Microtus (Allophaiomys) pliocaenicus from the Lower Pleistocene near Brielle, The Netherlands

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The Lower Pleistocene succession, the pollen and some smaller mammals from the upper part of the boring Brielle (SW Netherlands) are described. The correlation between the Eburonian Glacial Stage and the mammal-based subdivision of the Biharian Stage is discussed.

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Introduction

Systematical study of a great number of borings during past and recent years has largely increased the knowledge of the Pleistocene subsoil of the Netherlands. Wherever available, pollen is used to correlate the deposits, which themselves are classified in formations. A number of chronostratigraphic units has been based on subsurface data: the Eburonian, Waalian and Menapian (Zagwijn, 1957, 1960).

The chronostratigraphic subdivision of the Dutch Lower Pleistocene has been used in other countries as well, and Woldstedt (1969) has adopted it in his standard succession for Northwestern Europe. Being defined on climatic changes as recognized by changes in vegetation, these chronostratigraphic units can be traced by pollen only. The only exception is the (upper part of the) Tiglian, the stratotype of which yields both a rich floral and a mammal assemblage.

Every now and then fossil remains of mammals (smaller mammals in particular) are found in the borings, offering the possibility of correlations between Dutch stages and mammal-based subdivisions. The earlier finds, consisting of vole molars mainly, have been reported and discussed by A. Schreuder in a series of papers (1933, 1936, 1943). This collection will be revised in the near future in the light of the many new data both on the deposits that yielded Schreuder's material and on the Early and Middle Pleistocene vole species in Western Europe.

In this paper we will describe and discuss the lithological succession, the pollen (W.H.Z.) and some smaller mammal remains (A. J. v. d. M.) from the upper part of boring 37D/134 (File number Geological Survey of the Netherlands) near Brielle (= Den Briel), southwestern Netherlands. The pollen assemblages from about 40 samples from the lower 280 m were studied. The smaller mammals come from a sand body intercalated between two palynologically dated clay beds and, although small in number, they enable a comparison between the Eburonian Glacial Stage and the subdivision of the Hungarian Pleistocene, a subdivision mainly based on rodents.

Acknowledgements

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Lithology

Below 25 m of clay and sand representing the Dunkirk and Calais Members of Holocene age, relatively coarse sand was found down to 37 m, which belongs to the Kreftenheye Formation of Late Pleistocene age. As is the case elsewhere in the region, the Kreftenheye Formation overlies unconformably non-marine beds consisting of rather fine sand, in which two main clay members are intercalated: an upper one from 42.50 to 51.70 m and a lower one from 66.20 to 85.00 m below surface. By lithostratigraphic correlation it can be concluded, that the upper of the two belongs to the Kedichem Formation, whereas the lower one represents the Tegelen Clay Member, which is at the top of the Tegelen Formation. Below 90 m marine deposits follow down to the final depth of 325 m, which in Dutch literature are currently indicated as "Icenian deposits". A formal lithostratigraphic name for these beds should, however, be introduced, a procedure which we consider to be outside the scope of the present paper.

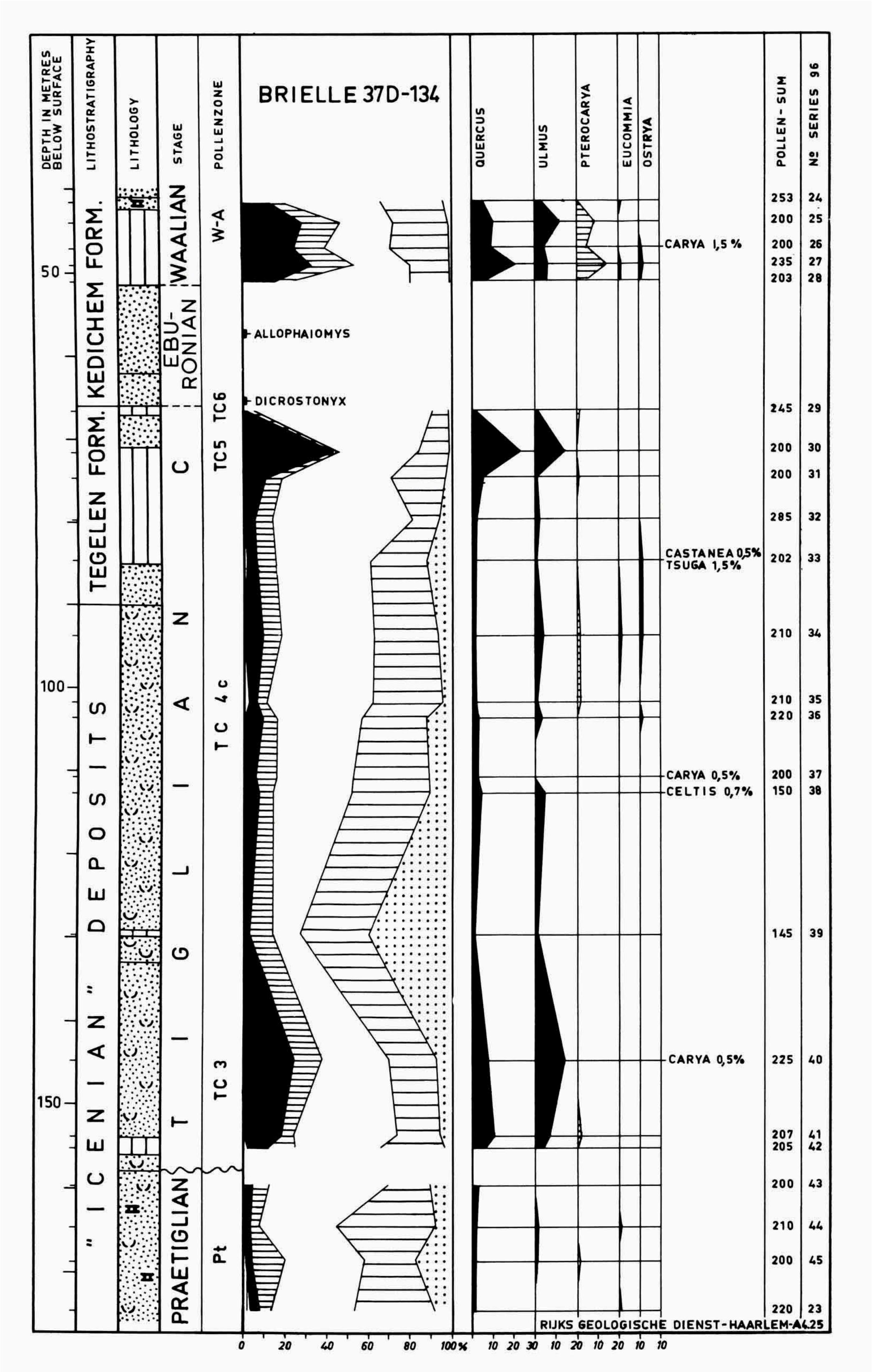
Pollen analysis

Samples of the clay-beds or clay-lenses were prepared according to standard methods (Zagwijn, 1960) in order to obtain pollen spectra. The data were plotted in a pollen diagram (Figure 1) in the way described by Zagwijn (1963). In the main diagram the following ecological groups are given from left to right: (1) trees not ranging further upward than the Pliocene (*Sequoia*-type, *Taxodium*-type, *Sciadopitys, Liquidambar,* etc.); (2) warmth-loving trees of relatively dry habitat *(Quercus, Ulmus, Corylus, Eucommia, Carya, Ostrya*-type, *Carpinus,* etc.); (3) warmth-loving trees of relatively wet habitats *(Alnus, Pterocarya, Myrica,* etc.); (4) climatically indifferent and cool trees *(Pinus, Betula, Salix, Picea, Abies, Tsuga,* etc.); (5) herbs; and (6) Ericales, as indicators of non-forest vegetation.

Only the pollen diagram from 41-175 m has been reproduced here. A diagram ranging down to total depth has been published in van Voorthuysen et al. (1972). The lowermost part of the boring (158-325 m) has yielded pollen spectra, which show high values of herbs and low ones of thermophilous trees. Especially in the diagram part 158-220 m reworked pollen of Mesozoic age are frequent and at the same time pollen usually common in beds of Late Tertiairy age. Most probably the latter have been reworked too. As discussed in van Voorthuysen et al. (1972) this part of the boring can be referred to the Praetiglian (cold) Stage of the lowermost Pleistocene.

At 158 m a hiatus must be present, as typical pollen assemblages referable to pollen-zones TA and TB of the Tiglian (Zagwijn, 1963) were not found.

The pollen assemblages of clay-beds in the Kedichem Formation (41.00-51.70 m) as well as those from the Tegelen Formation (66.20-85.00 m) and from the underlying marine beds down to 158 m, yielded pollen spectra showing varying values of thermophilous trees, among which *Pterocarya, Carya, Eucommia* and *Ostrya; Fagus* is absent. This indicates, that these beds belong to the Tiglian C and Waalian interglacial stages. In the diagram part 66.20-158 m two maxima of thermophilous trees are present (at 143-154 m and 71-72 m, respectively), whereas in between a zone showing spectra with rather low values of the thermophilous elements was found. Comparison with other sites in the western Netherlands (Zagwijn, 1963) makes it probable, that the two maxima of thermophilous trees correspond to the Tiglian pollen zones TC 3 and TC 5 respectively. Two facts strongly support this view, namely that the zone TC 5 was found within the Tegelen Clay Member and that the top of the marine ("Icenian") deposits was found in the


BRIELLE 37D-134
DEPTH IN METRES BELOW SURFACE
LITHOSTRATIGRAPHY
LITHOLOGY
STAGE
POLLENZONE
50
100
150
"ICENIAN" DEPOSITS
KEDICHEM FORM.
TEGELEN FORM.
WAALIAN
EBU-RONIAN
TIGLIAN
C
PRAETIGLIAN
W-A
TC6
TC5
TC 4c
TC 3
Pt
ALLOPHAIOMYS
DICROSTONYX
QUERCUS
ULMUS
PTEROCARYA
EUCOMMIA
OSTRYA
POLLEN-SUM
Nº SERIES 96
CARYA 1,5 %
CASTANEA 0,5%
TSUGA 1,5%
CARYA 0,5%
CELTIS 0,7%
CARYA 0,5%
253 24
200 25
200 26
235 27
203 28
245 29
200 30
200 31
285 32
202 33
210 34
210 35
220 36
200 37
150 38
145 39
225 40
207 41
205 42
200 43
210 44
200 45
220 23
RIJKS GEOLOGISCHE DIENST-HAARLEM-A425
0
20
40
60
80
100%
10
20
30
10
20
10
20
10
10

intervening cool subzone (TC 4c) (Zagwijn, loc. cit.). The spectrum 66.20-67.00 m, directly above zone TC 5, shows predominance of *Pinus* as well as low values both of thermophilous trees and herbs. It reminds of the uppermost cool zone TC 6 of the Tiglian. Above this level an interval of sandy beds follows from which no pollen spectra could be produced.

The clay-bed 42.00-51.70 m, however, again yielded spectra with high values of thermophilous trees, including especially *Pterocarya, Carya, Ostrya* and *Eucommia*. As these elements in general are missing from later interglacials, this part of the diagram represents part of the Waalian interglacial stage.

The intervening beds, barren in pollen, probably belong to the Eburonian glacial stage, with the possibility that also beds from the very top of the Tiglian or the base of the Waalian are included.

Systematical description of the smaller mammals

INTRODUCTION

In this paper only the smaller mammal remains from the sands at the depth of 51.70-66.20 m below the surface will be described. In addition the boring Brielle yielded a fragmentary palate with left M^1-M^2 (RGM 177 915) belonging to *Arvicola* (25-26 m below the surface) and isolated M_2 (RGM 177 916) and M_3 (RGM 177 917) belonging to an advanced, medium-sized *Mimomys* species from 72-73 m below the surface.

These fossils from the boring Brielle have been stored in the Rijksmuseum van Geologie en Mineralogie (National Museum of Geology and Mineralogy) at Leiden, The Netherlands.

The measurements were carried out with a Leitz ortholux microscope (ocular 10x, objective 3.8x) with mechanical stage and measuring clocks.

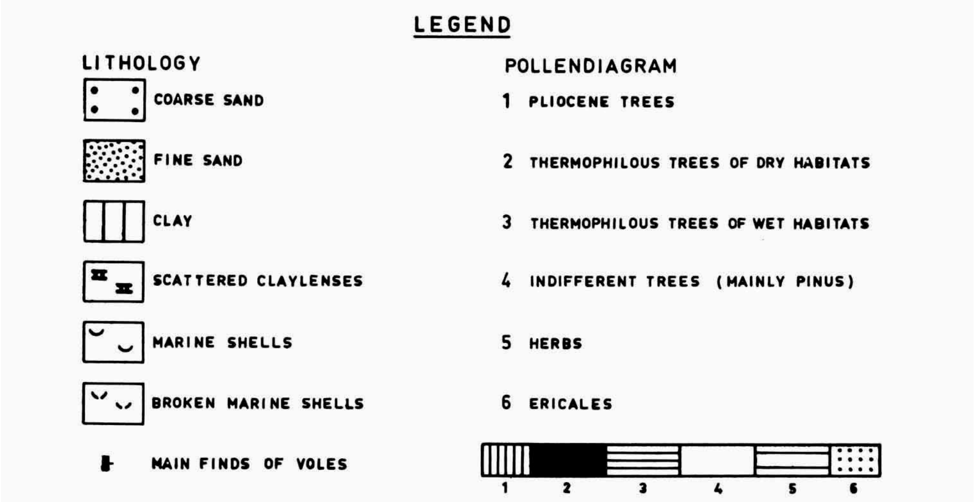


Fig. 1. Pollen diagram of the upper part of boring Brielle (37D/134).

DESCRIPTIONS

Order INSECTIVORA Bowdich, 1821
Family SORICIDAE Gray, 1821
Subfamily SORICINAE Fischer von Waldheim, 1817
Tribe NEOMYINI Repenning, 1967
Genus *Beremendia* Kormos, 1934

Beremendia cf. *fissidens* (Petényi, 1864)

Material – 1 left M_1, RGM 177 912.

Level – Boring Brielle 37D/134, 65-66 m below the surface.

Measurements – L = 2.55 mm; W = 1.58 mm. The maximal length (L) was measured parallel to the lingual border of the molar, the width (W) was taken perpendicularly to the length.

Remarks – This large soricid molar was compared to *Beremendia fissidens* from the Monte Peglia, Italy, and to a few specimens from Hungarian localities. Great morphological agreement was found in all this material, notably in the presence of a complete buccal cingulum and the high entoconid crest in M_1. A certain determination is impossible on a single molar.

Order RODENTIA Bowdich, 1821
Family ARVICOLIDAE Gray, 1821
Subfamily ARVICOLINAE Bonaparte, 1837

Terminology and method of measuring

Recently the first author introduced a new terminology for the elements of the vole molars (van der Meulen, in press). The terminology used for the various parts of the occlusal surface of M_1 is given in Fig. 2.

The maximum length of the teeth is recorded below as L. The width of the *Dicrostonyx* M^1 was measured from a line touching the tips of LSA2 and LSA3 to the tip of BSA3. In van der Meulen (in press) a number of *Microtus* species have been distinguished biometrically on the basis of the means and distributions of the following variables (see also Fig. 3):
A/L = 100a/L, in which a stands for the length of the ACC;
B/W = 100b/W, in which b stands for the shortest distance between BRA3 and LRA4, W standing for the width of the ACC measured between the tips of T4 and T5;
C/W = 100c/W, in which c stands for the shortest distance between BRA3 and LRA3. In the measurements of b, c and W the enamel is not included.

Dicrostonyx torquatus (Pallas, 1778)
Fig. 4a

Material – 1 right M^1, RGM 177 913.

Level – Boring Brielle 37D/134, 65-66 m below the surface.

Measurements – L = 2.61 mm, W = 1.38 mm.

Description – The rootless molar lacks crowncementum. There is an interruption of the enamel at the tip of each salient angle and at the posterior end of the molar. The enamel is conspicuously differentiated into thin portions at the anterior sides of the triangles and thick portions at their posterior sides. Behind the anterior lobe there are five fully alternating triangles and in addition a narrow, elongated field lying postero-buccaly, of which the complete posterior side lacks enamel.

Discussion – Three fossil *Dicrostonyx* species have been described from European Pleistocene deposits. *Dicrostonyx henseli* Hinton, 1910 and *D. gulielmi* Sanford, 1870, extensively described in Hinton (1926), have been discussed critically by Jánossy (1954). His conclusion that the forms described under these names represent no more than varieties of *D. torquatus* Pallas is considered correct.

Recently Fejfar (1966) has described *Dicrostonyx simplicior* on a small collection from two Middle Pleistocene localities at the Zlatý kůn near Koněprusy, Czechoslovakia.

The main criteria on which the three fossil species have been distinguished are molar length and the number of salient angles in M_2, M_3, M^1 and M^2. Our M^1 is of the *D. henseli* type, since it lacks the smaller postero-lingual salient angle, which is generally present in the living Eurasian *Dicrostonyx* species. As has been

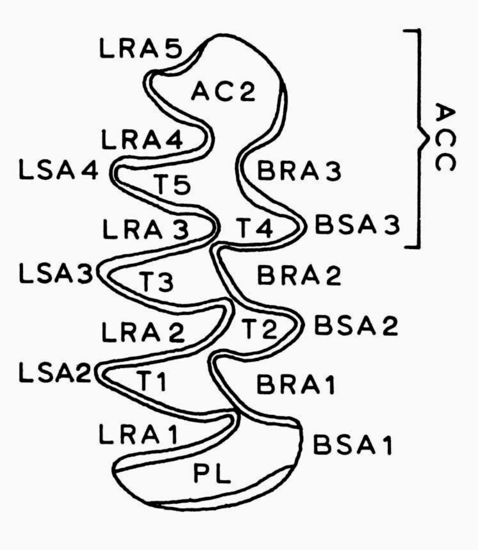


Fig. 2. Occlusial surface of a right *Microtus (Allophaiomys)* M_1 to show the terminology of its various parts. AC = anterior cap; ACC = anteroconid complex; BRA = buccal re-entrant angle; BSA = buccal salient angle; LRA = lingual re-entrant angle; LSA = lingual salient angle; PL = posterior lobe.

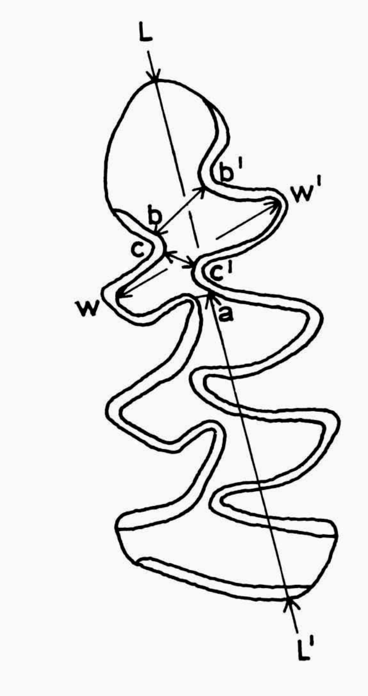


Fig. 3. Occlusal surface of a left *Microtus* (*Allophaiomys*) M_1 to illustrate the measurements that were taken. L – L' = L; a – L = a; W – W' = W; b — b' = b; c – c' = c

noted by Chaline (1973) such morphological criteria, which are subject to variation (Jánossy, 1954), may only be used if sufficient material is available. Thus far Middle Pleistocene collections of *Dicrostonyx* are small and therefore, they had better be assigned to *D. torquatus* in stead of using other names.

Microtus (Allophaiomys) pliocaenicus (Kormos, 1933)
Fig. 4b

Material – One fragmentary right mandible containing M_1 and part of the incisor (the lingual anticlines of M_1 are damaged), RGM 177 914.

Level – Boring Brielle 37D/134, 57-58 m below the surface.

Measurements – L = 2.70 mm, a = 1.13 mm, A/L = 42, B/W = 32, C/W = 22.

Description – The synclines are filled with crowncementum. The occlusal surface shows five dentine fields: PL, T1, T2, T3 and the anteroconid complex consisting of the broadly communicating T4, T5 and AC2. A true LSA5 is not developed, since the lingual side of AC2, although projecting, is rounded. There is a very narrow and shallow re-entrant angle at the lingual side of the AC2, which may be called an incipient LRA5. The buccal side of the AC2 is rounded. The enamel is differentiated into thicker portions at the anterior, and slightly thinner portions at the posterior sides of the triangles. The enamel is interrupted at the antero-buccal side of the ACC and at both sides of the PL.

Discussion – The *Microtus (Allophaiomys)* M_1 from Brielle was compared with the *M. (Allophaiomys)* sp. A and *M. (Allophaiomys)* sp. B M_1 assemblages from the Monte Peglia, Italy. These two species could be demonstrated to be clearly more advanced than *M. (A.) pliocaenicus* on the basis of distributions and means of the above mentioned ratios (van der Meulen, in press; see also Table I). The most frequent M_1 variants of both *M. (Allophaiomys)* sp. A and B. differ from our M_1 from Brielle in showing a more complicated pattern of ACC. In *M. (Allophaiomys)* sp. A most M_1 show a partly separated AC2, while well developed LSA5 and LRA5 are nearly always present. In this Monte Peglia assemblage only one value of A/L = 42 was found, and two values of B/W > 30 (Table I). A characteristic feature of *M. (Allophaiomys)* sp. B is the deep LRA4, of which the tip points anterobuccaly. This re-entrant angle is rarely as shallow as it is in the molar from Brielle. There are 9 values of A/L < 43 and 7 values of B/W > 30 in *M. (Allophaiomys)* sp. B from Monte Peglia.

Microtus (Allophaiomys) sp. A and B are probably identical to *M. (Allophaiomys) pliocaenicus nutiensis* Chaline, 1973 and to *M. (Suranomys) malei burgondiae* Chaline, 1973 respectively. Three more *Allophaiomys* species from Pleistocene deposits in Europe are known:

M. (Allophaiomys) pliocaenicus (Kormos, 1933) (= *Allophaiomys laguroides* Kormos, 1933) has been studied on the basis of a collection of 99 M_1 from its type locality Betfia-2, Rumania (van der Meulen, in press). The majority of these M_1 show four lingual re-entrant angles. In 14 molars, however, an incipient LRA5 is present. Some of these variants perfectly resemble the M_1 of Brielle. We found 19 values of B/W > 30. The remaining measurements of the M_1 of Brielle are

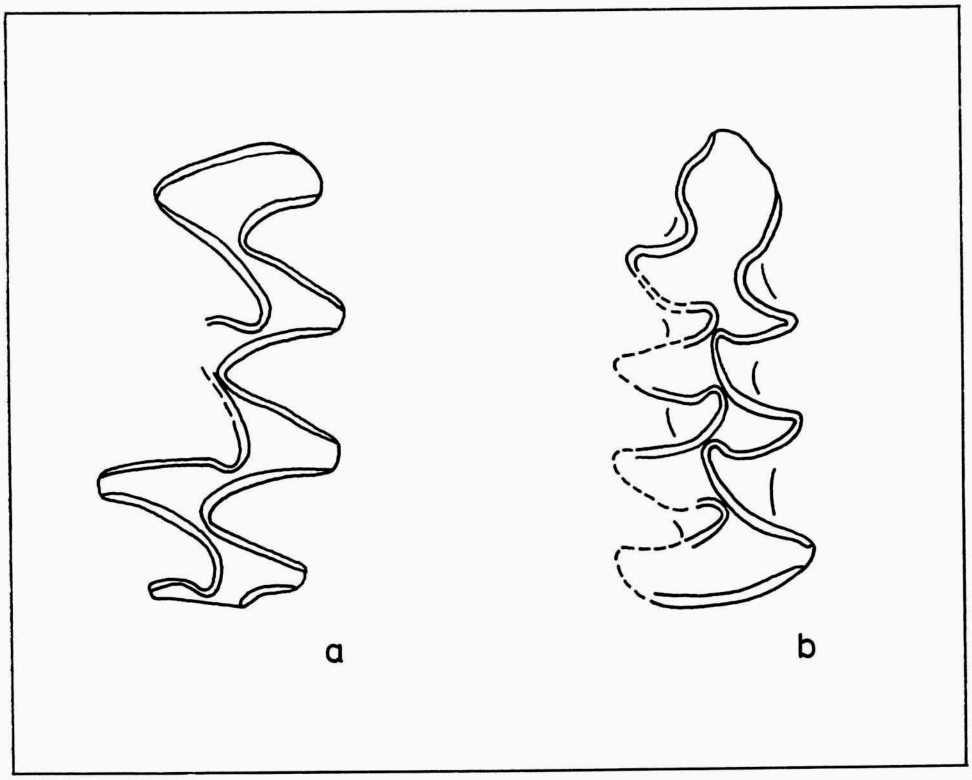


Fig. 4. Two arvicolid molars from the boring Brielle (37D/134): a: right M^1 of *Dicrostonyx torquatus* (RGM 177 913); b: right M_1 of *Microtus (Allophaiomys) pliocaenicus* (RGM 177 914).

very close to the mean values found for *M. (A.) pliocaenicus* (Table I).

M. (Allophaiomys) deucalion (Kretzoi, 1969) is represented only by its holotype, a M_1 from Villány-5, S. Hungary. In a scatterdiagram composed for a and L (van der Meulen, in press, fig. 24a) the large M_1 of *M. (A.) deucalion* is outside the scatter periphery of the cluster of *M. (A.) pliocaenicus* from Betfia-2. This was one of the reasons to retain *M. (A.) deucalion* as a separate species.

After finishing this manuscript we found 23 other *M. (A.) deucalion* M_1 in the vole assemblage from Villány-5, kindly offered for study by Dr M. Kretzoi, Budapest. On the basis of this new material it can be demonstrated that *M. (A.) deucalion* differs from *M. (A.) pliocaenicus*, notably in its type of differentiation of the thickness of the enamel which is unique within *Microtus*.

The third *Allophaiomys* species is *M. (Allophaiomys) ruffoi* (Pasa, 1947) known from a number of localities in the Soave region in Northern Italy. This species is now in revision by Dr G. Bartolomei, Ferrara, who kindly permitted us to see his collections. Pasa (1947) already noted that *M. (A.) ruffoi* is larger and somewhat more advanced than *M. (A.) pliocaenicus*. The AC2 is larger and LRA4 and BRA3 are generally deeper in the former. Specimens with a small AC2 (as also shown in the M_1 from Brielle) have not been observed when surveying Dr Bartolomei's material of *M. (A.) ruffoi*. So, if present, such variants are very rare.

It is often impossible to determine a single *Microtus* M_1 at the specific level. However, the M_1 from Brielle shows such a combination of characters, that assign-

Table I. Measurements and ratio data of some seleceted *Microtus (Allophaiomys)* M1 assemblages for comparison with those of *M. (A.) pliocaenicus* from boring Brielle (37D/134).

		M. (A.) sp. A Monte Peglia	*M. (A.) sp.* B Monte Peglia	*M. (A.) pliocaenicus* Betfia-2	*M. (A.) pliocaenicus* Brielle
L	Min.	2.32	2.36	2.30	
	Mean	2.581	2.741	2.651	2.70
	Max.	2.87	3.10	3.02	
	N	104	264	96	1
A/L	Min.	42	41	40	
	Mean	46.6	45.7	43.7	42
	Max.	51	50	48	
	N	101	255	96	1
B/W	Min.	<5	6	8	
	Mean	13.9	21.5	25.3	32
	Max.	33	33	35	
	N	148	181	89	1
C/W	Min.	6	<5	15	
	Mean	22.4	18.2	22.0	22
	Max.	37	31	30	
	N	147	165	89	1

ment to any other than *M. (A.) pliocaenicus* is highly improbable. Moreover, we did find variants among *M. (A.) pliocaenicus* from its type locality, which are near-identical to the molar from Brielle. If not for the presence of the tiny LRA5, it would, in fact show the typical *M. (A.) pliocaenicus* pattern.

Discussion and conclusions

On the basis of pollen analysis a Tiglian Age is assigned to the sediments between 66.20-158 m below the surface, and a Waalian Age to the clay bed between 41.00-51.70 m. The intercalated sands containing *Dicrostonyx, Allophaiomys* and *Beremendia* could not be dated by means of pollen.

Dicrostonyx torquatus was found just above the clay layer at 66.20-67.00 m below the surface. This clay was dated as Latest Tiglian. The living *D. torquatus,* the collared or arctic lemming, is confined to the Arctic regions north of, or above the tree-line (van den Brink, 1967, p. 92). We, therefore, conclude that the sedimentation of the sands started under cool conditions of a glacial interval. In consequence of the datings of the under- and overlying clay beds, this glacial is of Eburonian Age. We assigned an Eburonian Age to the entire sand body between 51.70-66.20 m below the surface, assuming that no major interruption of the sedimentation took place. However, an Early Waalian Age for the higher parts of the sands cannot be excluded.

The Early to Middle Pleistocene evolution of *Microtus* species in Europe has been subject of recent studies, and serves a detailed biostratigraphical subdivision (Chaline, 1970, 1972, 1973; van der Meulen, in press). The latter author distinguished the *M. (Allophaiomys) pliocaenicus* Range-zone, which can be use to correlate sediments of Early Biharian Age, since the zonal marker is present in two different reference localities in this Stage: Nagyharsányhegy-2 in S. Hungary, and Betfia-2 in W. Rumania. Nagyharsányhegy-2 has been considered to be the oldest of the reference localities of the Biharian. Its sediments and faunal association indicate a climate cooler than at the time of deposition of Betfia-2 (Kretzoi, 1956; Terzea & Jurcsák, 1967; van der Meulen, in press). At this time the conditions must have been fully interglacial (deposition of terra rossa, abundance of *Mimomys,* presence of *Macaca,* etc.).

On the basis of the evidence given above we correlated the sands with *Microtus (Allophaiomys) pliocaenicus* and *Dicrostonyx torquatus* in the boring Brielle to the locality Nagyharsányhegy-2 in S. Hungary. It follows that part of the Eburonian (presumably its later part) is time-equivalent to the earliest part of the Biharian.

Bourdier et al. (1969) report the co-occurrence of *Dicrostonyx* sp. and *Allophaiomys pliocaenicus* in loess deposits covering the High Terrace of the Somme in Grace, near Amiens. They correlate the loess to Late Günz. In our opinion the *Allophaiomys* M_1 from Grace should be referred to *Pitymys gregaloides* (see Chaline, 1973, Pl. 20, figs. 5-8; Chaline, 1972, figs. 7-8), which is known from numerous Late Early and Late Biharian deposits in Europe (e.g. Villány-8 and Tarkö, Hungary; Sackdillingen, Germany; Stranska Skala, Czechoslovakia).

Chaline (1972, fig. 63:2) mentions *Dicrostonyx* from Les Valerots, France. In this locality the lemming is accompanied by *Microtus (Allophaiomys) pliocaenicus nutiensis* Chaline, 1973 and *M. (Suranomys) malei burgondiae* Chaline, 1973. These two *Microtus* species are probably the same as respectively *M. (Allophaiomys)* sp. A and sp. B from the Monte Peglia, Italy (van der Meulen, in press). These Italian assemblages have been compared to *M.* (*A.*) *pliocaenicus* from its type locality Betfia-2, Rumania, and appeared to be more advanced. This suggests that the *Dicrostonyx* from Les Valerots indicates the glacial period following the Eburonian, i.e. the Menapian *(M. (Allopaiomys)* sp. B Peak subzone, van der Meulen, in press).

The *Dicrostonyx* from Brielle would thus represent the oldest known occurrence of the genus in Europe.

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