Meded. Werkgr. Tert. Kwart. Geol. | vol. 17 (2) | pp. 65 - 70 | 2 tabs. | Rotterdam, juni 1980

ELASMOBRANCH ASSOCIATIONS IN TERTIARY AND QUATERNARY DEPOSITS OF THE NETHERLANDS (VERTEBRATA, PISCES), 2. PALEOGENE OF THE EASTERN AND NORTHERN PART OF THE NETHERLANDS, NEOGENE IN THE EASTERN PART OF THE NETHERLANDS [1]

by

M. van den Bosch
Rijksmuseum van Geologie en Mineralogie,
Leiden

IUGS UNESCO IGCP 124
INTERNATIONAL GEOLOGICAL CORRELATION PROGRAMME

Bosch, M. van den. Elasmobranch associations in Tertiary and Quaternary deposits of the Netherlands (Vertebrata, Pisces), 2. Paleogene of the eastern and northern part of the Netherlands, Neogene in the eastern part of the Netherlands. - Meded. Werkgr. Tert. Kwart. Geol., 17 (2): 65 - 70, 2 tabs. Rotterdam, June 1980.

An attempt is made to complete and improve a biostratigraphical subdivision of Paleogene and younger Neogene deposits, published by the author in 1978. Sample processing and collecting methods are discussed in relation to quantitative interpretation of the faunas, also in boring samples. A final biostratigraphy is considered to be premature, but it may be concluded that marine Tertiary deposits in the Netherlands can be typified in detail by means of Elasmobranchii.

M. van den Bosch, Rijksmuseum van Geologie en Mineralogie, Hooglandse Kerkgracht 17, 2312 HS Leiden, The Netherlands.

Contents:

---

[1] Nr. 1 see M. van den Bosch, 1978. On shark teeth and scales from the Netherlands and the biostratigraphy of the Tertiary of the eastern part of the country. - Meded. Werkgr. Tert. Kwart. Geol., 15 (4): 129 - 136, 1 tab.

SAMENVATTING

In deze publicatie wordt een poging gedaan het biostratigrafisch overzicht dat reeds in 1978 gepubliceerd werd (Van den Bosch, 1978) voor wat betreft het Paleogeen en het jongere Neogeen verder aan te vullen en te verbeteren. Gewezen wordt op de grote verschillen welke ontstaan als gevolg van de toegepaste verzamelmethode. De reeds in 1978 vermelde standaardmethode om alle monsters op gaas van 0,4 mm doorlaat te zeven en de residue's volledig uit te zoeken, geeft een goed bruikbaar resultaat voor biostratigrafische vergelijking, ook in boringen. Een biostratigrafische indeling wordt hier nog niet gegeven; daarvoor zullen de resultaten welke in tabel 1 en 2 zijn weergegeven meer aan de praktijk moeten worden getoetst. Geconcludeerd kan worden dat de mariene tertiaire afzettingen in Nederland zich gedetailleerd door middel van associaties van Elasmobranchii laten typeren.

INTRODUCTION AND METHODS

One and a half year ago I published a paper on the biostratigraphy of Tertiary deposits in the eastern part of the Netherlands, based on shark teeth and scales (van den Bosch, 1978). In the meantime the knowledge of the Paleogene faunas was considerably increased by the study of material from N.A.M. boring 'De Wijk 19'. At the same time the already existing collections were revised and rearranged according to collecting-method, to enable comparisons.

In practice I find that good results are obtained by washing all raw samples over a 0.4 mm mesh sieve. The residues can be inspected rapidly for elasmobranch teeth. This method reveals more than 95% of the total species content. Investigation of finer fractions is only useful if one is interested also in this part of the fauna, or if the fractions coarser than 0.4 mm yield too small numbers of specimens for a reliable interpretation. The number of teeth below 0.4 mm may be considerable, but the processing of these fractions is very time-consuming.

In tables 1 and 2 the material is specified as follows. Material collected according to the standard-method described above (so over 0.4 mm in size) is calculated in percentages for each level if more than 30 pieces are available, or in absolute numbers n(X) if less than 30 pieces were collected. Also the second method suggests ratios in the material X, but these of course are only a very rough approach. As the faunas are always restricted in number of species a calculation in percentages of more than 30 pieces already gives rather good results. For reliable conclusions differences of e.g. more than 10%, depending on the total quantity of material, are considered to be of importance.

From some levels good collections were obtained by collecting visually in exposures. Here it is obvious that specimens below 15 mm in size are hardly found, because they are too inconspicuous. Especially line 4 in table 1 is an excellent example of unreal ratios when collecting in this way: 74.2% of the material collected visually in a clay-pit apparently represents no more than 5.4% of the total fauna! Still, species can be collected in this way that otherwise would remain unknown. This material is, as in the former case, specified either in % or in n(X).

The two tables are a preliminary effort to obtain a biozonation, which should also be recognizable in borings. A final result will only be obtained after more detailed investigation and an increased knowledge. In outline, however, this effort already seems to be useful. In some cases the identifications and nomenclature have a preliminary character.

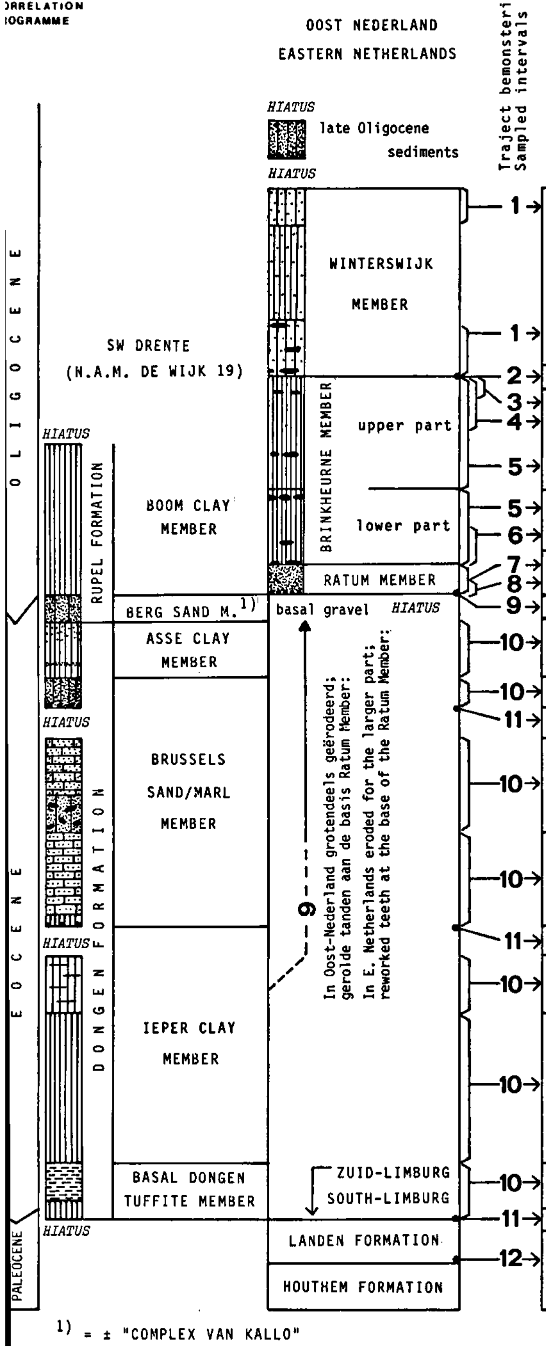
I would like to express my gratitude toward the Nederlandse Aardolie Maatschappij at Assen for valuable advices and for the opportunity of sampling boring sections, and to mr A. W. Janssen (Rijksmuseum van Geologie en Mineralogie, Leiden) for critically reading the manuscript.

IOSTRATIGRAFIE VAN ELASMOBRANCHII IN HET OUD-TERTIAIR VAN OOST- EN NOORD NEDERLAND
IOSTRATIGRAPHY OF ELASMOBRANCHII IN THE PALEOGENE IN THE EASTERN AND NORTHERN PART OF THE NETHERLANDS

Tab. 1

. van den Bosch - Rijksmuseum van Geologie en Mineralogie, Leiden - 15 februari 1980.

IUGS
NESCO
124
TERNATIONAL
EOLOGICAL
)RRELATION
IOGRAMME



In Oost-Nederland grotendeels geërodeerd; gerolde tanden aan de basis Ratum Member:

In E. Netherlands eroded for the larger part; reworked teeth at the base of the Ratum Member:

1) = ± "COMPLEX VAN KALLO"

Traject bemonstering (zie verklaring) Sampled intervals (see explanation)	Methode + voor berekening gebruikt materiaal Method + material used for calculations	RGM-coll.	*Heterodontus vincenti* (Leriche, 1905)	*Notorhynchus serratissimus* (Ag., 1844)	*Notorhynchus* sp. / *Hexanchus* sp.	*Hexanchus* sp. (non *H. primigenius*)	*Notorhynchus primigenius* (Ag.)	*Palaeohypotodus rutoti* (Winkler, 1874)	*Otodus obliquus* Ag.	*Hypotodus robustus* (Leriche, 1921)	*Hypotodus verticalis* (Ag.)	*Jaekelotodus trigonalis* (Jaekel, 1895)	*Striatolamia striata* (Winkler, 1874)	*Striatolamia macrota* (Ag.)	*Striatolamia ?teretidens* (White, 1931)	*Odontaspis hopei* (Ag.)	*Odontaspis cuspidata* (Ag.)	*Odontaspis winkleri* (Leriche, 1905)	*Odontaspis acutissima* (Ag.)	"*Lamna*" *inflata* Leriche, 1936	"*Lamna*" "*lerichei*" Casier, 1946	"*Lamna*" *rupeliensis* Le Hon, 1871	*Isurolamna affinis* (Casier, 1946)	*Odontaspis*, *Lamna*, etc. indet.	*Isurus praecursor* Leriche, 1904	*Isurus gracilis* Le Hon, 1871	*Procarcharodon auriculatus* (de Bl., 1810)	*Procarcharodon disauris* (Ag.)	*Procarcharodon* c.f. *turgidus* (Ag.)	*Procarcharodon angustidens* (Ag.)	*Procarcharodon* sp. indet.	*Alopecias exigua* (Probst, 1897)	*Cetorhinus parvus* Leriche, 1908 tanden teeth	*Cetorhinus parvus* Leriche, 1908 kieuwaanhangsels gill-rakers	*Scyliorhinus pattersoni* Cappetta, 1976	"*Scyliorhinus*" *biauriculatus* (Casier, 1950)	"*Scyliorhinus*" *minutissimus* (Winkler, 1874)	*Scyliorhinus gilberti* Casier, 1946	*Scyliorhinus* "aff. *coupatezi*" St.& Herm., 1978	*Scyliorhinus* sp. div. indet.	*Galeus* sp. 1	*Galeorhinus minutissimus* (Arambourg, 1935)	*Galeorhinus minor* (Ag.)	*Galeorhinus lefevrei* (Daimeries, 1891)	*Galeorhinus latus* (Storms, 1894)	*Physodon secundus* (Winkler, 1874)	*Physodon tertius* (Winkler, 1874)	*Carcharhinus elongatus* (Leriche, 1910)	*Carcharhinidae* sp. div. indet.	*Isistius trituratus* (Winkler, 1874)	*Squalus minor* (Leriche, 1902)	*Squalus alsaticus* (Andreae, 1892)	*Squatina angeloides* van Beneden, 1873	*Pristiophorus rupeliensis* St.& Herm., 1978 rostrale tanden rostral teeth	*Pristiophorus rupeliensis* St.& Herm., 1978 orale tanden oral teeth	*Pristiophorus* sp. 1	*Pristis lathami* Galeotti, 1837 rostrale tanden rostral teeth	*Rhynchobatus vincenti* Jaekel, 1894	"*Rhinobatos*" *bruxelliensis* Jaekel, 1894	*Rhynchobatidae* sp. 1	?*Rhinobatos* sp. 1	*Raja cecilae* St. & Herm., 1978	*Raja heinzelini* St. & Herm., 1978	*Raja terhagenensis* St. & Herm., 1978	*Raja casieri* St. & Herm., 1978	*Raja* sp. 7	*Raja* sp. kleine huidstekeltjes type A small dermal spines type A	*Raja* sp. kleine huidstekeltjes type B small dermal spines type B	*Dasyatis tricuspidata* Casier, 1946	*Dasyatis jaekeli* (Leriche, 1905)	*Dasyatis duponti* (Winkler, 1874)	*Dasyatis* sp. 1	*Dasyatis* sp. div.	*Mobula* sp. 1	*Myliobatidae* sp. div. indet.	*Aetobatis irregularis* Ag.	*Rhinoptera* sp.
1	n(X)>0,4 mm	(21 ex.)																	2																															14		1									2	1	1														
1	n(X)>0,4 mm	(6 ex.)																														1																		5																									
2	%>0,4 mm	(100%= 4164 ex.)					0,02												3,19			0,07										0,43	0,50							0,07				0,17			0,02				75,91	0,12	3,48	1,70	0,02					0,02	0,98	6,60	2,11	3,87	0,10	0,41	0,14				0,05		0,02			
3	%>0,4 mm	(100%= 187 ex.)																	5,4														3,7										0,5								68,6		3,7	0,5					0,5		1,6	7,0	4,8	3,2		0,5										
4	%>±15 mm	(100%= 347 ex.)					x										0,3		24,2			5,2				3,7						x		1,4										6,0							3,7	4,9	0,6																							
5	%>0,4 mm	(100%= 75 mm)																	4,5			1,3											9,3																		61,3	1,3	3,9								3,9	5,3	3,9	5,3												
5	%>0,4 mm	(100%= 69 ex.)				1,4													10,2														10,2					1,4						2,8							50,8		2,8								4,5	7,3	5,8	2,8												
6	n(X)>±15 mm	(8 ex.)																				2				5																		1																																
7	%>0,4 mm	(100%= 30 ex.)																	54,0							3,0																		10,0							30,0		3,0																							
8	%>±15 mm	(100%= 107 ex.)															5,6		70,2			9,3				10,3			0,9															3,7																																
9	n>±15 mm	(> 768 ex.)		3	1				2	52	53	13		399	3	14		20		13	7		17	∞	40		28	1	1		16						1						1														6																		23	54	
10	n(X)>0,4 mm	(9 ex.)																						4																1										2											1	1															
10	n(X)>0,4 mm	(19 ex.)																						8																		1				1			4	1							1				1								1	1							
11	n(X)>0,4 mm	(29 ex.)		2														1						2													2					4	1						2	1																		1	1						12		
10	%>0,4 mm	(88 ex.)	1,1	1,1	1,1						3,5			6,9										17,2												2,4						4,6			18,3	1,1		5,8	2,4								6,9											2,4	3,5			1,1		20,6		
10	%>0,4 mm	(44 ex.)																			2,3			15,9															2,3		4,5	4,5			18,2			13,6	2,3								4,5	2,3										2,3	6,8					20,5		
11	n(X)>0,4 mm	(7 ex.)																																											1			5																							1				
10	n(X)>0,4 mm	(10 ex.)	1															2			1														1										1			3		1																									
10	n(X)>0,4 mm	(4 ex.)																																2					1						1																														
10	n(X)>0,4 mm	(1 ex.)																						1																																																					
11	n(X)>0,4 mm	(2 ex.)																						2																																																					
12	n(X)>±10 mm	(15 ex.)						3					9			2																																																													1

VERKLARING - EXPLANATION

1 uit boringsecties Gelderse Achterhoek: Miste, Lievelde, Winterswijk-1 (N.A.M.)
from boring sections Gelderse Achterhoek: Miste, Lievelde, Winterswijk-1 (N.A.M.)

2 basis Winterswijk Member, groeve De Vlijt, Winterswijk
base Winterswijk Member, clay-pit De Vlijt, Winterswijk

3 bovenste 5 meter Brinkheurne Member, groeve De Vlijt, Winterswijk
upper 5 m Brinkheurne Member, clay-pit De Vlijt, Winterswijk

4 bovenste 10 à 12 m Brinkheurne Member, groeve De Vlijt, Winterswijk; los verzameld (incl. coll. Cadée)
upper 10 à 12 m Brinkheurne Member, clay-pit De Vlijt, Winterswijk; collected visually (incl. coll. Cadée)

5 uit diverse boringsecties Gelderse Achterhoek: Miste, Woold, Meddo, Winterswijk-1 (N.A.M.), etc.
from several boring sections Gelderse Achterhoek: Miste, Woold, Meddo, Winterswijk-1 (N.A.M.), etc.

6 onderste 5 - 10 m Brinkheurne Member, groeve Kuiperberg, Ootmarsum (Twente), los verzameld
lower 5 - 10 m Brinkheurne Member, clay-pit Kuiperberg, Ootmarsum (Twente), collected visually

7 uit diverse boringsecties Gelderse Achterhoek, genoemd onder 5
from several boring sections Gelderse Achterhoek, as specified under 5

8 niet verspoeld materiaal uit onderste deel Ratum Member, diverse locaties in Twente, Oldenkotte; los verzameld
not-reworked material from the lower part of the Ratum Member, several locations at Twente, Oldenkotte, collected visually

9 tussen gerolde eocene fosforieten als 8, getransporteerd
between reworked Eocene phosphoritic concretions from several locations as under 8

10 uit boring De Wijk 19 (N.A.M.), zuidwest Drente
from boring De Wijk 19 (N.A.M.), SW Drente

11 uit idem, gerold materiaal aan de basis
the same, reworked material from the base

12 Zuid- Limburg, o.a. S.M. Maurits III, 167,20 - 169,20 m, RGD
South-Limburg, a.o. S.M. Maurits III, 167,20 - 169,20 m, RGD

VERGELIJKBAAR ZIJN: 1, 2, 3, 5, 7, 10, 11 EN: 4, 6, 8, ±9, ±12
(= ± VERGELIJKBARE VERZAMELMETHODE)

COMPARABLE ARE: 1, 2, 3, 5, 7, 10, 11 AND: 4, 6, 8, ±9, ±12
(= ± THE SAME COLLECTING METHOD)

LITHOSTRATIGRAPHICAL REFERENCES

For Oligocene deposits of the eastern part of the Netherlands a lithostratigraphical subdivision was published by van den Bosch, Cadée & Janssen (1975), which is expected to be applicable in the other parts of the country as well. As the knowledge of the Brinkheurne Member has increased considerably, there is an urgent need of a more detailed lithostratigraphical subdivision. The lithological succession of this member appears to agree in detail with the Boom Clay Formation in the Boom area in Belgium, where a detailed subdivision was recently introduced by Vandenberghe (1978). A well-founded lithostratigraphy is considered to be of utmost importance as a base for a biozonation. Differences in opinion on the interpretation of sections in which biozonations are designated should be avoided as much as possible and a sufficiently detailed subdivision is essential as a frame work for biostratigraphical zonations.

For the Paleocene and the Eocene such a lithostratigraphical subdivision is not available. The existing subdivision of these chronological units, as used here in table 1 (van Staalduinen et al., 1979; Nederlandse Aardolie Maatschappij & Rijks Geologische Dienst, 1980) is not satisfactory. Its definitions are subject to discussions and the classification is too broad. Furthermore in practice this classification seems to be used merely as indications in a chronological sense. In future this subdivision will certainly need improvement.

PRELIMINARY RESULTS

Paleogene (table 1)

Eocene and Oligocene deposits contain, as is well-known, hardly any mutual species of elasmobranchs; therefore distinguishing between these two large units offers no problems. Near to the boundary between them, however, some problems do occur: the upper part of the Eocene Asse Clay Member already yields some species that are well-known from the Oligocene Rupel Formation. A characteristic Early Oligocene fauna is not yet known, and can hardly be expected to be found in the Netherlands, as boring sections in deposits of this age contain very few fossils. The Grimmertingen Sands, considered to be Early Oligocene (Lattorfian) in age, yield a fauna with many Eocene components (Van den Bosch, 1964a).

Paleocene - Houthem Formation. Sediments of this age yield strikingly many small teeth of *Striatolamia striata* and *Palaeohypotodus rutoti.*

Eocene- Deposits of Eocene age contain relatively many Carcharhinidae, among which *Physodon secundus* is the most important species. In the lower part of the Ieper Clay Member *Scyliorhinus pattersoni* is found. The Brussel Sand or Marl Member is characterized by strikingly many Myliobatidae, Dasyatidae and Rhynchobatidae, next to the Carcharhinidae already mentioned. *Odontaspis, Lamna,* etc. represent less than 30% of the fauna. In the middle part of the Brussel Sand or Marl Member a thick level with phosphoritic concretions *in situ* occurs, in which *Striatolamia macrota* is an important constituent. The beds with reworked Eocene phosphoritic concretions at the base of the Ratum Member in Twente (Van den Bosch, 1964b) contain shark-teeth that for a large part were reworked from this fauna, see table 1, nr. 9.

In the upper part of the Brussel Sand or Marl Member, which in boring 'De Wijk 19' is separated from the underlying sediments by a hiatus and a basal gravel, the occurrence of the species *Isistius trituratus* is striking, together with a.o. *Dasyatis* and *Squalus minor.* These deposits are poor in Myliobatidae.

BIOSTRATIGRAFIE VAN ELASMOBRANCHII IN HET JONG-TERTIAIR VAN OOST-NEDERLAND
BIOSTRATIGRAPHY OF ELASMOBRANCHII IN THE NEOGENE OF THE EASTERN PART OF THE NETHERLANDS

Tab. 2

M.v.d.Bosch - Rijksmuseum van Geologie en Mineralogie, Leiden - 31 januari 1980

IUGS UNESCO 124
INTERNATIONAL
GEOLOGICAL
CORRELATION
PROGRAMME

1 los verzameld materiaal: Twentekanaal bij Delden, Twickel, Borne; RGM-coll.
material collected visually: Twentecanal near Delden, Twickel, Borne; RGM-coll.

2 uit boringmonsters, fractie >0,4 mm; Delden, Zenderen, Neede; RGM-coll.
from boring samples, fraction >0.4 mm; Delden, Zenderen, Neede; RGM-coll.

3 fractie >0,4 - 1,2 mm, basisgrind 't Klooster,Aalten; RGM-coll., coll. Cadée, Kruissink
fraction >0.4 - 1.2 mm, basal gravel 't Klooster, Aalten; RGM-coll., coll. Cadée, Kruissink

4 uit boringmonsters, fractie >0,4 mm; Zenderen, Delden, Neede; RGM-coll.
from boring samples, fraction >0.4 mm; Zenderen, Delden, Neede; RGM-coll.

5 los verzameld materiaal: Twentekanaal bij Delden; RGM-coll.
material collected visually: Twentecanal near Delden; RGM-coll.

6 los verzameld materiaal: Holterhoek Eibergen; RGM-coll.
material collected visually: Holterhoek Eibergen; RGM-coll.

VERGELIJKBAAR ZIJN: 2, 3 + 4 EN: 1, 5 + 6
(= ± VERGELIJKBARE VERZAMELMETHODE)

COMPARABLE ARE: 2, 3 + 4 AND: 1, 5 + 6
(= ± THE SAME COLLECTING METHOD)

	OOST - NEDERLAND EASTERN NETHERLANDS *lithologie - lithology* *lithostratigrafie lithostratigraphy*			*Notorhynchus primigenius* (Ag.)	*Hexanchus gigas* (Sismonda, 1861)	*Odontaspis* aff. *cuspidata* (Ag.)	*Odontaspis* aff. *acutissima* Ag.	*Odontaspis vorax* Le Hon, 1871	*Lamna* sp. Van den Bosch, 1969	*Isurus hastalis* (Ag.) s.l.	*Isurus hastalis* (Ag.) - vrij breed type rather wide type	*Isurus hastalis* (Ag.) - breed type wide type	*Isurus hastalis* (Ag.) - zeer breed type very wide type	*Isurus escheri* (Ag.) - zwak gekarteld type weakly crenulate type	*Isurus escheri* (Ag.) - sterk gekarteld type strongly crenulate type	*Isurus* aff. *retroflexus* (Ag.)	*Cetorhinus maximus* (Gunner, 1765)	*Cetorhinus* sp. - kieuwaanhangsels gill-rakers	*Scyliorhinus coupatezi* Herman, 1974	*Galeorhinus galeus* (Linné, 1758)	*Carcharhinus priscus* (Ag.)	*Galeocerdo aduncus* Ag.	*Squalus acanthias* Linné, 1758	*Squatina* sp.	*Pristiophorus* cf. *schroederi* Springer & Bullis, 1960 - rostrale tanden - rostral teeth	*Raja* sp. 1	*Raja* sp. 2	*Raja* sp. 3	? *Raja* sp. 4	*Raja* sp. 5	*Raja* sp. - kleine huidstekeltjes small dermal spines	*Dasyatis* sp.	*Rhinoptera* sp.
EARLY - PLIOCENE	LIEVELDE MEMBER																																
	DELDEN MEMBER	1	%>15 mm 100%= 92 ex.	1,0		3,2	4,3	4,3	35,0				48,0		2,1						2,1												
		2	%>0,4 mm 100%= 207 ex.	0,5			2,0		9,0	4,0							0,5	7,0	0,5	0,5			4,0	6,0	4,0	44,0	11,0	11,0	1,0		2,0		
		3	%>0,4-1,2 mm 100%= 763 ex.	0,9	0,4		13,4	3,3	4,2	10,7					2,0		2,8	2,0	0,3	0,4		0,1	4,3	7,6	3,4	16,1	2,0	12,0	1,7	0,1	6,5	0,6	5,2
LATE - MIOCENE	ZENDEREN MEMBER *HIAAT HIATUS*	4	%>0,4 mm 100%= 67 ex.				1,5											7,5	1,0				18,0	1,0		50,0	4,5	3,0			7,5	3,0	3,0
		5	%>15 mm 100%= 220 ex.	0,5	0,5	1,4	0,5	4,1	2,3			59,0			29,4			2,3															
	EIBERGEN MEMBER	6	%>15 mm 100%= 493 ex.	0,4	0,2	0,6		2,2			81,6			8,1		2,6						4,3											
MIDDLE MIOCENE	AALTEN MEMBER	→		zie / see: van den Bosch, 1978, Meded. Werkgr. Tert. Kwart. Geol., 15(4): 129-136.																													

In the younger Eocene deposits, the Asse Clay Member, species occur that are well-known from Rupelian sediments: *Raja cecilae* and *Raja heinzelini*. The number of teeth, however, is very low here.

Oligocene - Oligocene deposits are especially characterized by high percentages of *Squalus alsaticus*: 30% in the Ratum Member, in the lower part of the Brinkheurne Member 50% in its higher levels 61%, to 68% in its uppermost part; in the basal part of the Winterswijk Member even as high as 76% and higher in this member at least 50%

But for the scarcely occurring species *Scyliorhinus* aff. *coupatezi*, which is absent from the higher part of the Brinkheurne Member, all species occur in the entire Rupel Formation. Just as for *Squalus*, however, the ratios are rather strongly differing. In the Ratum Member the numbers of *Odontaspis acutissima* (54%) and *Galeorhinus latus* (10%) are characteristic, next to the occurrence of *Squalus alsaticus* (30%). Furthermore other large species attrack attention: *Isurus gracilis* and *Odontaspis cuspidata*. Rajidae and Dasyatidae are scarce or absent. in contrast to the fauna of the Berg Sands s.s. (non Berg Sand Member) (RGM collections).

During the deposition of the Brinkheurne Member the composition of the fauna changes gradually. Compared to the Ratum Member fauna four species of *Raja* are introduced, finally forming 15 to 20% of the fauna. *Raja cecilae* distinctly decreases in number towards the higher parts of the deposit. Also *Odontaspis acutissima* becomes less important upwards (from 10% in the lower part to 4.5 - 5.4% at the top), as do *Isurus gracilis* and *'Lamna' rupeliensis*.

The base of the Winterwijk Member is especially rich in material as a result of interrupted sediment supply by which feature teeth are concentrated here; reworked material is hardly present. Among the 4,100 available teeth some are present that probably belong to exotic taxa: some Rhynchobatidae and a *Mobula* species. Little is known about the fauna of the higher part of the Winterwijk Member, but judging from the small quantity of available material the association is not expected to differ strongly from that in the upper part of the Brinkheurne Member.

Neogene (table 2)

Associations from the Eibergen Member, the Zenderen Member and the Delden Member were studied. These deposits are considered to be Late Miocene, the higher parts possibly Early Pliocene, in age. From the Eibergen Member no finer fractions were investigated as yet. These are available, however, and it is already certain that these will yield very few specimens. Among the larger species the two most frequent ones are of importance: *Isurus hastalis* and *I. escheri*. They demonstrate obvious evolutionary trends. *I. escheri* is most frequent in the Zenderen Member. A small number of teeth of these species is already sufficient for a stratigraphical interpretation, but unfortunately they are too rare to be useful in borings.

Among the smaller species the common occurrence of *Squalus acanthias* is characteristic for the Zenderen Member, as is *Lamna* sp. van den Bosch, 1964 for the Delden Member. There are also some differences in the Rajidae. The associations summarized in table 2 are very different from those in Middle Miocene deposits (van den Bosch, 1978) and in younger Pliocene sediments (RGM collections).

The available collections from sections between the Winterswijk Member and the Eibergen Member will be revised. The results, however, will not be available before long, as the collections are very extensive. A broad outline of this material was already published by van den Bosch (1978).

LITERATURE

Bosch, M. van den, 1964a. Enige haaientanden uit de Zanden van Grimmertingen. - Natuurh. Maandbl., 53 (9): 131 - 138, 6 figs., 2 tab.

Bosch, M. van den, 1964b. Haaientanden uit de fosforietenlaag aan de basis van het Oligoceen in Overijssel en Gelderland. - Publ. Natuurh. Genootsch. Limburg, 13: 61 - 78, 4 pls.

Bosch, M. van den, 1978. On shark teeth and scales from the Netherlands and the biostratigraphy of the Tertiary of the eastern part of the country. - Meded. Werkgr. Tert. Kwart. Geol., 15 (4): 129 - 136, 1 tab.

Bosch, M. van den, M. C. Cadée & A. W. Janssen, 1975. Lithostratigraphical and biostratigraphical subdivision of Tertiary deposits (Oligocene - Pliocene) in the Winterswijk - Almelo region (eastern part of the Netherlands). - Scripta Geol., 29: 1 - 167, 37 figs., 10 tab., 23 pls., 2 enclosures.

Herman, J., 1979. Reflexions sur la systématique des Galeoidei et sur les affinités du genre Cetorhinus à l'occasion de la découverte d'éléments de la denture d'un exemplaire fossile dans les Sables du Kattendijk à Kallo (Pliocène inférieur, Belgique). - Ann. Soc. Géol. Belgique, 102: 357 - 377, 4 figs., 3 pls.

Nederlandse Aardolie Maatschappij & Rijks Geologische Dienst, 1980. Stratigraphic nomenclature of the Netherlands. - Verh. Koninkl. Nederl. Geol. Mijnb. Genootsch;. 32: 1 - 77, 16 textfigs., 36 encl.

Staalduinen, C. J. van, et al., 1979. The geology of the Netherlands. - Meded. Rijks Geol. Dienst, 31 (2): 9 - 49, 42 figs., 2 maps.

Steurbaut, E. & J. Herman, 1978. Biostratigraphie et poissons fossiles de la Formation de l'Argile de Boom (Oligocène moyen du bassin belge). - Géobios, 11 (3): 297 - 325, 3 figs., 6 tabl., 3 pl.

Vandenberghe, N., 1978. Sedimentology of the Boom Clay (Rupelian) in Belgium. - Verhand. Kon. Acad. Wetensch., Lett. en Sch. Kunsten, (Kl. Wetensch.), 40 (147), 137 pp.