

ON REMAINS OF *HOMOTHERIUM* FROM THE BOTTOM OF THE NORTH SEA BETWEEN THE BRITISH ISLES AND THE NETHERLANDS AND THEIR STRATIGRAPHICAL AGE

The Southern Bight of the North Sea between the British Isles and the Netherlands is a rich source of fossil mammal remains dating from the entire Pleistocene (e. g., Kortenbout van der Sluijs 1971a; 1971b; 1983; 1985; van Kolfschoten/Laban 1995; Mol et al. 2003; 2006; 2013; Reumer et al. 2003; Mol/Reumer 2010). Some of these specimens are rare and very important. Fishermen have been collecting fossils from their nets since at least 1874 (figs 1-2; Mol et al. 2008a). Initially, localities near the Brown Bank were recognised as being prolific sources of finds, but later, many other fossil-rich sites in the Southern Bight were discovered. Current knowledge of these fossil localities is the result of intense collaboration between museums, private collectors and the fishing industry. It all began when the curator of fossil mammals of the former National Museum of Geology and Mineralogy, G. Kortenbout van der Sluijs, conducted regular visits to Dutch fishing ports in the 1960s to obtain fossil bones for his museum. He found that the larger vessels (>30 m in length) that went for flatfish outside the 12-mile zone were particularly successful in collecting fossil mammal remains as a bycatch of their haul of fish.



Fig. 1 A fishing vessel returning to the harbour at Stellendam (prov. Zuid-Holland/NL) after a 24-hour-trip, with a large amount of Late Pleistocene mammal remains on board. – (Photo H. Wildschut).



Fig. 2 Large male woolly mammoth skull trawled from the seabed at the quay in the harbour of Stellendam. – (Photo F. van der Vossen).

Subsequently, it appeared that smaller vessels that fished within the 12-mile zone also brought many skeletal remains back to port. These vessels are the so-called Eurocutters with engines of less than 300 bhp and a length of <22 m. Fossils collected by these smaller ships originated from an area north of the mouth of the Western Scheldt estuary, offshore from the provinces of Zeeland and Zuid-Holland. In the early 1990s, Eurocutters also started fishing in the so-called Eurogeul, the 28-m-deep shipping lane that connects with Rotterdam harbour (prov. Zuid-Holland/NL). This now appears to be the most productive locality, together with the region to the south of it. This latter site has become a major source for dredging sand in order to construct the new Rotterdam harbour extension, the so-called Maasvlakte 2. In 2001, we began a large-scale operation to fish for fossils specifically for research purposes (Mol/Post 2010); this work includes searching in dredged sand on beaches (Mol et al. 2013). As a result of all these activities, we now have a wealth of material from the area of the North Sea that has become known as the Southern Bight.

All material obtained from the bottom of the North Sea through fishing (as well as sand dredging) is obviously obtained *ex situ*. Therefore, specimens cannot be dated on the basis of their stratigraphical context. The lack of *in situ* context might seem to be a considerable challenge to their study, but over the past few decades we have observed that this is not the case. Based on the known stratigraphical ranges of species from *in situ* occurrences, combined with the state of preservation of the North Sea fossils and knowledge of the geology of the sea floor, it has proved possible to determine their age unequivocally. Furthermore, radiocarbon dating provides exact ages to fossils from <45 kyr BP. Finally, the question regarding exactly which stratigraphical data has been lost through the recovery *ex situ* should be addressed. The Southern Bight of the North Sea has witnessed repeated exposure and submersion of the shelf during the Pleistocene, especially during the Late Pleistocene, when it was exposed and inundated again within roughly 100 000

Fig. 3 Early and Late Pleistocene mammoth remains can be easily identified based on their morphology: **1** heavily mineralised, dark coloured upper M3 of *Mammuthus meridionalis*. – **2** barely mineralised upper M3 of *Mammuthus primigenius*. – (Photo H. Wildschut).



years. In addition, the character of the rivers running through it, notably the River Rhine-Meuse (Laban/Rijsdijk 2002), has changed repeatedly through Pleistocene climatic fluctuations, changing from a braided river system into a meandering one and vice versa (Berendsen 2011). All of this has resulted in the strong reworking of the majority of fossiliferous deposits, as we have observed on the basis of borehole cores taken from the Eurogeul area. For this reason, data obtained from the prime stratigraphical context of the fossils is limited anyway.

It is a fact that North Sea fossils of species typical of the Early or early Middle Pleistocene invariably are heavily mineralised and dark brown to black in colour. They produce a high-pitched/metallic sound when tapped upon with a solid object. Furthermore, they often contain significant amounts of iron, which may render a rusty appearance in some small parts. Finally, these fossils are normally obtained from a limited number of sites in the North Sea. Easily distinguished from this is the much more common type of preservation from the North Sea which is invariably observed in species typical of the Late Pleistocene or Early Holocene (fig. 3). These fossils are barely mineralised at all and are still very suitable for radiocarbon dating (Mol et al. 2006) and DNA analysis (Alter et al. 2015). They are often lighter in colour than the older material. These fossils are retrieved in great abundance from an extensive number of sites in the North Sea.

Based on the above observations, it is possible to assign with confidence a rough stratigraphical date to specimens that cannot be aged by morphology alone. For instance, a metacarpal of a large horse, *Equus* sp., can be confidently assigned either an Early to early Middle Pleistocene or a Late Pleistocene age by direct comparison with the preservation of other material obtained from the same area. We cannot stress enough the clear differences between the older and the younger material, which have proved so useful to our interpretations over the past few decades. In fact, this is a crucial point concerning the Late Pleistocene mandible of the sabre-toothed cat described below.

SITES AND FAUNAS

The Southern Bight of the North Sea, especially areas such as the Brown Bank and the Eurogeul, has produced large quantities of skeletal elements from the entire Pleistocene and Early Holocene (Mol et al. 2006). Based on radiocarbon dates, the Late Pleistocene fauna includes, amongst others: woolly mammoth / *Mammuthus primigenius* (Blumenbach, 1799); woolly rhinoceros / *Coelodonta antiquitatis* (Blumenbach,



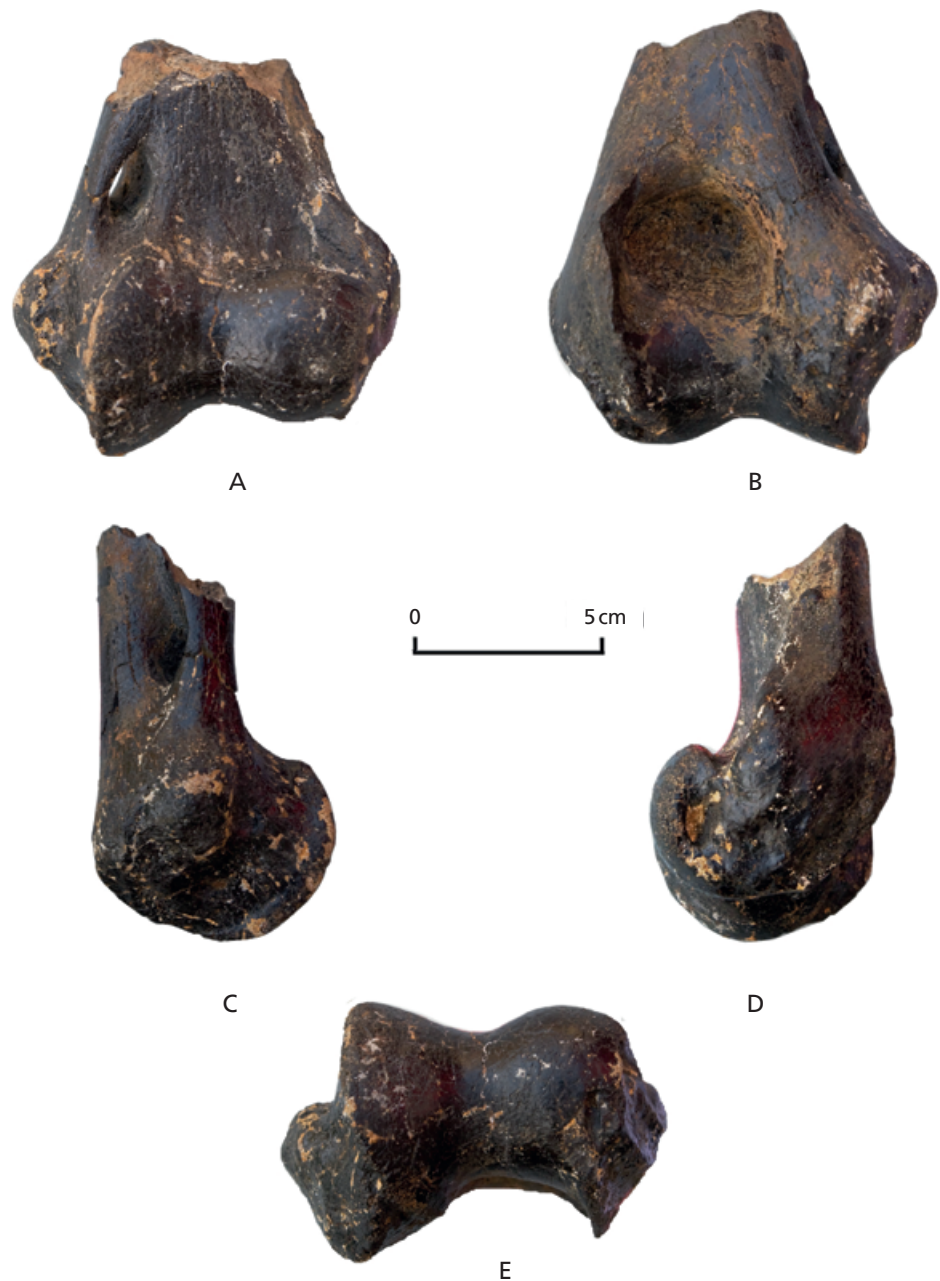
Fig. 4 Early Pleistocene *Mammuthus meridionalis* remains from the Eastern Scheldt estuary and of the so-called Deep Water Channel in the North Sea. – (Photo H. Wildschut).

1799); wild horse / *Equus caballus* Linnaeus, 1758; giant deer / *Megaloceros giganteus* (Blumenbach, 1799); reindeer / *Rangifer tarandus* (Linnaeus, 1758); steppe bison / *Bison priscus* (Bojanus, 1825); cave hyena / *Crocuta spelaea* (Goldfuss, 1823) and muskox / *Ovibos moschatus* (Zimmermann, 1780). Amongst other taxa, the Early Holocene fauna comprises red deer / *Cervus elaphus* Linnaeus, 1758; roe deer / *Capreolus capreolus* (Linnaeus, 1758); moose / *Alces alces* (Linnaeus, 1758); wild boar / *Sus scrofa* Linnaeus, 1758; otter / *Lutra lutra* Linnaeus, 1758 and humans / *Homo sapiens* Linnaeus, 1758. There are numerous sites that yield these Late Pleistocene and Early Holocene faunas in abundance. However, localities with Early to early Middle Pleistocene material are much rarer, and the quantity of these fossils retrieved per site is much lower. These localities are, therefore, of great importance, particularly in order to understand sabre-toothed cats.

***Homotherium cf. latidens* (Owen, 1846)**

One of the localities that has produced sabre-toothed cat remains is an estuary of the River Scheldt in the province of Zeeland (Hooijer 1962; Mol et al. 2008b). Fauna from the Early Pleistocene, recently redated between 2.5 and 2 million years old, by biostratigraphy (Scager 2015), has been recovered from the Eastern Scheldt. This assemblage includes, amongst others, the mastodon of Auvergne / *Anancus arvernensis* (Croizet/Jobert, 1828), southern mammoth / *Mammuthus meridionalis* (Nesti, 1825) (**fig. 4**), Perrier's hyena / *Pliocrocuta perrieri* (Croizet/Jobert, 1828) and rare *Homotherium*. D. A. Hooijer (1962) was the first to note a mandible fragment which he attributed to *Homotherium cf. latidens*. This incomplete mandible was collected from the Eastern Scheldt seabed by the mussel cutter ZZ8 of the Schot brothers of Zierikzee (the Netherlands). D. A. Hooijer (1962) described the specimen as dark brown and moderately mineralised, substantially less so than the Early Pleistocene remains that are usually collected in the deep gullies of the Eastern Scheldt. He thus assumed the deposits in which the specimen was embedded to have been of Middle Pleistocene age, i. e., between 800 000 and 200 000 years old. However, we have compared the 1962 specimen with remains of *Anancus arvernensis* from the same site. These have the same degree of mineralisation and the same dark brown colours as the *Homotherium* specimen described by D. A. Hooijer (1962).

Fig. 5 The distal end of the left humerus of *Homotherium crenatidens* from the North Sea: **A** anterior view. – **B** posterior view. – **C** medial view. – **D** lateral view. – **E** distal view of the trochlea. – (Photos H. Wildschut).



Since there are no Middle Pleistocene sediments known from the studied Eastern Scheldt area, and since characteristic Middle Pleistocene faunal elements are missing from the local fossil record, we attribute this specimen to the Early Pleistocene assemblage.

***Homotherium latidens* (Owen, 1846)**

In 1971, the mussel cutter ZZ8 collected another fossil of *Homotherium*: an incomplete right calcaneum from the Flauwerspolder locality in the Eastern Scheldt estuary. Again, this specimen shows features that are so typical of Early Pleistocene faunal elements from the Eastern Scheldt such as *Anancus arvernensis* and *Mammuthus meridionalis*. Both the 1962 and 1971 specimens are housed in the collections of Naturalis Biodiversity Center (Leiden).



Fig. 6 Schematic view of Maasvlakte 2 and the Eurogeul area, including the sand source area off the coast of the province of Zuid-Holland. Inset: location of Maasvlakte 2 (red dot) in the Netherlands. – (Map J. van Leeuwen / J. Streutker).

More remains that are attributable to *Homotherium latidens* were reported by van Hooijdonk (1999) and Mol et al. (2008b), including a right calcaneum from the locality »Onrust«. This site is located in the North Sea off the coast of Walcheren (prov. Zeeland/NL). From fairly close to »Onrust«, in the »Roompot« area (Eastern Scheldt), there are two metacarpals of *Homotherium latidens*. Again, these remains are heavily mineralised and characterised by a brown/blackish hue. Therefore, they are assigned an Early Pleistocene age. The specimens from both »Onrust« and »Roompot« are in the private collection of Kees van Hooijdonk (Rucphen, the Netherlands).

From a locality named »Het Gat« in the North Sea, east of the so-called Brown Bank, the trawler GO41 from Stellendam collected a distal portion of a humerus, which was attributed to *Homotherium latidens* by Mol et al. (2003). This well-preserved specimen is thoroughly black in colour and extremely heavily mineralised. When tapped upon with a hard object, the fossil produces a high-pitched sound. The locality »Het Gat« is famous for a fauna which is dated at c. 1 Ma, including an advanced type of *Mammuthus meridionalis* or an early type of the steppe mammoth / *Mammuthus trogontherii* (Pohlig, 1885), plus the extinct hippopotamus / *Hippopotamus antiquus* Desmarest, 1822. The specimen is housed in the Dick Mol Collection (Hoofddorp, the Netherlands).

***Homotherium crenatidens* (Weithofer, 1889)**

Van Logchem/Mol (2008) described and illustrated (fig. 5), for the first time from the bottom of the North Sea off the coast of East Anglia (United Kingdom), a distal end of a left humerus of an Early Pleistocene *Homotherium crenatidens* (Weithofer, 1889). This humerus was trawled from the seabed (52° 50' N, 02° 18' E) by the fishing vessel TX1, the Klasina-J. of skipper Cor Vonk of Texel (the Netherlands), in August 2008. The specimen, heavily mineralised and thoroughly black, was identified by van Logchem/Mol (2008) as *Homotherium crenatidens* on the basis of its large proportions in comparison with humeri of other felids such as *Homotherium latidens*. *Homotherium crenatidens* is a heavily built sabre-toothed cat and, as such, also referred to in the literature as the »greater scimitar cat«. The weight of this species could be as much as 400 kg (Hemmer 2001, 2004). It is considered the direct ancestor of *Homotherium latidens* (Balleisio 1963).



Fig. 7 Trailing suction hopper dredger creating new land (Maasvlakte 2) using Pleistocene sediments, including fossils, from the Eurogeul area. – (Photo H. Wildschut).

The trawling area off the coast of East Anglia is well known for remains of Early Pleistocene faunal elements such as *Mammuthus meridionalis*, the Etruscan rhinoceros / *Stephanorhinus etruscus* (Falconer, 1868) and large deer / *Eucladoceros ctenoides* (Nesti, 1841). All remains of these species, dated as Early Pleistocene, are characterised by their dark brownish to black colours, matching the *Homotherium* specimen. *Homotherium crenatidens* is considered a carnivorous member of such an Early Pleistocene faunal association. When tapped upon with a hard object, these fossils produce a metallic sound. The specimen belongs to the private collection of Bert Schagen of Texel (the Netherlands).

MAASVLAKTE 2 YIELDS NEW *HOMOTHERIUM* RECORDS

In addition to summarising previous records of *Homotherium* from the North Sea, we also present four new records here. These were all recovered by private collectors from the beach of Rotterdam's youngest harbour extension, i.e., Maasvlakte 2. First, we discuss Maasvlakte 2 and the state of palaeontological research of this young site; we then describe and illustrate the new specimens.

The area of the Maasvlakte 2 comprises 240 million m³ of sediment, which was sucker-dredged from the Eurogeul area by trailing suction hopper dredgers (figs 6-7). This sediment was carefully deposited seawards of the previous Rotterdam harbour extension (Maasvlakte, now often referred to as the first Maasvlakte, or Maasvlakte 1) in order to obtain a significant area for new harbour extensions. Its main goal is enabling the harbour industry to maintain and improve the position of Rotterdam harbour as a globally important port. The engineers responsible for retrieving the vast volume of sediment from the Eurogeul area needed for the construction came up with two options. Option 1 was a more or less classic approach, where sediment

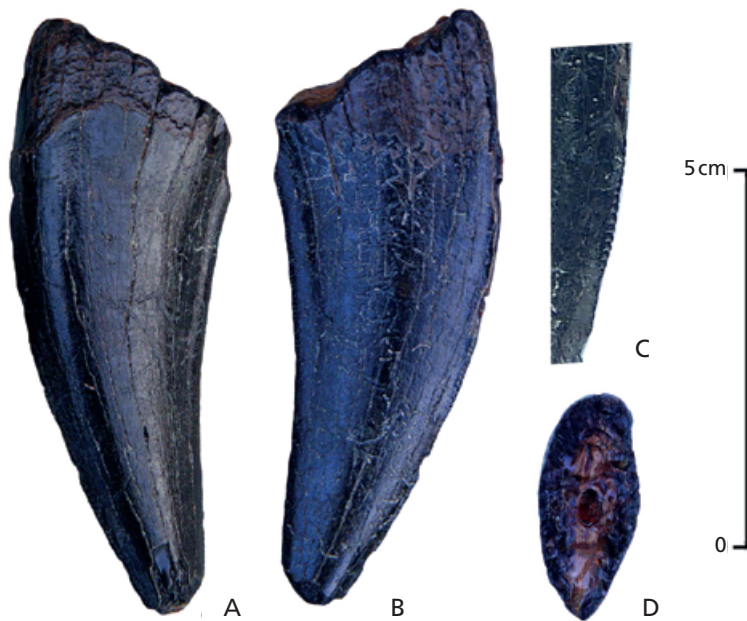


Fig. 8 *Homotherium latidens*, crown of an upper left canine (C sup. sin.) from Maasvlakte 2: **A** exterior view. – **B** interior view. – **C** detail of the enamel showing the typical serration. – **D** cross section of the root. – (Photos A-C H. Wildschut; D M. Simmelink).

would be dredged up to 4-6m below the original seabed. This would obviously require a vast area in order to obtain the necessary volume. The other option was a bolder one: retrieve all sediment needed from only a relatively small area by dredging not 6m below the original seabed, but down to a depth of up to 20m. Even though recovery of the sea floor dredged to 20m depth would take significantly longer, the lesser extent of the area disturbed made it the better alternative environmentally speaking. That environmental impact was an important factor in the final decision to proceed with the second option. Palaeontologically speaking, this decision could not have been better.

Prior to the construction of Maasvlakte 2, the Eurogeul and surrounding area were known solely for their huge abundance of well-preserved Late Pleistocene and Early Holocene mammal fossils (Mol et al. 2006). However, the extensive deepening of part of the area for the construction of Maasvlakte 2 resulted in palaeontological gold: sediments from the late Middle Pleistocene and possibly Early Pleistocene reached for the first time in this area (Busschers/van Heteren/Westerhoff 2012) appeared to yield significant volumes of Early to early Middle Pleistocene (partially reworked) fossils, as noted almost directly after the beach was declared open to the general public. This was triggered by the intense collecting activities on the Maasvlakte 2 beach by a large number of private collectors who had been waiting impatiently for free access to the beach. Based on their collections and the wealth of data contained in them Mol et al. (2013; 2015) and Mol/Langeveld (2015a; 2015b) identified c. three faunal assemblages from Maasvlakte 2, including one dated as Early Pleistocene or early Middle Pleistocene that had not been recovered from the Eurogeul area previously. Furthermore, the careful collecting by the private collectors has resulted in significant additions to the already well-known Late Pleistocene and Early Holocene faunas, through recovery of small- to medium-sized vertebrate remains. These include skeletal elements of e. g., hares and diverse birds (Mol/Langeveld 2016).

For the composition of Late Pleistocene and Early Holocene faunas from Maasvlakte 2, reference is made to the literature on the Eurogeul area (e. g., Mol et al. 2006) and the above. Species recovered from the Maasvlakte 2 beach assigned an Early to early Middle Pleistocene date include: *Mammuthus meridionalis*; *Stephanorhinus etruscus*; large horse / *Equus bressanus* Viret, 1954; wild boar / *Sus strozzi* Forsyth Major, 1881; extinct moose / *Alces latifrons* (Johnson, 1874); desman / *Desmana thermalis* Kormos, 1930 and giant beaver / *Trogontherium cuvieri* Fischer, 1809 (Mol et al. 2013; Mol/Langeveld 2015a; 2015b). Possibly slightly younger are remains of forest rhinoceros / *Stephanorhinus kirchbergensis* (Jäger, 1839) and a hip-

popotamus / *Hippopotamus incognitus* Faure, 1984. Again, remains of species dated to the Early to early Middle Pleistocene all show the same style of preservation: dark brown to black in colour, often with some rusty sediment adhering, invariably thoroughly mineralised, and yielding a high-pitched sound when tapped upon with a hard object. The four new *Homotherium* records described below show the very same preservational style and are therefore confidently dated to this Early to early Middle Pleistocene fauna.

The first Maasvlakte 2 specimen of *Homotherium latidens* is a more or less complete crown of an upper left canine (C sup. sin.), found on the beach by Marc Simmelink, March 15, 2015 (figs 8-9). This canine fragment, with a maximum length of 75 mm, shows all characteristics that allow it to be attributed to *Homotherium latidens*. The crown is typically laterally flattened and the enamel is completely serrated, with 22 serrations/cm. The tip of the crown is damaged; this may have occurred *in vivo*. The interior side of the crown is more or less smooth, whereas the exterior side is rounded. The anterior-posterior length, measured at the base of the crown, is 28.5 mm; the maximum thickness, measured interiorly-exteriorly is 12 mm. The overall preservation of the specimen suggests it to have been reworked from older sediments. It reveals all previously described characters of Early/early Middle Pleistocene fossils from Maasvlakte 2. It is housed in the collection of Marc Simmelink (Hellevoetsluis, the Netherlands). A cast of this specimen is stored in the collection of the Natural History Museum Rotterdam (NMR999100012093).

The second Maasvlakte 2 specimen (fig. 10) is also a fragmentary upper canine (C. sup. dex.); it is better preserved. On



Fig. 9 Reconstructed upper left canine (C sup. sin.) of *Homotherium latidens* using a cast of the crown illustrated in fig. 8. – (Photo H. Wildschut).

Fig. 10 *Homotherium latidens*, crown of an upper right canine (C sup. dex.) from Maasvlakte 2: **A** exterior view. – **B** interior view. – **C** detail of the enamel showing the typical serration. – **D** cross section of the root. – (Photos B. W. Langeveld).

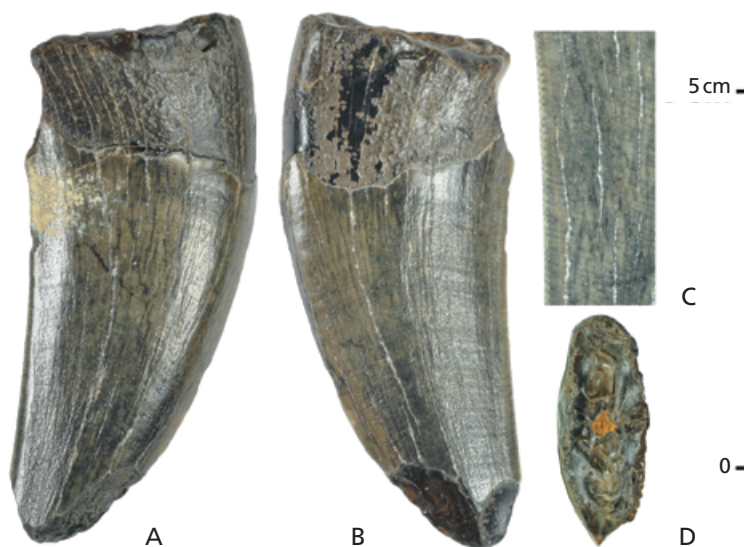




Fig. 11 *Homotherium latidens*, right lower canine (C inf. dex.) from Maasvlakte 2: **A** exterior view – **B** interior view – **C** posterior view. – (Photos B. W. Langeveld).

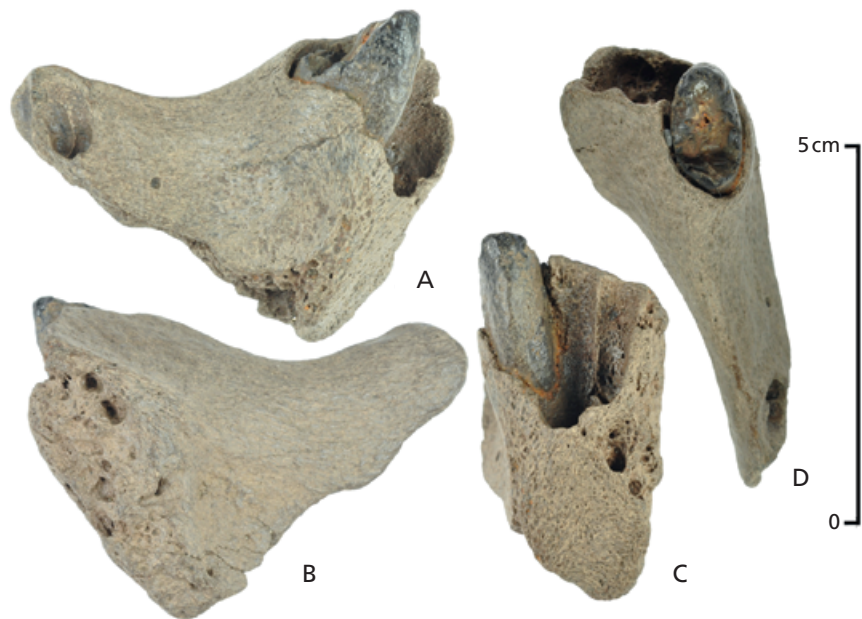
the basis of size it must have belonged to a slightly larger individual. It was collected on June 6, 2016 from the beach. This fossil shows part of the root, the base of the enamel and most of the crown, the tip having been broken off. The maximum length of the specimen is 71 mm and the serrations number 21 per cm. The anterior-posterior length, measured at the base of the crown, is 30 mm; the maximum thickness at the root, measured interiorly-exteriorly is 12 mm. The fractured surface at the upper end of the crown appears to be ancient damage. The preserved root is dark brown to black in colour and the pulp cavity contains the typical red rusty sediment. The colour of the enamel on both sites of the crown is olive green with some brown to black striations.

When observed at slightly higher magnification, the serrations are almost translucent. This differs markedly from the first specimen. Although showing all previously described typical characters of Early/Middle Pleistocene fossils from Maasvlakte 2, it is differentiated from the first specimen in that it was not, apparently, reworked. The second specimen, catalogued as WL0893, is housed in the collection of its collector Walter Langendoen (Hellevoetsluis, the Netherlands). The collection of the Natural History Museum Rotterdam contains a cast (NMR999100012090) of this specimen.

The third new specimen (**fig. 11**), also collected by Walter Langendoen (WL0894, plus a cast in the Natural History Museum Rotterdam, NMR999100012091) in the spring of 2016, consists of a complete lower right canine (C inf. dex.), of which the tip of the crown is worn. The maximum height is 56 mm, the maximum width, at the base of the crown, 11 mm and the maximum width in the middle of the root, 12 mm. The anterior-posterior length of the crown is 17 mm and the maximum anterior-posterior length of the root is 19 mm. The maximum height of the crown is 20 mm. The root of the specimen is flattened and slightly S-shaped interior to exterior; the crown has a laterally flattened cross section. The specimen is heavily mineralised, and the enamel is of an olive green hue with some black. The enamel is worn on the anterior side. The base of the crown on the posterior side shows five serrations. Above that part the enamel is worn. All observed characters allow attribution to *Homotherium*. The preservation shows its Early to early Middle Pleistocene age.

The fourth and last new specimen presented here (**fig. 12**) is a fragment of a right mandible, which was collected by René Lamers on May 5, 2016 from the beach of Maasvlakte 2. It consists of the most rostral part of the jaw, including the symphysis, the alveoli of i2 and i3, the root of the canine still in place, the alveoli of the p3 and a tiny part of the rostral alveolus of the p4. Behind and below this alveolus the jaw is broken off. The maximum length of the fossil is 63 mm; the maximum height equals 54 mm. The maximum thickness of the symphysis is 26 mm. Although being just a small fragment without any discernible characteristics on the sole dental element preserved, it is undoubtedly *Homotherium*. Proof is found in the very typical morphology of the fragment (e. g., its slope and slenderness directly caudal of the canine, the tiny alveoli of the p3, the flat rostral side of the symphysis and the oval cross section of the root) in direct comparison with the complete North Sea mandible described below. The jawbone is heavily mineralised and produces a high-pitched sound when tapped upon with a hard object. The pulp cavity of the canine root shows some rusty sediment, as does the border between the root and its alveolus. The specimen appears to have been reworked. Therefore, it can be dated as Early to early Middle Pleistocene. It is kept in the collection of its col-

Fig. 12 *Homotherium latidens*, fragment of right mandible with remnant of the canine from Maasvlakte 2: **A** buccal view – **B** lingual view – **C** cranial view – **D** dorsal view. – (Photos B. W. Langeveld).



lector, René Lamers (Rotterdam, catalogued as 219). A cast is stored in the collection of the Natural History Museum Rotterdam (NMR999100012092).

LATE PLEISTOCENE *HOMOTHERIUM LATIDENS*

One of the most remarkable palaeontological finds made during beam-trawling activities in the Southern Bight of the North Sea is a very well-preserved half mandible of a large felid from a locality southeast of the Brown Bank, by the crew of the vessel UK33 in March 2000. The specimen is kept in the collection of the Natural History Museum Rotterdam, catalogued as NMR999100001695 (preliminary catalogue number 02-011, as mentioned by Reumer et al. 2003). It is a right mandible (fig. 13) with the dental elements p3 and p4. Overall morphology of the dentary reflects known characteristics of *Homotherium latidens*. The specimen, yellow-brownish in colour, is not mineralised at all and lacks all preservational characteristics that are typical of all the other *Homotherium* remains (Early to early Middle Pleistocene) from the North Sea. The area of recovery, southeast of the Brown Bank, is known to produce faunal remains of Late Pleistocene and Early Holocene origin exclusively. In fact, the preservation of the specimen matches that of Late Pleistocene faunal remains recovered from the same area. This strongly suggests a Late Pleistocene date for the specimen, which would make it a unique find, given that it was generally accepted at the time of recovery that *Homotherium* went extinct on the Eurasian continent around 500 000 BP (Turner/Antón 1997).

To investigate the age in more detail, the mandible was sampled for ^{14}C dating. Care was taken to obtain non-contaminated samples, as described in detail by Reumer et al. (2003). The results of the radiocarbon analysis (carried out at the R. J. van de Graaff Laboratorium of Utrecht University/NL) were remarkable. The six performed ^{14}C dates, published by Reumer et al. (2003), are reproduced here in table 1. These results, c. 28 000 BP, confirmed our earlier interpretation on the basis of preservation of the specimen and demonstrated definitively the Late Pleistocene survival of *Homotherium* in northwest Europe. Furthermore, the specimen recently yielded aDNA (Paijmans et al. 2015). This can be interpreted as independent evidence for its relatively young age, as aDNA from older material (>50 kyr) has not yet been obtained from North Sea material.

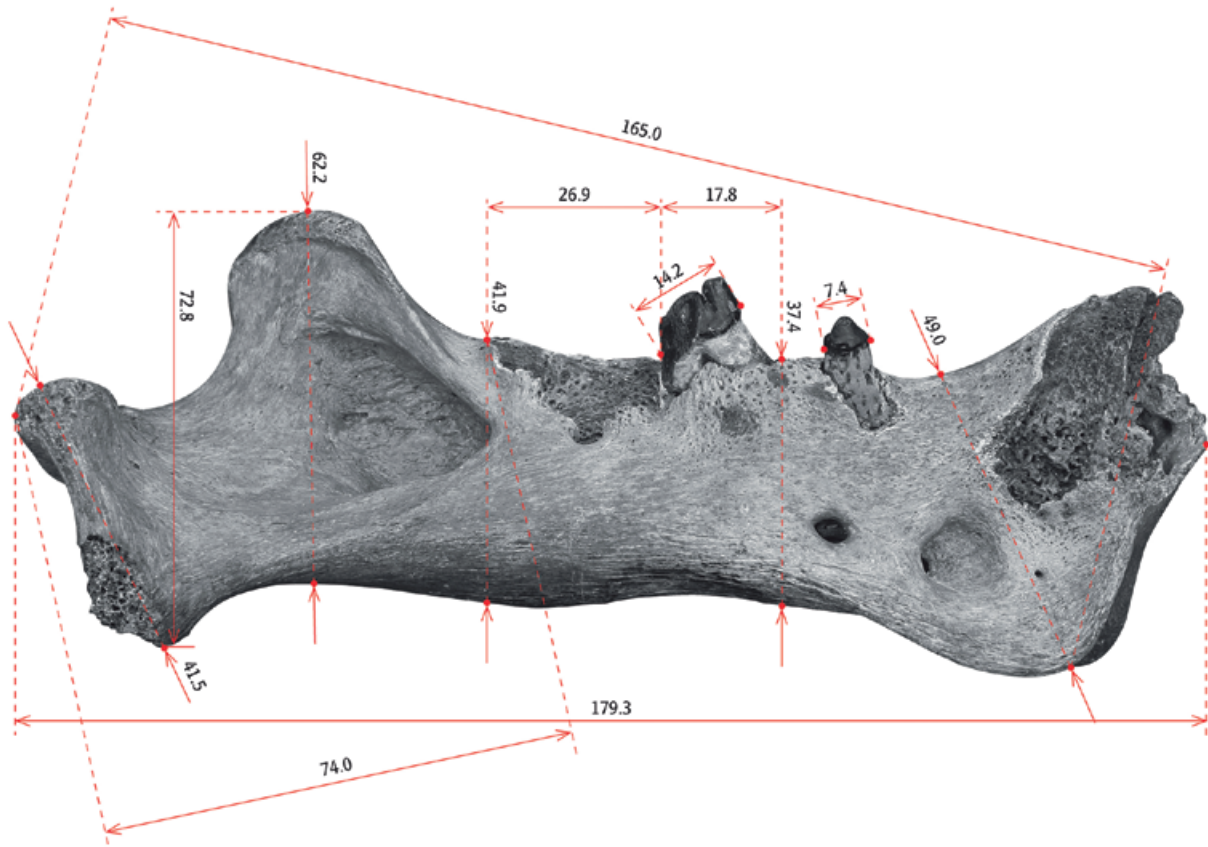


Fig. 13 Buccal side of the Late Pleistocene North Sea *Homotherium latidens* dentary. Measurements in mm. – (Photo H. Wildschut).

UtC number	sample	analysed fraction	mass [mg]	D ¹³ C [p mil]	¹⁴ C age [yr BP]
10456	tooth	collagen 1 st preparation	2.07	-18.1	31 300 ± 400
10999	tooth	collagen 1 st preparation	2.33	-17.6	31 300 ± 400
10908	mandible	collagen 1 st preparation	2.17	-18.9	26 900 ± 400
11064	mandible	collagen 1 st preparation	1.42	-15.3	26 700 ± 240
11000	tooth	collagen 2 nd preparation	0.60	-21.2	28 100 ± 220
11065	mandible	collagen 2 nd preparation	1.01	-17.7	27 650 ± 280

Tab. 1 Results of the six performed ¹⁴C dates from the North Sea *Homotherium latidens* dentary as published by Reumer et al. (2003). The ¹⁴C ages from the second preparation are considered the most reliable.

Inspired by these spectacular ¹⁴C results documenting the Late Pleistocene survival of *Homotherium latidens* in northwest Europe, Remie Bakker, a professional sculptor in Rotterdam, decided to produce a life-size reconstruction of this extinct animal (fig. 14). The idea was to produce a strolling animal with a powerful head and the typical shape of the lower jaw (fig. 15). It was decided to construct the head with its mouth slightly opened, exposing the long and serrated upper canines. The model shows the strongly developed long forelegs and the descending back line, based on the fossil record. Available examples of skeletons of *Homotherium* were used to determine the animal's dimensions. The life-size model with a shoulder height of 1.07 m and a 1.88-m length from the tip of the snout to the tail, is cloaked with artificial fur of different lengths. The main colour chosen was dark grey with an occasional dark stripe, similar to the coat of snow leopards, wolves and lynxes. The idea behind fur colour is that the scimitar cat was an element of



Fig. 14 Life-size model of *Homotherium latidens* by the Dutch sculptor Remie Bakker. – (Photo R. Bleuanus).



Fig. 15 Head of the model. – (Photo R. Bleuanus).



Fig. 16 *Homotherium latidens* resting in the tall grasses of the Late Pleistocene mammoth steppe, now the bottom of the North Sea. – (Painting R. Bakker).

the megafauna of the Late Pleistocene, an era dominated by woolly mammoths and woolly rhinoceroses which roamed the area of what is now the Southern Bight of the North Sea between the British Isles and the Netherlands, at around 28 000 BP. It shows the adaptation of the animal to a cold and dry environment of the mammoth steppe, predominantly with tall grasses (fig. 16).

CONCLUSIONS

The Southern Bight of the North Sea between the British Isles and the European mainland is extremely rich in faunal remains of Early Pleistocene to Early Holocene age, indicating that Great Britain was once connected to the European mainland. Most of the skeletal elements are very well preserved. They are all *ex situ* finds and either a bycatch of the fishing industry, obtained through expeditions fishing specifically for fossils, or collected during excursions on the artificial beaches alongside the Dutch coastline such as the beaches of Rockanje, Maasvlakte 1 and 2, Hoek van Holland and De Zandmotor. Based on their morphology, these skeletal elements can be identified to species. The species, where well known, can be placed within a certain time span of the Pleistocene or the Early Holocene. Factual data, such as the area where

the fossils are retrieved and the geological conditions in combination with the state of mineralisation, can be used confidently for a rough dating of the material. The four specimens from the Maasvlakte 2 artificial beach attributed to the Early Pleistocene *Homotherium latidens* presented here for the first time are good examples of this.

Most of the North Sea remains of the two species of sabre-toothed cats, *Homotherium crenatidens* and *Homotherium latidens*, can be placed in the Early Pleistocene to earliest Middle Pleistocene. The North Sea mandible of *Homotherium latidens* can be easily differentiated from the Early to early Middle Pleistocene North Sea remains: it is not at all mineralised, and the ¹⁴C analysis determined its age to be c. 28 000 BP. So far, that mandible in the collections of the Natural History Museum Rotterdam is the only specimen documenting the Late Pleistocene survival of *Homotherium latidens* in northwest Europe up to 28 000 BP. To date, it is the youngest *Homotherium* from the Eurasian continent.

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SUMMARY / ZUSAMMENFASSUNG

On Remains of *Homotherium* from the Bottom of the North Sea between the British Isles and the Netherlands and their Stratigraphical Age

This paper focuses on remains of sabre-toothed cats that have been recovered from sediments of the Southern Bight of the North Sea between the British Isles and the Netherlands. These skeletal elements have been recovered by fishermen over the years during trawling for bottom-dwelling flatfish. Other important sources of such fossils are the constructed beach of Maasvlakte 2 and some other replenished beaches. These beaches are being actively constructed by dredging sediments, inclusive of abundant fossil remains from the North Sea floor and dumping them in order to extend coastal land areas. All these remains are thus retrieved *ex situ*. Based on their morphology and state of preservation, these remains can be confidently dated as Early or early Middle Pleistocene, Late Pleistocene and Early Holocene. We discuss the faunal compositions and their age, inclusive of a mandible of *Homotherium latidens* (Owen, 1846) that was collected on March 16, 2000, by the fishing vessel UK33, southeast of the Brown Bank in the North Sea halfway between IJmuiden (the Netherlands) and Lowestoft (East Anglia) and described by Reumer et al. (2003). This specimen was radiocarbon dated by Utrecht University at c. 28000 BP, thus furnishing proof of the survival of *Homotherium latidens* into the Late Pleistocene in northwest Europe. Furthermore, we present four new records of Early Pleistocene *Homotherium latidens*, all recovered recently (2015-2016) from the beach of Maasvlakte 2.

Über Reste von *Homotherium* vom Grund der Nordsee zwischen den Britischen Inseln und den Niederlanden und ihr stratigraphisches Alter

In diesem Beitrag geht es um Überreste von Säbelzahnkatzen, die aus den Sedimenten der südlichen Bucht der Nordsee zwischen den Britischen Inseln und den Niederlanden geborgen wurden. Diese Skelettelemente wurden im Laufe der Jahre von Fischern bei der Schleppnetzfisherei auf bodenbewohnende Plattfische geborgen. Weitere wichtige Quellen für solche Fossilien sind der künstlich aufgeschüttete Strand von Maasvlakte 2 und einige andere aufgespülte Strände. Diese Strände werden aktiv aufgebaut, indem Sedimente, die reichlich fossile Überreste enthalten, vom Nordseeboden gebaggert und verklappt werden, um die Küstengebiete zu erweitern. Alle diese Überreste werden also *ex situ* geborgen. Aufgrund ihrer Morphologie und ihres Erhaltungszustands können diese Überreste mit Sicherheit in das frühe oder frühe Mittelpleistozän, das Spätpleistozän und das frühe Holozän datiert werden. Wir diskutieren die Zusammensetzung der Fauna und ihr Alter, einschließlich eines Unterkiefers von *Homotherium latidens* (Owen, 1846), der am 16. März 2000 vom Fischereischiff UK33 südöstlich der Brown Bank in der Nordsee auf halbem Weg zwischen IJmuiden (Niederlande) und Lowestoft (East Anglia) gesammelt und von Reumer et al. (2003) beschrieben wurde. Dieses Exemplar wurde von der Universität Utrecht auf ca. 28 000 BP ¹⁴C-datiert und liefert damit den Beweis für das Überleben von *Homotherium latidens* bis ins Spätpleistozän in Nordwesteuropa. Außerdem stellen wir vier neue Nachweise von *Homotherium latidens* aus dem frühen Pleistozän vor, die alle kürzlich (2015-2016) am Strand von Maasvlakte 2 gefunden wurden.