Meded. Werkgr. Tert. Kwart. Geol. | vol. 22(3) | pp. 143-151 | 2 figs, 3 tabs. | Leiden, September 1985

FISH OTOLITHS FROM THE RUPELIAN OF SAND-PIT ROELANTS AT HEIDE-BOSKAN(MUNICIPALITY OF LUBBEEKBELGIUM) AND THE STRATIGRAPHY OF THE EARLY RUPELIAN, 1. GENERAL PART

by

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Gaemers, P.A.M. Fish otoliths from the Rupelian of sand-pit Roelants at Heide-Boskant (municipality of Lubbeek, Belgium) and the stratigraphy of the Early Rupelian, 1. General part. — Meded. Werkgr. Tert. Kwart. Geol., 22 (3): 143-151, 2 figs, 3 tabs. Leiden, September 1984.

An otolith fauna of 21 species was found in the lower part of the Rupelian clays. The largest number of otoliths and the greatest species diversity (18) occur in the basal clay bed, which lithologically belongs to the Nucula Clay. Its otolith fauna most strongly resembles those of the Nucula Clay at other places. This bed represents only the top of this clay and was deposited on a not very shallow shelf. A hiatus exists between the Berg Sand and this bed.

The Berg Sand is the regressive upper part of a large sedimentary cycle. The Nucula Clay belongs to the transgressive lower part of the next large cycle.

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Contents:

SAMENVATTING

Dankzij het feit, dat het hogere deel van het profiel van de zandgroeve Roelants bij Lubbeek vorig jaar vers afgegraven bleek te zijn, was het mogelijk om de midden-oligocene klei in deze groeve beter te bestuderen en te bemonsteren.

De lithologische opeenvolging van het Rupelien in deze groeve wijkt sterk af van wat elders gevonden is. Boven het Zand van Berg komt slechts een zeer dunne laag Nuculaklei voor, die alleen de top van deze afzetting blijkt te vertegenwoordigen. Het grootste deel van de Nuculaklei ontbreekt, dus er bestaat een hiaat tussen het Zand van Berg en de Nuculaklei.

De Nuculaklei bevat de meeste fossielen. Het is de laag die de meeste otolieten en de meeste vissoorten heeft opgeleverd (18 van de in totaal 21 soorten). Deze laag werd gevormd in een niet erg ondiepe platzee. De foraminiferen zijn de beste diepte-indicatoren: *Spiroplecta* komt veel voor en milioliden ontbreken, wat wijst op zeediepten van meer dan 10 meter, waarschijnlijk zelfs enkele tientallen meters. De otolietenfauna in deze laag vertoont de grootste overeenkomst met die uit de Nuculaklei, zoals die tot op heden bekend is.

De otolieten uit de hogere kleilagen, die behoren tot de Klei van het Waasland en wel het gedeelte dat gecorreleerd kan worden met de Afzetting van Kotten deel A (onderste deel van de Klei van Boom), komen goed overeen met die van de Klei van Boom en de Brinkheurne Formatie elders.

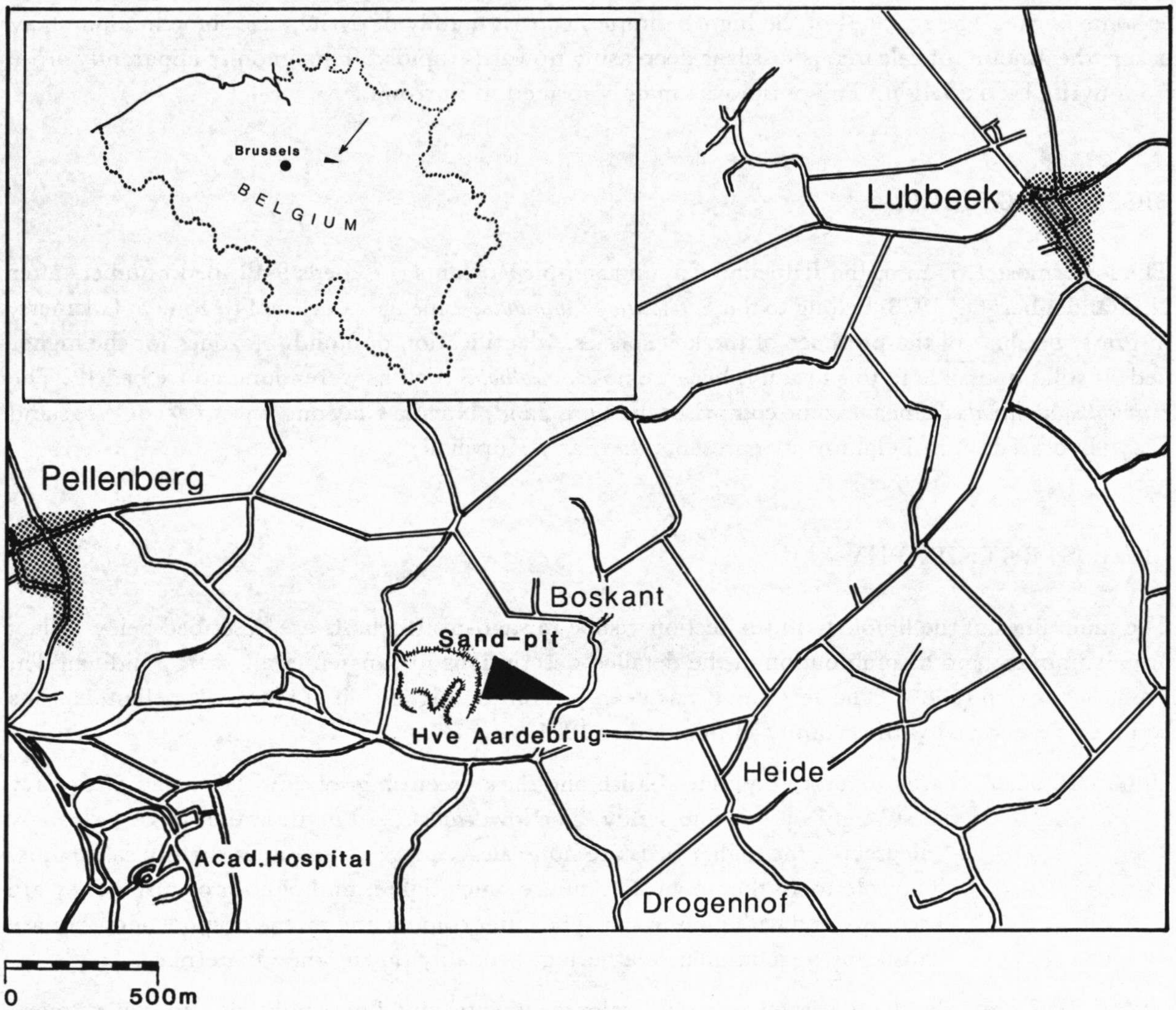
Er worden vijf nieuwe genera aan de hand van otolieten beschreven: *Parvicolliolus, Platyonos, Umbolota, Archilatilus* en *Serratidentex*. Ook worden er vier nieuwe soorten beschreven: *Platyonos limburgicus, Umbolota marina, Serratidentex sculptus* en "*Callionymus*" *pachyotus*. *Umbolota marina* is een mariene voorloper van de recente kwabaal, *Lota lota*, welke de enige in zoet water levende kabeljauwachtige is. Mariene voorouders van deze soort zijn nog niet eerder gevonden.

INTRODUCTION

The well-known Roelants sand-pit at Heide-Boskant (municipality of Lubbeek, province of Limburg, Belgium, see text-fig. 1) is the easternmost excavation in a much larger complex of sand-pits, the greater part of which is abandoned and overgrown nowadays. More or less detailed descriptions of sections in this complex were published by Gaemers (1973), Janssen et al. (1978) and others. In 1978 a rather extensive description of the Roelants sand-pit was given, but the higher part of the section, comprising the Boom Clay, was strongly weathered, which prevented a detailed description of that part of the section.

In 1984 members of W.T.K.G. during a geological field-trip observed that the higher parts of the Roelants section were recently excavated, so that only slightly weathered sediments could be studied. Mr M.C. Cadée (Leiden) noticed that the lower part of the clay was fossiliferous containing aragonitic shells. This was hitherto unknown.

These observations were so encouraging that Messrs M. van den Bosch and A.W. Janssen (Rijksmuseum van Geologie en Mineralogie, Leiden) together with the author organized a field-trip to this locality on 20 September 1984. Mr M. van den Bosch described in detail the lithology of the whole exposed section, and together with a lithostratigraphic interpretation this was included in van den Bosch & Janssen (1984). Mr A.W. Janssen and the author collected large samples in order to study the fauna. Sampling was limited to the lowermost 3.20 m of the clays because no calcareous



Text-fig. 1. Locality map of the Lubbeek-Pellenberg area, East of the city of Leuven. The Roelants sand-pit is indicated with an arrow.

fossils were observed in the higher part. Janssen (1984) described the mollusc fauna from the Rupelian clays. In this paper the otoliths of bony fish are described, which have been catalogued with registration numbers RGM 177 344 - RGM 177 408.

MATERIAL

Five large samples were taken for the museum collection at successive stratigraphic intervals. These samples were washed on a 0.3 mm mesh. The author collected a small sample of the lowermost clay horizon for the determination of the number of otoliths per kg of dry sediment. A survey of the collected samples is given in tab. 1.

The residues from the lowermost clay horizon consist mainly of limonite. Furthermore rather few and mainly fragmentary molluscs, many Foraminifera and a fair amount of otoliths occur, as well as some pyrite. The residues of the higher samples consist mainly of pyrite; also some limonite may occur; the amount of calcareous fossils is decreasing upwards rapidly. The limonite apparently arose from pyrite by oxidation. The pyrite was mainly formed in burrows.

BIOSTRATIGRAPHY

The lowermost 1.65 m of the Rupelian clay in sand-pit Roelants (i.e. beds 9-12; bed numbers after N. Vandenberghe, 1978) belong to the *Parvicolliolus minutulus* Lineage-zone (otolith zone 3; Gaemers, in press) because of the presence of the key species. Identification of otolith biozones for the higher beds is still impossible in this locality, because no *Parvicolliolus* otoliths were found above bed 12. The *Parvicolliolus minutus* Lineage-zone comprises the Berg Sand, Nucula Clay and lower part of Waasland Clay (Boom Clay) in Belgium; it represents the Early Rupelian.

LITHOSTRATIGRAPHY

The main lines of the lithology in the section visible in sand-pit Roelants are described below. They are a summary and a combination of the detailed descriptions in Janssen et al. (1978) and van den Bosch & Janssen (1984). The zero point has been put on the highest point where Rupelian deposits could be recognized with certainty in September 1984.

0.00 - 10.55 m	grey to dark grey, dark bluish and dark greenish grey clays. The clays are heavy to strongly silty or fine-sandy. The lowermost 2.70 m are rather to very strongly calcareous, the higher beds are non-calcareous, or sometimes slightly calcareous. The colours of the upper 2.45 m are much lighter and often brownish. They are accompanied with plant roots. The latter colours are not the original ones, but are caused by vegetational weathering, probably during the Quaternary.
10.55 - 10.70 m	light olive grey, strongly calcareous silty and fine sandy clay to clayey marl, strongly bioturbated. Burrows are usually filled with sand. Mollusc shells and fragments of shells are rather common.
10.70 - 14.95 m	upper part: fine to very fine light yellowish grey sand with rusty patches in the top. Some shell beds and dispersed shells ocur. Most shells are only present as rusty ghost structures. lower part: medium to fine light grey sand with one or two thin horizons at the base containing black, flattened flint pebbles.
14.95 - 16.35 m	light grey fine sand with a rather high mica content and many burrows towards the top. At the base 1 cm of greyish green heavy clay without mica, followed by 4 cm light greyish green coarse sand.
16.35 - 17.25 m	light to dark chocolate brown fine sand.

Lithostratigraphic interpretation:

0.00 - 7.85 m	Boom Clay Formation (Waasland Clay), Kotten B Member, presumably ± beds 20-30 of N. Vandenberghe (van den Bosch & Janssen, 1984)

7.85 - 10.55 m	Boom Clay Formation (Waasland Clay), Kotten A Member, beds 10-15 of N. Vandenberghe (van den Bosch & Janssen, 1984)
10.55 - 10.70 m	Nucula Clay, bed 9 of N. Vandenberghe
10.70 - 14.95 m	Berg Sand
14.95 - 16.35 m	Heide Sand, a local deposit not officially introduced (see Janssen et al., 1978), which may be included in the Kerkom Sand
16.35 - 17.25 m	soil in Kerkom Sand

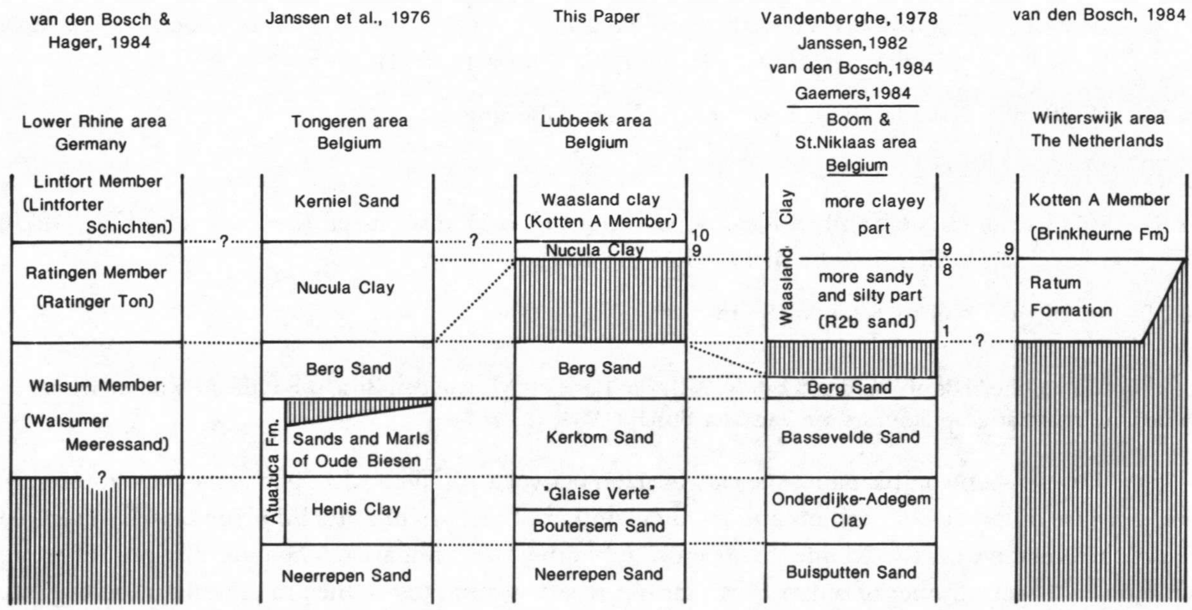
Identification of the beds of Vandenberghe (1978) was done by M. van den Bosch. For the new nomenclature of Rupelian lithostratigraphic units see van den Bosch (1984).

Within the scope of this paper the clay horizon between 10.55 and 10.70 m is the most interesting one, because of its crucial position and its high content of fish otoliths. Its lithology closely resembles that of the Nucula Clay (= Kleine Spouwen Clay) in the Tongeren area. The most obvious difference is the much larger number of burrows in sand-pit Roelants (and hence the amount of limonite/pyrite) than in the Tongeren area. Furthermore the colour in the Lubbeek section is somewhat darker. Nevertheless the resemblances in lithology are so strong that this bed may be called Nucula Clay. This locality is the westernmost occurrence of this lithological unit.

The Nucula Clay in sand-pit Roelants represents only the top of the Nucula Clay as it occurs in the Tongeren area and in the borings of airport Beek (South Limburg, The Netherlands). Beds 1-8 of N. Vandenberghe are missing according to M. van den Bosch, thus an important hiatus must exist between the Berg Sand and the Nucula Clay of sand-pit Roelants (see fig. 2, third column). Theoretically the Nucula Clay at Heide-Boskant could be a condensed sequence of the whole Nucula Clay, but this does not tally with the Foraminifera faunas. The Nucula Clay at Heide-Boskant contains a rich assemblage of Foraminifera with a high percentage of *Spiroplecta*, whereas miliolids are absent. The lower part of the Nucula Clay around Tongeren and at Beek always contain high percentages of miliolids and only a few or no individuals of *Spiroplecta*. In the borings of airport Beek I observed a gradual upward decrease of miliolids and a simultaneous upward increase of *Spiroplecta* leading to a Foraminifera assemblage with a high percentage of the latter genus and without miliolids in the top of the Nucula Clay. From this it is evident that only the top of the Nucula Clay is present at Heide-Boskant.

Most burrows in the Nucula Clay at Heide-Boskant contain many relatively coarse quartz grains which must come from the top of the Berg Sand. The least oxidized burrows have violet brown colours around these grains, indicating that iron humates may be present. Thus a terrestrial soil might have developed here before deposition of the Nucula Clay or such a soil might have been present in the immediate neighbourhood. The underlying Berg Sand has been oxidized very strongly. Rusty patches in the higher part of this sand and limonite formation around shells point to alternating oxidation-reduction circumstances. It is not yet clear if this rust was formed rather recently by changing ground-water-tables or during a possible soil formation before deposition of the Nucula Clay. The knowledge and experience of a soil expert is urgently needed.

In figure 2 a correlation scheme for the Late Tongrian and Early Rupelian deposits of five important areas is presented. With the data now available it seems to be a reasonable reconstruction although it still is a simplification of the reality. The presence of more, small hiatuses for instance can be expected.



Text-fig. 2. Proposed correlation scheme for Late Tongrian and Rupelian deposits of Belgium, the Federal Republic of Germany and The Netherlands. Horizontal lines indicate (approximate) isochrony. The numbers next to the lithostratigraphic columns are bed numbers after Vandenberghe (1978), who also introduced the Waasland Clay unit.

SURVEY OF THE FAUNA

The state of preservation of the otoliths in sand-pit Roelants is rather bad. Most of them are partly dissolved by weathering. The best preserved otoliths are those from the basal clay bed, the Nucula Clay, but even the majority of those is seriously affected. Therefore the percentages of the different species per sample may not be considered a reliable reflection of the original proportions within the fish fauna. The only bed giving a good insight in the qualitative composition of the fish fauna is the Nucula Clay (table 2). The state of preservation in the higher beds becomes increasingly worse, which has its repercussion on the number of species (see table 1) and the number of otoliths per kg of dry sediment. In the highest sample containing otoliths only *Semeniolum rupelense* occurs, the most compact and strongest otolith of the whole fauna. The Nucula Clay contains 4.5 otoliths per kg of dry sedi-

depth in m below top of Rupelian	bed nrs of Vandenberghe (1978)	wet weight	residue	number of otoliths	number of fish species
7.50 - 8.10	? + 15	ca 60 kg	285 g	0	0
8.10 - 9.05	14 + 13	ca 60 kg	225 g	10	1
9.05 - 9.80	12 + (upper 1/3 of 11)	ca 60 kg	265 g	23	5
9.80 - 10.55	(lower 2/3 of 11) + 10	ca 60 kg	335 g	45	5
10.55 - 10.70	9	ca 175 kg	3070 g	477	18
		dry weight			
10.55 - 10.70	9	7.5 kg	-	33	6

Table 1. Samples taken in sand-pit Roelants for palaeontological research.
"Wet weight" is the weight of the sediment with the natural content of moisture.
"Dry weight" is the weight of the sediment dried under normal room conditions.

	10.55 - 10.70 m, coll. RGM	10.55 - 10.70 m, coll. Gaemers	9.80 - 10.55 m, coll. RGM	9.05 - 9.80 m, coll. RGM	8.10 - 9.05 m, coll. RGM
1. *"Pterothrissus" umbonatus* (Koken, 1884)	5	-	-	-	-
2. *"Anguilla" rouxi* (Nolf, 1977)	1	-	-	-	-
3. Congridarum *trapezioides* Gaemers & v.Hinsbergh, 1978	-	-	1	-	-
4. *"Etrumeus"* sp.	1	1	-	-	-
5. *Argentina parvula* (Koken, 1891)	31	3	-	-	-
6. *Parvicolliolus minutulus* (Gaemers, 1978)	287	19	16	8	-
7. *Semeniolum rupelense* Gaemers, 1984	110	7	25	10	10
8. *Platyonos limburgicus* n. sp.	8	2	-	1	-
9. *Umbolota marina* n. sp.	2	-	-	-	-
10. *Palaeogadus compactus* Gaemers & v.Hinsbergh, 1978	2	-	2	-	-
11. ? *Palaeogadus* sp.	3	-	-	-	-
12. *Ensigadus ensiformis* (Steurbaut & Herman, 1978)	-	-	-	1	-
13. *Otarionichthys occultus* (Koken, 1891)	-	-	-	3	-
14. *Diplacanthopoma tortonesei* Nolf, 1977	1	-	-	-	-
15. *Acanthatrigla biangulata* Gaemers, 1984	7	-	-	-	-
16. *Archilatilus ellipticus* (Koken, 1884)	3	-	-	-	-
17. *Serratidentex sculptus* n. sp.	8	1	1	-	-
18. *"Trachinus"* aff. *biscissus* Koken, 1884	2	-	-	-	-
19. *Gymnammodytes arnoldmuelleri* Gaemers, 1984	1	-	-	-	-
20. *"Callionymus" pachyotus* n. sp.	2	-	-	-	-
21. *Citharus rhenanus* (Koken, 1891)	3	-	-	-	-
Total numbers	477	33	45	23	10

Table 2. Distribution of otoliths in the Rupelian deposits of sand-pit Roelants at Heide-Boskant, municipality of Lubbeek, province of Limburg, Belgium.

ment. The numbers of otoliths per kg of dry sediment for the successively higher samples are ca 1.25, ca 0.6 and ca 0.3 (these values were converted from the data of the wet samples). On the other hand the high otolith content of the Nucula Clay can not only be ascribed to a better preservation of the otoliths, but must for a great part also be a primary phenomenon.

The fish fauna from the Nucula Clay at Heide-Boskant shows the greatest correspondence with that of the Nucula Clay of other places: they have 15 species in common (table 3). *Umbolota marina* is only known from sand-pit Roelants and *Diplacanthopoma tortonesei*, of which only one juvenile otolith was found, has only been found in the Boom Clay up to now. One species, ''*Callionymus*'' *pachyotus*, is only known from the Nucula Clay and three species, viz. ''*Etrumeus*'' sp., *Acanthatrigla biangulata* and *Gymnammodytes arnoldmuelleri*, seem to be limited to Bassevelde Sand and Nucula Clay.

	Lubbeek, 10.55-10.70 m	Basseveldé Sand	Berg Sand	Nucula Clay	Boom Clay, Brinkheurne FM and Winterswijk Member
"*Pterothrissus*" *umbonatus*	L	Ba	Be	N	Bo
"*Anguilla*" *rouxi*	L	-	-	N	Bo
"*Etrumeus*" sp.	L	Ba	-	N	-
Argentina parvula	L	Ba	-	N	Bo
Parvicolliolus minutulus	L	-	Be	N	Bo
Semeniolum rupelense	L	Ba	Be	N	Bo
Platyonos limburgicus	L	Ba⁺	-	N	Bo
Umbolota marina	L	-	-	-	-
Palaeogadus compactus	L	Ba	Be	N	Bo
Palaeogadus emarginatus	?	Ba⁺	-	N	Bo
Diplacanthopoma tortonesei	L	-	-	-	Bo
Acanthatrigla biangulata	L	Ba	-	N	-
Archilatilus ellipticus	L	Ba	Be	N	Bo
Serratidentex sculptus	L	Ba	Be	N	Bo
"*Trachinus*" aff. *biscissus*	L	Ba	Be	N	-
Gymnammodytes arnoldmuelleri	L	Ba	-	N	-
"*Callionymus*" *pachyotus*	L	-	-	N	-
Citharus rhenanus	L	Ba	Be	N	Bo

Table 3. Comparison of the otolith fauna from the Nucula Clay at Heide-Boskant (first column) with other Oligocene otolith faunas of Belgium and The Netherlands. A forerunner species in the same lineage as the given species is indicated with ⁺.

The mollusc fauna from the Nucula Clay at Heide-Boskant contains elements characteristic for the Nucula Clay elsewhere as well as for the Boom Clay Formation (Janssen, 1984). Common species which are considered typical for the Nucula Clay are *Nucula comta* Goldfuss, *Nuculana westendorpi* (Nyst) and *Siphonodentalium* (s. lat.) sp. Common species which are to believed typical for the Boom Clay are *Nucula duchasteli* Nyst, *Nuculana deshayesiana* (Nyst), *Cyclocardia kickxi* (Nyst & Westendorp) and *Astarte kickxi* Nyst. We must however be careful when handling these data. It should be realized that the knowledge about Nucula Clay mollusc faunas is nearly completely limited to the lowermost 1.8 m of this deposit. To my knowledge only two borings at airport Beek (South Limburg, The Netherlands) have furnished rather small fossil collections from the upper part of the Nucula Clay. These collections are still undescribed, apart from some otoliths in this paper. The bivalve *Cyclocardia kickxi* turns out to be a common element in this fauna. It can't be excluded that other typical Boom Clay mollusc species will be found in the top of the Nucula Clay, when larger collections are made.

Although at Heide-Boskant otoliths are much more rare in the higher clays belonging to the Kotten A Member (lower part of Boom Clay), it is striking that three species occur which are typical for the Boom Clay, viz. Congridarum *trapezioides, Ensigadus ensiformis* and *Otarionichthys occultus*. The latter two species also were found in the Bassevelde Sand (Gaemers, 1984). All three species are unknown from the Nucula Clay.

PALAEOECOLOGY

The successive foraminiferal assemblages of the Nucula Clay in the borings at airport Beek, which are already mentioned in the section Lithostratigraphy, prove that the base of this deposit was formed in very shallow water; the sea gradually deepened towards the top of the Nucula Clay resulting in sea depths normal for the Boom Clay. The Foraminifera fauna from the Nucula Clay at Heide-Boskant with its high percentage of *Spiroplecta* and without miliolids indicates a sea depth probably of some tens of metres. Shallower water conditions must have existed before deposition of the basal clay bed and after deposition of the Berg Sand. One would expect to find sediments of this interval, but apparently they have not been preserved. They never were deposited or they were eroded before deposition of the thin Nucula Clay. The first possibility seems the most likely one. An accelerated deepening of the basin or an accelerated raise of the sea-level at the beginning of Nucula Clay sedimentation at Heide-Boskant may have taken place. This could explain the absence of older Nucula Clay formed in shallower water.

The hiatus between Berg Sand and Nucula Clay at Heide-Boskant is new evidence for an important event in Rupelian stratigraphy. The Berg Sand is a shallow marine deposit with regressive characteristics. The Nucula Clay, especially as it can be studied in the complete sections in the borings of airport Beek, turns out to be a transgressive shallow marine deposit. From this it can be concluded that the Berg Sand belongs to another, earlier sedimentation cycle than the Nucula Clay. Bassevelde Sand, Kerkom Sand, and Sands and Marls of Oude Biesen belong to the same sedimentary cycle as the Berg Sand, probably representing the transgressive phase of the cycle. The Henis Clay and its lateral equivalents (see fig. 2) are believed to be the beginning of this cycle in which the Boutersem Sand may represent a secondary oscillation.

The Nucula Clay and its more or less lateral equivalents Ratingen Member, Ratum Formation and the sandy/silty lower part of the Waasland Clay (the so-called R2b sand) are the beginning of the next large sedimentary cycle. It is not yet clear where this cycle ends, but it may be at the boundary between the Kotten and Woold Members (pers. comm. M. van den Bosch; see also van den Bosch & Hager, 1984).

ACKNOWLEDGEMENTS

Thanks are due to Mr M.C. Cadée (Leiden), for attracting our attention to the locality, and to the owners of the sand-pit, Messrs Roelants, for their permission to collect the samples and to study the section. I am grateful to Messrs M. van den Bosch and A.W. Janssen (RGM, Leiden) for their co-operation. Recent otoliths for comparison purposes were obtained from Dr T. Abe (Tokyo, Japan), Mr J. Bauza-Rullán (Palma de Mallorca, Spain), the late Mr J.E. Fitch (San Pedro, California), Dr D. Nolf (Brussels, Belgium) and Dr G. van der Velde (Nijmegen). Mr C.P. Barnard (RGM) washed the samples and sorted out the residues. Mr R.I.W. Dijkman (RGM) prepared text-figs 1 and 2. The SEM-photographs were made by Mr J.H.W. Krom (Rijksmuseum van Natuurlijke Historie, Leiden) with a Jeol JSM-T20 scanning microscope at 10 KV, the other photographs were made by Mr W.A.M. Devilé (RGM).