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PLEISTOCENE AND HOLOCENE MAMMALIAN FAUNAS FROM THE MAASVLAKTE NEAR ROTTERDAM (THE NETHERLANDS)

by

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The Maasvlakte is an artificially created area on the North Sea coast, NW of borehole Zuurland. The sediments used yielded all kind of fossil remains. More than three thousand mammalian fossils have been collected on the Maasvlakte. These fossils are subdivided into three different groups, representing three different faunas.

The oldest fauna, Fauna I, late Early- to early Middle Pleistocene in age, is discussed in detail. A mandibula of *Aonyx antiqua* (Blainville, 1841) (extinct otter) belonging to this fauna is described. Fauna II dates from the Late Pleistocene (Weichselian); Fauna III has a Holocene age.

The Maasvlakte faunas are correlated to those from borehole Zuurland at Brielle (The Netherlands).

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SAMENVATTING

Pleistocene en Holocene zoogdierfauna's van de Maasvlakte bij Rotterdam (Nederland)

De Maasvlakte is een kunstmatig aangelegd gebied aan de Noordzeekust, ten W van Rotterdam. Met het zand, dat voor de aanleg van de Maasvlakte werd opgezogen, kwamen vele fossiele overblijfselen van dieren naar boven.

De verzamelde zoogdierfossielen van de Maasvlakte kunnen, op grond van verschillen in fossilisatiegraad en evolutiestadia van de fossielen en de milieuindicaties van de soorten, in drie groepen verdeeld worden. Deze groepen vertegenwoordigen drie verschillende fauna's.

Van Fauna I, met een ouderdom van laat Vroeg- tot vroeg Midden Pleistoceen, wordt een mandibula van *Aonyx antiqua* (Blainville, 1841) (uitgestorven otter) beschreven.

Fauna II heeft een Weichselien ouderdom en Fauna III een Holocene. De Maasvlakte-fauna's worden vergeleken met de zoogdierfauna-opeenvolging van de boring Zuurland te Brielle.

INTRODUCTION

The Maasvlakte is an artificially created area (1951-1987) on the North Sea coast, W of Rotterdam and about 10 km NW of Zuurland. The sediments used were suction-dredged from a maximum depth of 40 metres from areas S and E of the Maasvlakte (Fig. 1).

Non-professional palaeontologists, such as Mr and Mrs Kerkhoff, have collected more than three thousand mammalian fossils from these sediments during the past ten years. The fossils were found along the coast-line, washed out of the sediments by waves and tides. The preservation of the material demonstrates that it originates from the suction-dredged Maasvlakte sediments and has not been washed ashore from some remote North Sea locality.

The results on the Maasvlakte faunas are compared with those obtained in the Zuurland boreholes at Brielle, situated some 10 km SE of the Maasvlakte area. In this area there is no evidence of tectonical disturbances. Therefore similarities can be expected between the faunas from the Maasvlakte and those from the Zuurland borehole.

Most of the Maasvlakte fossils are from large mammals and most of the Zuurland fossils from small mammals, thus both localities offer supplementary data to each other.

THE FAUNA-ASSEMBLAGES FROM THE MAASVLAKTE

The collection of Maasvlakte fossils consists of remains of reptiles, fishes, birds and small and large mammals. Also archeological finds are known from this locality. In this paper only the small and large mammals of Fauna I will be discussed in detail because this is the most interesting fauna which can be correlated very well to Fauna 5 of borehole Zuurland (-27 to -37 m).

The material found on the Maasvlakte is very well preserved and indicates that hardly any reworking of the material had taken place before deposition on the Maasvlakte. Most of the material

Fig. 1. Map showing the location of the Maasvlakte area, borehole Zuurland, and the places (*) where the sediments used for the creation of the Maasvlakte were obtained by suction-dredging.

is fragmentary, caused by the way in which the fossiliferous sediments were obtained and transported to the Maasvlakte.

The fossils show a large variation in the degree of mineralization. Based on this and on the stratigraphical range and palaeoecological indications of the species the Maasvlakte mammalian assemblage can be subdivided into three groups, presumed to represent three different faunas.

Fauna I

The material assigned to Fauna I is heavily mineralized and has a dark brown colour.

Composition of Fauna I:

	number of elements
Galemys sp.	1
Desmana thermalis Kormos, 1930	5
Sorex (*Drepanosorex*) sp.	3

Petaxia hungerica Kormos, 1934	1
Mimomys savini Hinton, 1910	5
Mimomys sp. (small species)	2
Ursus aff. *deningeri* von Reichenau, 1904	5
Trogontherium cuvieri Fischer de Waldheim, 1809	1
Aonyx antiqua (Blainville, 1841)	1
Lynx lynx (Linnaeus, 1758)	1
Archidiskodon meridionalis (Nesti, 1825)	6
Dicerorhinus etruscus brachycephalus (Schroeder, 1903)	23
Sus scrofa Linnaeus, 1758	6
Hippopotamus major Cuvier, 1824	4
Cervalces latifrons (Johnson, 1874)	5
Cervidae indet.	22

Insectivora and Rodentia

Desmana thermalis (extinct desman)—The fossils of this species have about the same size as those from Tegelen (Rümke, 1985).

Mimomys savini (extinct vole)—The fossils have rooted, hypsodont molars without primitive characters such as a Mimomys-island or a Mimomys-ridge.

Trogontherium cuvieri (extinct beaver) (Plate 1, Fig. 1)—According to Mayhew (1978) the evolution of *Trogontherium* during the Early Pleistocene shows two trends:

–incisors become larger in cross-section and

–M3 and p4 extend posteriorly and anteriorly respectively.

Most of the incisors from the Maasvlakte material have a cross-section larger than the mean of the Tegelen incisors and smaller than the mean of the incisors from the main fauna of Mosbach. Based on this it can be stated that the evolutionary stage of the *Trogontherium* from the Maasvlakte is intermediate between the stages of the *Trogontherium* from Tegelen and Mosbach.

The p4 from the Maasvlakte shows the presence of the anterior extension, mentioned by Mayhew (1978) as being an advanced character. However, this character seems to be less useful as an indication of the evolutionary stage of *Trogontherium cuvieri* since it appeared to be present in the p4 from the Middle Pleistocene fauna from Mosbach, as well as, although in a lower percentage, in the Early Pleistocene fauna from Tegelen.

Carnivora

Ursidae

Ursus aff. *deningeri* (extinct bear) (Plate 1, Fig. 2)—One of the traits in the evolution of bears (*Ursus etruscus* Cuvier, 1823–*U. deningeri* von Reichenau, 1904–*U. spelaeus* Rosenmüller & Heinroth, 1794) is the increase of accessory tubercles on the occlusal surface of molars, especially in the M2. Coon-

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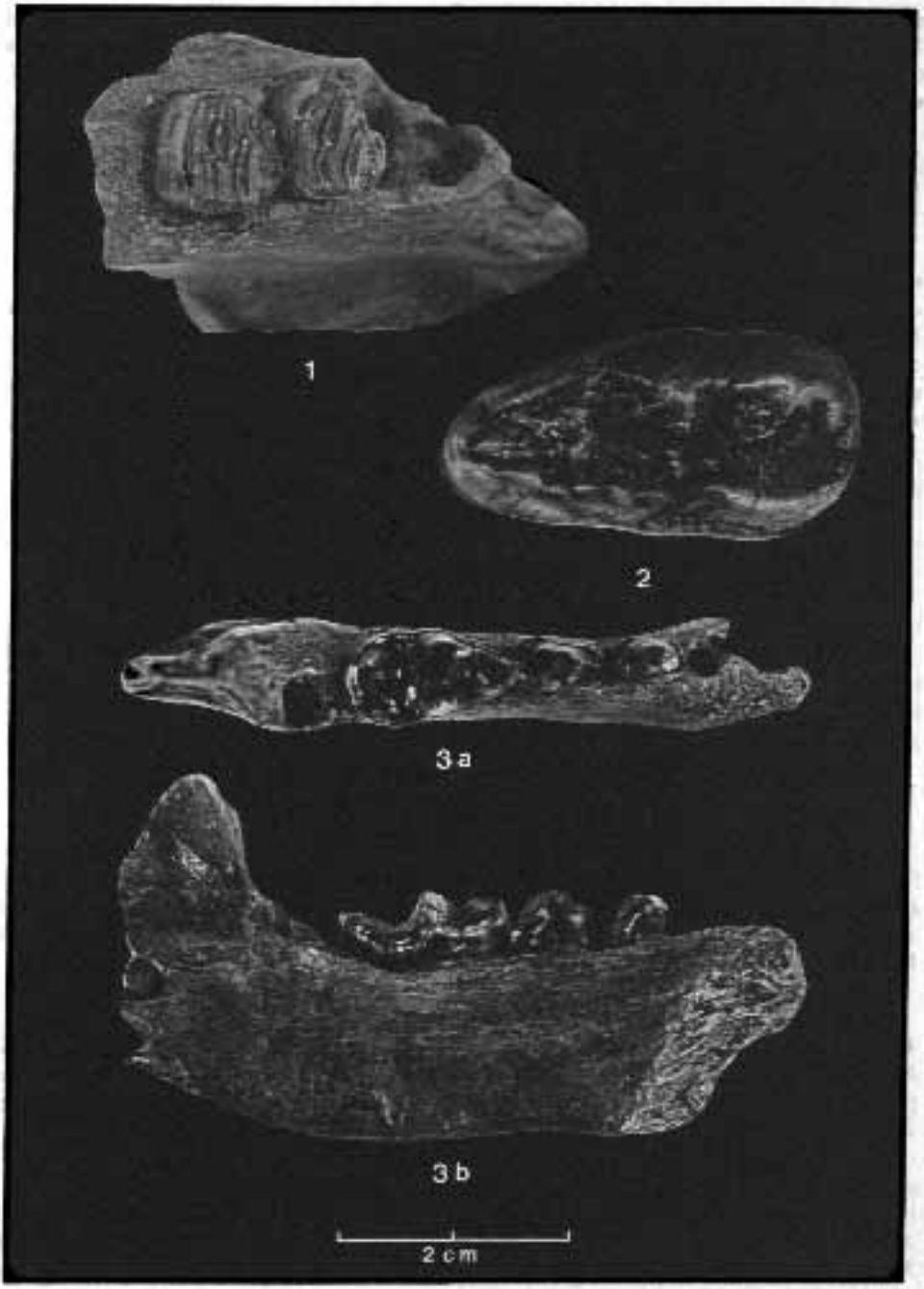
Plate 1

Fig. 1. *Trogontherium cuvieri*, upper jaw P4, M1 (RM 129) (occlusal view).
Fig. 2. *Ursus* aff. *deningeri*, M2 (RM 203) (occlusal view).
Fig. 3. *Aonyx antiqua*, mandibula p3, p4, m1 (RM 226), a. occlusal view; b. lingual view.

All specimens from the Maasvlakte area.


1
2
3 a
3 b
2 cm

parison of the bear molars from the Maasvlakte with those from Tegelen shows that those from the Maasvlakte are more complex than the ones from Tegelen, identified as *Ursus etruscus* by Newton (1913). The molars from Mosbach (main fauna), identified as *U. deningeri* have more accessoric tubercles than those from the Maasvlakte.

It is therefore concluded that the bear material from the Maasvlakte is of intermediate age between that from Tegelen and that from the main fauna of Mosbach.

Mustelidae

Lutrinea

Aonyx antiqua (extinct otter) (Plate 1, Fig. 5)—Clawless otters of the genus *Aonyx* differ from the otters of the genus *Lutra* in having broad blunt-cusped teeth (Stuart, 1982). One otter mandibula in the Maasvlakte collection (Plate 1, Fig. 9) is relatively robust. The m1 has a relatively large talonid in comparison with *Lutra* (Table 1). The mandibula has only two foramina mentalia instead of three as in *Lutra lutra* (Linnaeus, 1758).

	m1 *Aonyx*	m1 Lutra lutra			
		max	min	x	n
length	14.4	14.1	12.4	13.2	6
length talonid	6.0	5.6	5.2	5.5	3
width talonid	8.3	7.0	6.0	6.4	5
	mandibula mandibula *Aonyx*	*Lutra lutra*			
		max	min	x	n
height beneath m1	16.4	12.8	11.2	12.0	3
width beneath m1	8.2	6.9	6.4	6.7	3

Table 1. Measurements on m1 and mandibula of *Aonyx antiqua* and *Lutra lutra* from the Maasvlakte (in mm).

Up to date *Aonyx antiqua* is only known from European faunas of Holsteinian or Saalian age (Willemsen, 1987). The *Aonyx antiqua* mandibula of the Maasvlakte should be much older. It is assigned to Fauna I on the basis of the state of preservation of the fossil. There are no other fossils from the Maasvlakte indicating a Holsteinian or Saalian age.

Felidae

Lynx lynx (lynx) — This species is assigned to Fauna I because it is not known from Late Pleistocene faunas from other localities in NW Europe. *Lynx lynx* occurs in other Holocene faunas in Europe (Clason, 1977), but the preservation of the fossil is not similar to that of the other fossils of Holocene age.

Proboscidea

Elephantidae

Archidiskodon meridionalis (extinct elephant) (Plate 2, Fig. 1)— Most of the elephant material from the Maasvlakte belongs to *Mammuthus primigenius* (Blumenbach, 1799). Some molar fragments, however,

have the low lammellar frequency, thick enamel and low hypsodonty, characters of *Archidiskodon meridionalis*. This identification is confirmed by the form of the plates (Brüning, 1980).

Perissodactyla

Rhinocerotidae

Dicerorhinus etruscus brachycephalus (extinct rhinoceros) (Plate 2, Fig. 2)-The extinct rhinoceros *D. etruscus* (Falconer, 1859) can be divided into two subspecies: *D. etruscus etruscus* (Falconer, 1859) and *D. etruscus brachycephalus* (Schroeder, 1903). The latter, occurring during the late Early and early Middle Pleistocene, had a larger skull and larger, more hypsodont molars (Gurin, 1980).

The measurements, e.g. the hypsodonty, of the molars of the Maasvlakte collection are more comparable to those of the molars of *D. etruscus brachycephalus* Artiodactyla

Hippopotamidae

Hippopotamus major (extinct hippopotamus) (Plate 2, Fig. 5) — Representatives of the genus Hippopotamus occurred in Western Europe during several periods of the Pleistocene. Two different species have been recognized: the larger *H. major* (≙ *H. antiquus*) and the smaller *H. incognitus* (Faure, 1984).

The measurements from the Maasvlakte fossils C, M3 dext. and cuboid are compared with those of both species of *Hippopotamus* and are more similar to those of *H. major* (van Kolfschoten & Vervoort-Kerkhoff, in prep.). The occurrence of this species is restricted to the late Early and early Middle Pleistocene (Faure, 1984).

Suidae

Sus scrofa (pig) (Plate 2, Fig. 4) — Some of the fossil molars from the Maasvlakte identified as belonging to the Suidae have, compared to the modern *Sus scrofa*, a simple enamel pattern; they have less accessory tubercles. The molars are more advanced than the molars of *Sus strozzi* Meneghini from Tegelen which have less accessory tubercles. Some molars from Mosbach have more accessory tubercles than those from the Maasvlakte.

Cervidae

Cervalces latifrons (extinct elk) (Plate 2, Fig. 3) — A small number of fossils belong to a large deer. Based on morphological characters of the molars (*e.g.* well-developed ectostyles), these are identified as *Cervalces latifrons* Cervidae indet. — A number of heavily mineralized fossils were recognized as belonging to small and medium sized deer. They could not be identified to a specific level.

Stratigraphical position of Fauna I

The stratigraphical position of the Maasvlakte Fauna I is not easy to determine. This is partly due to the fact that the fossils are not found in situ but in suction-dredged sediments.

However, the occurrence of *Pitymys hungarica*, *Mimomys savini* and *Mimomys* sp. (small species) and the absence of *Microtus* (*Allophaiomys*) indicate a late Early, or early Middle Pleistocene age.

The stratigraphical range of *P. hungarica* is restricted to the Early Ruscinian to the Templomhegy Phase of the Early Biharian (Reumer, 1984). It is unknown from *e.g.* the Cromerian fauna of West Runton (Stuart, 1982).

The small *Mimomys* was most probably extinct in NW Europe already before Interglacial III of the "Cromerian Complex". *M. (Allophaiomys)*, known from borehole Zuurland below -43.75 m, from deposits dated as Waalian or older, was extinct before the Bavelian (van Kolfschoten, 1987, 1988).

Most of the large mammals of Fauna I from the Maasvlakte have an evolutionary stage intermediate in between that of the Early Pleistocene (Tiglian) mammals from Tegelen and the Middle Pleistocene (Late Cromerian or Elsterian) ones from Mosbach.

The presence of e.g. *Hippopotamus major* indicates that Fauna I reflects a fauna from an interglacial period. The stratigraphical range and the evolutionary stage of the species of Fauna I indicate that this period should be younger than the Menapian and older than Interglacial III of the "Cromerian Complex".

Fauna II

The fossils assigned to Fauna II are less mineralized and have a lighter colour than those of Fauna I.

Composition of Fauna II:

Spermophilus cf *undulatus* Pallas, 1799	(longtailed suslik)
Crocuta crocuta spelaea Goldfuss, 1832	(cave hyaena)
Panthera leo spelaea (Goldfuss, 1810)	(cave lion)
Mammuthus primigenius (Blumenbach, 1799)	(mammoth)
Coelodonta antiquitatis (Blumenbach, 1799)	(woolly rhinoceros)
Megaloceros giganteus (Blumenbach, 1803)	(giant deer)
Rangifer tarandus (Linnaeus, 1758)	(reindeer)
Bison priscus Bojanus, 1827	(extinct bison)

Fauna II consists of species such as *Mammuthus primigenius*, *Coelodonta antiquitatis* and *Rangifer tarandus*, indicating a cold phase with tundra vegetation. This fauna is correlated with the Weichselian because of the evolutionary stage of the molars of *M. primigenius*. Also the presence of *R. tarandus*, which is until now not known from the Saalian in The Netherlands or England, indicates a Weichselian age.

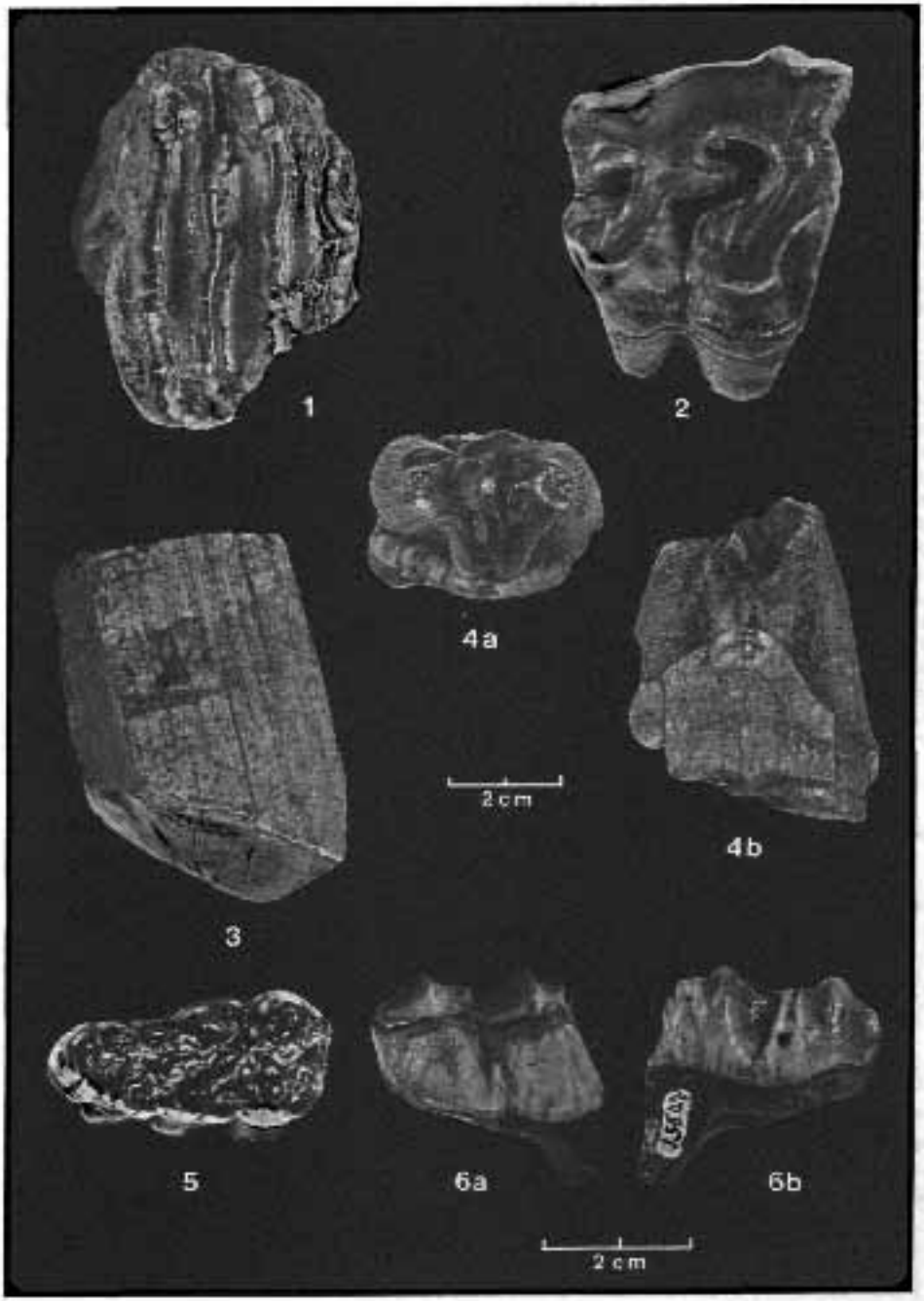
Fauna III

The material belonging to Fauna III is slightly mineralized and has a light brown colour.

Plate 2

Fig. 1. *Arvicolidicodon meridionalis*, molarfragment (RM 315) (occlusal view).
Fig. 2. *Dicrostonyx straeus brachycephalus*, M1 (RM 552) (occlusal view).
Fig. 3. *Hippopotamus major*, C sup. (RM 901).
Fig. 4. *Hippopotamus major*, m3 (RM 902); a. occlusal view; b. anterior view.
Fig. 5. *Sus scrofa*, M3 (RM 651) (occlusal view).
Fig. 6. *Cervalces latifrons*, m3 (RM 911); a. lingual view; b. labial view.

Figs 1-5: natural size.
All specimens from the Maasvlakte area.


1
2
4a
2 cm
4b
3
5
6a
6b
2 cm

Composition of fauna III

Homo sapiens Linnaeus, 1758	(man)
Erinaceus europaeus Linnaeus, 1758	(hedgehog)
Sorex araneus Linnaeus, 1758	(common shrew)
Neomys fodiens Pennant, 1771	(water shrew)
Clethrionomys glareolus (Schreber, 1780)	(bank vole)
Arvicola terrestris (Linnaeus, 1758)	(water vole)
Microtus oeconomus (Keyserling & Blasius, 1841)	(root vole)
Microtus arvalis (Pallas, 1779)	(common vole)
Microtus agrestis (Linnaeus, 1761)	(short-tailed vole)
Apodemus sylvaticus (Linnaeus, 1758)	(wood mouse)
Micromys minutus (Pallas, 1771)	(harvest mouse)
Lepus europaeus Pallas, 1778	(hare)
Castor fiber Linnaeus, 1758	(beaver)
Canis lupus familiaris (Linnaeus, 1758)	(dog)
Lutra lutra (Linnaeus, 1758)	(otter)
Martes martes (Linnaeus, 1758)	(marter)
Putorius putorius Linnaeus, 1758	(polecat)
Mustela nivalis Linnaeus, 1766	(weasel)
Mustela erminea Linnaeus, 1758	(stoat)
Felis sylvestris Schreber, 1777	(cat)
Equus caballus Linnaeus, 1758	(horse)
Sus scrofa Linnaeus, 1758	(pig)
Alces alces (Linnaeus, 1758)	(elk)
Cervus elaphus Linnaeus, 1758	(red deer)
Capreolus capreolus Linnaeus, 1758	(roe deer)
Bos primigenius Bojanus, 1827	(aurochs)
Bos taurus Linnaeus, 1758	(cow)
Ovis aries Linnaeus, 1758	(sheep)
Capra hircus Linnaeus, 1758	(goat)

Fauna III is dominated by domesticated species such as cows, sheep, goats and dogs and is therefore dated as Holocene. The large number of archaeological finds are from the same period.

Fossils of marine mammals have also been found at the Maasvlakte. The fossils are identified as belonging to:

Phocidae (seals)	
Phoca vitulina (Linnaeus, 1758)	(harbour seal)
Halichoerus grypus (Fabricius, 1791)	(grey or atlantic seal)
Phoca (Pusa) hispida (Schreber, 1775)	(ringed seal)
Phocoenidae (porpoises)	
Phocoena phocoena (Linnaeus, 1758)	(common porpoise)
Delphinidae (dolphins)	
Tursiops truncatus (Montague, 1821)	(bottle-nosed dolphin)
Delphinus delphis Linnaeus, 1758	(common dolphin)
Monodontidae (toothed whales)	
Monodon monoceros Linnaeus, 1758	(narwhal).

The fossils of *Monodon monoceros* show a rather advanced degree of mineralization and are, according to van Bree & Bosscha Erdbrink (1987), possibly of Late Eemian age.

The degree of mineralization of the other marine mammalian fossils is comparable to that of the remains of the species assigned to Fauna III. They probably date from the Holocene.

CORRELATION OF THE MAASVLAKTE FAUNAS WITH THOSE FROM BORING ZUURLAND

The sediments used to create the Maasvlakte originate from the same area as where the Brielle and Zuurland boreholes are located (Fig. 1). There are no important geological disturbances in that area and therefore similarities between the Maasvlakte faunas and those from borehole Zuurland can be expected.

The small mammals of Fauna I of the Maasvlakte are comparable to Fauna 5 of the Zuurland borehole. Fauna 5 is correlated with the Templombegy Phase of the Early Biharian (late Early—early Middle Pleistocene) (van Kolfschoten, 1988). In both faunas the small *Mimomys* species and the advanced larger *Mimomys savini* are present and *Microtus (Allophaiomys)* is absent.

Fauna II most probably originates from The Weichselian deposits of the Twente Formation (Weichselian) demonstrated in the Zuurland borehole between -22.30 and -23.80 m (Burger, 1988) and should be correlated to Fauna 3 from borehole Zuurland.

Fauna III from the Maasvlakte originates beyond any doubt from sediments of the Westland Formation. The upper part of the section of borehole Zuurland (0.00 to -22.30 m), with Fauna 1 and 2, consists of sediments assigned to the Westland Formation which dates from the Holocene.

DISCUSSION

The Maasvlakte Fauna I is correlated to Fauna 5 of borehole Zuurland (-27 to -37 m) both indicating an age younger than the Menapian and older than Interglacial III of the "Cromerian Complex".

The remains of Zuurland Fauna 5 are collected from sediments assigned to the Kreftenheye/Eem Formation deposited during the Late Pleistocene (Burger, 1988). The fossils should have been reworked from older deposits. The correlation between Fauna I from the Maasvlakte and Zuurland Fauna 5 does not imply that the fossils of Fauna I originate from the same formation and are reworked too. The small and large mammalian fossils of Fauna I are well-preserved and indicate that hardly any reworking of the material had taken place before deposition on the Maasvlakte.

The relatively high number of mammalian fossils of Fauna I found at the Maasvlakte indicates that the original layer is rich in mammalian fossils, or a rather high percentage of the suction-dredged sediments originated from late Early, to early Middle Pleistocene deposits. These deposits might represent the top of the Kedichem Formation or the Sterksel Formation. Whether sediments of these formations occur above the level of -40 m in the areas where the the suction-dredged material was obtained, is unknown. Investigations in that particular area might answer this question.

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