Preliminary report on a field campaign in the continental Pleistocene of Tegelen (The Netherlands)

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By means of modernized sieving techniques 110 m^3 of matrix from a gully filling in the Tegelen Clay were sieved. This yielded a good collection of small mammals, which clarifies the stratigraphic position of the Tiglian, a collection of other vertebrates, a small collection of mollusks, and a vast amount of plant material. A good collection of mollusks was made through classical collecting techniques. The faunal lists in this paper constitute a considerable enlargement of the known Tegelen fauna. Collecting is continuing, and further additions to the fauna may be expected.

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Introduction (by M. Freudenthal)

The Pleistocene clays of Tegelen have throughout the years yielded a considerable collection of fossil mammal material. Most of this material is kept at the Rijksmuseum van Geologie en Mineralogie, Leiden, the Netherlands, and was collected by workmen in the clay-pits, during a period when the exploitation was done mainly by hand. Due to the mechanization of the exploitation nowadays most of the material passes undetected and is destroyed.

Furthermore a number of pits have been abandoned, either because they were exhausted, or because they reached the limits of the concession. Unfortunately, the pits that yielded most of the fossils in the past are among those now abandoned.

A list of mammal species of the Tegelen Clay is given by Kortenbout van der Sluijs & Zagwijn, 1962. This list contains 23 species, 18 of which are of medium or large size; only 5 are micromammals. This poor representation of small mammals is apparently due to the way of collecting; most of the material was picked by hand, and only a very small amount of it has been acquired by means of washing and sieving techniques. Many of the small teeth and bones available were collected by Kortenbout van der Sluijs when he discovered a gully filled with fossiliferous clayey sand. A smaller number of teeth were collected earlier and described by Schreuder (1945) and Newton (1907).

During the past years the micromammals have come to play a role of ever increasing importance for the Pleistocene stratigraphy, and in view of this fact the lack of sufficient information about the composition of the Tegelen fauna became more and more embarrassing.

In 1970 we got message from Dr Zagwijn (Geological Survey, Haarlem), that the Tegula company planned to reopen the clay-pit Egypte (co-ordinates 51° 21′ N, 6° 10′ E) for a period of about a month, which would make it necessary to lower the water-level in the pit. Thereby the sand-filled gully described by Kortenbout van der Sluijs & Zagwijn, 1962 would become accessible again. We got the impression that this was possibly the last opportunity to collect fossil mammals from this pit, and in view of its importance as a Pleistocene mammal locality we decided to try whether modernized collecting techniques would enable us to exploit this relatively poor locality in a remunerative way. Our main goal was to collect a sufficiently large number of small mammals, especially the voles, to establish the position of Tegelen in the international rodent stratigraphy. We realized that we would have to process very large amounts of matrix, and that the success of such an undertaking would mainly depend upon the collecting technique and the type of sediment being processed.

Apart from mammal fossils our campaigns yielded fish, amphibian, reptilian and bird remains, an extensive collection of plant remains (compare van der Burgh, 1974), and some terrestrial and fresh-water mollusks. T. Meijer personally recovered a fine collection of mollusks. The vertebrate collection is stored at the Rijksmuseum van Geologie en Mineralogie at Leiden. A representative series will be chosen from it, to be kept at the Geological Institute at Utrecht. The plant remains will be divided among the RGM at Leiden and the Paleobotany Department of the University of Utrecht. The molluscan material is kept at the RGM, and in the private collections of T. Meijer (Amsterdam), K. Jonges (Amsterdam), W. J. Kuijper (Rijnsburg), and W. R. Schlickum (Cologne).

We wish to express our sincere thanks to the Tegula brick company for their kind permission to work in their clay-pit, and to Mr and Mrs Kloover of Belfeld, who must have had some regrets in lodging people who return from their work covered with mud.

We are very grateful to all who enthusiastically assisted in making the various field campaigns a success; we will not mention all names, but an exception should be made for Mrs Germeraad, who participated disinterestedly, and proved to be a very fine companion.

Collecting technique

Our first collecting campaign at Tegelen fortunately coincided with our finishing the construction of an equipment for sieving on a large scale. A description of this device will be given here:

It can best be described as a table of about one metre high and with a surface of 100 by 40 cm. The table-top is a sieve with a 2.5 mm mesh (in other localities we use e.g. a 5 mm mesh, if this is desirable; in Tegelen 2.5 mm gave the best results; dismounting a screen and mounting another one takes only a couple of minutes). The sieve has walls of 10 cm high on both long sides, and on one short side. The fourth side is open, and here a sort of funnel may be mounted in a few seconds. On this same side the sieve can rotate on a horizontal axis and be put in a vertical position. Any material present on the sieve will then slide down through the funnel, and thus it may be easily collected in a bag held under it.

In many localities we use a second sieve with 10 mm mesh, which is placed in the 2.5 mm sieve. Thus, the coarsest fraction is separated from the rest immediately, and generally it is possible to search it through on the spot, pick out all valuable specimens, and throw away whatever is not worth while; this reduces the volume of residue to be taken home considerably.

Under the 2.5 mm mesh a third sieve is mounted on rails, so that it may easily be taken out. This sieve has a 0.5 mm mesh (0.7 and 1.0 mm mesh sieves are available for use instead of the 0.5 mm one, if such a change is appropriate). The size of this sieve is 100 by 55 cm.

In Tegelen we worked with four persons, and we found the following procedure optimal: two people dug the matrix from the pit, transported it in buckets, and loaded it on the sieve. The sieve can hold a 100 kg at a time. Each of the other two held a hose-pipe with a variable nozzle, connected to a motor-pump. One would spray the water on the upper sieve, the other one on the lower sieve. For this purpose the upper sieve (which is 15 cm narrower than the lower one) is shoved as far as possible towards the man who will spray the upper sieve. This will leave a 15 cm broad gap through which the other one can spray the lower sieve. When the material on the upper sieve is clean, the amount of material on it, and on the lower sieve is considered in order to decide whether a new load will be put onto it, or whether the upper sieve alone, or both sieves will be emptied.

For transportation the sieve-table may be folded in such a way that it takes a volume of about 100 x 60 x 20 cm. Mounting or dismounting the sieve-table takes about a quarter of an hour.

Sieving speed

The amount of matrix sieved per hour depends largely on the type of sediment to be processed: a clay has to be excavated, dried, soaked in water, and sieved; if the result is not satisfactory, the residue is dried, soaked, and sieved again, etc. Fortunately, the sediment we exploit at Tegelen is a clayey sand that needs no drying in advance; it may be excavated, put in buckets, and brought to the sieve immediately. The speed is then defined by the quality and the amount of residue in the sieve. The Tegelen residue is easily cleaned, but a disadvantage is that, especially in the lower levels of the pit, there is a very large amount of plant material in the sediment so that the sieve has to be emptied often, and that part of this plant material contains still elastic rubber that tends to block the meshes of the sieves. The higher levels of the sediment contain only a small amount of plant material, and here sieving was easiest.

We managed to sieve, working with four man, well over one ton per hour when we were processing the upper levels, and somewhat less than one ton per hour for the lower levels rich in plants.

At other localities, under the most disadvantageous conditions, sieving compact clay sediments from fissure fillings, extremely rich in fossils, we still managed to process over a ton per day, working with three man. And in this case much time was spent in picking valuable and very fragile specimens from the sieve. So, our new equipment presents a considerable improvement over sieving techniques previously used.

The Tegelen locality

The sediment we processed at Tegelen is a clayey sand, deposited in a stream gully cut into the Tegelen Clay of the pit Egypte. The lower part contains more coarse grains than the upper part; the middle part of the gully filling is extremely rich in plant material. The Tiglian sediment is covered by sands of Eburonian age.

So far, we have held four campaigns at Tegelen, of three weeks each, with a team of four persons. Only during the last campaign we worked with two sieves, two pumps, and seven persons.

We are concentrating our efforts on the central part of the gully, which is richest in plant fossils, and where the sediment is thickest. During the first campaign (in 1970) we had the advantage that the fossiliferous sediment was right at the surface, with no overburden whatsoever; however, sieving technique was not yet optimal then, and the equipment still needed improvement. Through the next campaigns — in 1971, 1972 and 1974 — sieving improved quite a bit, but, as our excavation site was moving uphill, an ever increasing amount of overburden had to be removed, before actual sieving could start. In the 1974-campaign we had to remove some 60 m^3 of tough sands with bog-ore veins before we reached the fossiliferous sediment. In view of the local conditions this had to be done by hand.

Another difficulty at Tegelen is that, since the clay pit was abandoned, it soon filled with water. The water-level varies, but generally about 40% of the gully-filling is below this level. We are now working in such a way, that the overburden is dug out and used to build a dam around the excavation site. Even so it is necessary to have the pump drain the site several times a day.

So far we have actually passed through the sieve over 110 m^3 of sediment. Up to 60 m^3 were sieved using a 0.5 mm mesh as bottom sieve. Since then we decided to use a 0.7 mm mesh as lower margin, as it appears hardly probable that we will manage to pick out the fossils from the finest fractions within a reasonable time, the amount of specimens from these finer fractions is liable to be poor, and changing to 0.7 mm mesh speeded up sieving considerably.

The first 60 m^3 were processed in a total of 35 days, working with four persons and one sieve, the other 50 m^3 were processed in 12 days, working with seven persons and two sieves (0.7 mm mesh).

In part the sediment is very rich in plant fossils, mammal fossils are extremely rare throughout the entire section. For this reason it is virtually impossible to pick teeth or bones from the sieve, while working in the field. Our procedure is processing as much matrix as possible in the field, without even trying to look for results. The total sieving residue from the 110 m^3 of matrix is estimated at 5 m^3, most of it plant material. Picking the rare teeth from this amount of residue is hardly possible, neither in the field, nor in the lab. Therefore, after cleaning the residue, we dry it thoroughly, and then dump it in a large container with water, stir it for a short time, and then bail out all floating material; this should be done rather quickly, because after a short time the wood absorbs so much water that it sinks. This gravity separation in water may be repeated with the heavy residue, if that seems appropriate. After the maximum quantity of plant material has been eliminated in this way, we dry the heavy residue again, and then we proceed with a gravity separation in carbon tetrachloride. Heavier liquids would give better results, but the extra profit would be in no relation with the higher costs of these liquids. The final residue consists of almost pure white quartz sand, some white lime concretions, and a reasonable amount of dark coloured teeth and bones, that may easily be picked out. So far, only sieve fractions over 1.2 mm have been picked out, and in this way we collected 1150 teeth and jaws from 45 m^3 of matrix, less then 26 specimens per m^3: Tegelen is certainly not a rich locality.

During the excavations we divided the site in blocs that were excavated and further processed separately, in order to find out whether all parts of the gully were equally rich (or poor) in fossils. Table 1 shows the distribution of the fossils. The samples 5/1, 5/2, 5/3, 6/1, 6/3, 6/5 are from the upper part of the gully. Samples 5/4, 5/5, 6/2, 6/4, 6/6 are from the middle and lower part. The samples 5/1 through 5/5 were collected in 1970, the samples 6/1 through 6/6 in 1971. For the samples from 1970 the result is not very convincing, but for 1971 it is evident that the lower levels of the gully yielded much more specimens per m^3 than the upper levels. The teeth are certainly not distributed evenly over the sediment, but they are concentrated in clusters. Otherwise the difference between 6/2 and 6/4 is difficult to explain. The best proof is that one of the authors (T. Meijer), when collecting mollusks, got 15 mammal teeth from a sample of only 50 kg. Such a good result was never achieved in our large samples; we mix in these large samples a few small concentrations with a large amount of (almost) sterile matrix. Unfortunately there is no way of recognizing the fossil concentrations in the field. Furthermore we discussed the possibility of throwing away the upper level sediment, and only screen the lower part. But, in view of the fact that 26% (303 specimens) of our material comes from these upper levels, we decided to continue, at least for the moment, sieving the entire vertical section.

Extrapolating the results from the samples picked out so far, we may estimate that the total amount of matrix processed may yield about 2800 specimens. To this figure may be added an amount of material from the smaller fractions (under 1.2 mm) that have not been investigated as yet.

We are aware of the fact that our present work at Tegelen may be the last possibility to record the composition of the Tiglian fauna. Larger mammals are hardly ever encountered, but making a good collection of micromammals is possible. Some of these smaller mammals are rather frequent, others, on the contrary, are very rare. Of course it is impossible to make a statistically useful collection for all the species present in the Tegelen fauna. But through our present large scale approach we may succeed in collecting sufficient material of all significant species. A rough calculation shows that this means we will have to set our goal at 10 000 specimens, or 450 m³ of matrix to be processed in total. Let us hope that geological, financial, and technical conditions will allow us to reach this limit.

Table 1. Distribution of mammal teeth in different samples from Tegelen.

Sample	volume in m³	number of specimens	specimens/m³
1	4.0	55	68.0
2		25	
2-3-4		19	
4		173	
5/1	3.0	88	29.3
5/2	2.0	42	21.0
5/3	3.0	117	39.0
5/4	1.75	95	54.3
5/5	2.25	86	38.2
6/1	4.5	26	5.8
6/2	1.5	68	45.3
6/3	4.5	3	0.7
6/4	2.25	361	160.4
6/5	4.5	32	7.1
6/6	2.25	25	11.1

The molluscan assemblage (by T. Meijer)

The presence of terrestrial and fresh-water mollusks in the Tiglian sediments has been known for quite some time (van Benthem Jutting, 1931; Kortenbout van der Sluijs & Zagwijn, 1962; van Regteren Altena, 1955; Tesch, 1929 and 1944; van der Vlerk & Florschütz, 1950). Unfortunately, the fauna has never been studied and published as an entity. Although the ancient collections contain some terrestrial species, the Tegelen fauna was mainly characterized by fresh-water mollusks. The composition of this fauna is quite similar to comparable faunas from Lower Pleistocene fresh-water sediments that were found in borings. A good example is the boring Rosmalen (prov. Noord Brabant), which yielded many fresh-water mollusks from a depth of 107-123 m; frequent species are: *Viviparus glacialis* (Wood, 1872), *Valvata goldfussiana* Wüst, 1900, *Lithoglyphus naticoides* (Pfeiffer, 1828), (?) *Nematurella minima* Tesch, 1939, *Corbicula fluminalis* (Müller, 1774), *Pisidium amnicum* (Müller, 1774), *Pisidium clessini* Neumayr, 1875, and *Pisidium supinum* Schmidt, 1850. The beds in which this fauna was found are known as the 'Horizon of *Viviparus glacialis*', considered to belong to the Tiglian (= Günz-Mindel Interglacial, according to Tesch, 1929).

Since 1970 I have visited the clay-pit Egypte several times. This pit is no longer in exploitation and most of the 11 m thick section of grey lacustrine clay (the so-called Tegelen Clay) is under water-level now. This clay formation contains a gully filled with coarser sediments: clayey sand with plant remains in the lower part of the gully, and well-sorted sand in the upper part. In the following, these sediments will be referred to as 'clay', 'gully basis', and 'sand'. For a detailed description see Kortenbout van der Sluijs & Zagwijn, 1962.

According to Zagwijn (1963b) all these sediments belong to the Upper Tiglian (Tiglian C). The clay with fresh-water mollusks belongs to pollen-zone TC-3, the gully sediments to TC-5. Both zones represent climatic optima.

Apart from the material collected during the campaigns from 1970 through 1974, I had the opportunity to study material that had been collected previously, and which is kept at the RGM (Leiden), Rijks Geologische Dienst at Haarlem (RGD), and the collection of Dr C. O. van Regteren Altena, kept in the Paleontologisch-Mineralogisch Kabinet of Teyler's Stichting at Haarlem.

I am intending to make an inventory of all mollusks collected at Tegelen through the years, and to come to an extensive review of this fauna.

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Collecting methods

The conservation of the mollusk material is poor. In the clay they are squeezed, possibly as a result of the setting of the sediment, so, during washing of the clay the shells — especially the gastropods — may easily fall apart. For this reason most of the specimens from the clay had to be picked by hand and freed from the attached clay. After preparation each specimen had to be impregnated with plastic. The pieces of clay remaining after the preparation were washed on a 0.5 mm mesh. The washing residue contained quite a few small mollusks, mainly Pisidiidae, lime-grains from Lumbricidae (Annelida, Oligochaeta) — which were sometimes considered as remains of Arionidae — vertebrate, and plant remains. A sample from the gully basis was washed and after drying the residue was submitted to a gravity separation by means of carbon tetrachloride. The heavy fraction yielded mainly thousands of lime-grains from Lumbricidae. The mollusk remains are largely opercula of Bithyniidae, shells of Limacidae, and apexes of gastropod shells.

The mollusks from the sand are extremely fragile. Whenever possible they were recovered with the adhering sediment, and cleaned and impregnated at home. In this way mainly the larger species are found, the smaller ones are overlooked. For this reason washing samples were taken at a few places. In these samples the larger specimens were destroyed during sieving, but it was the only way to get the smaller species.

Results

By these methods we collected about 60 species of terrestrial and fresh-water mollusks. Twenty-seven of these were not yet known from the Dutch Tiglian,

Table 2. Mollusks from the Dutch Tiglian.

	pit Egypte			previous records for Dutch Tiglian
	clay	gully basis	sand	
Cochlostoma (Obscurella) sp.	–	–	x	–
Viviparus viviparus (L., 1758)	x	–	x	–
Viviparus contectus (Millet, 1813)	x	–	–	–
Viviparus diluvianus (Kunth, 1865)	x	–	x	x
Viviparus glacialis (Wood, 1872)	x	–	–	x
Valvata piscinalis (Müller, 1774)	x	–	x	x
Valvata goldfussiana Wüst, 1900	x	–	–	x
Neumayria crassitesta (Brömme, 1885)	x	x	–	x
Bithynia tentaculata (L., 1758)	–	x	–	x
Bithynia leachi troscheli (Paasch, 1842)	–	x	x	–
Lithoglyphus naticoides (Pfeiffer, 1828)	x	–	–	x
Tanousia stenostoma (Nordmann, 1901)	x	–	–	x
Carychium sp.	–	–	x	–
Lymnaea palustris (Müller, 1774)	?	–	x	x
Lymnaea peregra (Müller, 1774)	?	–	x	x
Planorbis planorbis (L., 1758)	–	–	x	x
Planorbarius corneus (L., 1758)	?	–	x	x
Acroloxus lacustris (L., 1758)	–	–	x	–
Succinea elegans Risso, 1826	–	–	x	x
Succinea oblonga Draparnaud, 1801	–	–	x	x
Cochlicopa sp.	–	–	x	?
Vertigo cf. *alpestris* (Alder, 1838)	–	–	x	–
Chondrinidae	–	–	x	–
Pupilla muscorum (L., 1758)	–	–	x	x
Pupilla cf. *sterri* (Voith, 1838)	–	–	x	–
Vallonia pulchella (Müller, 1774)	–	–	x	x
Vallonia costata (Müller, 1774)	–	–	x	x
Ena montana (Draparnaud, 1801)	–	–	x	–
Discus ruderatus (Studer, 1820)	–	–	x	–
Discus perspectivus (Megerle von Mühlfeldt, 1816)	–	–	x	–
(?) Aegopinella sp.	?	?	x	x
Aegopinella cf. *nitidula* (Draparnaud, 1805)	–	–	x	–
Retinella (Riedeliella) sp.	–	–	x	–
Vitrea crystallina (Müller, 1774)	–	–	x	–
Vitrinobrachium breve (Férussac, 1821)	–	–	x	x
Eucobresia diaphana (Draparnaud, 1805)	–	–	x	–
Limax sp.	–	x	–	–
Limacidae	–	x	x	–
Clausiliidae	–	–	x	?
Perforatella sp.	?	?	x	x
Perforatella dibothryon (von Kimakowicz, 1884)	–	–	x	–
Steklovia cf. koehnei Schlickum & Strauch, 1972	–	–	x	–
Trichia hispida (L., 1758)	–	–	x	x
Trichia cf. *striolata* (Pfeiffer, 1828)	–	–	x	–
Soosia sp.	–	–	x	–
*Helicigon*a sp.	–	–	x	–
Arianta arbustorum (L., 1758)	x	–	x	x
Helicidae	–	–	x	–
Unio tumidus Philipsson, 1788	x	–	–	–
Anodonto cf. *cygnea* (L., 1758)	x	–	–	–
Sphaerium corneum (L., 1758)	x	–	x	x
Pisidium amnicum (Müller, 1774)	x	–	x	x
Pisidium clessini Neumayr, 1875	x	–	x	x
Pisidium moitessierianum Paladilhe, 1866	x	–	x	x
Pisidium henslowanum (Sheppard, 1823)	x	–	x	x
Pisidium supinum Schmidt, 1850	x	–	x	x
Pisidium subtruncatum Malm, 1855	x	–	x	x

while 11 out of the 27 are entirely new for the Dutch Quaternary. The presence of a rich fauna of terrestrial mollusks was certainly a surprise. Among these are probably a number of undescribed forms, which will be published in the 'Archiv für Molluskenkunde'.

Table 2 contains all species recognized so far. In view of the provisional character of this publication no frequency figures are given.

Remarks on some of the species

Cochlostoma (Obscurella) sp.
Only one specimen of this terrestrial gastropod was found, lacking the apical whirls. Some apical fragments found may belong to the same species. Its size (the body whirl is 4.5 mm high), its sculpture consisting of length-ribs that thicken near the upper suture, and its flatter whirls clearly distinguish this specimen from *C. septemspirale* (Razoumowsky, 1789), and remind one of the subgenus *Obscurella* Clessin, 1889. It might represent a new species, but, especially in this genus, more material is required to decide this question. The genus *Cochlostoma* was not yet known from the Netherlands, neither fossil, nor Recent.

Viviparus viviparus (L., 1758)
Some deformed specimens of this species were found in the clay, and one badly preserved shell in the sand. This proves that the species is not a recent addition to the fauna of our area, as was supposed by Tesch (1944), but that it was already present during the Tiglian. Recent observations show, that *Viviparus viviparus* may have lived here throughout the Quaternary. For example, it was found in Waalian sediments near Bavel (Meijer & Spaink, in preparation), and recently I discovered it in a sample of *Viviparus diluvianus* that had been collected in a claypit near Neede (age: Needian) and that is kept at the Geological Museum of the Landbouwhogeschool at Wageningen.

Viviparus contectus (Millet, 1813)
No complete specimens of this species were found so far. The Tegelen material consists of some characteristic apical fragments, some distorted adult specimens, and some internal casts with the apical whirls missing. The material shows clearly, that we are dealing with an exceptionally large form. For Recent specimens a maximum height of 45 mm is generally stated; in our material the best preserved internal cast shows a height of 41 mm for the last whirl alone. For this species too, Tesch thought that its occurence was restricted to the Late Holocene, considering that reliable data for older strata were missing. Like *V. viviparus, V. contectus* was found in the Waalian beds near Bavel. Further references are from Eemian beds in the boring Brielle (Kuijper, 1973), and from fields near Amsterdam that were heightened by pumping Upper Pleistocene sands on them (Meijer, 1973).

Valvata goldfussiana Wüst, 1900
Found in the clay only. All specimens are much distorted. This makes it impossible to decide whether the material also contains specimens of *V. naticina* Menke, 1845, a species known from other Tiglian localities. Furthermore, confusion is possible with *Lithoglyphus naticoides.*

Bithyniidae

All bithyniid species listed had been found previously, but through misidentifications this is not obvious from the litterature (see Tesch, 1929 and 1944). So, a revision of the Quaternary Bithyniidae from the Netherlands was necessary, and recently carried out (Meijer, 1974). *Bithynia tentaculata* and *Bithynia leachi* are represented by opercula only; of the latter species only the larger form *troscheli* (Paasch, 1842) is present. The large majority of the material of *Neumayria crassitesta* consists of opercula too. In the sand a badly preserved shell was found, and the clay yielded some flattened shells.

Lithoglyphus naticoides (Pfeiffer, 1828)

Some distorted shells of adult specimens were found in the clay. As explained above *Valvata goldfussiana* and *L. naticoides* may be confused, especially if the shells are so distorted that the umbilicus is not visible.

As long as the status of *L. pyramidatus* (Möllendorf, 1873) is not clear, it seems best to assume that the Dutch fossil material belongs to *L. naticoides*.

Tanousia stenostoma (Nordmann, 1901)

Although this species is very frequent in some parts of the clay, it has not yet been possible to collect whole specimens. Considering the size of the shell and the rather convex whirls, the material belongs to this species, which was confirmed by H. Schütt as well as by W. R. Schlickum, who revised the genus (Schlickum & Schütt, 1971; Schlickum, 1974).

Carychium sp.

Only one specimen, without aperture, has been found. It allows no specific identification.

Cochlicopa sp.

Here again the material is too fragmentary for a species identification.

Vertigo cf. *alpestris* (Alder, 1838)

The single *Vertigo* specimen in our material is best referable to *V. alpestris*. In the aperture there are two teeth, one on the columella, and one on the parietal wall. Apart from a dubious specimen from pumped sand grounds near Zaandam (Late Pleistocene), this species had so far not been mentioned from the Dutch Quaternary (see Meijer, 1973).

Pupilla muscorum (L., 1758)

One specimen has been found in the sand. The shell is thick-walled. There is a broad basal crest behind the outer lip. Immediately, behind this ridge the basis of the body whirl tends obliquely upwards, matching the illustration in Adam, 1960 (fig. 66 A, B). There are two massive teeth in the aperture; one palatal and one parietal.

Pupilla cf. *sterri* (Voith, 1838)

An apical whirl and a defective specimen with body whirl were found. The shell is thinner than it is in the preceding species. There are three teeth in the aperture: one parietal, a very weak upper parietal tooth, and a strong lower palatal one.

Although *Pupilla sterri* is cited to have a maximum of two teeth, the other features of our material prove a close relationship with this species. The basal crest behind the outer lip is narrower and more sharply defined than it is in our specimen of *P. muscorum*. Furthermore the basis of the body whirl does not tend obliquely up directly behind the basal crest, but it begins parallel to the top of the whirl, and then rises in a regular curve (see also Adam, 1960, fig. 66 C). Finally the whirls are more convex, which makes the sutures deeper. *Pupilla sterri* was not known from the Netherlands, neither fossil nor recent. In Belgium it is extant along the river Meuse and its tributaries.

Chondrinidae

The upper part of the sand yielded one fragment of a body whirl with some teeth on the columellar and parietal sides. Gittenberger (personal communication) thinks it belongs either to *Chondrina* Reichenbach 1828, or to *Abida* Leach, 1831. The fragment allows no further identification. These genera are new for the Dutch fossil and recent faunas.

Ena montana (Draparnaud, 1801)

Some fragments and apical whirls, doubtlessly belonging to this species, were collected in the sand. *Ena montana* had not yet been known from the Dutch Quaternary. It was, however, known from a Holocene lime-deposit in the limestone quarry 'Rouscheweid' near Montzen (Belgium), just south of the Dutch border near Margraten (prov. Limburg).

Discus ruderatus (Studer, 1820)

Our material contains a defective specimen and some fragments. This species no longer occurs in the Netherlands. In our Quaternary it has been found in Waalian, Needian, Eemian and Weichselian deposits.

Discus perspectivus (Megerle von Mühlfeldt, 1816)

We have only one fragment, which shows the very sharp carina characteristic of this species. It had hitherto not been mentioned in fossil or recent Dutch faunas.

? *Aegopinella* sp.

This is one of the most frequent terrestrial mollusks from the sand, and one of the few that had been found by previous collectors. Tesch (1944) describes it under the name *Retinella hiulca* Jan. Comparison with Recent material of *Retinella hiulca* from Italy, and with the quite similar *Aegopinella ressmanni* (Westerlund, 1883), which is often mistaken for *R. hiulca,* showed that our material is different from both. Dr A. Riedel from Warsaw, who kindly studied some of our specimens gave as his opinion: 'Sie steht einigen weitgenabelten Exemplaren von *Aegopinella graziadei* (Boeckel, 1940) am nächsten, ist aber auch von dieser Art gut verschieden' (personal communication).

It is quite probable that the *Aegopinella* material from Tegelen belongs to an undescribed species. It is even questionable, whether this species, in view of its exceptionally wide umbilicus should still be considered as belonging to the genus *Aegopinella*. This doubt is reinforced by the lacking of the fine spiral sculpture, which is normally present in this genus.

So far this species is restricted to lower Pleistocene deposits. Apart from the clay-pit Egypte material (in the collections of the RGM, RGD, and Teyler's), I saw a specimen from a boring near Rosmalen (prov. Noord Brabant), and another one from a clay-pit near Wyler (between Nijmegen and Kleve, about 100 m on the German side of the frontier); both are from Tiglian deposits (coll. RGD at Haarlem). Furthermore some defective and juvenile specimens from the Waalian near Bavel might belong to the same species.

Aegopinella cf. *nitidula* (Draparnaud, 1805)
One defective specimen and a few fragments have been found. It is clearly distinguished from the more common ? *Aegopinella* sp. by its narrower umbilicus.

Retinella (Riedeliella) sp.
Only one specimen from the sand. This specimen appears to belong to the recently described subgenus *Riedeliella* Schlickum & Strauch, 1975. It seems closely related to *Retinella (Riedeliella) jourdani* (Michaud, 1862) from Upper Pliocene deposits in France and Germany (Schlickum & Strauch, 1975). In my opinion, *Zonites elephantinum* Bourguignat, 1869 from Lower Pleistocene deposits in the surroundings of Paris is also a member of this subgenus.

Vitrinobranchium breve (Férussac, 1821)
This species is frequent in the sand. L. Forcart at Basel kindly identified the material. It is known to occur nowadays in a few places in our country. As a fossil it has been recognized in deposits from the Waalian, Needian, Eemian and Weichselian.

Eucobresia diaphana (Draparnaud, 1805)
We collected one specimen from the sand, which was identified by L. Forcart at Basel. It is extant in a few places in the Netherlands, and it was not yet known from the Dutch Quaternary.

Limacidae
Until now there is no satisfactory way of identifying the rudimentary shells of these naked snails, and if a determination is possible it will not reach farther than genus level. Most of our material is from the gully basis. The majority belongs to a group of small Limacidae, probably *Deroceras* sp. Only one specimen is larger (length 12 mm) and might belong to *Limax* sp.

Clausiliidae
Among the large number of fragments about four species may be distinguished, but it is hardly probable that these fragments could ever be identified specifically. Only one fragment has the aperture completely preserved. Loosjes (1953) mentions the following species from the Dutch Lower Pleistocene: *Clausilia bidentata* (Ström, 1765), *Laciniaria biplicata* (Montagu, 1803), and *Cochlodina laminata* (Montagu, 1803). Our specimen with well-preserved aperture appears to belong to none of these, although it probably does belong to the genus *Clausilia* Draparnaud, 1805.

Perforatella sp.
This is the most common one of the two species of *Perforatella* found. Therefore it is probable that Tesch (1944) meant this one when citing *Perforatella bidens* (Chemnitz, 1786) f. *dibothryon* (von Kimakowicz, 1884), the more so, as it is the only one present in the collection of the RGD at Haarlem. However, it does not

belong to *P. dibothryon,* nor is it the typical form of *P. bidentata* (Gmelin, 1788). Although it corresponds in size with the 'large form' of *P. bidentata* described by Kuijper (1973) from Tiglian deposits in the boring Brielle, I hesitate to identify the shells from the clay-pit Egypte with the same form.

Perforatella dibothryon (von Kimakowicz, 1884)
Apart from the form described above, a single specimen was found in the sand that is clearly different.

Due to the bad preservation of the shell it was not possible to clear the teeth in the aperture, which are one of the most important characters within this genus. Nevertheless the shape and the sculpture of the shell are so typical that there is hardly any doubt that the specimen belongs to *P. dibothryon.* This conclusion was reinforced by comparison with Recent material from the collections of Mr W. Neuteboom at Heemskerk, and of the Zoological Museum at Amsterdam. Furthermore, Mr E. Krolopp at Budapest kindly put some material at my disposal.

Steklovia cf. *koehnei* Schlickum & Strauch, 1972
This species was first described from Upper Pliocene sediments in the brown-coal pit 'Frechen' near Cologne, some 60 km southeast of Tegelen. The pit Egypte yielded three adult specimens, some juvenile ones, and some fragments, all belonging to a species that resembles *S. koehnei* largely, except for some (minor ?) details. One point of difference is the surface sculpture. The arrangement of the papillae is identical, but in the Tegelen material the papillae are considerably larger than they are in the specimens from Frechen. Furthermore the shells from Tegelen are thinner-walled. Apart from these differences the shells are so similar, that the Tegelen specimens may be considered as direct descendants from *S. koehnei* from the Upper Pliocene of Frechen. Another species of *Steklovia* is *S. fraudulosa* (Steklov, 1966) from Upper Miocene to Upper Pliocene deposits in the Caucasus. Our findings prove the genus survived into the Early Pleistocene.

Soosia sp.
Some adult and juvenile specimens, and some fragments were collected in the sand. Until recently *Soosia* was unkwown from our areas, both fossil and living. For many years only one (Recent) species of this genus was known: *S. diodonta* (Férussac, 1821) from the Northern Balkans. During the Pleistocene it had a wider habitat. Ložek (1964) states: 'Interglaziale Leitart, die in pleistozänen Warmzeiten über dem ganzen Karpatenbogen und Ungarn bis nach Böhmen und Süddeutschland verbreitet war' (see also Dehm, 1969; Zilch & Jaeckel, 1962). Schlickum & Strauch (1970) described *S. monikae* from the Upper Pliocene of the brown-coal pits Frechen and Fortuna near Cologne. Furthermore a fragment of a rather large *Soosia* was found in Tiglian deposits from the boring Brielle (Kuijper, 1973). The shells from the pit Egypte belong neither to the extant nor to the Pliocene species. They differ from both by their size, the height/width ratio, and - most important of all - by the dentition. In view of these facts it might be of interest to check whether all references of Early Pleistocene *S. diodonta* do actually refer to this species.

Helicigona sp.
Four adult specimens and a few fragments from the sand. Only one fragment of *H. lapicida* (L., 1758) has been found in Dutch Quaternary deposits, actually in

the Tiglian from a boring near Brielle (Kuijper, 1973). This fragment, especially its surface sculpture, is identical to the species *H. lapicida.* True enough, the specimens from the pit Egypte show the same pattern in their sculpture, but the papillae are much coarser than they are in *H. lapicida,* where they show little variation. Another difference is the thread-like carina, which does not exist in the typical *H. lapicida* (this kind of carina does exist in *H. lapicida andorrica* (Bourguignat, 1876), a subspecies from the Pyrenees). Furthermore the specimens from the pit Egypte are somewhat larger than the Recent ones.

Helicidae

Two juvenile specimens of an unknown Helicidae were found in the sand. The shell has a very thin wall, and shows no sculpture apart from the growth-lines. The body whirl has a blunt carina above its middle. The umbilicus is very narrow. The measurements of the largest specimen are: largest diameter 16.6 mm; smallest diameter 13.2 mm; height 10.0 mm. Number of whirls: 4¼. Through a damage of the shell it is not possible to observe whether the protoconch is set off against the rest of the shell. The second specimen is distorted, and cannot be measured exactly. Both specimens resemble juvenile shells of *Cepaea* Held, 1837, but there are some differences. Van Benthem Jutting (1931) mentions *Helix tonnensis* Sandberger, 1875 (= *Cepaea nemoralis tonnensis* (Sandberger, 1875)), from the 'Tegelen Clay', which is a giant form of *C. nemoralis.* Whether our two specimens belong to this form might be decided by finding adult specimens.

The smaller mammal assemblage (by A. J. van der Meulen)

COMPOSITION OF THE FAUNA

As far as mammals are concerned the recent collecting campaigns have yielded virtually only microfauna: insectivores, lagomorphs, and rodents. Provisional determination of the tooth elements in the collections of 1970 and 1971 results in Table 3 (the species marked with an * are new for the assemblage from Tegelen).

Table 3. Smaller mammals from the clay-pit Egypte.

Insectivora
Talpa fossilis Petenyi, 1864
Desmana tegelensis Schreuder, 1939
* *Desmana* sp. (small species)
* *Sorex* sp.
* *Sorex* cf. *praearaneus* Kormos, 1934
* *Petenyia* cf. *hungarica* Kormos, 1934
* *Beremendia fissidens* (Petenyi, 1864)
Lagomorpha
Hypolagus sp.
Rodentia
* *Sciurus* cf. *vulgaris* Linnaeus, 1758
* *Muscardinus* cf. *avellanarius* (Linnaeus, 1758)
* *Ungaromys* nov. sp.
* *Clethrionomys* ? sp.

Mimomys pliocaenicus (Major, 1889)
* *Mimomys reidi* Hinton, 1910
Mimomys newtoni Major, 1902
* *Apodemus* cf. *sylvaticus* (Linnaeus, 1758)
* *Micromys* sp.

Additionally I have recognized among the bone material the presence of *Trogontherium* and possibly of *Castor*. *Hystrix* described by Bernsen (1932), has not yet been recognized in our new material.

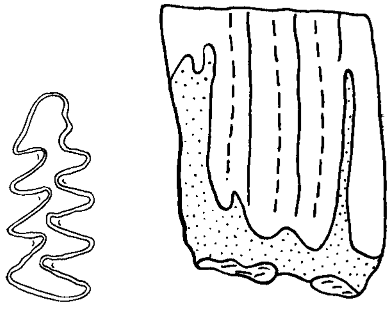


Fig. 1. *Clethrionomys* ? sp., M_1 inf. sin., sample Tegelen 5/4; 1a: occlusal view, 1b: buccal view; enlargement 12.5 ×.

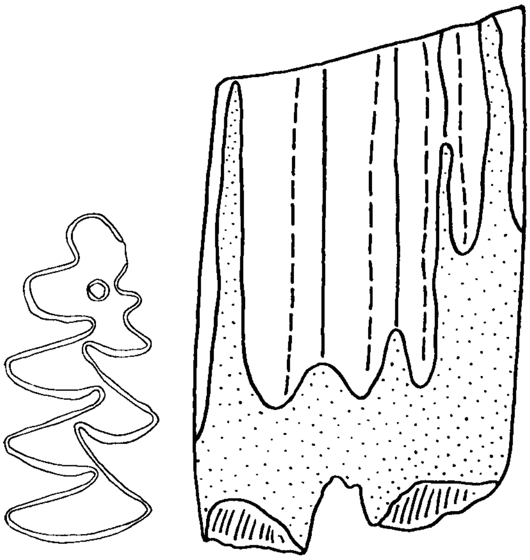
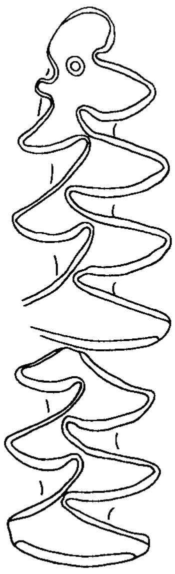


Fig. 2. *Mimomys pliocaenicus* (Major, 1889), M_1 inf. dex., sample Tegelen 5/4; 2a: occlusal view, 2b: buccal view; enlargement 12.5 ×.

We will refer to our microfaunal assemblage as the *Mimomys newtoni* - *Mimomys pliocaenicus* Assemblage, the former species being the most common vole, the latter being an important biostratigraphical marker.

Among the Talpidae Miss C. G. Rümke (Geological Institute, Utrecht) noted the presence of a smaller *Desmana* species in addition to *D. tegelensis* (personal communication). The soricid genera *Petenyia* and *Beremendia* are frequently met with in Lower - Middle Pleistocene deposits in Europe. *Sorex* is more common than *Petenyia* and *Beremendia* in our *M. newtoni-M. pliocaenicus* Assemblage. Determination of the two *Sorex* species will be possible only after a detailed study. The smaller species — *Sorex* sp. — is intermediate in size between *S. minutus*



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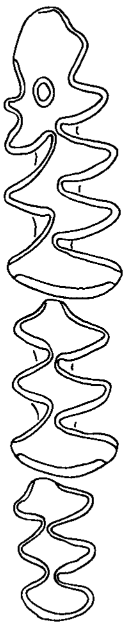

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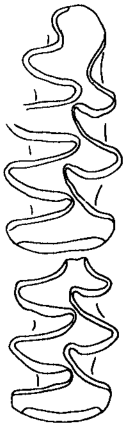

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Fig. 3. *Mimomys pliocaenicus* (Major, 1889), M_1-M_2 inf. sin., sample Tegelen 6/6; occlusal view; enlargement 12.5 ×.

Fig. 4. *Mimomys reidi* Hinton, 1910, M_1-M_3 inf. sin., sample Tegelen 5/4; occlusal view; enlargement 12.5 ×.

Fig. 5. *Mimomys newtoni* Major, 1902, M_1-M_2 inf. dex., sample Tegelen 5/1; occlusal view; enlargement 12.5 ×.

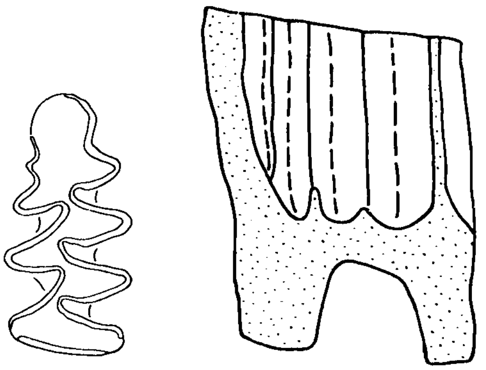

Fig. 6. *Mimomys reidi* Hinton, 1910, M_1 inf. sin., sample Tegelen 5/4; 6a: occlusal view, 6b: buccal view; enlargement 12.5 ×.

and *S. runtonensis*. The other *Sorex* species from Tegelen — *S.* cf. *praearaneus* — is larger than *S. runtonensis*.

The *Sciurus* species is closely related to the living squirrel, and *Muscardinus* cf. *avellanarius* is probably identical to the living dormouse. Both species are rare.

The voles are most numerous, both in individuals and in number of species. The genus *Ungaromys* comprises a few extinct species with primitive dentition. The species from Tegelen is more primitive than the Middle Pleistocene *U. nanus*, and more advanced than the Late Pliocene *U. weileri*.

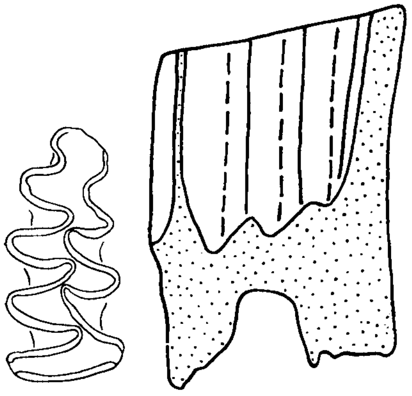

Fig. 7. *Mimomys newtoni* Major 1902, M_1 inf. dex., sample Tegelen 5/5; 7a: occlusal view; 7b: buccal view; enlargement 12.5 ×.

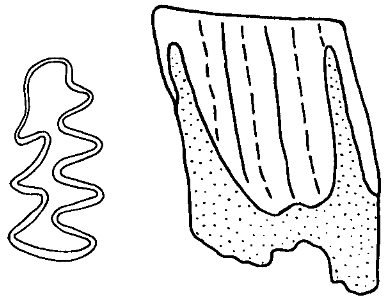

Fig. 8. *Ungaromys* nov. sp., M_1 inf. sin., sample Tegelen 6/4; 8a: occlusal view; 8b: buccal view; enlargement 12.5 ×.

Clethrionomys ? sp. belongs to the group of fossil voles which combine a *Clethrionomys*-like M_1 and a more or less *Mimomys*-like M^3 (Jánossy, 1970). Related, or perhaps identical, forms are known as *Dolomys kretzoii* from Kadzielnia, Poland (Kowalski, 1958, 1973) and *Clethrionomys sebaldi* from Deinsdorf, Germany (Heller, 1967).

Mimomys pliocaenicus has been the first vole species recognized from Tegelen (Newton, 1907). This is probably due to its large size, because in our material *M. pliocaenicus* is rather rare. *M. pliocaenicus* is known from many Lower Pleistocene deposits in Europe and already the early students of voles (e.g. Hinton, Schreuder and Kormos) recognized its value as a biostratigraphical marker. It occurs in the classical coeval deposits of the Upper Valdarno, the Norwich Crags, and the Tegelen Clay. Furthermore, *M. pliocaenicus* has since long been considered to be the ancestor of *M. savini* sensu lato, known from younger deposits, such as the Upper Freshwater Beds that overlie the East Anglian Crags (Major, 1902; von Méhely, 1914). Kowalski (1960) further increased the stratigraphical value of *M. pliocaenicus*, when he described its ancestor, *M. polonicus* from Rebielice Królewskie, Poland. In terms of zonation for the European terrestrial Pleistocene deposits, *M. polonicus* would mark the Earliest Pleistocene, *M. pliocaenicus* the later part of the Early Pleistocene and *M. savini* the Middle Pleistocene.

M. newtoni is the most common vole species. The species has been based on a scanty material from the Freshwater Beds at East Runton, East Anglia. The presence of *M. newtoni* in Tegelen had been established already by Hinton (1926), the author of the species. On the basis of our ample new material, it may demonstrated that the name *M. newtoni* in the literature has been abused for various other species.

The Netherlands			Hungary			
epoch	stages	localities	localities	zones	stages	epoch
LOWER PLEISTOCENE				*Pliomys* superzone	BIHARIAN	MIDDLE PLEISTOCENE
	WAALIAN		Betfia-2			
	EBURONIAN	Brielle	Nagyharsânyhegy-2			
			Osztramos-3	*Mimomys* superzone	VILLANYIAN	LOWER PLEISTOCENE
	TIGLIAN		Villâny-5			
		Tegelen	Villâny-3			
			Osztramos-7 Beremend-5			

Fig. 9. Correlation of some Dutch and Hungarian Pleistocene mammal localities. It is unknown whether the Lower Villanyian assemblages, a number of which (e.g. Osztramos-7) contain *Lemmus*, should be correlated to a cooler phase of the Tiglian or to the Praetiglian. The latter possibility seems preferable, but no smaller mammals from the Praetiglian have been found thus far.

M. reidi is rare in our *M. newtoni* - *M. pliocaenicus* Assemblage. This species is only slightly larger than *M. newtoni* and it is distinguished by its more primitive M_1. The variation of this species remains poorly known. Nevertheless, *M. reidi* can be distinguished from *M. mehelyi* (Beremend-5; Kretzoi, 1967, and own observations), from *M.* cf. *stehlini* (Osztramos-7; Jánossy, 1973, and own observations), and from *M.* cf. *stehlini* (Rebielice Królewskie; Kowalski, 1960, and own observations) by its lesser degree of development of the *Mimomys* islet and ridge, and its higher enamel-free areas at the sides of the crown.

Newton (1910) has reported *M. savini* (= *M. intermedius)* from Tegelen. He estimates the length of its slightly worn M_1 (without posterior lobe) to be approximately 2.5 mm. From this estimate and from the absence of the *Mimomys* islet it seems probable that Newton was dealing with one of the two smaller *Mimomys* species from Tegelen.

AGE OF THE M. NEWTONI - M. PLIOCAENICUS ASSEMBLAGE

The stratigraphical importance of the Tegelen Clay arises from the fact that its floral, mollusk and mammal remains are found together in the type section of the Tiglian. The exposed type section covers several pollen zones ranging from the Tiglian C3 to the Tiglian C6 (Kortenbout van der Sluijs & Zagwijn, 1962; Zagwijn, 1963a). On top of it lie sands of the Kedichem Formation, which represents the next stage, the Eburonian.

Larger mammal remains have been collected from all levels of the type section and from corresponding deposits elsewhere in the Tegelen area. Our *M. newtoni - M. pliocaenicus* Assemblage comes from the Tiglian C5 pollenzone. It follows that all these mammals date from the Late Tiglian.

The larger mammals include Villafranchian markers, such as *Elephas meridionalis* and *Leptobos.* They have been used to correlate the Tegelen Clay with the Upper Villafranchian (for instance: Schreuder, 1945; Azzaroli & Cita, 1967; Tobien, 1970).

The 'Tiglian' faunal list composed by van der Vlerk and Florschütz (1953) has caused confusion, particularly so among biostratigraphers dealing with smaller mammals (Kretzoi, 1956; Chaline, 1972). This is understandable since the smaller mammals of the list come not only from the Tegelen area but also from various borings scattered over the larger part of the Netherlands. So, species from Lower Tiglian or from Post-Tiglian sediments have been included. Evidently *Dolomys milleri, Mimomys pusillus* and *M. savini* do not belong to the *M. newtoni - M. pliocaenicus* Assemblage. Our Upper Tiglian Assemblage allows a better correlation with subdivisions based on smaller mammals, elsewhere in Europe.

One of the earliest of such subdivisions is that of the Lower Pleistocene of Hungary by Kretzoi (1941, 1956, 1962, 1969). Van der Meulen (in press) introduced the *Mimomys* Superzone, a term which replaces Kretzoi's first Pleistocene faunal wave and which corresponds to the Villányian Stage of Kretzoi, 1941. The assemblages of the *Mimomys* Superzone are characterized by predominance of *Mimomys* species (Kretzoi, loc. cit.). It is evident that our *M. newtoni - M. pliocaenicus* Assemblage belongs to this superzone.

Kretzoi (1956) has subdivided this *Mimomys* unit into three assemblage zones as shown in Table 4.

Table 4. Subdivision of the *Mimomys* Superzone

	Typelocality
Mimomys-Kislangia Zone	Villány-5
Mimomys-Lagurodon Zone	Villány-3
Dolomys-Mimomys Zone	Beremend-5

Preliminary results of a revisional study of the vole faunas from these Hungarian localities permit the following remarks.

The *M. newtoni* - *M. pliocaenicus* Assemblage from Tegelen is considered to be younger than the *Dolomys-Mimomys* Zone, because 1) *Dolomys* is absent in our assemblage, 2) *M. reidi* from Tegelen is a more advanced species than the closely related *M. mehelyi* from Beremend-5.

The same criteria used for Tegelen suggest that Villány-3 is younger than Beremend-5. The succession of the *Mimomys-Lagurodon* Zone of Villány-3 and the *Mimomys-Kislangia* Zone of Villány-5 is based on observed superposition in the field (Kretzoi, 1956).

Preliminary study of the vole species from these two localities necessitates some modifications of Kretzoi's (1956) faunal lists. From the material in the collections of the Geological Survey and the Natural History Museum in Budapest I assembled the results as given in Table 5.

Table 5. Smaller mammals from Villány-3 and Villány-5.

Villány-3	Villány-5
Mimomys pliocaenicus (Major, 1889)	*Mimomys pliocaenicus* (Major, 1889)
Mimomys reidi Hinton, 1910	*Mimomys reidi* Hinton, 1910
?*Mimomys newtoni* Major, 1902	*Mimomys newtoni* Major, 1902
Mimomys n. sp.	*Mimomys* n. sp.
Mimomys hungaricus Kormos, 1935	*Mimomys hungaricus* Kormos, 1935
Kislangia rex (Kormos, 1934)	*Kislangia rex* (Kormos, 1934)
Clethrionomys ? sp.	*Clethrionomys* ? sp.
Lagurodon arankae (Kretzoi, 1956)	—
—	*Microtus deucalion* (Kretzoi, 1969)
—	*Villanyia exilis* Kretzoi, 1956

On the whole these two faunal lists are remarkably alike. Data on the relative frequency of the vole species from Villány-3 are not available, since part of the original material is now scattered over several collections in Europe. Kretzoi (1956) has emphasized the absence of *Lagurodon* in the *Mimomys-Kislangia* Zone, and the appearance of *Microtus deucalion* and *Villanyia exilis*. Other newcomers are *Citellus primigenius* and *Drepanosorex margaritodon*.

The vole assemblages from Tegelen, Villány-3 and Villány-5 share the species *Mimomys pliocaenicus, M. reidi,* and *M. newtoni,* which suggests that differences in age are small. The absence of *Microtus deucalion* in our *Mimomys newtoni* - *M. pliocaenicus* Assemblage might indicate that Tegelen is somewhat older than Villány-5. So far, *M. deucalion* is only known from Villány-5 (van der Meulen, 1974). For its eventual presence at Kadzielnia see the end of this chapter. Kretzoi (1956) concluded on lithological evidence that the sediments of Villány-5 were deposited during a climate that was cooler than that during the deposition of terra rossa in Villány-3. Perhaps the genus *Villanyia* is a faunistic indicator of cooler climate, since it occurs together with *Lemmus* in Rebielice Królewskie (Kowalski, 1973), in Osztramos-7 (Jánossy, 1973), and Osztramos-3 (Jánossy, 1969, 1970).

The vole species of the latter locality have been revised by Jánossy and van der Meulen (in prep.) One of the results is that the M_1 assemblage that was provisionally called *Mimomys* cf. *pliocaenicus* and *M.* aff. *hassiacus* (Jánossy, 1969, 1970) has been referred to a new species, intermediate between *M. pliocaenicus* and *M. savini*. Osztramos-3 is placed in the upper part of the *Mimomys* Superzone (Jánossy, loc. cit.). From the co-occurrence of the above mentioned new species and *Lemmus* it may be concluded that this upper part of the *Mimomys* Superzone (Uppermost Villányian) would correspond to the Early Eburonian.

Van der Meulen and Zagwijn (1974) have given evidence for the correlation of a higher part of the Eburonian with the lower zone, the *Microtus (Allophaiomys) pliocaenicus - Pliomys simplicior* Zone from Nagyharsanyhegy-2, of the Biharian.

The correlation of the Tegelen Clay with the Hungarian Lower Pleistocene is given in Figure 9. Our correlation differs from the one given by Chaline (1972, table 19), who places Tegelen higher than Villány-3, possibly because of the supposed presence of *Mimomys savini* in the former locality. In the correlation scheme by Alekseev, Menner, Nikiforova, Pevner, and Vangengeim (1973), the Tiglian has been made much too short and placed too high (its base at 1.8 m. y. B.P.). According to van Montfrans (1971) the Tiglian ended about 1.6 m.y. ago. His estimate is in accordance with the date of 1.92 m.y. for St. Georges-d'Aurac, France, the only dated locality so far that yielded *M. pliocaenicus* (Chaline & Michaux, 1969).

The French vole specialists Chaline and Michaux (1972) use a subdivision in terms of 'chronological reference levels based currently on the evolutionary stage of the specimens of the line *stehlini-savini*' (loc. cit., p. 51). They distinguish a sequence of so-called chronological levels characterized by the evolutionary stage of faunas from the localities after which the levels are called. We do not follow their stratigraphical terminology as we prefer the multiple stratigraphic classification (International Subcommission Stratigraphical Classification). Apart from this, the chronological levels of Sète, Rebielice, Kadzielnia and Les Valerots merely duplicate Kretzoi's (1956, 1962) sequence of Csarnotian, Lower Villányian (Beremendian), Upper Villányian (Arnian) and Lower Biharian. In Chaline and Michaux's subdivison, our *M. newtoni - M. pliocaenicus* Assemblage belongs to the chronological level of Kadzielnia.

The presence of primitive *Allophaiomys* molars in the faunal assemblage of Kadzielnia (Poland) is noted by Kowalski (in press). These molars, which I have been able to study through the kind permission of Dr Kowalski, are probably referable to *Microtus deucalion.* The occurrence of this species together with *Villanyia, Citellus,* and *Mimomys pliocaenicus* suggests a correlation of Kadzielnia with Villány-5, instead of with Villány-3 as previously thought by various authors.

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Plate 1

Fig. 1. *Talpa fossilis* Petenyi, 1864. Humerus sin., × 7.2; Tegelen 5/1. RGM 179 047.
Fig. 2. *Desmana* sp. P^4 sup. sin., × 18; Tegelen 6/2. RGM 179 048.
Fig. 3. *Desmana tegelensis* Schreuder, 1939. P^4 sup. dex., × 18; Tegelen 4. RGM 179 049.
Fig. 4. *Sorex* sp. Mandibula dex., × 7.2; Tegelen 6/4. RGM 179 050.
Fig. 5. *Sorex* cf. *praearaneus* Kormos, 1934. Mandibula dex., × 7.2; Tegelen 5/1. RGM 179 051.
Fig. 6. *Petenyia* cf. *hungarica* Kormos, 1934. Mandibula dex., × 7.2; Tegelen 6/4. RGM 179 052.
Fig. 7. *Beremendia fissidens* (Petenyi, 1864). Maxilla sin., × 7.2; Tegelen 0. RGM 179 054.
Fig. 8. *Beremendia fissidens* (Petenyi, 1864). Mandibula sin., × 7.2; Tegelen 0. RGM 179 053.

Plate 1


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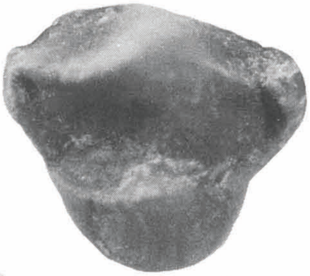
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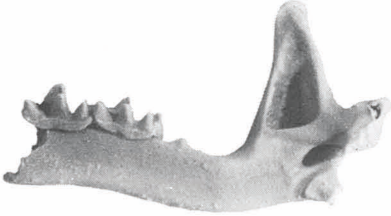
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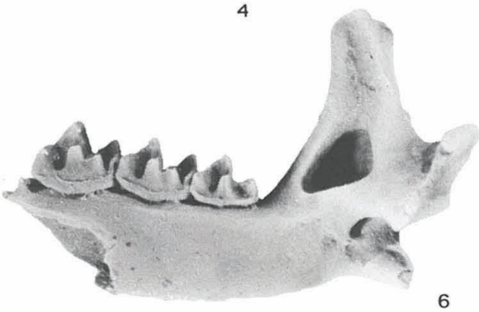
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Plate 2

Fig. 1. *Sciurus* cf. *vulgaris* Linnaeus, 1758. P^4 sup. dex., × 22; Tegelen 6/4. RGM 179 055.

Fig. 2. *Muscardinus* cf. *avellanarius* (Linnaeus, 1758). M_1 inf. sin., × 22; Tegelen 6/4. RGM 179 058.

Fig. 3. *Muscardinus* cf. *avellanarius* (Linnaeus, 1758). M^1 sup. dex., × 22. Tegelen 6/4. RGM 179 059.

Fig. 4. *Apodemus* cf. *sylvaticus* (Linnaeus, 1758). M_1 inf. sin., × 22; Tegelen 6/5. RGM 179 060.

Fig. 5. *Apodemus* cf. *sylvaticus* (Linnaeus, 1758). M^1 sup. sin., × 22; Tegelen 6/5. RGM 179 061.

Fig. 6. *Micromys* sp. Maxilla sin., × 22; Tegelen 1. RGM 179 062.

Plate 2


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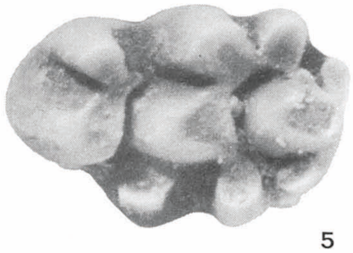
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