g., that of Limopsis aurita and Astarte radiata. Those of Spisula spec. and Hiatella arctica, however, appear to be hardly recognizable. Of the first, a percentage of about 25 per cent was overlooked in the field, the same was the case with a high percentage of Hiatella. Obviously this is due to the fragmentary state or inconspiciousness of these species.
In the laboratory, routine countings of 100 specimens can be made for a quick orientation of the sample; it is preferable to count two adjacent samples. Material of more than 2 mm diameter can be used in this case, as the results of the countings by Janssen (1966b) are fully comparable with those of my investigations with regards to the larger species. Actuallay, the optimum of Hiatella arctica can not be found in this way; this zone is determined also by the very low percentages of the afore mentioned important species, and the additional fauna as well.
It should be mentioned here that the clay-sand boundary does not show a constant relation to the species content. When the molluscs in the sample are very corroded or absent, no reliable data concerning the mollusc-content of the sample can be derived from lithological features.

COMPARISON WITH PREVIOUS INVESTIGATIONS

In this investigation, no use has been made of the connection of some genera or species with a certain habitat, their restriction to a certain geographical area, or with certain ecological conditions. It is not known whether the genetic information of these species has changed with time, causing a change in behaviour. It is well-known that recent species can inhabit totally different niches in different parts of their area.
Until 1966, when Janssen (1966b) published the results of his investigations of a boring in Dingden, the various borings and outcrops were usually not treated in a systematic way; and when percentages were given, they were usually not based on small samples, but on complete collections which were not collected for comparative studies (e. g. Anderson 1964). Rare species are over-represented in these investigations. Moreover, materials from various layers are usually mixed, because in the field these layers cannot bo recognized. For example, Anderson (1964) mentions from the Bislich boring large numbers of Limopsis, Spisula, Hinia bocholtensis and Gemmula zimmermanni, which indicate, according my results, that at least a part of the

Dingdener Schichten is present. The subdivision in'Stufen" and "Schichten", as followed until Boekschoten (1969b, c) can be applied to my results with some restrictions. The difference is that boundaries between recognized entities do not exist. In the area I investigated, conditions were rather uniform, as canbe seen in my results. For adjacent areas, similar investigations are desired, because differences in composition of the layers occur in various places, for instance in the Hoerstgen boring, in which about 66 m of sandy layers are present. More distant areas show more deviations, as exemplified by the results of Boekschoten (1969b, c).
In the following discussion, the features of the various informations will be dealt with, especially the characters that distinguish the various formations.

"Hemmoor Stufe"

Anderson (1961a) states that: so many outcrops are known in this stufe ..... that its existance cannot be doubted. The composition of species in all localities is rather uniform and well characterized, so that it may be recognized with certainty. There is a large content of "southern species". Typical molluscs are Nuculana emarginata, "Cardium" hanseatum, Haustator eryna, Dorsanum boreobaccatum and Hinia schroederi, while Lutetia nitida, Bittium tenuispina and Hinia cimbrica also indicate this Stufe when they are common. Not all of these species need to be present. If only one is present, the sample is still considered to belong to the "Hemmoor Stufe" if the additional fauna supports this. In this way, Janssen (in Van den Bosch, 1968) concluded from the occurrance of Haustator eryna, the absence of large numbers of Astarte radiata and from the additional fauna, the fact that Miste 41E.2-65 must be concluded to have "Hemmoor" age. Later, this was supported by a find of Nuculana emarginata (not published). As Miste 41E. 2-75 and Beuting (Ellewicker Feld) correspond with a part of the section of Miste 41E. 2-65, these must also be placed in this Stufe. To do this, however, based on such little evidence is rather speculative.
In this area, the borings with a speciescontent that resembles that of the "Hemmoor Stufe" are found east of those with a speciescontent resembling that of the Reinbek Stufe. In Miste 41E. 2-65, the change to a speciescontent as is typical for the Laag van Ticheloven is present in the top of the section; the change is gradual, without boundary.

Laag van Ticheloven

Janssen (1967) based the Laag van Ticheloven on a boring that is situated only a few meters from Ticheloven 34G. 1-24. Only this formation was supposed

to be present in this boring. Unfortunately, he did not mention in the text of his article whether this formation should be included in the "Hemmoor Stufe", the Reinbek Stufe, or whether it represents a formation of equal level. From his figure 2, however, we can conclude that he intends it to belong in the Reinbek Stufe.

The main feature is the fact that especially Astarte radiata is present in a very high percentage. In his publication there is no further information on the type-boring; the description of this formation was anounced but has not yet appeared. Some other Dutch localities where this formation is present at the base of the Miocene are mentioned. All information on the speciescontent of this formation is based on the results from the countings of the boring in Dingden. At the base Astarte radiata shows a maximum number. At about 8,50 m a clear changing of the habitat is supposed to have taken place; however, when comparing the graphs, this boundary appears to be very vague and rather wide, if Limopsis aurita is the species that indicates the other side of this boundary. Only a few species show important increases and decreases in the neighbourhood of this "boundary". Most of the species that are said to have a boundary only show a gradual change during this interval. I cannot conclude that there is a noticable changing in the habitat in this part of the section; no boundary is present.

In all borings dealt with in this investigation the transition between the Laag van Ticheloven and the Dingdener Schichten is found to be gradual. Two species disappear during the deposition of the Laag van Ticheloven; these are Haustator eryna and Hinia schroederi, both regarded to be typical for the "Hemmoor Stufe". At the end of the "Hemmoor Stufe" the other species typical for this formation must have disappeared; no information is available as to in what level this has occurred, as no systematical countings have been made.

When referring to the graph of Astarte radiata in Ticheloven, it appears that the maximum of this species probably is present, but that the part of the graph lying just below this maximum is not present. Moreover, species such as Spisula spec. and Limopsis aurita are present in the upper samples in hihg percentages, the last species being typical for the Dingdener Schichten when it is present in high numbers. Taking this boring as the type-boring now appears not to have been a good choice, because of the absence of a part of the section where Astarte radiata shows a high percentage, and the presence of high numbers of Limopsis aurita and Spisula spec. that are both typical for another formation.

Reinbek Stufe

The only species that are characteristic for this Stufe are Aquilofusus festivus and Streptochetus abruptus, a rather weak basis as already discussed by Boekschoten (1969b, c). In fact, Anderson (1964) is rather brief in characterising this Stufe and he himself appears to question the value of these guide-fossils, as he states that they are not always present.
During the Reinbek-period, various species disappeared. In this Stufe four "Hauptfazies" are recognized, two in the north-eastern part and two in the western part of the basin; only the latter are important for our purpose of comparing, as these are based on localities in the neighbourhood; the other ones having deviating faunas.

a. Bislicher Schichten - Dingdener Feinsand

According to Anderson (1964), this is a sand facies, with a high content of bivalves among which especially Limopsis, Corbula gibba and Spisula "triangula" (= Spisula spec.) are present. Among the gastropods, Hinia bocholtensis, Archimediella subangulata, Ringicula buccinea, Gemmula zimmermanni and Aporrhais alata are most common. The results of the Dingden boring as given in the graphs of Janssen (1967), can be compared with the featuresof this layer given by Anderson (1964). The Bislicher Schichten are situated in this boring between 8.50 and 4.00 m, Janssen proposes to name this interval Dingdener Feinsand. It appears from his countings that this layer does not contain the real optimum of Limopsis aurita, that Spisula spec. has his real optimum here and that Corbula gibba shows a maximum in the underlying layer. In agreement with Anderson 1964, Hinia bocholtensis, Ringicula buccinea, and Aporrhais alata show little deviation from the overlying strata. The number of these species cannot be used when characterising the difference between the Bislicher Schichten and the Dingdener Schichten (sensu Anderson). Janssen does not give a graph of Gemmula zimmermanni, but this species is of no use for the same reason. Finally, Archimediella subangulata is not the most frequent in this formation, but in the basal layers of the overlying formation.
This Dingdener Feinsand formation is represented in all the borings investigated. It should be mentioned again that the striking resemblance of the results of Janssen and my own investigations clearly demonstrates that countings of residues larger that 2 mm may be used for a quick orientation of the sample.

b. Dingdener Schichten - Dingdener Glimmerton

Only in a few borings the overlying layers are present. In these borings, no sharp boundary could be observed, either lithological or in the fauna, as can

also be seen in the graphs by Janssen (1967). In the upper layers of this formation, the molluscs become scarce and therefor the results derived with this method are not very accurate. Since most of the outcrops are situated in this formation, the best way to obtain information about it is to take samples by digging, because in that way more material can be collected. The speciescontent of this formation is the best known, due to the intensive sampling in the outcrops in Dingden, Stemerdink and formerly in De Giffel and Zwilbroek 34G.3-1. The differences from the underlying formation are treated above.

Overlying formations

In our area, these layers are usually regarded to belong to the Upper Miocene. Molluscs are very scarce or even absent. This is not a secondary phenomenon. The calciumcarbonate has not been dissolved, as microfossils are still present. No subdivision can be made with the method of counting molluscs. In other areas where lines of development in the molluscs can be recognized, a subdivision is made, based on the evolution of molluscs.

CORRELATION OF THE BORINGS

Some layers contain concretions in situ. These are usually coloured rather light when dry, and contain the same fauna as the not-luted sediment. Although these are not mentioned separately in the original boringlogs because they are usually scarce, the occurrance became interesting when in Miste 41E.3-75 a large amount of these concretions appeared to be present. They are usually found in the layers where Astarte radiata is common, as well as in the layers below these. There is no relation with the present depth from which the samples in which they occur are derived, but the relation of these concretions to a certain thanatocoenoses indicates the approximate depth of the sea.

In the area investigated the Miocene layers have a more or less constant thickness. Actually, the layers containing a noticible amount of molluscs rarely extend over ten, sometimes twelve meters. In the westernmost part of the area little is known about their thickness, because of the fact that the tertiary strata are overlain by by huge quaternary deposits. Good borings are badly needed in that part of the area, but uptil now the depth was to considerable for the drilling equipment at our disposal. To illustrate this declination, compare the depths of Miste, De Haart and Aalten. In the western area, complete and undisturbed section of the Miocene must be present, and for a better understanding of the Miocene deposits we must try to get from there more information. A consequence of the constancy in thickness of

these shell bearing layers is that the margin of the Miocene basin cannot be sought to have been situated in the eastern area, where the Miocene deposits are just absent. This leads to the conclusion in an unknown part east to the area investigated these Miocene deposits must have been eroded.
When comparing the borings, it appears that three different types can be distinguished in relation to the speciescontent in their basal samples:

a. Borings with a maximum of Astarte radiata in the basal samples.
b. Borings with a low number of Astarte radiata in the basal samples that increases in the next sample.
c. Borings of which the percentage of Astarte radiata from the base onwards remains low in a number of succeeding samples.

When locating these borings on a map (figure 1), it appears that the groups represent each a distinct area. Group a is situated in the northern part of the area. Group b is generally located west of the borings of group c, with exception of Stemerdink and Renskers. These deviations are due to the presence of saltdome action in the underground, and are discussed in the chapter on the general conditions in the Miocene sea. The borings of group b are best known; those of group c are situated more eastward, in an area where the Miocene layers are usually eroded. It is possible that more northwards or westwards other section of type a and c can be found.
Not all borings represent long sections, a few consist of only one or a few samples. These are placed in the best-fitting group on account of the additional fauna. In each group the borings are treated from south to north.

a. Borings with a maximum of Astarte radiata in the basal samples.

Rekken, 34G. 2-1
This boring consists of only one sample, derived from a rather long section of 2.5 m. The high Astarte radiata content may be due to a high content of this species in the uppermost part of the section, while in the basal part this may be low. This high percentage is artificial then, as it is influenced by the sampling method. The percentage of gastropod specimens is even 52; the number of gastropod species is rather high in relation to that of the bivalve species. Spisula spec. is present in a low percentage.

Ticheloven, 34G. 1-24
This boring is situated a few meters besides the boring Ticheloven 34G. 1-1/34, on which Janssen 1967 based the Laag van Ticheloven. The differences of this boring as compared to De Haart are real, and not due to sampling errors. It seems as if the lower part of the section is not present, the remaining part agreeing very well with De Haart, in spite of the fact that they are

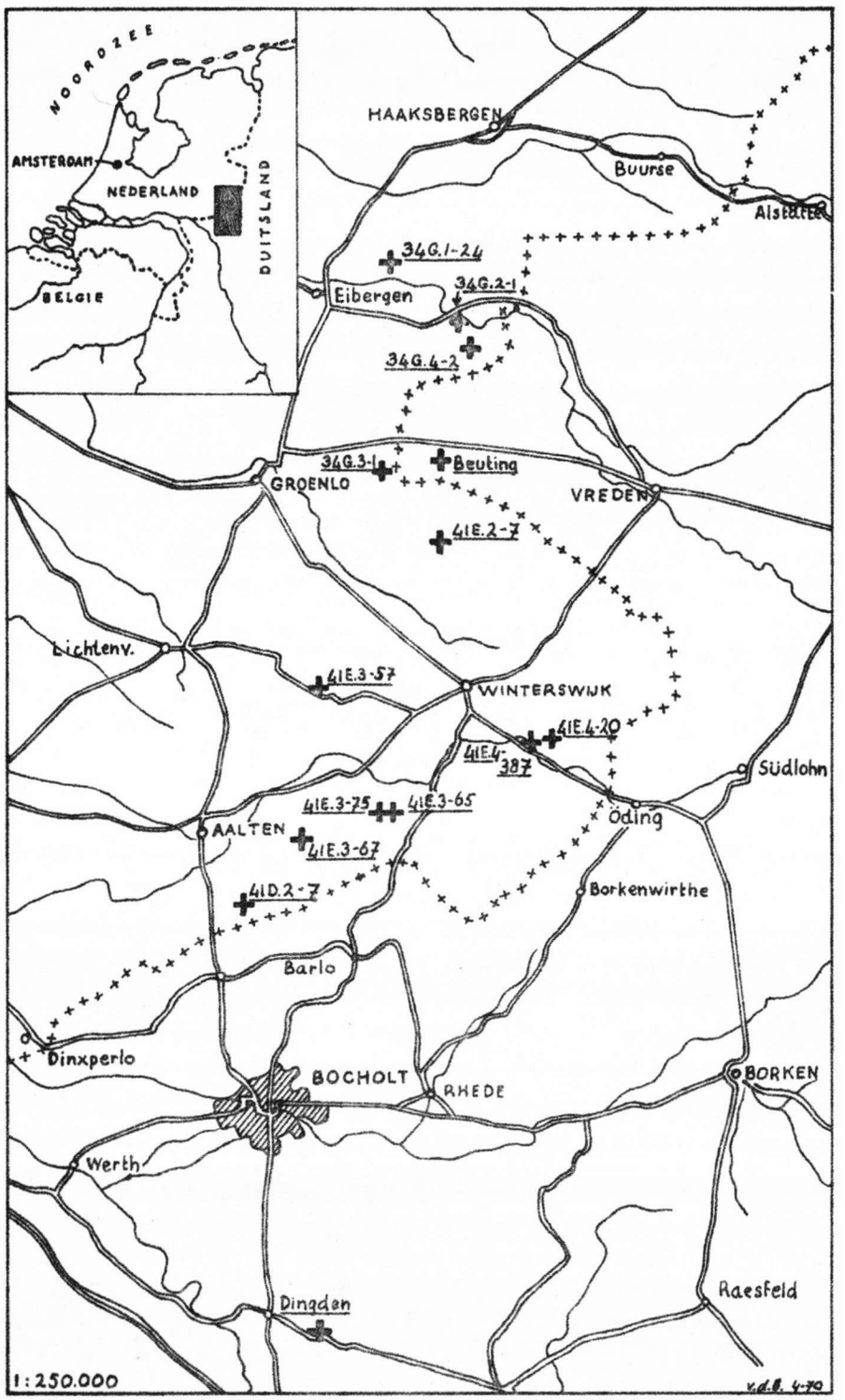

NOORDZEE
AMSTERDAM
NEDERLAND
DUITSLAND
BELGIE
HAAKSBERGEN
Buurse
Alstätte
34G.1-24
Eibergen
34G.2-1
34G.4-2
34G.3-1
Beuting
GROENLO
VREDEN
41E.2-7
Lichtenv.
41E.3-57
WINTERSWIJK
41E.4-20
41E.4-387
Südlohn
41E.3-75
41E.3-65
AALTEN
Oding
41E.3-67
41D.2-7
Borkenwirthe
Barlo
Dinxperlo
BOCHOLT
RHEDE
BORKEN
Werth
Dingden
Raesfeld
1:250.000
v.d.B. 4-70

fig. 1

more than 21 km apart. Real percentages count less in this respect than the sequence and mutual relation of the optima of the different species. Interesting is the situation of the clay-sand boundary that is here rather at the base of the section, far below the maximum of Spisula spec. The Miocene is absent one sample above the maximum of Spisula.

b. Borings with a low number of Astarte radiata in the basal samples that increases in the next sample.

Aalten, De Vlijt, 41D.2-7

As this boring is situated only 3 km from De Haart, it shows in genetal the same tendencies in the speciescontent as that boring. The number of countable specimens in the samples is usually low, although the sedimentquantities of the samples are of a normal size. The number of gastropodspecies in relation to that of the bivalve species shows the same tendencies as that in De Haart, although the percentage of the gastropod specimens is due to irregular and unexpected variations.

De Haart, 41E.3-67

In the basal layers the molluscan content is rather high but this decreases higher in the section. This decrease is not gradual as can be seen in sample 13-14 m. Above 11 m depth the number of countable molluscs is so low, that these samples are not counted at all.

Starting again with the lower layers, the percentage of gastropod specimens is rather high, beeing 45 per cent in the basal sample, rapidly decreasing in the higher samples, with a slight increase in sample 14-15 m. Decrease of the number of gastropod species can also be noted, but the fall of this number above sample 19-20 m is striking, since it is a decrease of 66 per cent. From the next sample, which is somewhat higher, the decrease is rather slow, up to only one species in the uppermost sample. The decrease of the number of bivalve species is more gradual. These are less frequent than the gastropod species in the basal layers, but in the upper sample they are still present with 8 species, whereas this sample only contains 27½ specimens.

It is useless to deal with all species encountered in the samples. Fluctuations can be read in the lists, and for the more important species they can be seen in the graphs. Nevertheless I had make here a few remarks about some of the species because in this boring the features of the graphs are typical. E.g. Astarte radiata starts in the basal samples with a low percentage, to reach a maximum in the sample 18-19 m, after which it decreases to be absent in the sample 15-16 m. The graph shows no discontinuities. As another

example, Spisula spec. is present in the basal sample with 4.3 per cent and ascends rapidly upwards to a maximum of 25.4 per cent, just above that of Astarte radiata. The clay-sand boundary is situated just above this maximum. In the sample 13-14 m this species has disappeared. Limopsis aurita, the most important species of the Dingdener Glimmerton, starts with a low percentage and rises slowly to a maximum of 18.3 per cent above that of Spisula spec. In this part of the boring, the graph is irregular, probably because of the small number of countable specimens, but it remains rather high. Other species of interest are Hiatella arctica and Amyclina facki, because these are only present in the lower samples.

Stemerdink, 41E.4-387

In general, this boring agrees with that of De Haart, although the section seems stretched. Here to, irregular fluctuations in the percentage of gastropod specimens occur, while also the number of gastropod species shows irregularities, since their number is about as high of the number of bivalve species in the upper samples. The clay-sand boundary is situated just below the maximum of Spisula spec.

Renskers, 41E.4-20

Of this boring a large upper part is eroded. The profile is streched like that of Stemerdink. The results agree remarkably with those of De Haart, even the general features of gastropods and bivalves. The clay-sand boundary is situated in this boring far below the maximum of Spisula spec., even below the maximum of Astarte radiata !!

Maneschijn, 41E.3-57

Of this boring only the two basal samples are counted, of each of them only 100 specimens. The percentage of gastropod specimens is high. For a basal sample the number of bivalve species is rather high as compared to the number of gastropod species. This may be due to the small number of specimens counted, since two valves of a bivalve represent one individual but two valves can represent two species, whereas one shell of a gastropod counts only for one specimen and can only represent, of course, one species.

De Giffel, 41E.2-7

The similarity of the fossilcontent of this boring with that of De Haart is striking, although the distance between them is about 12 km. The upper part of the section is missing. Note that the percentage of gastropod specimens is very high and that the number of species of this group is higher than that of the bivalve species. The clay-sand boundary is situated above the optimum of Spisula spec.

Rekken, 34G.4-2

This boring only consists of one sample that fits best in this group. Astarte radiata and Spisula spec. are not encountered, so in this respect it can be supposed to represent the upper part as well of the basal part of De Haart. Limopsis aurita, however, is present in a rather low number, while additional fauna-elements as Hiatella arctica, Astarte waeli etc. indicate that this sample must be correlated with the lower part of De Haart. This is corroborated by the fact that the percentage of gastropod specimens is very high, as the low number of gastropod species in relation to that of the bivalve species is probably due to the small number of the specimens counted.

c. Borings of which the percentage of Astarte radiata from the base onwards remains low in a number of succeeding samples.

Miste, 41E.3-75

Whem comparing this boring with De Haart there seems to be little resemblance although these borings are only 2200 m apart. At closer view, however, it appears that the two uppermost samples of this boring are fully comparable to the two lowest samples of De Haart, the graphs being more or less a continuation of each other, although the absolute percentages do not fully agree. The percentage of gastropod specimens is high, except in the higher samples, as is the number of gastropod species in relation to that of the bivalve species. Interssting features of Miste are the low number of Astarte radiata, Spisula spec. and Limopsis aurita in the lower samples, whereas the number of Hiatella arctica is rather high. The clay-sand boundary is situated in the part of the section where the Astarte radiata percentage is not yet important; when comparing this with other borings this appears to be very low in the section. The section is very short. Unfortunately the overlying layers, which must have contained in my opinion a fauna as is found in the basal layers of De Haart, are not present. A line of intermediate borings between this one and De Haart can give more imformation concerning this question.

Miste, 41E.3-65

This boring consists of only one sample, which agrees very well with the basal layers of Miste 41E.3-75. Note the high percentage of Hiatella arctica and that of the gastropod specimens, whereas the number of bivalve species is low compared with that of the gastropod species.

Ellewicker Feld, Beuting.

Only one sample was taken when digging a pit. Hiatella arctica is present in a high percentage; Astarte radiata, Spisula spec. and Limopsis aurita are

absent. It fits best with the basal samples of Miste 41E.3-75 with respect to the additional fauna. The percentage of the gastropod specimens as well as the number of species of this group are comparatively low, probably due to the small number of specimens available and the rather bad preservation of the material. More information will be obtained from more accurate and more complete sampling.

RANGE OF "CHARACTERISTIC" "HEMMOOR" SPECIES IN THE VARIOUS BORINGS

A species can be so scarce in a sample that the possibility to encounter it with this method is very small. This is for instance the case with species that descend from a maximum and are absent in the overlying layers. Thus the upper boundary of a species as it is given in my graphs is more or less approximate.

Typical "Hemmoor" species are, according to Anderson 1964:

Nuculana emarginata (Lamarck)
Cardium hanseatum Kautsky
Haustator eryna (Orbigny)
Sandbergeria wolffi Kautsky
Dorsanum boreobaccatum Kautsky
Hinia schroederi (Kautsky)

Only the third and the last species occur in my samples. According to information by Mr. A. W. Janssen two different facies can be distinguished in the "Hemmoor" Stufe, each characterised by the occurrence of certain species. So, species typical when occurring in rather high numbers are:

rather fine sediments	rather coarse sediments
Haustator eryna	Oliva dufresnei Basterot
Hinia schroederi	Sandbergeria wolffi
	Dorsanum boreobaccatum
	Nuculana emarginata

The facies with coarse sediment appears to be absent from the area investigated. The facies with fine sediment is present in some places, but its typical species can also be found in many of the other borings. Their occurrence is discussed below.

Borings of group a.

Neither in Rekken 34G.2-1 nor in Ticheloven were these species present.

Borings of group b.

Both species are absent in the following borings: Aalten, Stemerdink and Rekken 34G.4-2.

In De Haart Haustator eryna is present in the sample 18-19 m, where the maximum of Astarte radiata occurs. Hinia schroederi is found in the sample just below this maximum.

In Renskers Hinia schroederi is present in the two basal samples below the maximum of Astarte radiata, whereas Haustator eryna is absent.
In Maneschijn Haustator eryna is present in the basal sample below the maximum of Astarte radiata, whereas Hinia schroederi is absent.
In De Giffel Haustator eryna is present from the base towards sample 10.40 - 11.40 m; Hinia schroederi is only present in the sample 9.30-10.40 m. The two samples mentioned represent the maximum of Astarte radiata.

Borings of group c.
In Miste 41E.3-75 Haustator eryna is present up to sample 2.25-2.75 m, whereas the uppermost sample in which Hinia schroederi is found is 3.25-3.75 m.
In the overlying layers where Astarte radiata climbs up to its maximum these species are absent.
In Miste 41E.3-65 both species are present in the only sample, in Ellewicker Feld, Beuting, they were not encountered.
Conclusion: It appears that both species are present in samples that must be recknoned to the Laag van Ticheloven; the consequence is that this formation must be incorporated in the "Hemmoor Stufe". However, according to the remainder of the speciescontent it can be reckoned to belong to the Reinbek Stufe as well.

ECOLOGICAL CONDITIONS IN THE MIOCENE SEA

The conditions in the Miocene sea in the Achterhoek area must have changed slowly, for nowhere in the sequence of strata sudden changes in the speciescontent occur. However, in the sediment sometimes an alternation of small banks of sand and clay can be observed; in general there is a change from layers of sand, with more or less addition of clay at the base, to layers of clay with more or less addition of sand to the top. In the sand as well as in the clay many bivalve shells are found in living position, with the two valves still together, which indicates rather quiet conditions. This is also illustrated by the presence of free living colonies of bryozoans (Lagaay, 1963) and by the solitary corals, which can not live in a mooving environment, where sediments are regularly rebuilt. Although sandlayers can only be formed when there is a sufficient supply of sand (which is the case for in all layers at least some sand is present) these are mainly built in shallow waters. If there is supply of new sediment, the coarser sediments have already settled when the finer material still remains suspended in the water and can be carried off. If any rebuilding of the sediments in the Miocene sea occur, this must have happened very gently.
Near a coast, some places may be more sheltered than others. In more shelte-

red parts fine material can settle, forming more clayish layers; these being deposited at depth in which only sandlayers can be formed in the more exposed parts. The occurrance of clay layers is, to my opinion, usually not to be correlated with the depth of the sea, but with the exposure.
When regarding the relation of the Spisula spec. maximum to the clay - sand boundary, it appears that these do not show a constant relation. Sometimes this species is found in a clayish sediment, another time it is present in a sand layer. The same can be observed for other species. The conclusion is that the maxima of species appear to be independant of the type of sediment in these Miocene deposits to a certain degree.
The zonation of animals (and algae) in the sea is correlated with the depth (Cadée 1968, fig, 36). In shallow water there is a good saturation with oxygen and a good light supply if compared with deeper water. To my opinion, the main cause of the variation of the speciescontent in the borings must be the gradual changing of the depth of the Miocene sea. I have not found a boundary caused by more than one species, as is found by Cadée (1968), so that the samples encountered in my investigations are probably situated in one such a zone as recognized by him. Changes in characters have not been observed in any species, although no special attention has been paid to this subject during this study.
From my investigations it does not become clear how long it took for the deposition of the shell bearing Miocene sediments in this region.
The borings of group c, with their high content of gastropods (species as well as specimens) and their coarse sediments, indicate a formation in less quiet water, which may have been shallow, whereas the basal layers of De Haart indicate a deposition in a comparatively more sheltered or deeper area. This is possibly not in contradiction with Boekschoten (1969a), who, on account of the features of the foraminifera, wants to accept a non deposition area on "hills" in a plain, somewhat deeper sea. Consequently the sea over these hills must have been more shallow. There appear to be two borings, at a distance of only 2200 m, of which the basal samples of the more western one show environmental circumstances differing from those from the more eastern one. These differences can be regarded as caused either by differences in depth or by a more sheltered position. Of these two possibilities, that of differences in depth fits best with the idea that these layers are deposited in a slowly declining basin, which is flooded by a transgression. This basin must have had a coast somewhere which, at the beginning of the transgression in this area, must have been situated in the neighbourhood of these localities. At that moment the rise of the water must have been very

rapid, because in the borings on the western side of the area no trace is found in the speciescontent indicating a shallow water deposition. According to information of M. van den Bosch (in litt.) these basal samples show a reworked fauna of shark teeth that is identical in both borings; the fauna of shark teeth in situ is also identical. This is not a piece of evidence that makes it probable that the differences in the mollusc content of these basal layers was mainly influenced by differences in depth as sharks are not restricted to a certain depth.

The flooded area continued to decline, the water in the flooded parts becoming steadily deeper, thus causing the change in species composition. According to information of M. van den Bosch the fauna of shark teeth in situ chages considerably from the base of Dingden Feinsand upwards, so that changes in the shark fauna may be due to new influences from outside the basin. For the molluscs this seems to have been not very important, because no boundaries occur in the species sequence, and new species are not found in my countings. The declination of the area makes it understandable stah the same species sequence that is present in the western borings in the basal layers occurred in the eastern borings when already a considerable thick bank of sediment had been deposited, with a speciescontent of which no trace can be found in the former. Each zone mooves to the east with the increasing of the transgression (see figure 2).

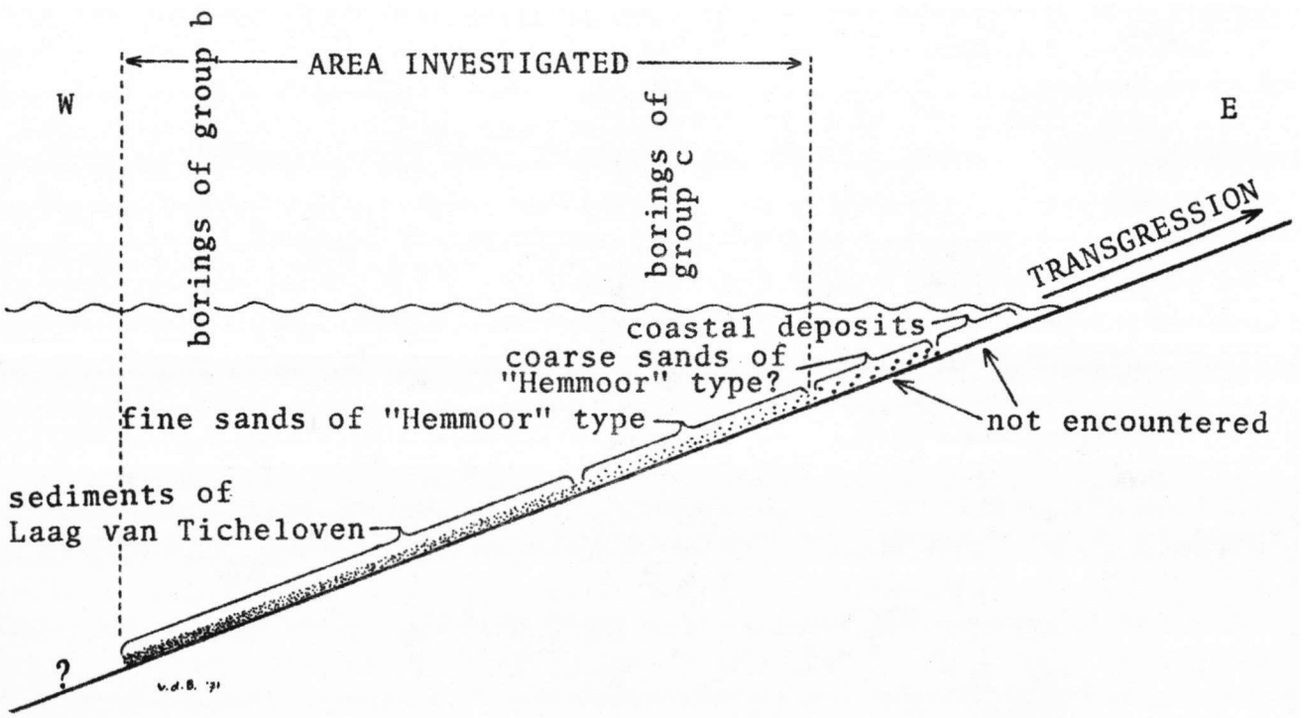


Fig. 2. Situation of the different types of sediment at the start of the transgression in this area, borings of group b and c indicated.

Unfortunately more to the east the Miocene deposits are eroded, so that it can not be estimated how far the transgression has reached to the east. However, there must be still be some places where Miocene deposits remain. In Stemerdink and Renskers, for instance, situated most to the east, the same deposits as in De Haart are found at the base. These localities represent an isolated Miocene deposit, which is not trasported, but situated on a salt-dome. Probably this area was situated lower as compared to the neighbouring country, because the salt was somewhat dissolved when the transgression reached it, so that there was already a deeper pit. Here the section starts with a speciescontent as found in De Haart, indicating a deposition in somewhat deeper water. This dissolving of the salt must have continued in later times, causing the area to sink steadily. When the Netherlands rose above sea-level and erosion started to carry off the newly formed layers, the Miocene in this pocket was nearly carried off. It is possible that on other salt-domes more eastwards still more Miocene deposits are left, from which the extension of the Miocene sea can be estimated.
In the higher levels the molluscs mecome scarce in number of specimens as well as in number of species. These layers usually consist of clay, with rather little sand and rather much mica and the percentage of Limopsis aurita remains high. With regard to the molluscs nothing definite can be said about the depth of the sea in those days; other methods must bring forward more evidence on this subject. The occurrance of complete skeletons of whales and sirens in the claypits of F. O. W. brickworks at Eibergen (Zwilbroek 41E.3-57, see fig. 1) may be an indication of shallow water, as I already have mentioned.
From the evidence here given it is clear that Boekschoten (1969b, c) is right when he states that the finer sediments deposited in deeper water with "Reinbeker Faunenbild" (= species composition of the Reinbek type) and shallow water sands with "Hemmoorer Faunenbild" (= species composition of the Hemmoor type) must represent one and the same transgression.

This is a good place to make some remarks about the Miocene deposits in "De Peel" (province of Limburg, Netherlands). During investigations early this century several deep borings were brought down in this area, where long sections containing mollusc fauna's mainly of the Hemmoor-type occur (Waterschoot van der Gracht 1918). Rich collections were made, but unfortunately samples from various levels were put together, so that variations in the species sequence can not be estimated anymore. This is the more regrettable because this area, according to the descriptions, must constantly have been situated in a shallow water area. As the Miocene deposits represent here a considerable time interval, it is possible that in this area changes in the

speciescontent that are not due to changes in environment, but to for instance climatic changes, and lines of development of molluscs in time will be found. One or two new, well samples borings in this area will probably give much information on these shallow water deposits, if they are made skilfully and with great care. Moreover, changes in the lithological features may be found in that case, for the increased drilling methods make it possible to take good samples from small intervals without admixture of contaminations, which was impossible in earlier times.

GENERAL AND STRATIGRAPHIC CONCLUSIONS

It must be concluded from the great resemblance in the results for very close as well as for distant borings, that this method of counting 500 specimens from samples from an interval of 1 m or less can be applied for comparing the composition of the fauna's with reliable results. Changes in species sequence, the maxima of species, transitions and impoverishments of the fauna can be clearly recognized. The results will be more accurate if the samples are taken carefully from smaller trajects.

It appeared in my countings that the drilling-method had no influence on the counting-results. In borings where the drilling-method was changed somewhere in the traject no discrepencies were observed.

The lithology of the strata shows variations in relation to the mollusc fauna, as is demonstrated for the clay-sand boundary in relation to Spisula spec. Another lithological feature, the occurrance of concretions in situ, is restricted to a certain layer, and probably connected with the depth of the sea, and in this way linked to a certain thanatocoenosis.

At the start of the transgression the coast of the Miocene sea in the area investigated was situated somewhere eastwards of Miste and Beuting, and the rise of the water was very fast at that time. After this the rise appears to have been much slower. The sea must have extended further eastwards, judging from the thick deposits of the complete Miocene sediments in the western part of the area, and the occurrance of some rests of Miocene deposits on salt-domes more to the east.

The stratigraphy of the area studied is rather well-known, but the interpretation of some features was sometimes incorrect. The nomenclature has sometimes been used in a wrong sense; moreover, several units are not named (see fig. 3 and 4).

Two chronostratigraphical names (Hemmoorium = Hemmoor Stufe and Reinbekium = Reinbek Stufe) were recognized for the whole of the shell-bearing strata.

The Middle-Miocene deposits of the region have not yet received any formation name. The members were recognized as follows. For the sands of the Hemmoor type no lithostratigraphical name has been proposed. The sediments of the Reinbek type were subdivided by Janssen 1967 in two units of equal value, the Laag van Ticheloven and the Dingdener Schichten, the latter subdivided in Dingdener Feinsand and Dingdener Glimmerton. The last two units were already recognized by Anderson 1964, resp. as Bislicher Schichten and Dingdener Schichten. Sediments of the Laag van Ticheloven were not known to him. This presentation can be seen in fig. 3.

<table>
<tr><th colspan="2">Chronology</th><th colspan="2">Lithological units</th></tr>
<tr><td rowspan="3">Middle Miocene
Koenen 1886</td><td rowspan="3">Reinbek Stufe
(Reinbekium)
Köwing 1957</td><td rowspan="2">Dingdener Schichten Janssen 1967</td><td>Dingdener Schichten Anderson 1964
Dingdener Glimmerton Janssen 1967</td></tr>
<tr><td>Bislicher Schichten Anderson 1958
Dingdener Feinsand Janssen 1967</td></tr>
<tr><td colspan="2">Laag van Ticheloven Janssen 1967</td></tr>
<tr><td></td><td>Hemmoor Stufe
(Hemmoorium)
Köwing 1957</td><td colspan="2">Sands of "Hemmoor" type (see Janssen 1968)</td></tr>
</table>

Fig. 3. Chronostratigraphical and lithostratigraphical subdivision of the Miocene deposits in the region Winterswijk - Dingden, as used up to now.

As all the transitions between the recognized members appeared to be gradual and not limited by boundaries, the conclusion must be that the shell-bearing sediments represent here but a basal part of only one sedimentation-cycle, which should have only one chrono-stratigraphical name and one formation name. In my opinion, if one wants to recognize limited lithological units, it is best to accept here four members of equal value. The thickness of the distinguished members in this area is relatively small, they never exceed 5 m, and are usually smaller, together rarely exceeding 12 m in this area.

The chronological name Middle Miocene is understood to cover the whole shell-bearing complex. The names Hemmoor Stufe and Reinbek Stufe, having been used merely in a chronological sense, as explicitly stated by Anderson 1964, can better be abandoned in this area, because a chronological bipartition of the Miocene in the Winterswijk - Dingden area is not supported by features.

The names Hemmoor Stufe and Reinbek Stufe are not applicable in a lithological sense in the area too, because they are of a tainted stock. Moreover a direct correlation with the type.localities in Northern Germany seems to be

rather difficult.

The deposits on top of the studied section are a continuation of the same sedimentation cycle.

In my opinion the correct way to classify the Miocene deposits of the Achterhoek-area and Dingden, lithologically and chronologically, is as follows (most important molluscan species indicated):

CHRONO STRAT.	LITHO STRATIGRAPHY		
	Formation	Member (important species between brackets)	
Middle Miocene	not named	Dingdener Glimmerton (*Limopsis aurita*) Dingdener Feinsand (*Spisula sp.*) Laag van Ticheloven (*Astarte radiata*) Fine Sands of "Hemmoor" type (*Hiatella arctica*) (not named)	TRANSGRESSION ↑

fig. 4. Proposed chronological and lithological subdivision of the Miocene deposits in the region Winterswijk - Dingden.

Sediments of the Ticheloven type and the Hemmoor type may be deposited synchrone.

Haustator eryna and Hinia schroederi can not be used as guide-fossils for sands of the Hemmoor type, as these species are also found in sediments of the Laag van Ticheloven.

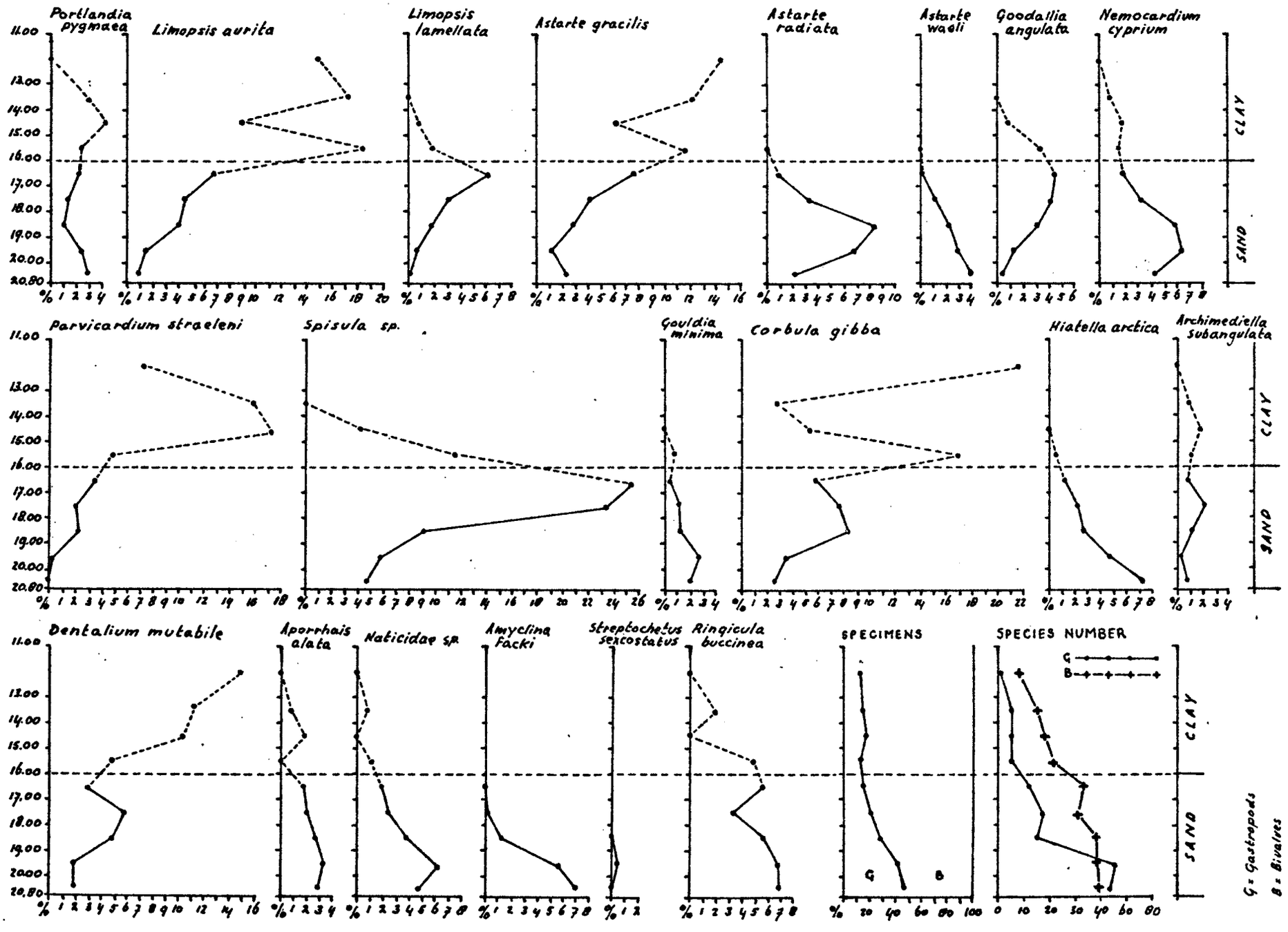
The maxima of mollusc species appear to be independant of the grain size of the sediment.

The changes of the thanatocoenoses can be thought to be due to the changing of the depth of the Miocene sea.

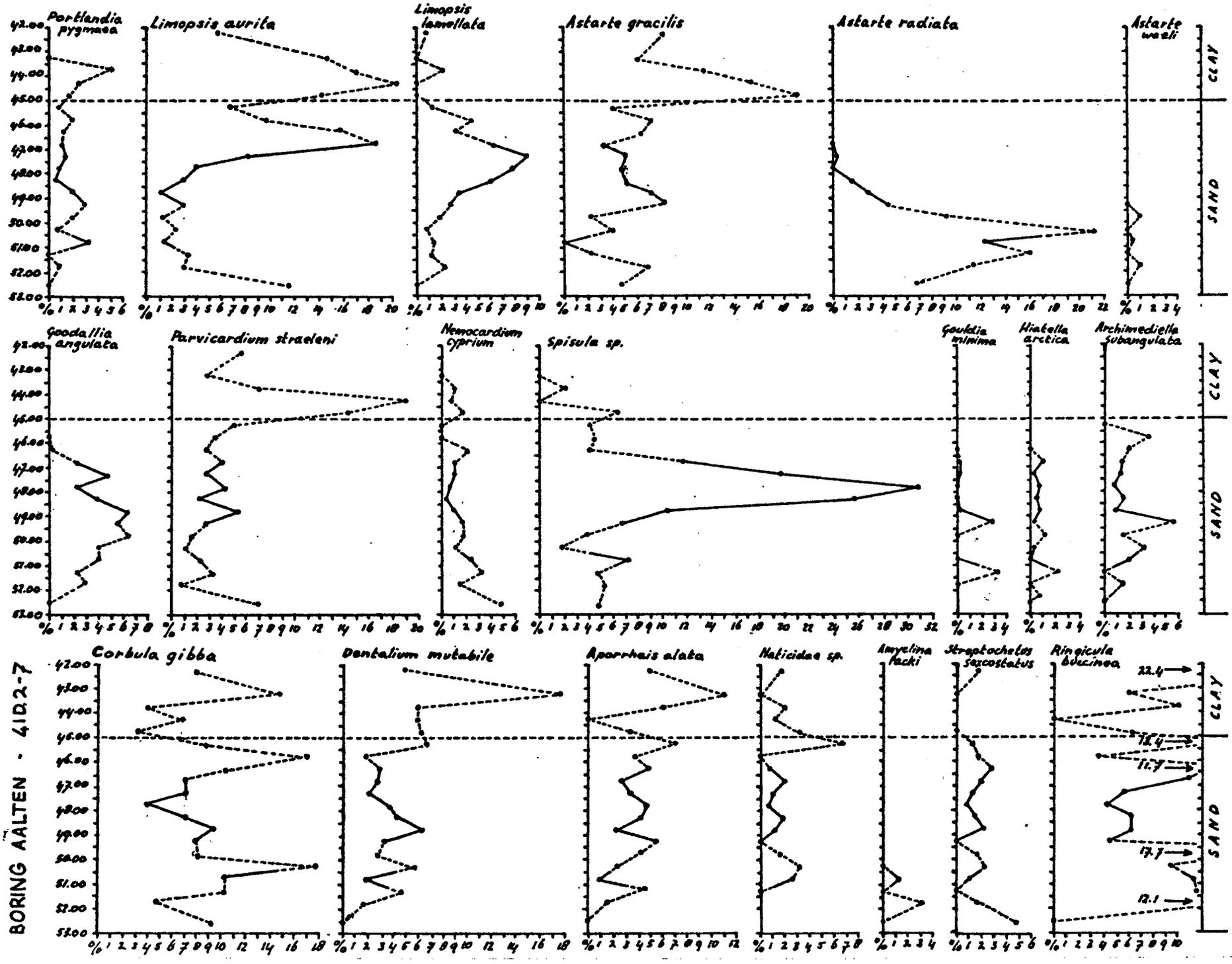
Leiden, 31 januari 1971

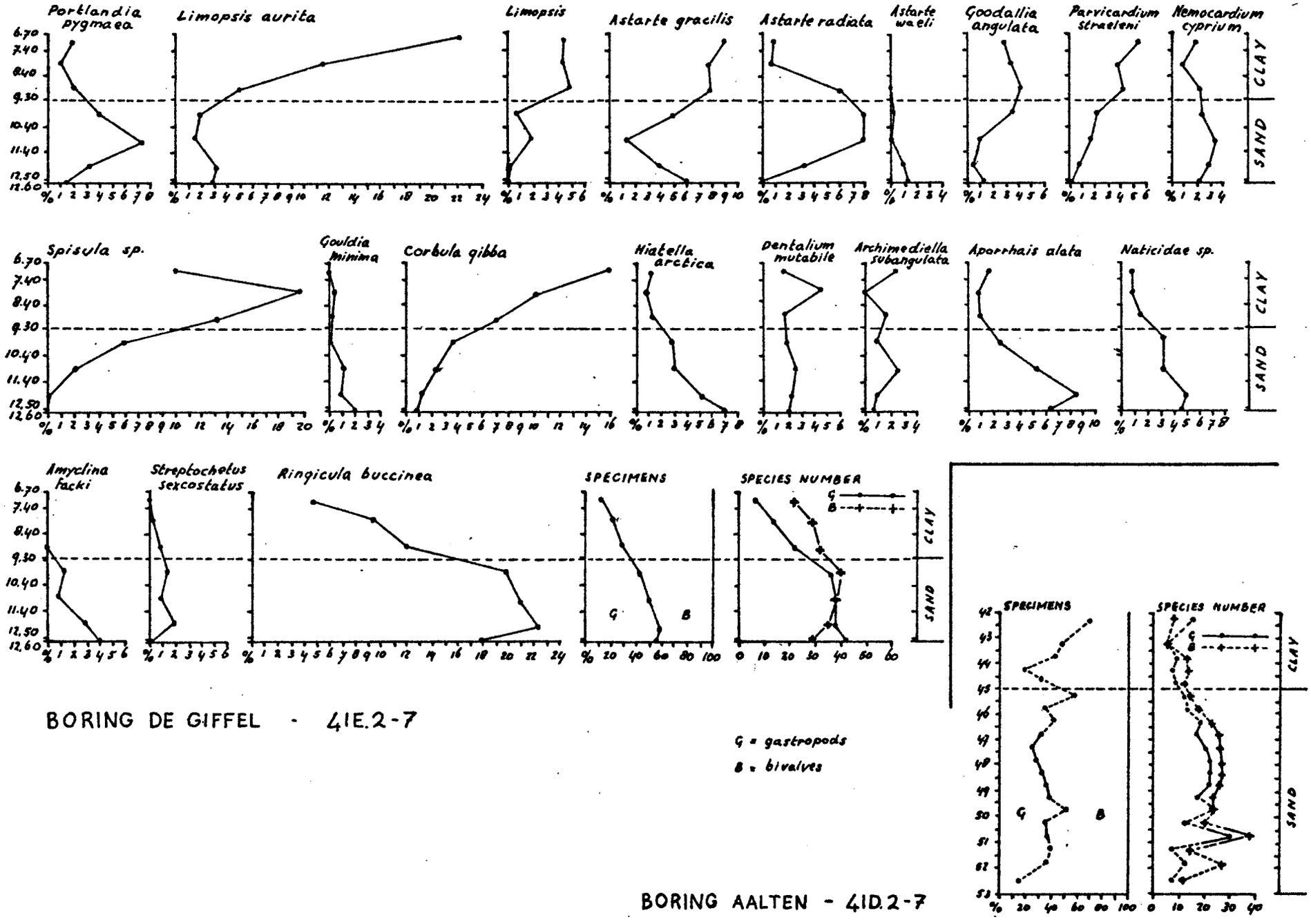
The auther's address: Drs. E. F. de Vogel,
Rijn en Schiekade 82,
Leiden.

Prijs van dit nummer Fl. 6,50



BORING DE HAART - 41E.3-67


BORING AALTEN - 41D2-7
Portlandia pygmaea
Limopsis aurita
Limopsis lamellata
Astarte gracilis
Astarte radiata
Astarte warti
Goodallia angulata
Parvicardium straeleni
Nemocardium cyprium
Spisula sp.
Gouldia minima
Hiatella arctica
Arcthimediella subangulata
Corbula gibba
Dentalium mutabile
Aporrhais alata
Naticidae sp.
Amycline packi
Streptochetes saxicostatus
Ringicula buccinea
22.4
13.4
11.7
17.7
12.1
CLAY
SAND
CLAY
SAND
CLAY
SAND

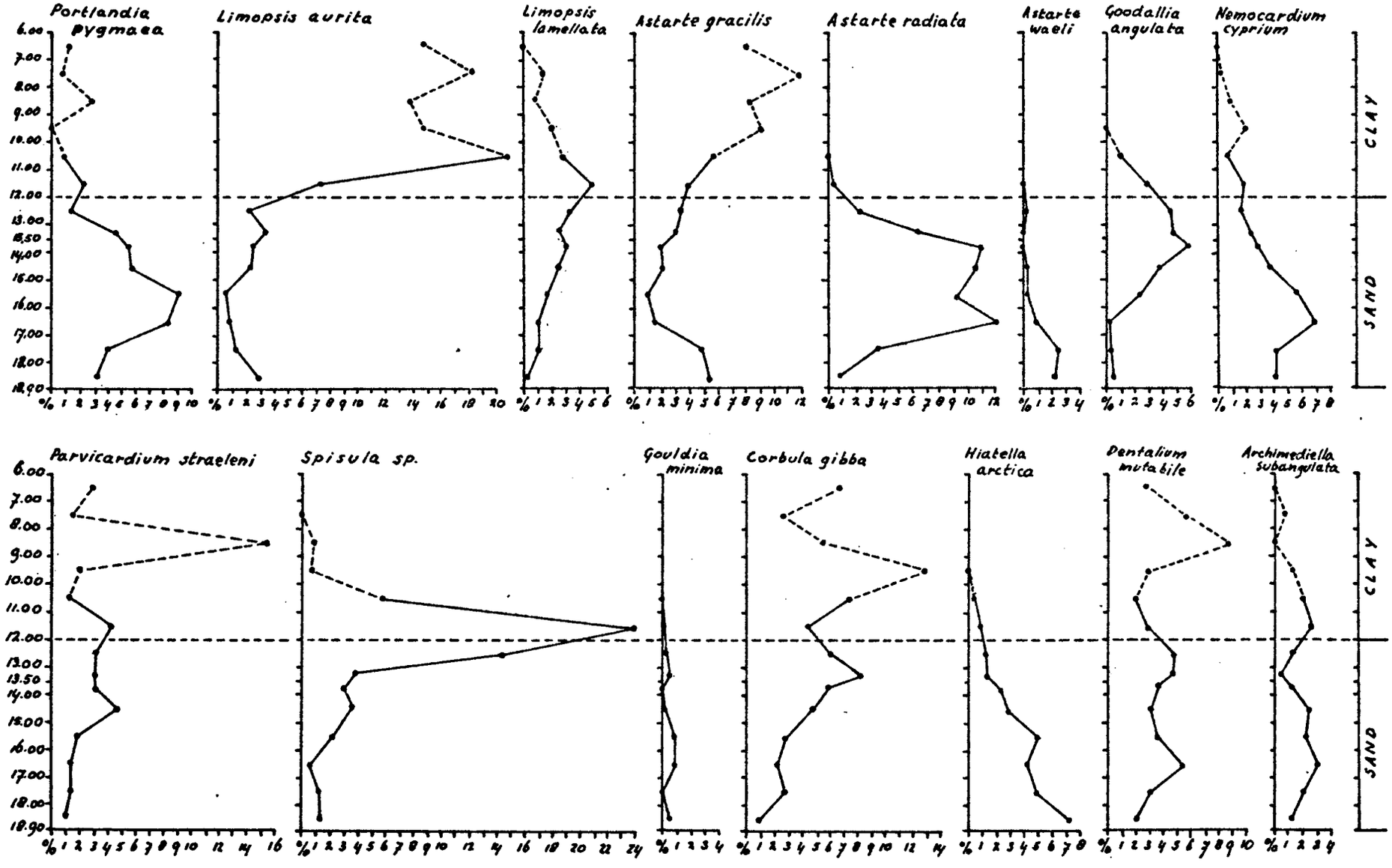


BORING DE GIFFEL - 41E.2-7

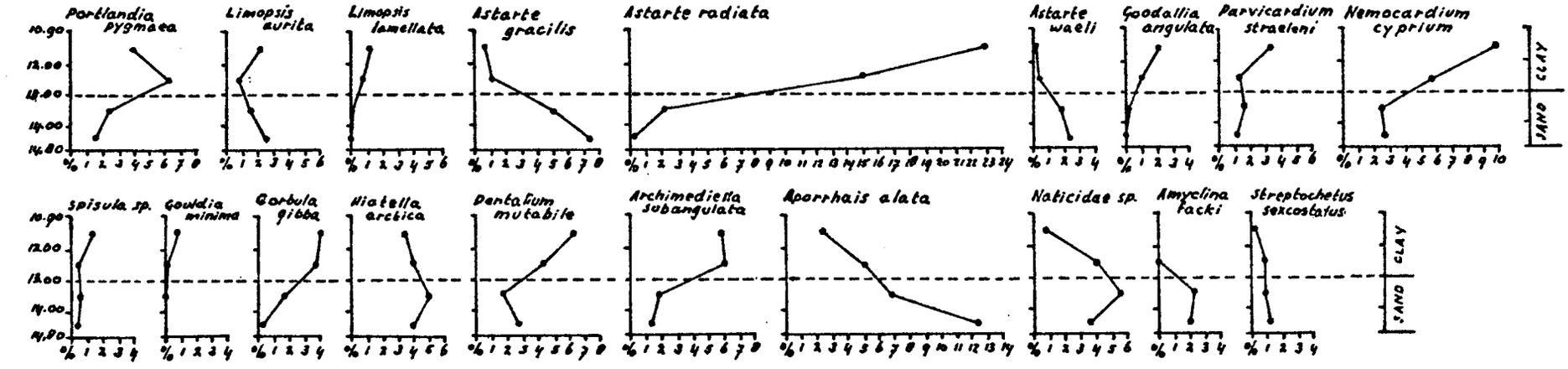
G = gastropods

B = bivalves

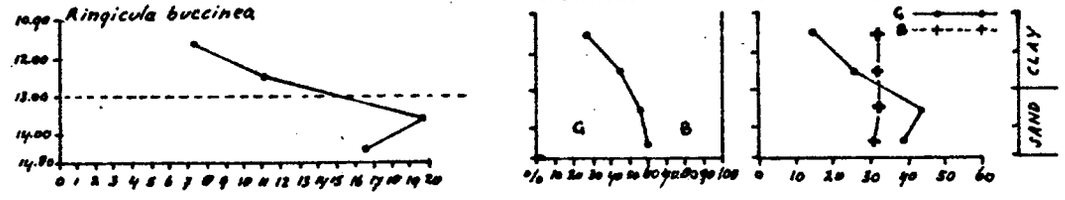
BORING AALTEN - 41D.2-7



BORING STEMERDINK - 41E.4-387



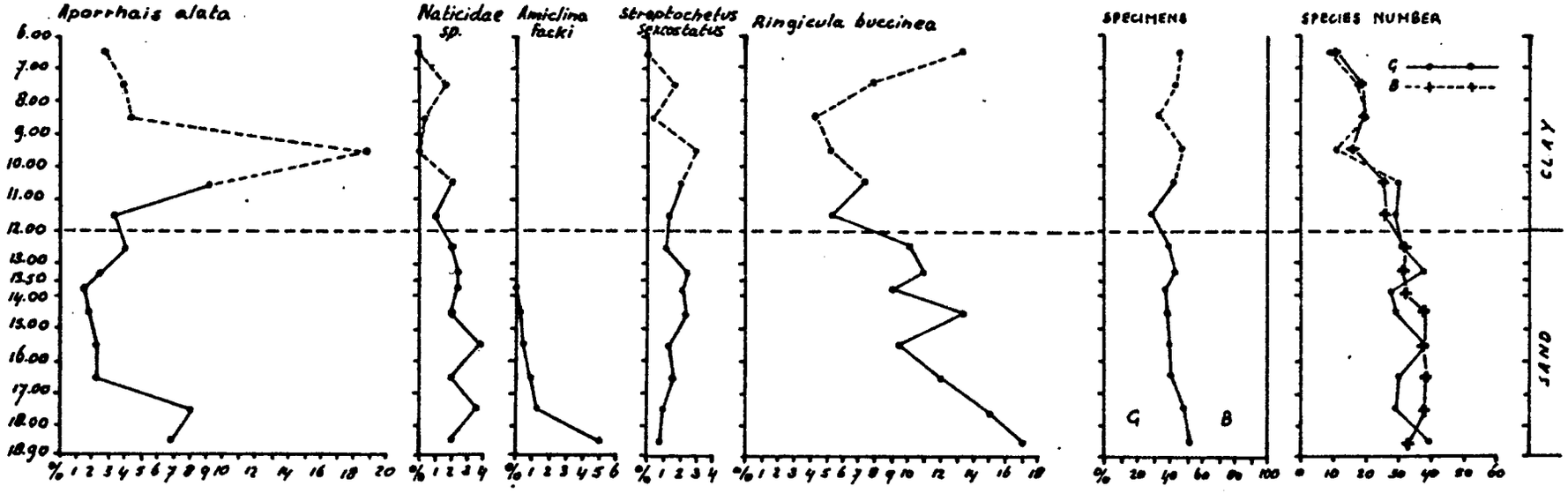
BORING RENSKERS - 41E.4-20

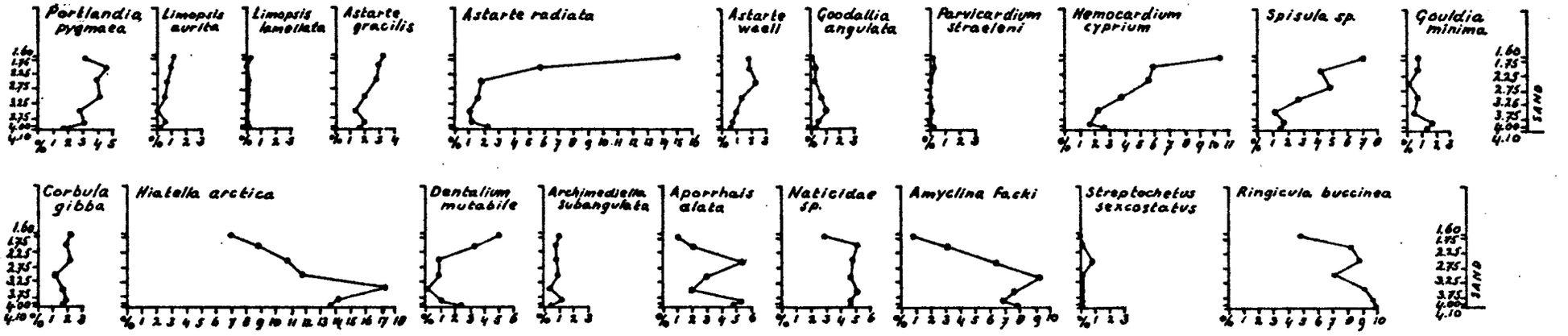


G = Gastropods

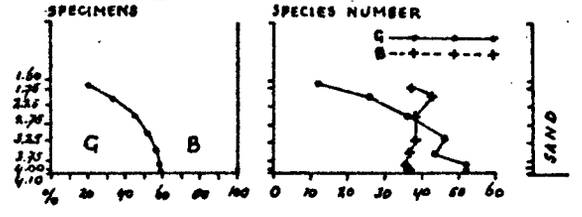
B = Bivalves

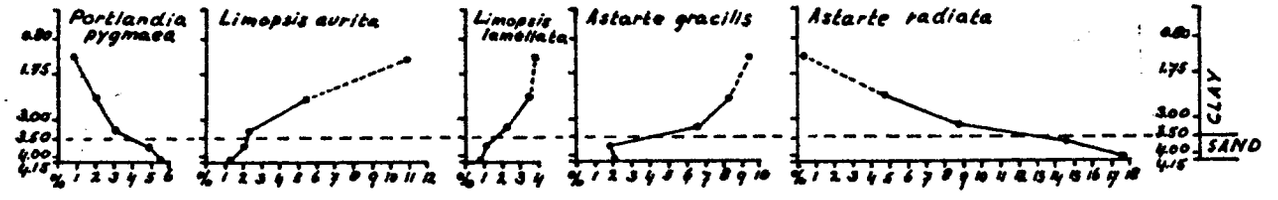
BORING STEMERDINK - 41E.4-387

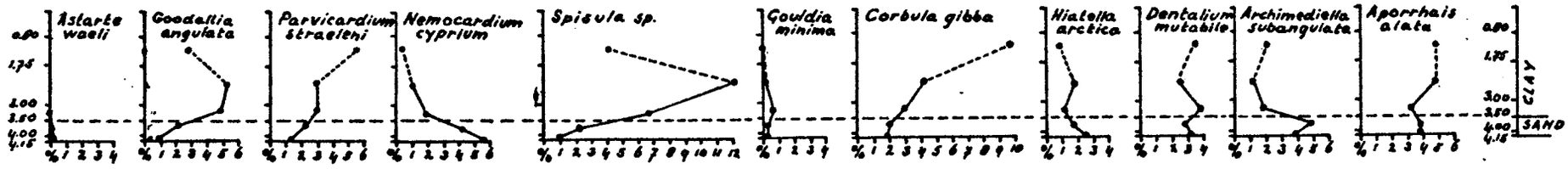


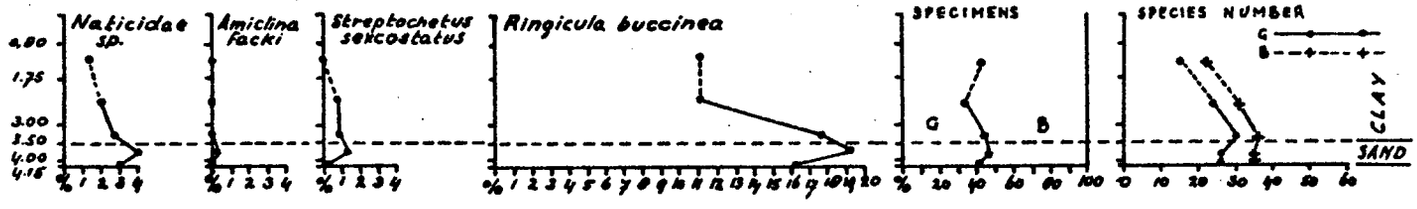


BORING MISTE - 41E.3-75









G = Gastropods

B = Bivalves

BORING TICHELOVEN - 34G.1-24

M E D E D E L I N G E N

VAN DE WERKGROEP VOOR TERTIAIRE EN KWARTAIRE GEOLOGIE

Vol. 7, no. 4, februari 1971 (bijlage)

Appendix to:

E. F. de Vogel - A study of marine Miocene faunas in the "Achterhoek" (Netherlands, prov. of Gelderland), part 2

AALTEN, De Vlijt, 41D.2-7 depth in m	42–42.50	43–43.50	43.50–44	44–44.50	44.50–45	45–45.50	45.50–46	46–46.50	46.50–47	47–47.50	47.50–48	48–48.50	48.50–49	49–49.50	49.50–50	50–50.50	50.50–51	51–51.50	51.50–52	52–53	53–53.50
number counted	62.5	17.0	50.0	82.0	31.5	75.5	56.5	150.0	202.5	300.0	404.5	263.5	240.5	51.5	192.0	88.0	347.5	44.0	67.0	21.5	13.5
1 specimen = ...%	1.6	6.0	2.0	1.3	3.2	1.3	1.8	0.7	0.5	0.3	0.3	0.4	0.4	1.1	0.5	1.1	0.3	2.3	1.5	4.7	7.4
% Gastr. specimens	68.8	47.3	42.0	19.8	31.8	58.4	35.4	41.0	32.8	26.4	28.6	31.1	36.3	38.5	50.9	35.1	36.2	38.7	36.1	14.1	
number Gastr. species	15	5	9	7	8	12	13	18	16	21	22	22	22	16	23	12	30	6	12	6	
number Bivalve species	8	7	13	14	11	14	18	23	25	26	27	27	26	23	24	20	37	14	26	11	
Nucula spec.	–	–	–	–	–	–	–	–	–	–	–	–	0.2	–	–	–	0.1	–	–	–	–
Nuculana westendorpi	–	2.9	2.0	1.8	–	1.9	1.8	0.3	1.0	1.7	1.4	1.5	0.6	0.5	0.8	1.1	0.4	–	–	–	–
Portlandia pygmaea	–	–	5.0	2.4	1.6	0.6	1.8	1.3	1.2	1.5	0.9	0.6	1.9	2.7	1.8	0.6	3.2	–	0.7	–	–
Portlandia spec. ? nov.	–	–	–	–	–	–	–	0.3	–	–	0.4	0.4	–	1.1	–	–	0.4	–	1.5	–	–
Yoldia glaberrima	0.8	2.9	3.0	2.4	1.6	2.6	–	1.3	0.5	0.7	0.5	0.2	0.6	1.1	–	0.6	1.3	–	–	–	3.7
Bathyarca pectunculoides	–	–	–	–	–	–	–	0.7	1.5	0.3	0.9	0.6	0.4	–	1.0	0.6	0.6	1.1	1.5	–	–
Anadara diluvii	–	–	–	–	–	–	–	0.3	–	–	–	–	–	–	–	–	0.1	–	0.7	–	–
Limopsis aurita	5.6	14.5	17.0	20.3	14.3	6.6	9.6	15.7	18.5	8.2	4.0	2.9	1.2	2.7	1.3	2.3	1.4	3.4	3.0	11.5	7.4
Limopsis retifera	–	–	–	1.3	–	2.6	0.9	2.0	2.5	2.7	3.5	2.3	2.9	1.6	0.3	1.1	0.1	1.1	2.2	–	3.7
Limopsis lamellata	0.8	–	2.0	–	–	1.3	4.4	3.3	6.2	8.7	7.8	6.0	3.3	2.6	1.8	0.6	1.3	1.1	2.2	–	7.4
Glycymeris lunulata baldii	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3	–	–	–	–
Arcoperna sericea	–	–	–	–	–	–	–	–	–	–	–	0.2	–	–	–	–	0.1	–	–	–	–
Modiolula phaseolina	–	–	–	–	–	–	–	–	0.2	0.2	–	0.4	0.4	–	0.5	0.6	0.7	–	–	–	–
Korobkovia woodi	0.8	–	–	1.8	1.6	1.3	1.8	0.6	0.5	0.3	0.7	0.6	0.4	0.5	–	0.6	1.0	–	0.7	2.3	–
Pseudamussium lilli	–	–	–	–	–	–	–	–	–	–	0.1	0.2	–	–	0.5	0.6	0.3	–	–	–	–
Limaria loscombii	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	–	–
Limidae spec.	–	–	–	–	–	–	–	–	–	–	–	0.2	–	–	–	–	–	–	–	–	–
Cavilucina dreyeti	–	–	–	–	–	–	–	0.3	0.2	–	–	–	–	–	–	–	–	–	–	–	–
Lucinoma borealis	–	–	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–	0.1	–	0.7	–	–
Thyasira spec.	–	–	–	–	–	–	0.9	–	–	0.2	0.1	–	–	–	–	–	–	–	–	–	–
Erycinidae spec.	–	–	–	–	–	–	–	–	–	–	0.3	–	–	–	–	–	0.3	–	–	–	–
Diplodonta rotundata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.7	–	–
Cyclocardia chamaeformis	–	6.0	1.0	0.6	–	0.7	1.8	2.7	2.0	2.7	1.2	2.7	5.7	2.7	0.8	–	1.0	2.3	0.7	–	3.7
Erycinella chavani	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.0	–	–
Astarte gracilis	8.0	6.0	11.0	15.1	19.0	4.0	7.0	6.3	3.2	5.0	4.7	5.2	7.0	8.2	2.3	4.0	–	2.3	6.7	4.7	7.4
Astarte radiata	–	–	–	–	–	–	–	–	–	0.2	–	1.5	2.7	4.4	9.1	21.1	12.2	16.0	11.4	6.9	14.9
Astarte kickxi	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	2.2	–	–
Astarte waeli	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.8	–	0.3	–	0.7	–	–
Goodallia angulata	–	–	–	–	–	–	–	0.3	2.2	4.5	2.2	3.8	6.3	5.5	6.4	4.0	4.0	2.3	3.0	–	3.7
Goodallia laevigata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5	–	0.7	–	2.2	2.3	–
Parvicardium straeleni	5.6	2.9	7.0	18.8	14.2	4.6	3.5	2.7	4.0	2.7	4.2	2.1	5.4	2.7	1.6	1.1	2.3	3.4	0.4	6.9	–

AALTEN, De Vlijt, 41D.2-7 continued depth in m	42–42.50	43–43.50	43.50–44	44–44.50	44.50–45	45–45.50	45.50–46	46–46.50	46.50–47	47–47.50	47.50–48	48–48.50	48.50–49	49–49.50	49.50–50	50–50.50	50.50–51	51–51.50	51.50–52	52–53	53–53.50
Parvicardium aff. scabrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
Nemocardium cyprium	-	-	1.0	0.6	1.6	-	-	2.0	1.0	1.0	0.7	0.4	0.8	1.6	1.8	1.1	2.4	3.4	1.5	4.7	-
Spisula spec.	-	-	2.0	-	6.3	4.0	4.4	4.0	11.6	19.6	30.6	25.6	10.4	6.6	3.9	1.7	7.2	4.5	5.2	4.7	11.1
Macoma elliptica	-	-	-	-	-	-	0.9	0.7	0.7	0.5	0.3	0.4	0.2	1.1	0.3	1.1	0.3	-	1.5	-	-
Gari affinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-
Abra sorgenfreii	-	-	-	-	-	-	0.9	0.3	0.7	0.5	0.7	0.4	0.4	-	0.3	-	1.6	-	-	2.3	-
Abra lehmanni	0.8	-	2.0	5.5	3.2	1.3	5.3	1.0	1.0	0.5	0.6	0.6	0.4	-	0.5	0.6	0.6	-	-	-	-
Lutetia nitida	-	-	-	1.8	-	0.7	0.9	-	0.2	-	-	-	0.2	-	-	-	-	-	-	-	-
Glossus lunulatus	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-
Venus multilamella	-	-	1.0	-	-	-	0.9	1.3	0.5	2.0	0.4	0.8	1.0	1.1	1.6	2.3	2.2	-	1.5	4.7	3.7
Gouldia minima	-	-	-	-	-	-	-	-	0.2	0.2	-	-	0.2	2.7	-	-	-	3.4	1.5	-	-
Corbula gibba	8.0	14.5	4.0	6.7	3.2	8.6	16.9	10.3	7.2	7.3	4.0	7.0	9.3	7.8	8.1	17.5	10.3	10.2	4.5	9.3	3.7
Hiatella arctica	-	-	-	-	-	-	-	1.0	0.2	0.8	0.5	0.8	0.4	1.1	0.3	-	2.2	-	0.7	-	3.7
Saxicavella pusilla	-	-	-	-	-	-	-	-	-	0.2	-	-	-	0.5	0.8	-	0.7	-	-	-	-
Panopea meynardi	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-
Cochlodesma aff. pretenue	-	-	-	-	1.6	-	0.9	-	-	0.2	-	-	-	0.5	-	-	-	-	-	-	-
Thracia ventricosa	-	-	-	0.6	-	-	-	-	-	-	-	-	0.2	0.5	-	-	-	-	-	-	-
Cuspidaria spec.	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	-	0.1	-	-	-	-
Cardiomya costellata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
Bivalvia spec.	0.8	2.9	-	0.6	-	0.7	-	0.3	-	0.2	0.5	0.9	1.2	1.6	1.0	1.7	0.7	5.7	3.0	6.9	-
Dentalium entalis	4.8	17.6	6.0	6.0	6.3	6.6	1.8	2.7	2.5	2.0	3.7	4.2	6.3	3.3	2.6	5.7	1.7	4.5	1.5	-	7.4
Dentalium spec.	1.6	-	-	-	3.2	1.3	-	-	-	0.3	0.3	-	-	-	-	-	0.3	2.3	3.0	-	-
Cadulus gadus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-	-	-	-	-	-
Solariella formosa	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Circulus p. praecedens	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Circulus hennei	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-
Putilla gottscheana westfalica	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-	-	-	-	-
Alvania holsatica	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-
Alvania pseudopartschi	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-
Archimediella subangulata	-	-	-	-	-	-	3.5	2.0	1.5	1.3	0.7	1.5	0.8	5.5	1.6	3.4	2.0	-	1.5	-	-
Bittium spina	-	-	-	-	-	1.3	1.8	1.3	-	-	0.5	1.9	-	-	0.5	-	-	-	-	-	-
Cerithiella genei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-
Cerithiopsis spec.	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Opalia pertusa	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	0.3	-	-	-	-
Turriscala straleni	1.6	-	-	-	-	-	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strombiformis glaber	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-

AALTEN, De Vlijt, 41D.2-7, continued depth in m	42-42.50	43-43.50	43.50-44	44-44.50	44.50-45	45-45½.50	45.50-46	46-46.50	46.50-47	47-47.50	47.50-48	48-48.50	48.50-49	49-49.50	49.50-50	50-50.50	50.50-51	51-51.50	51.50-52	52-53	53-53.50
Melanella glabella	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-	-
Melanella alba	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-	-	-	4.7	-
Aporrhais alata	4.8	11.8	6.0	-	3.2	6.6	3.5	4.7	2.5	3.3	4.9	4.2	2.1	5.5	4.2	2.3	0.9	4.5	1.5	-	-
Calyptraea chinensis	-	-	-	-	-	-	-	0.7	-	-	0.3	-	0.4	-	-	-	0.3	-	-	-	-
Xenophora deshayesi	-	-	-	-	-	-	-	-	-	-	0.5	0.4	-	-	-	-	-	-	-	-	-
Naticidae spec.	1.6	-	2.0	1.3	3.2	6.6	-	0.7	2.0	1.0	0.7	1.9	1.2	-	1.6	3.4	2.9	-	-	-	-
Eudolium dingdense	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-	-	-
Murex inornatus	-	-	2.0	-	-	-	-	-	-	-	0.3	-	0.4	-	-	-	0.3	-	-	-	-
Lyrotyphis sejunctus priscus	-	-	-	1.3	-	-	1.8	2.0	2.0	1.0	-	0.4	1.7	2.2	2.6	-	0.3	-	1.5	-	7.4
Hadriania coelata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-
Mitrella nassoides	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-	-	-	-	-
Anachis corrugata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-
Anachis pulchella	-	-	-	-	-	-	-	-	-	0.3	0.3	-	-	-	-	-	-	-	-	-	-
Amyclina facki	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	-	3.0	-	-
Hinia bocholtensis	11.2	5.9	8.0	6.0	3.2	14.8	7.0	3.3	2.0	3.7	4.9	1.9	2.5	4.4	1.6	1.1	1.6	-	-	-	-
Hinia turbinella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-
Hinia cimbrica	-	-	-	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Hinia holsatica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	-	-
Hinia tenuistriata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-	-	-
Nassariidae spec.	-	-	-	1.3	-	-	-	-	0.5	0.7	0.5	0.8	1.2	-	1.0	-	0.3	2.3	-	9.3	-
Vexillum spec.	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-	-
Latirus rothi	-	-	-	-	-	-	-	-	-	-	-	-	0.8	-	-	-	-	2.3	-	4.7	-
Streptochetus sexcostatus	1.6	-	-	-	-	1.3	1.8	2.7	2.0	1.3	0.7	1.5	2.1	-	1.6	2.3	0.9	-	1.5	4.7	-
Babylonella fusiformis	1.6	-	-	1.3	3.2	1.3	-	1.3	-	0.3	-	-	0.4	2.2	0.5	-	-	-	0.3	-	-
Gemmula boreoturricula	-	-	-	1.3	-	1.3	-	-	-	-	0.3	-	0.8	1.1	-	3.4	0.3	-	-	-	-
Gemmula denticula borealis	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-
Gemmula zimmermanni	-	-	0.2	-	-	-	-	1.3	1.0	1.3	1.2	1.1	2.5	-	1.6	-	0.3	-	-	4.7	7.4
Turris aquensis	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-
Turris duchasteli flexiplicata	1.6	-	-	-	-	-	-	1.3	-	-	-	0.4	0.4	1.1	-	-	0.3	-	-	-	-
Epalxis cataphracta s.lat.	3.2	-	-	-	-	-	3.5	-	-	-	-	0.4	-	-	0.5	-	-	-	-	-	-
Crassispira borealis	-	-	-	-	-	-	1.8	1.3	-	-	0.5	0.4	-	-	2.1	-	-	-	-	-	-
Brachytoma pannoides	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	0.5	-	-	-	-	-	-
Aphanitoma debilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-
Boreodrillia hosiusi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-
Haedropleura maitreja	-	-	-	-	-	-	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mangeliidae spec.	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-	-	1.5	-	-
Teretia anceps	-	-	-	-	-	-	-	-	-	-	0.3	0.4	0.4	-	-	-	0.3	-	-	-	-
Turridae spec.	8.0	6.0	2.0	-	-	2.6	1.8	-	2.0	0.7	1.2	0.4	2.5	2.2	3.6	1.1	2.3	-	3.0	-	-

AALTEN, De Vlijt, 41D.2-7, continued	42-42.50	43-43.50	43.50-44	44-44.50	44.50-45	45-45.50	45.50-46	46-46.50	46.50-47	47-47.50	47.50-48	48-48.50	48.50-49	49-49.50	49.50-50	50-50.50	50.50-51	51-51.50	51.50-52	52-53	53-53.50
depth in m																					
Conus antediluvianus	-	-	-	-	-	-	-	-	0.5	-	-	0.4	0.4	-	0.5	-	-	-	-	-	-
Strioterebrum hoernesi	-	-	-	-	-	-	-	-	-	-	-	0.4	1.2	-	0.5	-	-	-	-	-	-
Chrysallida pygmaea	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-
Odostomia spec.	-	-	-	-	-	-	-	1.3	0.5	-	-	0.4	-	1.1	0.5	-	0.3	-	-	-	-
Syrnola hoernesi	1.6	-	-	-	-	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-	-
Turbonilla spec.	1.6	-	-	-	3.2	1.3	-	-	-	-	0.3	-	-	1.1	-	-	0.6	-	-	4.7	-
Actaeonidae spec.	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-
Ringicula buccinea	22.4	6.0	10.0	-	6.3	13.4	3.5	11.7	10.8	5.7	4.2	6.2	6.2	4.4	17.7	9.1	11.2	11.4	12.1	-	-
Cylichna aff. cylindracea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	-	-
Roxania utriculus	-	-	2.0	-	-	-	-	1.3	-	0.3	-	-	-	-	-	-	0.3	-	-	-	-
Scaphander grateloupi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	1.1	-	-	-	-	-
Retusa elongata	-	-	-	-	-	-	-	0.7	-	1.3	0.7	-	-	-	1.0	-	0.6	-	-	-	-
Rhizorus acuminatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-
Gastropoda spec.	-	-	2.0	1.3	-	-	-	-	1.5	-	0.7	1.1	1.2	-	2.6	-	2.6	11.4	1.5	-	-

LITHOLOGY

Wash-drilling, borehole of 9 cm ∅, without casing, with thick drilling-mud, made by M. van den Bosch and E. F. de Vogel

0.00 - 7.35 m : Quaternary deposits

7.35 - 14.50 m : Dark green, very fine quartz-sand, 80-100 mu, with a high content of clay, with much fine mica and little fine glauconite.

14.50 - 45.00 m : Dark green-brown to dark green-grey clay, with much to very much fine sand; from 30.80 - 34.80 m with a layer fine sand of 80-100 mu, with a very high content of clay; towards the base with a rather low content of fine sand, varying between 60-180 mu; the upper layers with much, towards the base with less, from 36.75 m with few to very few mica; down to 35.00 m with few glauconite; from 43.50 - 44.50 m with few concretions; from 33.80 m with some, towards the base with rather few molluscan shells.

45.00 - 53.00 m : Dark green-grey fine quartz-sand, 100-150 mu, from 50.50 m onwards green-grey fine quartz-sand up to 100 mu; with some mica and few, from 51.00 m onwards rather much glauconite; from 47.50 m some small, below 52.50 m towards the base with many large fosforites; with few to rather much, from 51.00 m onwards with few molluscan shells.

53.00 -(56.00) m: Light green-grey fine sand, 80-150 mu, with many, towards the base with rather few clay; with a trace of mica and some glauconite; with some corroded shell-fragments (Oligocene).

DE HAART, 41E.3-67

depth in m	11-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-20.80
number counted	27.5	107.5	58.0	103.0	476.0	500.0	500.0	500.0	500.0
1 specimen = ...%	3.6	0.9	1.7	1.0	0.2	0.2	0.2	0.2	0.2
% Gastr. specimens	14.6	15.8	18.0	13.8	16.0	20.2	27.0	40.6	45.0
number Gastr. species	1	5	5	5	12	17	15	45	43
number Bivalve species	8	15	18	21	34	33	38	38	39
Nucula spec.	-	-	-	-	-	-	-	0.2	0.1
Nuculana westendorpi	1.8	4.7	5.2	1.0	0.6	1.0	0.7	0.8	0.6
Portlandia pygmaea	-	2.8	4.3	2.4	2.3	1.4	1.0	2.4	2.7
Portlandia spec. ? nov.	-	-	-	-	-	0.3	-	-	-
Yoldia glaberrima	3.6	3.7	4.3	1.5	1.6	0.2	0.2	0.2	-
Bathyarca pectunculoides	-	-	-	-	0.4	0,2	0.1	-	-
Anadara diluvii	-	-	-	-	-	-	0.1	-	0.1
Limopsis aurita	14.6	17.1	8.6	18.3	6.8	4.4	4.0	1.3	0.8
Limopsis retifera	-	-	-	1.9	2.5	2.5	1.4	0.6	0.6
Limopsis lamellata	-	-	0.9	1.9	6.1	3.0	1.7	0.3	0.1
Glycymeris lunulata baldii	-	-	-	-	0.1	0.4	0.8	1.3	0.9
Arcoperna sericea	-	-	-	-	-	-	-	0.1	0.1
Modiolula phaseolina	-	-	-	-	0.5	0.2	0.4	0.4	0.3
Korobkovia woodi	12.9	1.4	2.6	-	1.2	1.1	0.9	0.5	0.1
Pseuda mussium lilli	-	0.5	-	0.5	0.1	0.3	0.4	1.1	0.9
Pododesmus squamula	-	-	-	-	-	-	-	-	0.2
Limea aff. strigillata	-	-	-	-	-	-	-	0.2	0.5
Lucinoma borealis	-	-	0.9	-	0.1	-	-	0.1	0.1
Diplodonta rotundata	-	-	-	-	-	0.1	0.2	0.4	0.6
Erycinidae spec.	-	-	-	-	0.2	-	-	-	-
? Tellimya aff. coarctata	-	-	-	-	-	-	-	-	0.2
Cyclocardia chamaeformis	3.6	11.6	0.9	1.0	2.2	2.3	1.6	0.3	0.7
Erycinella chavani	-	-	-	-	-	0.1	0.6	1.6	5.0
Astarte gracilis	14.6	12.1	6.0	11.5	7.6	4.1	2.8	1.2	2.3
Astarte radiata	-	-	-	-	0.8	3.3	8.3	6.7	2.2
Astarte waeli	-	-	-	-	0.1	1.2	2.2	2.9	4.0
Goodallia angulata	-	-	0.9	3.4	4.4	4.1	3.0	1.2	0.4
Goodallia laevigata	-	-	-	-	0.3	0.3	1.3	1.1	0.7
Parvicardium straeleni	7.3	15.8	17.2	4.9	3.6	2.0	2.1	0.3	-
Nemocardium cyprium	-	0.9	1.7	1.5	1.9	3.1	5.9	6.3	4.2
Spisula spec.	-	-	4.3	11.6	25.4	23.3	9.0	5.6	4.7
Ensis spec.	-	-	-	-	-	-	0.1	-	-
Angulus aff. donacilla	-	-	-	-	0.2	0.5	0.2	0.3	1.5
Macoma elliptica	-	0.5	-	0.5	1.5	0.5	0.7	0.6	0.2
Gari affinis	-	-	-	-	-	0.6	0.6	0.6	0.1
Abra sorgenfreii	-	-	-	0.5	0.8	3.3	5.0	7.4	5.1
Abra lehmanni	-	6.1	11.2	1.5	0.4	0.5	0.3	-	-
Ascorinus chamasolen miocenicus	-	-	-	-	0.1	-	-	-	-
Arctica islandica	-	-	-	-	-	-	0.1	-	-
Lutetia nitida	-	-	-	-	-	-	-	0.2	1.2
Glossus lunulatus	-	-	-	-	0.3	0.3	-	0.2	0.1
Venus multilamella	-	-	1.7	1.5	1.6	2.0	2.2	1.1	0.6
Gouldia minima	-	-	-	0.5	0.3	1.2	1.2	2.5	2.0
Pitar rudus rudis	-	-	-	-	-	-	-	0.1	-
Timoclea ovata	-	-	-	-	-	-	0.1	-	-
Veneridae spec.	-	-	-	-	-	-	0.1	-	-
Corbula gibba	21.5	2.8	5.2	16.9	5.9	7.6	8.3	3.5	2.6
Hiatella arctica	-	-	-	0.5	1.2	2.3	2.6	4.7	7.4
Anisodonta duvergieri	-	-	-	-	-	-	-	0.1	-

DE HAART, 41E.3-67, continued

depth in m	11-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-20.80
Cochlodesma praetenue	-	0.9	0.9	-	0.2	-	0.2	-	0.2
Thracia ventricosa	-	0.5	0.9	-	0.2	-	0.6	-	0.1
Cuspidaria spec.	-	-	-	0.5	-	-	-	0.1	0.2
Bivalvia spec.	5.5	2.8	4.3	2.4	2.5	2.1	1.5	0.8	0.6
Dentalium mutabile	14.6	11.2	10.3	4.9	2.9	5.8	4.6	1.8	1.8
Dentalium dunasi	-	-	-	-	0.4	-	-	0.2	0.2
Dentalium spec.	-	-	0.9	-	1.5	1.0	1.4	0.8	2.0
Cadulus gadus	-	-	-	-	-	-	2.0	2.2	2.8
Scurria compressiuscula	-	-	-	-	-	-	-	0.4	0.4
Solariella spec.	-	-	-	-	-	-	-	1.0	0.4
Calliostoma spec.	-	-	-	-	-	-	-	0.2	-
Circulus hennei	-	-	-	-	-	0.2	-	-	0.2
Putilla gottscheana westfalica	-	-	-	-	-	-	-	0.2	-
Haustator eryna	-	-	-	-	-	-	0.4	0.2	0.8
Archimediella subangulata	-	0.9	1.7	1.0	0.8	2.0	1.0	0.2	0.6
Bittium spina	-	-	-	-	-	-	-	0.2	-
Bittium tenuispina	-	-	-	-	-	-	-	1.2	0.8
Cerithiella genei	-	-	-	-	-	-	-	0.2	-
Opalia pertusa	-	-	-	-	-	-	-	0.2	0.4
Turriscala straeleni	-	-	-	-	-	0.2	0.2	-	-
Epitonium linoe	-	-	-	-	-	-	-	0.2	-
Epitonium weyersi	-	-	-	-	-	-	-	-	0.2
Melanella glabella	-	-	-	-	-	0.2	-	-	-
Niso terebellum acarinatoconica	-	-	-	-	-	-	-	0.2	-
Aporrhais alata	-	0.9	1.7	-	1.7	2.0	2.6	3.2	2.8
Calyptraea chinensis	-	-	-	-	0.2	-	-	0.4	-
Xenophora deshayesi	-	-	1.7	1.0	-	-	-	-	-
Naticidae spec.	-	0.9	-	1.4	1.9	2.2	3.8	6.2	4.6
Phalium bicoronatum bicoronatum	-	-	-	-	-	-	-	0.4	-
Murex inornatus	-	-	-	-	-	-	-	0.4	0.2
Lyrotyphis sejunctus priscus	-	-	-	-	-	0.2	0.8	0.2	0.2
Mitrella nassoides	-	-	-	-	-	-	-	0.2	0.4
Anachis corrugata	-	-	-	-	-	-	-	0.2	-
Anachis pulchella	-	-	-	-	-	-	-	0.2	0.6
Phos decussatus	-	-	-	-	-	-	-	-	0.2
Amyclina badensis	-	-	-	-	-	-	-	0.2	0.2
Amyclina facki	-	-	-	-	-	0.2	1.2	5.6	7.0
Hinia schroederi	-	-	-	-	-	-	-	0.2	0.4
Hinia cf serraticosta	-	-	-	-	-	-	-	-	0.4
Nassariidae spec.	-	-	-	-	-	0.6	-	-	0.8
Latirus rothi	-	-	-	-	-	-	-	0.2	0.2
Streptochetus sexcostatus	-	-	-	-	-	-	-	0.4	-
Ancilla obsoleta	-	-	-	-	-	0.2	-	0.4	0.2
Babylonella fusiformis	-	-	-	-	-	-	-	0.2	-
Gemmula denticula borealis	-	-	-	-	-	-	-	-	0.4
Gemmula zimmermanni	-	-	-	-	-	0.2	-	-	-
Turris aqu nsis	-	-	-	-	-	-	-	0.2	-
Turris duchasteli flexiplicata	-	-	-	-	-	0.2	-	0.2	0.4
Crassispira borealis	-	-	-	-	-	0.4	-	-	-
Brachytoma obtusangula	-	-	-	-	-	-	-	-	0.4
Brachytoma pannoides	-	-	-	-	-	-	-	-	0.2
Microdrillia grippi	-	-	-	-	-	-	-	0.2	-
Asthenotoma festiva	-	-	-	-	-	-	-	0.2	-
Haedropleura maitreja	-	-	-	-	-	-	-	0.4	-

DE HAART, 41E.3-67, continued

depth in m	11-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-20,80
Bela tenella	-	-	-	-	-	-	0.2	0.2	0.2
Pleurotomoides luisae	-	-	-	-	-	-	-	-	0.2
Turridae spec.	-	-	-	-	-	0.6	1.0	0.8	0.6
Conus antedilivianus	-	-	-	-	-	-	-	0.2	0.2
Strioterebrum hoernesi	-	-	-	-	-	-	-	-	1.2
Odostomia (s.lat.) spec.	-	-	-	-	-	-	-	0.2	0.2
Syrnola hoernesi	-	-	-	-	0.2	-	-	-	0.4
Eulimella aff. acicula	-	-	-	-	0.2	-	-	-	-
Actaeonidae spec.	-	-	-	-	0.2	-	-	-	-
Ringicula buccinea	-	1.9	-	4.9	5.6	3.4	5.6	6.8	6.8
Cylichna cylindracea	-	-	-	-	0.2	-	0.4	1.0	1.4
Roxania utriculus	-	-	-	-	-	-	-	0.4	0.6
Roxania paucistriata	-	-	-	-	-	-	-	-	0.2
Retusa elongata	-	-	-	-	-	-	0.2	0.8	0.6
Rhizorus acuminatus	-	-	-	-	-	-	-	-	0.2
Gastropoda spec.	-	-	1.7	1.0	0.2	0.6	1.8	1.0	2.0

LITHOLOGY

Wash-drilling, borehole of 7.5 cm ø, with thick drilling-mud, made by M. van den Bosch

0.00 - 1.70 m : Quaternary deposits

1.70 - 16.00 m : Very dark green to dark green-grey clay, towards the base with a high content of fine sand; with much, towards the base with some fine mica; at the top and the base with some glauconite; from 10 - 11 m with some jagged quartzites and a hard sandy concretion; from there with some, towards the base to rather few molluscs.

16.00 - 20.80 m : Dark green-grey, to very dark green, rather fine glauconite sand, with some quartz-sand, and some fine mica; with very few, from 19 m with some larger fosforites; towards the base with very much shells.

20.80 - ? m : Light blue-grey, hard clay with very much fine sand, with an eroded surface (Oligocene)

Very few contamination was observed when drilling in the basal, sterile Oligocene beds.

MISTE, 41E.3-75

depth in m	1.60-1.75	1.75-2.25	2.25-2.75	2.75-3.25	3.25-3.75	3.75-4.00	4.00-4.10
number counted	390	500	500	500	500	500	500
1 specimen = ...%	0.3	0.2	0.2	0.2	0.2	0.2	0.2
% Gastr. specimens	19.9	32.0	44.4	52.0	57.0	58.0	59.0
number of Gastr. species	12	26	37	46	44	52	52
number of Bivalve species	37	43	38	38	37	36	37
Nucula spec.	-	0.1	0.7	0.6	0.5	0.2	0.1
Nuculana westendorpi	2.3	1.6	1.1	1.1	0.1	0.7	0.7
Portlandia pygmaea	3.3	4.5	3.9	4.1	2.7	3.2	1.7
Yoldia glaberrima	0.9	0.8	0.4	0.6	0.3	1.0	0.9
Anadara diluvii	0.8	0.1	0.4	0.2	0.3	0.7	0.6
Limopsis aurita	1.3	1.0	0.6	0.5	-	0.5	0.2
Limopsis retifera	0.1	1.0	0.6	0.1	1.2	0.3	0.6
Limopsis lamellata	0.3	-	0.2	-	0.1	0.1	0.2
Glycymeris lunulata baldii	1.0	1.6	1.4	0.7	0.2	0.2	0.7
Arcoperna sericea	-	-	-	0.1	-	-	-
Modiolula phaseolina	0.3	-	0.1	0.1	0.2	-	0.2
Korobkovia woodi	0.5	0.5	0.1	0.4	0.1	-	0.2
Aequipecten angelonii	-	-	-	-	-	-	0.2
Pseudamussium lilli	-	0.1	0.4	0.5	0.2	0.6	0.4
Pododesmus squamula	-	0.2	-	-	-	0.2	-
Limea aff. strigillata	-	-	-	-	0.2	0.1	0.1
Limatula sulcata	-	-	-	-	-	-	0.1
Cavilucina droueti	0.4	0.4	-	0.6	1.1	1.6	0.9
Lucinoma borealis	0.1	0.1	0.2	0.8	0.3	0.5	0.3
Thyasira spec.	-	-	-	-	0.1	-	-
Diplodonta rotundata	1.0	0.9	1.2	0.7	0.9	0.3	0.3
Erycinidae spec.	-	-	-	0.1	-	-	0.1
Cyclocardia chamaeformis	0.6	0.7	0.3	0.6	0.8	0.7	0.6
Erycinella chavani	0.9	3.9	4.1	3.3	2.5	1.0	0.8
Astarte gracilis	3.2	2.9	2.8	1.9	1.3	2.0	1.6
Astarte radiata	14.8	5.6	1.7	1.6	1.1	1.2	2.3
Astarte waeli	1.7	1.8	2.2	1.4	1.0	0.7	0.6
Goodallia angulata	0.1	0.4	0.3	0.7	1.0	0.5	0.4
Goodallia laevigata	1.4	2.0	1.0	0.3	0.2	0.2	0.4
Parvicardium straeleni	0.1	0.2	-	-	0.1	-	0.2
Parvicardium aff. scabrum	-	0.1	-	-	-	-	-
Nemocardium cyprium	10.3	5.8	5.5	3.7	2.3	1.6	2.6
Spisula spec.	7.0	4.2	4.9	2.7	1.2	1.6	1.5
Phaxas pellucidus	-	-	-	-	0.1	0.1	-
Angulus aff. donacilla	0.4	2.0	1.6	0.5	1.0	0.5	0.7
Angulus fallax	-	-	0.1	-	-	-	-
Macoma elliptica	0.8	0.9	0.3	-	0.2	0.5	0.9
Gari affinis	0.3	0.7	0.6	-	-	-	-
Abra sorgenfreii	6.7	6.2	2.8	2.8	2.3	1.6	1.6
Abra lehmanni	-	0.1	-	0.1	0.1	-	-
Lutetia nitida	-	0.2	0.2	0.4	0.5	0.2	0.5
Glossus lunulatus	0.9	0.2	0.3	0.1	-	-	0.2
Venus multilamella	2.8	0.8	0.9	1.0	0.4	0.9	0.5
Gouldia minima	0.8	0.8	0.2	0.8	0.5	1.7	1.3
Clausinella scalaris	0.1	0.2	-	0.1	-	-	-
Pitar rudis rudis	0.1	0.3	-	0.2	-	-	-
Corbula gibba	2.2	1.9	2.2	1.3	1.6	1.8	1.7
Hiatella arctica	6.8	8.7	10.6	11.6	17.2	14.2	13.7
Saxicavella pusilla	-	-	-	-	-	0.1	-

MISTE, 41E.3-75, continued

depth in m	1.60–1.75	1.75–2.25	2.25–2.75	2.75–3.25	3.25–3.75	3.75–4.00	4.00–4.10
Anisodonta duvergieri	-	0.1	0.2	-	-	-	-
Panopea meynardi	0.3	0.1	0.2	-	-	-	-
Teredinidae/Xylophaginae spec.	-	0.1	-	-	-	-	-
Thracia ventricosa	0.9	0.2	0.4	0.3	-	0.2	-
Cuspidaria cuspidata	0.1	0.3	0.1	0.1	0.1	-	-
Cardiomya costellata	-	-	-	-	-	0.1	-
Bivalvia spec.	4.5	3.7	0.8	1.2	0.8	0.4	0.4
Dentalium mutabile	4.9	3.2	0.8	0.8	0.2	1.0	2.4
Dentalium dumasi	-	0.2	-	0.4	-	0.2	-
Dentalium spec.	2.8	0.8	2.8	0.2	1.0	2.4	2.6
Cadulus gadus	-	1.4	0.8	4.4	4.0	3.4	3.0
Scurria compressiuscula	0.5	0.2	1.0	0.4	1.2	0.8	0.6
Solariella spec.	-	-	-	-	0.2	-	-
Circulus hennei	-	0.2	-	-	-	-	-
Tornus trigonostoma	0.3	-	-	-	-	-	-
Haustator eryna	-	-	0.6	0.6	0.8	1.6	1.4
Archimediella subangulata	1.0	0.8	0.8	1.0	0.4	1.2	0.4
Bittium spina	-	0.6	1.0	2.0	2.4	1.2	0.2
Bittium tenuispina	-	-	-	-	-	-	.2
Acirsa lanceolata	-	-	0.2	0.2	0.2	0.2	0.2
Opalia (Nodiscala) spec.	-	-	-	0.2	-	-	-
Amaea amoena subreticulata	-	-	-	-	-	-	0.2
Cirsotrema scaberrimum	-	-	-	-	0.2	-	-
Strombiformis glaber	-	-	-	-	0.2	0.4	-
Melanella alba	-	-	0.4	-	-	0.2	0.8
Niso terebellum acarinatoconica	-	-	-	-	0.2	0.2	-
Aporrhais alata	1.0	2.0	5.4	3.0	2.0	5.4	4.8
Calyptraea chinensis	-	-	-	0.2	-	-	-
Xenophora deshayesi	-	0.2	-	-	-	0.2	0.2
Naticidae spec.	2.6	5.0	4.8	4.6	5.2	4.6	4.6
Phalium bicoronatum bicoronatum	-	-	0.2	-	-	0.6	-
Charonia tarbelliana	-	-	0.2	-	-	-	-
Ficus conditus	-	-	-	0.2	-	0.6	0.4
Murex inornatus	-	-	-	-	-	0.2	0.2
Lyrotyphis sejunctus priscus	-	-	-	0.2	0.2	-	0.2
Hadriania coelata	-	-	-	1.0	0.2	-	0.2
Mitrella nassoides	-	-	0.8	1.0	-	0.4	0.8
Anachis corrugata	-	-	-	-	-	0.4	-
Anachis pulchella	-	-	0.2	0.4	0.8	0.6	-
Pl[illegible] decussatus	-	0.2	-	-	-	-	-
Amyclina facki	0.8	3.0	6.4	9.2	7.6	6.8	7.8
Hinia schroederi	-	-	-	-	0.6	0.4	0.4
Hinia bocholtensis	-	-	1.0	0.2	-	-	-
Hinia turbinella	-	-	-	-	-	1.4	-
Hinia holsatica	-	-	-	0.2	-	-	-
Hinia tenuistriata	-	-	-	0.4	0.2	-	0.2
Nassariidae spec.	-	-	0.2	1.6	1.0	0.2	0.8
Latirus rothi	-	-	-	-	0.2	0.6	0.6
Streptochetus sexcostatus	-	0.2	0.6	0.2	0.2	0.2	0.2
? Streptochetus contiguus	-	-	0.2	-	-	-	-
Ancilla obsoleta	0.3	0.2	0.4	-	0.8	0.2	0.2
Cancellaria spec. nov.	-	-	0.2	-	-	-	-
Trigonostoma spinifera	-	-	-	-	-	0.2	-
Narona varicosa	-	0.2	-	0.2	-	0.2	-

MISTE, 41E.3-75, continued

depth in m	1.60-1.75	1.75-2.25	2.25-2.75	2.75-3.25	3.25-3.75	3.75-4.00	4.00-4.10
Babylonella fusiformis	-	-	0.2	-	0.4	0.2	0.4
Cancellariidae spec.	-	-	-	-	0.2	0.2	-
Gemmula stoffelsi	-	-	-	-	-	0.2	-
Gemmula boreoturricula	-	-	-	0.4	-	-	0.4
Gemmula denticula borealis	-	0.2	0.4	-	-	0.4	0.2
Turris aquensis	-	-	0.2	0.2	0.2	-	-
Turris duchasteli flexiplicata	-	-	0.4	0.2	0.4	-	0.2
Epalxis cataphracta s. lat.	-	-	0.4	-	-	-	-
Turricula steinvorthi	-	-	-	0.2	-	-	-
Clavus selenkae	-	-	0.2	-	-	0.2	0.2
Crassispira borealis	-	-	0.2	0.2	0.6	0.4	-
Brachytoma obtusangula	-	-	-	-	-	0.2	-
Brachytoma pannoides	-	0.2	-	0.2	-	-	0.2
? Brachytoma hispidula	-	-	-	-	0.2	-	-
Microdrillia grippi	-	-	0.2	-	-	-	-
Asthenotoma festiva	-	-	-	0.6	0.8	1.8	2.0
Boreodrillia hosiusi	-	-	-	0.2	-	0.4	-
? Bela tenella	-	-	-	0.2	-	0.6	0.2
? Bela calais	-	-	-	-	-	-	0.6
Mangeliidae spec.	-	-	-	0.2	0.2	-	-
Pleurotomoides borealis	-	-	-	-	-	-	0.2
Pleurotomoides campanulata	-	-	-	-	-	0.2	0.4
Teretia anceps	-	-	-	-	-	0.2	0.2
Turridae spec.	-	1.0	0.2	1.6	1.6	0.8	0.8
Conus antediluvianus	-	0.2	-	0.2	-	-	-
Strioterebrum hoernesi	-	0.4	-	0.6	0.4	0.2	1.6
Phasianema spec. nov.	-	-	-	0.2	-	-	-
Menestho nordmanni	-	-	-	-	0.2	-	-
Odostomia spec.	-	0.2	0.6	0.6	0.6	-	0.2
Syrnola hoernesi	-	-	-	-	0.2	-	0.4
Eulimella aff. acicula	-	-	-	0.2	-	-	-
Turbonilla spec.	-	-	-	0.2	-	-	-
Pyramidella spec.	-	-	-	-	-	-	0.2
Actaeonidae spec.	-	0.2	-	-	0.4	0.4	-
Crenilabium terebelloides	-	-	-	-	0.6	-	0.2
Ringicula buccinea	4.6	8.2	8.6	7.2	9.2	9.6	9.8
Cylichna cylindracea	0.5	0.4	0.8	1.4	2.2	1.0	0.8
Roxania utriculus	-	-	0.4	-	0.4	0.2	1.4
Roxania paucistriata	-	-	0.2	0.2	-	0.2	0.2
Scaphander gratelcupi	0.3	-	-	-	-	-	-
Retusa elongata	-	0.6	1.6	2.6	1.8	1.8	2.6
Rhizorus acuminatus	-	-	-	0.4	1.0	0.4	0.2
Vaginella depressa	-	-	-	-	-	0.8	0.4
Gastropoda spec.	0.3	2.0	0.8	1.2	3.6	1.6	1.4

LITHOLOGY

Bailer-drilling, borehole of 12.5 cm ø, with casing, made by M. van den Bosch and E. F. de Vogel

0.00 - 1.25 m : Quaternary deposits

1.25 - 4.10 m : Dark to very dark green glauconite sand, 200-400 mu (from 2.75 m - 3.25 m up to 600 mu), with few clay and with rather much quartz-sand; with very much large, down to 3.25 m with an increasing number of fosforites in situ, from 3.25 m towards the base with few rounded black fosforites, with rather few, towards the base with very much molluscan shells.

4.10 - ? m : Blue-grey clay, with rather few sand (Oligocene)

MISTE, 41E.3-65

depth in m	3.10-3.60
number counted	470
1 specimen = ...%	0.2
% Gastr. specimens	56.7
number of Gastr. species	38
number of Bivalve species	33
Nuculana westendorpi	0.4
Portlandia pygmaea	2.6
Yoldia glaberrima	1.4
Anadara diluvii	1.1
Limopsis retifera	1.4
Limopsis lamellata	0.1
Glycymeris lumulata baldii	0.1
Modiolula phaseolina	0.2
Korobkovia woodi	0.2
Pseudamussium lilli	0.3
Limea aff. strigillata	0.1
Cavilucina droueti	2.2
Lucinoma borealis	0.5
? Tellimya aff. coarctata	0.2
Cyclocardia chamaeformis	1.1
Erycinella chavani	0.9
Astarte gracilis	2.8
Astarte radiata	2.0
Astarte waeli	0.7
Goodallia angulata	0.5
Parvicardium aff. scabrum	0.1
Nemocardium cyprium	1,4
Spisula spec.	0.5
Angulus aff. donacilla	0.4
Macoma elliptica	1.2
Abra sorgenfreii	1.3
Lutetia nitida	0.1
Venus multilamella	1.8
Cordia minima	2.0
Corbula gibba	1.6
Hiatella arctica	11.9
Anisodonta duvergieri	0.1
Cuspidaria spec.	0.1
Bivalvia spec.	0.1
Dentalium mutabile	1.7
Cadulus gadus	4.5
Haustator eryna	1.1
Archimediella subangulata	0.6
Bittium tenuispina	1.9
Opalia pertusa	0.2
Strombiformis glaber	0.2
Melanella alba	0.2
Niso terebellum acarinatoconica	0.2
Aporrhais alata	10.0
Naticidae spec.	4.9

depth in m	3.10-3.60
Phalium bicoronatum bicoronatum	0.2
Hadriania coelata	1.1
Mitrella nassoides	0.9
Amyclina facki	5.5
Hinia schroederi	1.3
Hinia tenuistriata	0.4
Streptochetus sexcostatus	0.2
Narona varicosa	0.2
Babylonella fusiformis	0.4
Gemmula boreoturricula	0.2
Gemmula denticula borealis	0.4
Crassispira borealis	0.2
Asthenotoma festiva	0.2
Boreodrillia hosiusi	0.4
Mangeliidae spec.	0.6
Turridae spec.	0.9
Strioterebrum hoernesi	1.7
Chrysallida pygmaea	0.2
Odostomia spec.	0.2
Pyramidella plicosa	0.2
Actaeonidae spec.	0.6
Ringicula buccinea	9.6
Cylichna cylindracea	1.3
Roxania paucistriata	0.2
Retusa elongata	2.0
Rhizorus acuminatus	0.6
Gastropoda spec.	1.5

LITHOLOGY

Edelman-drilling, borehole of 5 cm ∅, made by H.G. Kolstee.

0.00 - 1.80 m : Quaternary deposits

1.80 - 3.60 m : Dark green glauconite sand with some black fosforites, towards the base with very much molluscan shells.

3.60 - ? m : large concretion (? Oligocene)

STEMERDINK, 41E.4-387

depth in m	6 - 7	7 - 8	8 - 9	9 -10	10-11	11-12	12-13	13-13.50	13.50-14	14-15	15-16	16-17	17-18	18-18.90
Number counted	37.5	177	235.5	75	349	500	500	500	330	500	500	500	500	500
1 specimen = ...%	2.7	0.6	0.4	1.3	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2
% Gastr. specimens	45.4	43.9	31.7	46.4	42.1	28.8	39.8	41.2	36.2	37.8	39.6	39.8	47.2	50.8
Number Gastr. species	9	17	20	11	30	29	31	36	27	29	38	30	29	39
Number Bivalve species	10	18	19	15	25	26	32	32	33	37	37	38	37	34
Nucula spec.	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1	-
Nuculana westendorpi	-	2.0	4.0	1.3	1.2	0.7	1.3	0.8	0.7	1.2	1.4	1.5	2.1	2.7
Portlandia curvirostris	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-
Portlandia pygmaea	1.3	0.8	2.8	-	0.9	2.1	1.5	4.3	5.6	5.8	9.0	8.4	4.0	3.2
Portlandia spec. ? nov.	-	-	-	-	-	0.1	0.2	0.2	1.8	0.5	-	-	-	-
Yoldia glaberrima	2.7	1.7	3.6	2.0	0.6	0.4	0.3	1.2	1.4	1.9	4.0	4.7	3.3	2.6
Bathyarca pectunculoides	-	-	-	0.7	0.9	0.6	0.5	0.8	0.5	0.6	0.1	-	-	-
Anadara diluvii	-	-	-	-	-	-	-	-	-	0.1	0.2	-	0.4	0.8
Limopsis aurita	14.6	18.2	13.8	14.7	20.8	7.4	2.1	3.4	2.4	2.3	0.5	0.8	1.2	2.8
Limopsis retifera	-	-	0.9	0.7	2.6	4.8	3.8	2.6	0.5	0.6	0.3	1.4	1.3	1.3
Limopsis lamellata	-	1.4	0.9	2.0	2.6	4.8	3.2	2.5	3.0	2.5	1.7	1.1	1.0	0.2
Glycymeris lunulata baldii	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
Arcoperna sericea	-	0.3	-	-	0.1	-	-	-	-	-	0.2	0.2	-	-
Modiolula phaseolina	-	-	-	-	-	0.1	0.2	0.4	1.1	0.8	1.1	0.2	0.2	0.1
Korobkovia woodi	1.3	-	0.9	0.7	0.7	0.5	0.8	0.3	0.3	1.0	0.8	0.8	0.8	0.1
Pseudamussium lilli	-	-	0.2	-	0.1	-	-	0.1	0.3	-	-	-	-	-
Limatula sulcata	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-
Cavilucina droueti	-	-	-	-	-	-	-	-	-	-	0.5	0.2	1.0	0.9
Lucinoma borealis	-	-	-	-	0.1	-	0.2	0.2	-	0.3	0.6	1.7	0.5	0.3
Thyasira spec.	-	-	-	-	-	-	-	0.1	-	-	-	0.1	-	-
Diplodonta rotundata	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1	0.1
Erycinidae spec.	-	-	-	-	-	-	-	0.1	0.2	-	-	-	-	-
Lepton transversarium	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1
Cyclocardia chamaeformis	1.3	5.9	3.0	0.7	1.6	2.3	3.1	1.7	1.1	0.4	0.4	0.5	2.3	3.3
Erycinella chavani	-	-	-	-	-	-	-	-	-	0.1	0.1	-	0.1	0.6
Astarte gracilis	8.0	11.9	8.3	8.7	5.6	3.9	3.4	3.1	1.8	2.0	0.9	1.5	4.8	5.4
Astarte radiata	-	-	-	-	-	0.4	2.2	6.3	10.7	10.5	9.2	12.0	3.6	0.9
Astarte waeli	-	-	-	-	-	-	0.1	-	-	0.2	0.3	1.0	2.4	2.2
Goodallia angulata	-	-	-	-	1.0	2.9	4.5	4.9	5.8	3.8	2.3	0.2	0.3	0.4
Goodallia laevigata	-	-	-	-	-	-	-	-	-	0.4	0.1	-	-	-
Parvicardium straeleni	2.7	1.7	15.5	2.0	1.3	4.1	3.6	3.6	3.6	4.8	1.9	1.5	1.5	1.0
Parvicardium aff. scabrum	-	-	0.4	-	-	-	0.2	-	0.2	0.2	0.8	1.0	0.4	0.1
Nemocardium cyprium	-	0.3	0.6	2.0	0.6	1.8	1.7	2.4	2.7	3.8	5.7	6.9	4.4	4.3
Spisula spec.	-	-	0.9	0.7	5.9	23.9	14.4	3.9	2.9	3.5	2.1	0.5	1.1	1.3

STEMERDINK, 41E.4-387, continued

depth in m	6 - 7	7 - 8	8 - 9	9 -10	10-11	11-12	12-13	13-13.50	13.50-14	14-15	15-16	16-17	17-18	18-18.90
Angulus aff. donacilla	-	-	-	-	-	-	-	-	-	-	1.0	-	0.7	0.1
Macoma elliptica	-	0.6	1.1	-	1.3	0.7	1.3	0.4	0.5	0.9	1.0	0.8	0.4	0.8
Abra sorgenfreii	-	-	-	-	0.1	0.7	0.1	0.7	0.6	0.4	0.6	0.8	0.4	1.4
Abra lehmanni	2.7	3.7	4.9	-	1.2	0.5	0.4	0.4	0.9	0.7	0.3	0.2	0.1	-
Azorinus chamasolen miocenicus	-	-	-	0.7	-	-	-	0.2	-	-	-	-	-	-
Arctica islandica	-	-	-	-	-	-	-	-	0.2	-	-	0.2	-	-
Lutetia nitida	-	-	-	-	-	-	0.1	-	-	-	-	-	0.2	0.2
Glossus lunulatus	-	0.6	-	-	-	0.1	0.2	-	-	0.3	0.1	0.2	0.8	-
Venus multilamella	1.3	0.6	0.2	1.3	0.6	1.5	1.1	1.8	1.1	1.2	3.5	2.0	2.4	1.1
Gouldia minima	-	-	-	-	-	0.1	0.2	0.5	-	0.2	0.6	0.6	-	0.4
Pitar rudis rudis	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
Clausinella scalaris	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-
Corbula gibba	6.7	2.5	5.5	12.7	7.4	4.4	6.0	8.1	5.8	4.6	2.7	2.1	2.6	0.9
Hiatella arctica	-	-	-	-	0.3	0.9	1.2	1.3	2.3	2.7	4.7	4.1	4.9	7.2
Saxicavella pusilla	-	-	-	-	-	-	-	-	0.2	0.5	0.4	0.3	-	-
Anisodonta duvergieri	-	-	-	-	-	-	0.1	0.1	0.2	0.2	-	0.1	-	-
Panopea meynardi	-	-	-	-	-	-	-	-	-	-	0.4	0.2	0.4	0.2
Cochlodesma aff. pretenue	-	-	0.2	-	0.1	-	-	-	-	-	-	0.1	-	-
Thracia ventricosa	-	0.6	-	-	0.1	-	0.1	0.3	0.2	1.0	0.2	1.0	0.1	0.1
Peromya neaeroides	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-
Cuspidaria spec.	-	-	-	-	-	0.1	-	-	0.6	0.3	0.3	-	-	0.2
Cardiomya costellata	-	0.3	-	-	-	-	0.1	0.1	-	0.3	-	-	0.1	-
Bivalvia spec.	9.3	2.5	0.6	2.7	0.4	1.4	2.0	2.0	4.2	1.5	1.1	1.0	1.3	1.9
Dentalium mutabile	2.7	5.6	8.5	2.7	2.0	2.8	4.6	4.6	3.6	3.2	3.6	5.2	3.0	2.0
Dentalium dumasi	-	-	-	-	-	-	-	-	-	-	-	1.0	0.4	1.4
Dentalium spec.	2.7	-	0.4	-	0.6	0.2	-	0.4	0.3	0.4	0.8	0.2	1.8	1.8
? Scurria compressiuscula	-	-	-	-	-	-	-	-	-	-	-	-	0.2	0.4
Solariella formosa	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-
Circulus precedens precedens	2.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Circulus hennei	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-
Putilla gottscheana westfalica	-	-	-	-	-	0.2	-	0.2	-	-	-	-	-	-
Alvania holsatica	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-
Teinostoma hosiusi	-	-	-	-	-	0.2	-	-	-	-	-	0.2	-	0.2
Tornus trigonostoma	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-
Architectonica spec.	2.7	-	-	-	-	-	0.2	-	-	-	-	-	-	-
Archimediella subangulata	-	0.6	-	1.3	2.0	2.4	1.4	0.4	1.2	2.4	2.2	2.8	2.0	1.4
Bittium spina	-	2.8	0.4	1.3	0.6	0.2	0.8	0.8	-	-	0.2	-	-	0.2
Triphora fritschi	-	-	-	-	-	0.2	-	-	-	-	-	0.4	-	-

STEMERDINK, 41E.4-387, continued

depth in m	6 - 7	7 - 8	8 - 9	9 -10	1 -11	11-12	12-13	13-13.50	13.50-14	14-15	15-16	16-17	17-18	18-18.90
Amaea amoena subreticulata	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-
Opalia pertusa	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-
Opalia pontileviensis	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-
Turriscala straleni	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-
Epitonium frondiculum	-	1.1	-	-	-	-	-	-	0.3	-	-	-	-	-
Strombiformis glaber	-	-	-	-	0.3	-	-	-	0.3	0.2	0.2	0.2	-	-
Melanella glabella	-	-	-	-	0.3	-	-	0.2	-	-	-	-	-	-
Melanella alba	-	-	-	-	-	-	-	0.2	-	0.2	0.2	-	-	-
Niso terebellum acarinatoconica	-	-	-	-	-	-	-	-	-	-	-	-	0.2	0.2
Aporrhais alata	2.7	3.9	4.3	18.6	9.1	3.2	4.0	2.4	1.5	1.8	2.2	2.2	8.0	6.8
Calyptraea chinensis	-	-	-	-	-	-	0.2	0.4	0.3	0.4	-	0.4	0.2	-
Xenophora deshayesi	-	-	0.4	-	0.3	-	-	0.2	-	-	-	-	-	0.2
Naticidae spec.	-	1.7	0.4	-	2.0	1.0	2.0	2.4	2.4	2.0	3.8	2.0	3.6	2.0
Phalium bicoronatum bicoronatum	-	-	-	-	0.3	-	-	0.2	-	0.2	0.2	-	-	-
Ficus conditus	-	-	-	-	-	0.2	-	-	-	-	-	0.6	0.2	6.2
Murex inornatus	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-
Lyrotyphis sejunctus priscus	-	-	0.4	-	0.6	0.6	1.2	1.0	0.9	0.8	0.4	1.2	0.4	0.6
Hadriania coelata	-	-	-	-	-	-	-	-	-	-	0.2	0.4	-	0.2
Tritonalia spec. nov.	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-
Mitrella nassoides	-	-	-	-	-	-	-	-	-	-	0.2	-	1.2	1.0
Anachis corrugata	-	-	-	-	-	0.4	0.2	-	-	-	-	-	-	-
Anachis pulchella	-	-	-	-	1.2	-	0.2	-	0.9	-	0.6	-	-	-
Scalaspira festiva	-	0.6	-	1.3	-	-	-	-	-	-	-	-	-	-
Amyclina facki	-	-	-	-	-	-	-	-	-	0.2	0.4	0.8	1.2	5.0
Hinia bocholtensis	8.0	5.6	4.7	8.0	5.2	3.4	4.0	2.0	0.3	0.4	-	-	0.6	1.0
Hinia cimbrica	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-
Hinia holsatica	-	-	-	-	-	-	0.4	0.8	-	-	0.6	0.4	0.2	-
Hinia tenuistriata	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4
Nassariidae spec.	2.7	-	-	-	-	-	-	1.6	0.9	-	0.2	-	0.6	0.2
Vexillum spec.	-	-	-	-	-	-	0.4	-	-	-	0.2	-	-	-
Latirus rothi	-	-	-	-	-	-	-	0.2	0.6	0.4	0.4	-	-	0.2
Streptochetus sexcostatus	-	1.7	0.3	2.7	2.0	1.4	1.2	2.4	2.1	2.2	1.4	1.6	1.0	0.8
Ancilla obsoleta	-	-	-	-	-	-	-	-	-	-	0.2	-	-	0.4
Narona varicosa	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-
Babylonella fusiformis	-	1.1	0.9	-	-	0.4	0.2	0.2	-	0.6	-	-	0.4	0.8
Cancellariidae spec.	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-
Gemmula stoffelsi	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-
Gemmula boreoturricula	-	-	-	-	0.3	0.4	0.2	-	-	-	-	-	-	0.2
Gemmula denticula borealis	-	-	0.4	-	-	-	-	-	-	-	-	0.4	-	0.4

STEMERDINK, 41E.4-387, continued

depth in m	6 - 7	7 - 8	8 - 9	9 -10	10-11	11-12	12-13	13-13.50	13.50-14	14-15	15-16	16-17	17-18	18-18.90
Gemmula zimmermanni	-	2.8	3.0	1.3	1.4	2.6	1.2	1.0	0.9	-	0.2	-	-	-
Turris duchasteli flexiplicata	-	1.1	-	-	0.3	-	0.2	0.4	0.6	0.6	0.4	0.6	0.2	0.2
Epalxis cataphracta s.lat.	-	-	-	-	0.3	-	-	0.2	-	0.2	-	0.4	-	-
Turricula steinvorthi	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2
Clavus selenkae	-	-	0.4	1.3	0.3	-	-	0.2	0.6	-	0.2	-	-	0.4
Crassispira borealis	-	-	0.4	-	0.3	-	-	-	1.8	0.4	1.0	0.2	0.2	-
Brachytoma obtusangula	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-
Brachytoma pannoides	-	-	-	1.3	0.6	-	0.2	-	-	-	-	-	0.2	-
? Brachytoma hispidula	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-
Asthenotoma festiva	-	-	-	-	-	0.2	-	0.2	-	0.2	0.2	-	-	0.4
Boreodrillia hosiusi	-	-	0.4	-	-	0.2	-	-	-	-	-	-	-	0.2
Borsonia uniplicata	-	0.6	0.4	-	-	0.2	0.2	-	-	-	-	-	-	-
Haedropleura maitreja	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-
? Bela calais	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2
Mangeliidae spec.	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-
Raphitoma scabra	-	-	-	-	-	-	-	-	-	0.2	-	-	-	-
Metuonella grippi	-	-	-	-	-	-	0.2	0.4	-	-	0.4	-	-	-
Teretia anceps	-	-	-	-	-	-	0.6	0.2	-	-	0.2	-	-	-
Turridae spec.	-	1.7	0.4	-	1.7	0.4	2.0	1.8	1.8	2.8	3.4	2.4	2.2	0.8
Comus antediluvianus	-	-	-	-	-	-	0.2	-	-	0.4	-	-	-	-
Strioterebrum hoernesi	-	-	-	-	0.3	0.2	-	0.4	-	0.2	-	-	-	0.8
Odostomia spec.	-	-	-	-	-	-	0.2	0.4	-	-	0.6	0.6	-	0.2
Syrnola hoernesi	-	-	-	-	-	-	-	-	0.3	-	0.4	0.2	-	-
Eulimella acicula	-	-	-	-	-	-	0.2	0.2	-	-	-	-	-	-
Turbonilla spec.	-	1.7	0.4	-	0.3	-	-	0.2	0.6	0.4	-	-	-	-
Pyramidella spec.	-	-	-	-	0.3	-	-	-	-	-	-	-	0.2	-
Pyramidella plicosa	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-
Actaeonidae spec.	-	-	-	-	-	-	-	0.4	0.3	-	0.2	-	-	-
Ringicula buccinea	13.2	7.9	4.3	5.3	7.4	5.4	10.0	10.6	8.9	13.2	9.4	12.0	15.2	17.0
Cylichna aff. cylindracea	-	-	-	-	-	-	-	0.2	0.3	0.6	0.2	0.6	0.4	1.2
Roxania utriculus	-	0.6	-	-	-	-	0.2	-	-	0.2	0.6	-	-	0.4
Roxania paucistriata	-	-	-	-	-	-	-	-	-	-	-	0.2	0.6	0.4
Retusa elongata	-	-	-	-	-	0.6	1.2	1.0	1.2	1.6	2.2	1.0	1.6	-
Rhizorus acuminatus	-	-	-	-	-	-	-	0.4	0.3	0.4	0.2	0.2	0.4	0.2
Gastropoda spec.	2.7	2.8	0.4	1.3	0.6	0.6	1.4	2.4	2.7	0.8	1.0	1.0	1.6	0.2

LITHOLOGY: description see p. 22

RENSKERS, 41E.4-20

depth in m	10.90-12	12 - 13	13 - 14	14-14,80
number counted	400	500	500	500
1 specimen = ...%	0.3	0.2	0.2	0,2
% Gastr. specimens	28.5	43.0	58.0	60.0
number Gastr. species	15	26	44	39
number Bivalve species	32	32	32	31
Nuculana westendorpi	1,6	0.9	3.3	2.2
Portlandia pygmaea	4.0	6.1	2.3	1.5
Portlandia sp. ? nov.	0.5	-	-	0.1
Yoldia glaberrima	3.9	7.3	3.6	3.0
Bathyarca pectunculoides	0.1	0.5	0.1	-
Anadara diluvii	0.3	0.1	-	0.4
Limopsis aurita	2.1	0.7	1.5	2.5
Limopsis retifera	-	0.5	0.7	0.7
Limopsis lamellata	1.3	0.8	0.1	-
Glycymeris lunulata baldii	-	-	-	0.1
Modiolula phaseolina	0.5	-	0.2	-
Korobkovia woodi	0.3	0.6	0.5	-
Cavilucina droueti	0.1	0.3	1.0	2.0
Lucinoma borealis	0.6	1.7	0.7	0.3
Diplodonta rotundata	0.3	-	-	-
Lepton transversarium	-	-	0.1	-
Tellimya coarctata	-	-	-	0.1
Cyclocardia chamaeformis	0.3	0.7	3.8	4.2
Erycinella chavani	-	-	-	0.1
Astarte gracilis	0.7	1.1	5.1	7.4
Astarte radiata	22.7	14.7	2.2	0.3
Astarte waeli	0.3	0.4	1.9	2.4
Goodallia angulata	2.1	1.0	0.2	-
Goodallia laevigata	0.1	o.1	-	0.2
Parvicardium straeleni	3.5	1.4	1.6	1.2
Parvicardium aff. scabrum	-	0.1	-	-
Nemocardium cyprium	9.8	5.7	2.4	2.6
Spisula spec.	1.3	0.3	0.4	0.3
Angulus aff. donacilla	-	-	0.2	0.3
Macoma elliptica	0.9	1.0	0.1	0.4
Gari affinis	-	-	-	0.1
Abra sorgenfreii	-	0.3	0.2	0.8
Abra lehmanni	0.9	0.2	0.1	-
Arctica islandica	-	-	0.1	-
Lutetia nitida	-	-	-	0.1
Glossus lunulatus	0.1	0.2	0.3	0.1
Venus multilamella	3.1	3.0	1.6	1.5
Gouldia minima	0.6	0.1	-	-
Pitar rudis rudis	-	-	0.1	-
Corbula gibba	4.0	3.8	1.7	0.2
Hiatella arctica	3.5	4.0	4.7	4.0
Saxicavella pusilla	0.1	0.1	-	-
Panopea meynardi	-	0.1	0.3	-
Thracia ventricosa	0.3	0.3	-	0.4
Cuspidaria spec.	0.3	-	0.3	0.1
Bivalvia spec.	1.3	0.1	0.6	0.4
Dentalium mutabile	6.2	4.4	1.8	2,6
Dentalium dumasi	0.3	0.2	0.2	1.8
Dentalium spec.	1.3	0.4	0.4	0.4

RENSKERS, 41E.4-20, continued

depth in m	10.90-12	12 - 13	13 - 14	14-14.80
Cadulus gadus	-	0.2	0.8	1.6
Circulus hennei	-	-	0.2	-
Teinostoma hosiusi	-	-	0.2	0.4
Architectonica spec.	-	-	0.4	-
Archimediella subangulata	5.9	6.0	1.6	1.4
Acirsa mioplicatula	-	-	0.4	-
Acirsa lanceolata	-	-	0.2	-
Strombiformis glaber	-	-	-	0.2
Melanella alba	0.3	-	0.4	0.4
Niso terebellum acarinatoconica	-	0.2	-	-
Aporrhais alata	2.3	5.0	6.8	12.4
Calyptraea chinensis	0.3	0.2	0.2	-
Eocypraea miobadensis	-	-	0.2	-
Naticidae spec.	0.7	4.0	5.6	3.6
Phalium bicoronatum bicoronatum	-	0.2	-	-
Ficus conditus	-	-	-	0.2
Murex inornatus	-	-	-	0.2
Lyrotyphis sejunctus priscus	-	1.6	1.2	0.2
Hadriania coelata	-	0.2	-	0.6
Mitrella nassoides	-	-	0.8	0.8
Amyclina faoki	-	-	2.2	2.0
Hinia schroederi	-	-	0.2	0.2
Hinia bocholtensis	-	-	0.4	0.8
Hinia tenuistriata	-	-	0.2	0.8
Nassariidae spec.	0.5	0.8	2.4	0.6
Vexillum spec.	-	0.2	-	-
Streptochetus sexcostatus	0.3	0.8	0.8	1.2
Ancilla obsoleta	-	-	-	0.2
Narona varicosa	-	-	0.4	0.6
Babylonella fusiformis	-	0.6	0.4	-
Cancellariidae spec.	-	-	0.2	-
Gemmula boreoturricula	-	0.2	0.4	0.2
Gemmula denticula borealis	-	-	0.2	0.4
Gemmula zimmermanni	-	-	0.2	-
Turris duchasteli flexiplicata	-	0.4	0.8	0.8
Epalxis cataphracta s.lat.	-	-	-	0.2
Clavus selenkae	-	-	0.2	-
Crassispira borealis	-	-	0.2	-
? Microdrillia grippi	-	-	0.2	0.2
Asthenotoma festiva	-	-	-	0.2
Boreodrillia hosiusi	-	0.2	-	0.4
Haedropleura maitreja	-	-	0.2	-
Mangeliidae spec.	-	-	0.2	0.2
Pleurotomoides luisae	-	-	-	0.2
Turridae spec.	0.7	2.0	2.4	1.2
Conus antediluvianus	-	-	-	0.2
Strioterebrum hoernesi	-	-	0.8	0.2
Odostomia spec.	0.5	0.6	0.4	-
Turbonilla spec.	0.3	0.4	-	0.6
Pyramidella plicosa	-	-	0.2	-
Ringicula buccinea	7.4	11.0	19.6	16.4
Ringicula ventricosa	-	-	0.2	-
Cylichna aff. cylindracea	0.5	0.8	0.2	-
Roxania paucistriata	-	0.4	0.2	0.8
Retusa elongata	-	0.6	0.6	1.4
Rhizorus acuminatus	-	-	0.2	-
Gastropoda spec.	1.0	1.4	2.0	3.2

LITHOLOGY
Wash-drilling, borehole of 7,5 cm ø, without casing, made by M. van den Bosch
0.00 - 8.60 m : Quaternary deposits
8.60 -12.80 m : Dark greengrey clay, with some, towards the base with very much fine quarz-sand, from 10.90 m with some, downwards with rather much molluscan shells.
12.80 -13.00 m : As above, but with many large shells.
13.00 -14.85 m : Dark greengrey, very fine quarz-sand, with high clay content; at the base with some worm black fosforites and shark-teeth; with rather much molluscan shells.
14.85 - ? m : Blue-grey, very hard clay, containing quarz (Oligocene)

MANESCHIJN, 41E.3-57

depth in m	35-36	36-36.60
number counted	100	100
1 specimen = ...%	1	1
% Gastr. specimens	44	59
number Gastr. species	19	22
number Bivalve species	30	26
Nucula spec.	-	1.5
Nuculana westendorpi	3.0	0.5
Portlandia pygmaea	1.5	1.5
Portlandia spec. ? nov.	0.5	-
Yoldia glaberrima	1.0	-
Anadara diluvii	1.0	-
Limopsis aurita	1.0	1.5
Limopsis retifera	0.5	1.0
Glycymeris lunulata baldii	0.5	0.5
Modiolula phaseolina	0.5	-
Korobkovia woodi	1.0	0.5
Pseudamussium lilli	0.5	0.5
Diplodonta rotundata	1.5	-
Cyclocardia chamaeformis	-	1.0
Erycinella chavani	0.5	1.0
Astarte gracilis	2.0	2.0
Astarte radiata	10.0	5.5
Astarte wacli	0.5	1.0
Goodallia angulata	0.5	0.5
Goodallia laevigata	3.0	0.5
Parvicardium straeleni	2.0	-
Nemocardium cyprium	2.5	2.5
Spisula spec.	10.0	4.5
Ensis spec.	1.5	-
Macoma elliptica	1.5	0.5
Gari affinis	0.5	-
Abra sorgenfreii	3.0	3.5
Venus multilamella	0.5	0.5
Gouldia minima	1.0	1.5
Corbula gibba	2.0	4.0
Hiatella arctica	1.5	3.5
Panopea reynardi	-	0.5
Thracia ventricosa	0.5	0.5
Haliris spec.	-	0.5
Bivalvia spec.	0.5	-
Dentalium mutabile	5.0	1.0
Dentalium spec.	-	1.0
Cadulus gadus	3.0	2.0
Teinostoma hosiusi	-	1.0
Haustator eryna	-	1.0
Archimediella subangulata	3.0	4.0
Bittium tenuispina	1.0	-
Aporrhais alata	4.0	7.0
Xenophora deshayesi	-	1.0
Naticidae spec.	4.0	7.0
Murex inornatus	-	1.0
Lyrotyphis sejunctus priscus	-	1.0
Mitrella nassoides	-	1.0

depth in m	35-36	36-36.60
Amyclina facki	-	7.0
Hinia bocholtensis	1.0	-
Latirus rothi	2.0	-
Streptochetus sexcostatus	1.0	-
Ancilla obsoleta	1.0	1.0
Narona varicosa	-	1.0
Gemmula boreoturricula	-	1.0
Gemmula denticula borealis	-	1.0
Gemmula zimmermanni	2.0	-
Epalxis cataphracta s.lat.	1.0	-
Asthenotoma festiva	1.0	-
Turridae spec.	1.0	3.0
Conus antediluvianus	1.0	-
Odostomia spec.	1.0	-
Actaeonidae spec.	-	1.0
Ringicula buccinea	6.0	13.0
Cylichna aff. cylindracea	1.0	2.0
Roxania pauciatriata	-	1.0
Retusa elongata	3.0	-
Gastropoda spec.	2.0	-

LITHOLOGY

Combined bailer-washdrilling, from 12.80 m wash-drilling with borehole of 6.3 cm ∅, with thick drilling-mud, made by M. van den Bosch

0.00 - 12.80 m : Quaternary deposits

12.80 - 33.00 m : Clay with varying sand content, from 24.00 m with few, downwards with rather much molluscan shells

33.00 - 36.60 m : Dark green-grey to dark green glauconite sand, up to 500 mu, with rather much, towards the base with rather few quartz-sand, up to 250 mu; with a rather high clay - content and some mica, towards the base with a few black fosforites and much molluscan shells

36.60 - ? m : tough blue-grey clay with eroded surface (Oligocene)

DE GIFFEL, 41E.2-7

depth in m	6.70–7.40	7.40–8.40	8.40–9.30	9.30–10.40	10.40–11.40	11.40–12.50	12.50–12.60
number counted	131	500	500	500	500	500	500
1 specimen = ...%	0,8	0.2	0.2	0.2	0.2	0.2	0.2
% Gastr. specimens	12.3	20.6	26.3	42.9	49.4	58.2	56.6
number Gastr. species	7	14	22	36	38	38	42
number Bivalve species	22	29	32	40	37	35	29
Nucula spec.	-	-	-	-	-	0.2	0.2
Nuculana westendorpi	1.5	0.8	1.2	0.6	0.8	0.8	1.0
Portlandia pygmaea	1.9	1.0	2.0	4.0	7.2	3.2	1.5
Portlandia spec. ? nov.	-	-	0.8	1.4	0.1	-	-
Yoldia glaberrima	1.5	1.2	2.4	3.1	4.5	3.6	2.5
Bathyarca pectunculoides	-	0.2	0.2	0.3	0.1	-	-
Anadara diluvii	-	0.1	0.1	0.2	0.4	0.5	0.9
Limopsis aurita	22.1	11.5	4.8	1.9	1.5	3.1	2.9
Limopsis retifera	1.1	4.3	2.0	0.8	0.3	1.3	0.7
Limopsis lamellata	4.2	4.1	4.6	0.9	1.7	0.1	-
Glycymeris lunulata baldii	-	-	-	0.1	-	-	-
Arcoperna sericea	-	-	0.1	0.4	0.2	-	-
Modiolula phaseolina	-	-	0.1	0.6	0.3	0.1	-
Korobkovia woodi	2.3	0.2	0.5	1.4	1.3	0.5	0.3
Pseudamussium lilli	-	-	-	0.1	0.3	0.1	-
Limaria loscombei	-	-	-	0.1	-	-	-
Cavilucina droueti	-	-	-	0.2	0.5	2.0	3.0
Lucinoma borealis	-	0.1	0.4	0.2	1.7	0.7	0.9
Lepton transversarium	-	-	-	0.5	-	-	-
Spaniorinus cimbricus	-	0.1	-	-	-	-	-
Cyclocardia chamaeformis	1.9	3.0	2.5	0.6	0.4	1.2	3.1
Astarte gracilis	8.8	7.7	7.8	5.0	1.4	3.8	6.0
Astarte radiata	0.8	0.6	6.0	7.8	7.8	3.1	-
Astarte wasli	-	-	-	0.1	-	0.6	1.1
Goodallia angulata	2.7	3.3	4.1	3.5	1.0	0.6	1.4
Parvicardium straeleni	5.0	3.8	4.1	2.1	1.6	0.8	0.2
Parvicardium aff. scabrum	-	-	-	-	0.4	0.2	0.3
Nemocardium cyprium	1.9	0.9	2.1	2.2	3.1	2.8	2.2
Spisula spec.	10.0	19.6	13.1	5.9	2.2	0.1	-
Angulus aff. donacilla	-	-	-	0.2	0.2	0.2	0.1
Macoma elliptica	0.4	0.4	1.1	1.5	0.4	0.9	1.5
Abra sorgenfreii	-	-	-	0.4	0.2	0.6	0.7
Abra lehmanni	1.1	0.8	0.4	0.4	0.2	0.2	0.1
Azorinus chamasolen miocenicus	-	0.1	-	-	-	-	-
Lutetia nitida	-	-	-	-	0.1	-	0.1
Glossus lunulatus	0.8	0.3	0.2	0.4	0.3	0.3	0.1
Venus multilamella	1.9	1.4	0.8	1.9	1.8	1.6	1.3
Gouldia minima	-	0.4	0.3	0.2	1.0	0.8	2.0
Pitar polytropa nysti	-	-	-	0.2	-	-	-
Corbula gibba	15.9	10.1	7.0	3.6	2.4	1.4	0.7
Hiatella arctica	1.1	0.8	1.3	2.6	2.9	5.1	6.9
Saxicavella pusilla	-	-	0.1	0.1	-	0.1	-
Anisodonta duvergieri	-	-	0.1	-	-	-	-
Panopea meynardi	-	-	-	0.1	0.1	0.2	-
Teredinidae/Xylophaginae spec.	-	-	0.1	-	-	-	-
Cochlodesma aff. praetenue	-	0.1	-	-	-	-	-
Thracia ventricosa	0.4	0.2	0.3	0.8	0.8	0.1	0.1
Cuspidaria spec.	0.4	0.1	0.1	-	0.2	-	0.1
Cardiomya costellata	-	-	-	-	-	0.1	-
Bivalvia spec.	-	2.2	2.9	1.5	1.0	0.8	0.7

DE GIFFEL, 41E.2-7, continued

depth in m	6.70-7.40	7.40-8.40	8.40-9.30	9.30-10.40	10.40-11.40	11.40-12.50	12.50-12.60
Dentalium mutabile	1.5	4.4	1.6	1.8	2.4	2.2	2.0
Dentalium dumasi	-	-	-	-	-	0.4	0.4
Dentalium spec.	-	1.4	-	-	-	0.4	3.0
Cadulus gadus	-	-	-	-	0.2	0.4	0.2
Teinostoma hosiusi	-	-	-	-	0.2	0.2	-
Architectonica berthae	-	-	-	-	-	-	0.2
Haustator eryna	-	-	-	-	0.2	0.6	0.8
Archimediella subangulata	2.3	-	1.6	0.8	2.4	0.8	0.6
Bittium spina	0.8	0.6	-	-	0.2	-	-
Cerithiella genei	-	0.2	-	0.2	-	-	-
Acirsa lanceolata	-	-	-	-	-	-	0.2
Opalia pertusa	-	-	-	-	-	0.2	-
Epitoniidae spec.	-	-	-	-	-	0.2	-
Strombiformis glaber	-	-	-	0.4	-	-	0.4
Niso terebellum acarinatoconica	-	-	0.2	-	-	0.8	-
Aporrhais alata	1.5	0.6	0.8	2.4	5.2	8.4	6.4
Calyptraea chinensis	-	-	-	0.2	0.6	-	-
Xenophora deshayesi	0.8	-	-	0.2	-	-	0.2
Naticidae spec.	0.8	0.8	1.4	3.0	3.0	4.8	4.6
Murex inornatus	-	-	0.2	0.2	0.4	-	-
Typhis pungens	-	-	0.2	-	0.4	-	-
Lyrotyphis sejunctus priscus	-	0.2	0.6	2.0	0.2	1.0	0.6
Hadriania coelata	-	-	-	-	-	-	0.2
Mitrella nassoides	-	-	-	0.2	0.2	0.4	0.8
Phos decussatus	-	-	-	-	0.4	-	-
Amyclina facki	-	-	-	1.2	0.6	2.8	4.0
Hinia schroederi	-	-	-	0.2	-	-	-
Hinia bocholtensis	-	-	0.4	-	-	-	-
Hinia turbinella	-	-	-	-	0.2	0.2	-
Hinia holsatica	-	-	-	-	0.6	-	-
Hinia tenuistriata	-	-	-	0.2	-	-	0.4
Nassariidae spec.	-	0.4	0.2	-	1.0	0.4	0.4
Latirus rothi	-	-	-	0.2	0.2	0.4	0.2
Streptochetus sexcostatus	-	0.2	0.6	1.4	0.6	1.8	0.2
Ancilla obsoleta	-	-	0.2	-	-	0.6	1.0
Cancellaria spec.	-	-	-	-	-	-	0.6
Trigonostoma spinifera	-	-	-	-	-	0.2	-
Trigonostoma aperta	-	-	-	-	-	0.2	-
Narona varicosa	-	-	-	-	-	-	0.2
Babylonella fusiformis	-	-	0.2	0.2	0.8	0.2	-
Cancellariidae spec.	-	-	-	-	-	-	0.2
Gemmula boreoturricula	-	-	-	0.2	0.2	-	-
Gemmula denticula borealis	-	-	-	0.2	-	-	-
Gemmula zimmermanni	-	0.4	-	0.2	0.2	0.2	-
Turris aquensis	-	-	-	-	-	-	0.2
Turris duchasteli flexiplicata	-	-	0.2	0.6	1.4	1.0	-
Epalxis cataphracta s.lat.	-	0.2	-	-	-	-	-
Genota ramosa	-	-	-	-	-	0.4	-
Clavus selenkae	-	0.4	-	0.2	0.2	-	-
Crassispira borealis	-	-	0.4	0.4	0.8	0.2	-
Brachytoma obtusangula	-	-	0.2	0.2	-	-	-
Brachytoma pannoides	-	-	-	-	0.2	-	0.2
Asthenotoma festiva	-	-	-	-	-	0.4	0.8
Boreodrillia hosiusi	-	-	-	-	-	0.6	0.4

DE GIFFEL, 41E.2-7, continued

depth in m	6.70-7.40	7.40-8.40	8.40-9.30	9.30-10.40	10.40-11.40	11.40-12.50	12.50-12.60
Bela tenella	-	-	-	0.2	-	-	0.2
Metuonella grippi	-	-	-	0.2	-	-	-
Teretia anceps	-	-	-	0.2	-	-	-
Turridae spec.	-	-	0.8	2.2	0.6	1.0	0.8
Conus antediluvianus	-	-	-	-	-	-	-
Strioterebrum hoernesi	-	-	-	-	0.2	0.2	0.2
Odostomia spec.	-	-	-	0.4	0.6	0.4	0.2
Syrnola hoernesi	-	-	0.4	0.2	0.4	-	-
Eulimella acicula	-	0.2	-	-	-	-	-
Turbonilla spec.	-	-	-	0.2	-	0.2	-
Pyramidella plicosa	-	-	-	-	0.2	-	0.4
Actaeonidae spec.	-	-	-	-	-	-	0.6
Crenilabium terebelloides	-	-	-	-	-	-	0.2
? Actaeocina bellardii	-	-	-	-	-	0.2	-
Ringicula buccinea	4.6	9.4	12.0	19.8	21.0	22.4	17.8
Cylichna aff. cylindracea	-	-	0.6	0.6	0.4	-	1.6
Roxania utriculus	-	-	0.2	0.2	0.2	0.6	0.2
Roxania paucistriata	-	-	-	-	0.2	-	0.4
Retusa elongata	-	-	0.4	0.8	0.6	0.6	1.2
Rhizorus acuminatus	-	-	-	0.2	0.2	0.2	0.4
Gastropoda spec.	-	1.2	2.8	0.4	1.8	2.0	3.0

LITHOLOGY

Combined Edelman-bailerdrilling, borehole of 8 cm ø, down to 8.50 m with Edelman-drill; borehole of 5.5 cm ø, down to 12.75 m, with casing, by bailer sampling; made by H. van den Bosch.

0.00 - 2.20 m : Quaternary deposits

2.20 - 9.30 m : Greengrey to darkbrown clay, with some fine sand, alternating with some small layers with a higher content of fine sand; with many, downwards to few mica; with some small concentrations of glauconite; from 3.25 m onwards with few molluscan shells.

9.30 -12.50 m : Darkbrown very fine sand, with much clay and a few fosforites, with very much molluscan shells.

12.50 -12.60 m : As above, but with rather much rounded black fosforites and shark-teeth and some large pyrite concretions.

12.60 - ? m : Dark bluegreen tough clay with eroded surface, in which holes filled up with the overlaying sediment (Oligocene)

ELLEWICKER FELD (Beuting)

depth in m	unknown
Number counted	64.5
1 Specimen = ...%	1.6
% Gastr. specimens	31.5
Number Gastr. species	15
Number Bivalve species	18
Nucula spec.	2.3
Nuculana westendorpi	7.7
Portlandia pygmaea	4.6
Anadara diluvii	1.6
Limopsis retifera	0.7
Korobkovia woodi	0.7
Pseudamussium lilli	1.6
Lucinoma borealis	1.6
Cyclocardia chamaeformis	3.8
Astarte gracilis	4.6
Astarte waeli	1.6
Laevicardium cyprium	2.3
Angulus aff. donacilla	2.3
Abra sorgenfreii	4.6
Venus multilamella	0.7
Pelecyora polytropa nysti	1.6
Corbula gibba	0.7
Hiatella arctica	24.8
Dentalium mutabile	1.6
Naticidae spec.	1.6
Mitrella nassoides	1.6
Amyclina badensis	1.6
Amyclina facki	1.6
Latirus rothi	1.6
Streptochetus sexcostatus	3.1
Metuonella grippi	1.6
Turridae spec.	1.6
Syrnola hoernesi	1.6
Actaeonidae spec.	1.6
Ringicula buccinea	3.1
Cylichna aff. cylindracea	3.1
Roxania utriculus	1.6
Retusa elongata	4.6

DESCRIPTION OF SAMPLE

A small sample of greengray quarzsand containing glauconite and mica from the digging of a pit with a depth of about 3 m below surface was present in the collections of the Rijksmuseum van Geologie en Mineralogie at Leiden.

LITHOLOGY OF STEMERDINK, 41E.4-387

Combined was-bailerdrilling; wash-drilling down to 12 m, borehole 7.5 cm ø, with thick drilling-mud; bailer-drilling down to 19 m, borehole of 6.3 cm ø, with casing, made by M. van den Bosch.

0.00 - 1.50 m : Quaternary deposits

1.50 - 12.00 m : Dark brown to dark green-grey clay, towards the base with to rather much fine sand; with rather much, towards the base with few mica; from 7 m downwards with some concentrations of glauconite; from 6 m with few, towards the base with rather much molluscan shells.

12.00 - 18.90 m : Dark green-grey to dark groe-brown, fine to rather fine glauconite sand, towards the base with much fine quartz-sand and clay and few mica; down from 13.30 m with very few, very small, from 17 m onwards with rather much, larger, rewashed fosforites; with rather much molluscan shells.

18.90 - ? m : Light green-grey, hard clay, with few fine sand (Oligocene)

REKKEN, 34G.4-2

depth in m	1.20-1.50
Number counted	177.5
1 Specimen = ...%	0.6
% Gastr. specimens	60.9
Number Gastr. species	18
Number Bivalve species	24
Nuculana westendorpi	1.4
Portlandia pygmaea	0.3
Yoldia glaberrima	2.5
Anadara diluvii	0.3
Limopsis aurita	3.1
Limopsis retifera	0.3
Limopsis lamellata	0.8
Cavilucina droueti	2.5
Lucinoma borealis	0.3
Diplodonta rotundata	0.6
Cyclocardia chamaeformis	3.6
Astarte gracilis	5.9
Astarte waeli	1.1
Goodallia angulata	0.6
Parvicardium straeleni	0.3
Nemocardium cyprium	2.5
Angulus aff. donacilla	1.1
Macoma elliptica	0.6
Abra sorgenfreii	0.6
Venus multilamella	2.5
Corbula gibba	0.6
Hiatella arctica	2.8
Panopea meynardi	1.7
Thracia ventricosa	0.3
Bivalvia spec.	2.8
Dentalium dumasi	1.1
Cadulus gadus	2.8
Architectonica spec.	0.6
Archimediella subangulata	1.1
Aporrhais alata	15.7
Naticidae spec.	3.9
Amyclina facki	1.7
Nassariidae spec.	1.7
Ancilla obsoleta	0.6
Cancellariidae spec.	0.6
Turris duchasteli flexiplicata	0.6
Boreodrillia hosiusi	0.6
Turridae spec.	2.3
Odostomia spec.	0.6
Ringicula buccinea	22.4
Cylichna aff. cylindracea	0.6
Roxania utriculus	0.6
Retusa elongata	0.6
Gastropoda spec.	2.8

LITHOLOGY

Edelman-drilling, borehole of 8 cm ∅, made by M. van den Bosch.

0.00 - 0.60 m : Quaternary deposits
0.60 - 1.20 m : Green clay with very much sand, containing some corroded fragments of molluscan shells
1.20 - 1.50 m : Fine green sand with high clay content, rounded black fosforites and shark-teeth, and much corroded molluscan shells.
1.50 - ? m : dark grey, sandy clay. (Oligocene deposits)

REKKEN, 34G.2-1

depth in m	7.50-10
number counted	100
1 specimen = ...%	1
% Gastr. specimens	52
Number Gastr. species	21
Number Bivalve species	24
Portlandia pygmaea	2.5
Yoldia glaberrima	3.0
Anadara diluvii	0.5
Limopsis aurita	2.5
Limopsis retifera	2.0
Limopsis lamellata	1.0
Cavilucina droueti	1.0
Lucinoma borealis	0.5
Cyclocardia chamaeformis	1.5
Astarte gracilis	3.0
Astarte radiata	11.5
Goodallia angulata	1.0
Parvicardium straleni	1.5
Nemocardium cyprium	2.0
Spisula spec.	2.0
Macoma elliptica	1.5
Abra sorgenfreii	0.5
Abra lehmanni	1.0
Glossus lunulatus	0.5
Venus multilamella	1.5

depth in m	7.50-10
Corbula gibba	4.0
Hiatella arctica	2.0
Panopea meynardi	1.0
Cuspidaria spec.	0.5
Dentalium mutabile	2.0
Dentalium dumasi	1.0
Cadulus gadus	2.0
Archimediella subangulata	5.0
Teinostoma hosiusi	1.0
Aporrhais alata	5.0
Naticidae spec.	1.0
Murex inornatus	1.0
Lyrotyphis sejunctus priscus	1.0
Amyclina facki	1.0
Hinia spec.	1.0
Latirus rothi	1.0
Streptochetus sexcostatus	3.0
Ancilla obsoleta	1.0
Gemmula boreoturricula	2.0
Crassispira borealis	1.0
Strioterebrum hoernesi	2.0
Odostomia spec.	1.0
Ringicula buccinea	15.0
Retusa elongata	3.0
Gastropoda spec.	2.0

LITHOLOGY

Washed holes in a trench for a barrage, without use of drilling-mud, without casing, described by M. van den Bosch

0.00 - 5.00 m : Quaternary deposits

5.00 - 9.50 m : Green, rather fine sand, containing clay, from 7 m onwards with much corroded molluscan shells, the fraction below 3 mm almost without fossils.

9.50 - ? m : Grey to blue-grey clay, containing few sand (Oligocene)

TICHELOVEN, 34G.1-24

depth in m	0.80-1.75	1.75-3	3-3,50	3,50-4	4-4,15
Number counted	145.5	500	500	500	500
1 specimen = ...%	0.7	0.2	0.2	0.2	0.2
% Gastr. specimens	41	34,2	43.4	45.4	41.2
Number Gastr. species	15	24	30	26	26
Number Bivalve species	22	31	36	35	35
Nucula spec.	-	-	0.1	-	-
Nuculana westendorpi	0.4	1.3	1.0	0.9	1.5
Portlandia pygmaea	0.7	2.0	3.1	4.8	5.5
Portlandia spec. ? nov.	-	0.5	0.4	0.4	0.1
Yoldia glaberrima	0.4	0.7	1.6	2.8	4.7
Bathyarca pectunculoides	0.4	0.1	-	-	0.1
Anadara diluvii	-	-	-	-	0.2
Limopsis aurita	10.7	5.4	2.2	2.0	1.3
Limopsis retifera	0.4	1.8	0.4	0.3	0.3
Limopsis lamellata	3.7	3.5	2.2	1.1	0.8
Arcoperna sericea	-	0.3	0.1	0.1	0.2
Modiolula phaseolina	-	0.1	0.4	0.3	-
Korobkovia woodi	1.0	0.6	0.5	1.0	1.0
Pseudammusium lilli	-	-	-	0.1	0.2
Cavilucina drouetі	-	-	-	0.1	0.4
Lucinoma borealis	0.4	0.2	0.8	1.4	2.0
Thyasira spec.	-	-	0.1	-	-
Diplodonta rotundata	-	-	-	0.1	-
Erycinidae spec.	0.4	0.1	0.2	-	-
Spaniorinus cimbricus	-	0.1	-	-	-
Cyclocardia chamaeformis	4.1	3.2	1.2	0.5	0.3
Astarte gracilis	9.3	8.2	6.5	1.9	2.1
Astarte radiata	0.4	4.6	8.7	14.6	17.7
Astarte waeli	-	-	-	0.1	0.2
Astarte angulata	2.7	5.1	4.9	2.1	0.9
Parvicardium straeleni	5.4	2.7	2.8	2.2	1.3
Parvicardium aff. scabrum	-	0.1	0.1	0.1	0.2
Nemocardium cyprium	0.4	1.0	1.9	4.3	5.7
Spisula spec.	4.1	12.1	6.5	2.2	0.9
Angulus aff. donacilla	-	-	0.1	-	-
Macoma elliptica	0.4	0.4	0.6	0.8	1.3
Abra sorgenfreii	-	0.6	0.5	0.3	0.6
Abra lehmanni	1.0	0.5	0.4	0.6	0.1
Azorinus chamasolen miocenicus	-	-	0.1	-	-
Arctica islandica	-	-	-	0.4	0.3
Lutetia nitida	-	0.1	-	-	-
Glossus lunulatus	-	-	0.1	0.1	0.2
Venus multilamella	-	0.7	1.0	2.7	1.6
Gouldia minima	-	0.2	0.5	0.3	0.3
Corbula gibba	9.6	4.2	2.9	2.0	1.8
Hiatella arctica	0.7	1.7	1.2	1.7	2.5
Saxicavella pusilla	-	-	-	0.1	0.1
Panopea meynardi	-	-	-	-	0.1
Cochlodesma aff. pretemue	0.4	0.1	0.3	-	-
Thracia ventricosa	-	0.1	0.5	0.6	1.0
Cuspidaria spec.	-	-	0.1	0.2	-
Cardiomya costellata	-	-	0.1	-	-
Bivalvia spec.	2.0	3.5	2.5	1.6	1.3

TICHELOVEN, 34G.1-24, continued

depth in m	0.80-1.75	1.75-3	3-3.50	3.50-4	4-4.15
Dentalium mutabile	3.4	2.6	3.8	2.8	3.2
Dentalium dumasi	-	-	-	-	0.6
Dentalium spec.	-	-	0.4	0.8	1.2
Putilla gottscheana westfalica	-	0.4	-	-	-
Teinostoma hosiusi	-	-	0.2	-	-
Archimediella subangulata	2.0	1.2	1.8	4.8	3.8
Bittium spina	4.1	2.0	0.8	0.4	-
Cerithiella genei	-	-	-	-	0.2
Melanella alba	-	-	-	-	0.2
Aporrhais alata	4.7	4.6	3.2	3.8	3.8
Calyptraea chinensis	-	0.2	0.6	0.2	0.6
Naticidae spec.	1.4	2.0	2.6	4.0	3.0
Ficus conditus	0.7	-	0.6	0.2	-
Lyrotyphis sejunctus priscus	-	0.4	0.4	0.2	0.6
Hadriania coelata	-	-	-	-	0.2
Mitrella nassoides	-	-	-	-	0.2
Anachis corrugata	-	-	-	0.2	0.2
Amycina facki	-	-	-	0.2	-
Hinia bocholtensis	-	0.6	1.8	0.2	-
Hinia holsatica	-	-	-	0.2	0.4
Nassariidae spec.	0.7	0.4	0.4	1.4	0.4
Latirus rothi	-	0.2	0.4	-	-
Streptochetus sexcostatus	-	0.6	0.8	1.4	0.2
? Streptochetus contiguus	-	-	0.2	-	-
Ancilla obsoleta	-	-	-	-	0.2
Scaphella bolli	0.7	-	-	-	-
Narona varicosa	-	-	-	-	0.2
Babylonella fusiformis	-	0.2	0.2	0.2	-
Gemmula stoffelsi	-	0.4	-	-	-
Gemmula boreoturricula	-	-	0.2	-	-
Gemmula zimmermanni	2.0	0.6	0.4	0.6	-
Turris duchasteli flexiplicata	1.4	0.4	0.6	-	-
Epalxis cataphracta s.lat.	-	0.4	-	-	-
Clavus selenkae	0.7	-	-	0.2	-
Crassispira borealis	-	-	0.2	-	0.4
Asthenetoma festiva	-	-	-	0.2	-
Boreodrillia hosiusi	-	-	0.4	-	-
Mangeliidae spec.	-	-	0.2	-	-
Pleurotomoides campanulata	-	-	-	0.2	-
Teretia anceps	-	-	0.2	-	-
Turridae spec.	2.7	0.8	1.8	0.8	0.6
Conus antediluvianus	-	-	-	-	0.2
Chrysallida spec.	-	-	0.2	-	-
Odostomia spec.	-	0.2	-	0.4	0.4
Eulimella acicula	-	0.2	-	-	-
Turbonilla spec.	1.4	0.4	0.4	0.2	-
Actaeonidae spec.	-	-	0.4	0.2	-
Ringicula buccinea	11.0	11.0	17.6	19.2	16.2
Cylichna aff. cylindracea	-	-	-	0.4	0.4
Roxania utriculus	-	-	0.2	-	0.2
Retusa elongata	1.4	0.2	0.6	-	0.2
Gastropoda spec.	2.7	4.2	1.8	1.	3.4

LITHOLOGY

Auger-sampling, borehole of 12.5 cm ϕ, with casing, made by M. van den Bosch and E. F. de Vogel

0.00 - 0.80 m : Quaternary deposits

0.80 - 3.50 m : Dark greenbrown to dark greengrey clay, containing few sand, 80-100 um, to much sand, 80-200 (-300) mu; with rather much downwards to rather few mica; with some downwards to few glauconite; with few downwards to rather few molluscan shells (Miocene)

3.50 - 4.15 m : Dark greengrey sand, 120-400 mu, downwards to 200-500 mu, containing much, downwards to few clay; in the upper parts some mica; with very much coarse glauconite, 400-600 mu; with rather few, to the base many rounded glauconite containing fosforites and some shark-teeth; some bits of pyrite; with molluscan shells abundant.

4.15 - ? m : Blue-grey, hard clay (Oligocene).