Introduction

Large quantities of vertebrate remains were recovered from the sand depots of the sandpit 'de Kuilen' in the village of Langenboom (municipality Mill en Sint Hubert, Noord Brabant, the Netherlands) during the last 15 years. The sand originates from the nearby deposits of the Breda and Oosterhout Formations, excavated for industrial purposes. In 2008, a single tooth of the beaver *Castor* was collected by the third author. A remarkable find of a land mammal fossil, since the majority of the vertebrate fossils are from either marine mammals or sea birds.

The geology and the stratigraphic position of the Mill sediments are described in Wijnker et al. (2008), based on in situ collecting in 2005 of dinoflagellate cysts and macrofossils (molluscs, bivalves, gastropods, shark and ray teeth and otoliths). Four lithostratigraphic units were distinguished: early-middle Tortonian (Unit A, Breda Fm.), Zanclean-Early Piacenzian (Unit B; Oosterhout Fm.) and the Quaternary Unit D. Unit B is interpreted as a single depositional sequence, with a transgressive base containing many reworked Miocene and Early Pliocene fossils. The top of Unit B also contains many reworked fossils. The bottom layers of this unit are interpreted as deposited near the storm wave base, the top layers are a mix of storm wave base and storm and fair weather base (Wijnker et al., p. 177). In earlier years, vertebrate remains were collected in situ from the base of Unit B: shark and ray teeth, bird bones, and many remains of marine mammals (whales, porpoises, true seals, and walruses). A molar of a deer was recovered one metre above the base of Unit B (described in De Vos & Wijnker, 2006). The colour of the recovered vertebrate fossils is black (marine mammals) or brown (birds) and the specimens are well preserved. Land mammals recovered (ex-situ) so far from the Langenboom sediments are mastodon, bear, pig, cow, rhinoceros, deer, tapir, horse, and possibly panther and antelope (De Vos & Wijnker, 2008; Noud Peters pers. comm.; Mol et al., 2011).

This single beaver molar collected ex-situ in 2008 is black-brown of colour and heavily worn and is interpreted as originating from the base of Unit B.
The dental nomenclature is according to Hugueney (1999). The measurements were taken with a Leitz Ortholux microscope; the pictures were taken with a Leica multifocus microscope.

**Taxonomy**

Rodentia Bowdich, 1821  
Castoridae Hemprich, 1820  
Castorinae Hemprich, 1820  
Castor Linnaeus, 1758  
Castor fiber Linnaeus, 1758  
Synonym: Castor praefiber Depéret, 1897

**Locality**

Langenboom ex-situ.

**Age**

Early Pliocene.

**Material and measurements:**

- 1 lower molar m2 (sin); Fig. 1; collection number MAB 4600.
- Minimum length: 6.9 mm; minimum width: 6.7 mm; maximum height: 21 mm.
- Striae free area on the lingual side: 10 mm.
- The material is stored in the geological museum ‘Oertijdmuseum de Groene Poort’ in Boxtel, the Netherlands.

**Description**

The molar is damaged, especially at the labial and lingual top. The enamel layer is on the lingual side thin and pitted, and covered with cement on a few small areas. The, slightly undulating, base of the enamel is present at the lowermost part of the molar. The roots are not preserved, but small remnants of the labial roots are still visible. Small wear facets on the anterior and posterior sides indicate the contact with an anterior and a posterior tooth. The anterior wear facet is almost as wide as the tooth, the posterior wear facet is half the width size and positioned on the lingual part of the molar.

The occlusal surface of the molar is slightly longer than wide, the labial and lingual edges are abraded, quite strongly on the lingual side. The hypoflexid is posteriorly directed, with a transversal orientation at its lingual part. It does not exceed the midline. The hypoflexid is strong on the topside of the tooth, downwards it diminishes in depth. It is filled with cement. The paraflexid is transverse and bended forwards at its labial part. The mesoflexid and metaflexid are transverse. The lingual side of the tooth is almost without striae, the mesoflexid and metaflexid are closed on their lingual part just below the occlusal surface, and thus the mesostriid and metastriid are only present at the top part of the tooth. The paraflexid descends into the parastrid, which is only 5 mm deep.

*Fig. 1. Castor fiber from Langenboom, m2 sin: a. Occlusal view; b. Labial view; c. Lingual view (coll. nr. MAB 4600).*
Identification as an m2 is based on the size and position of the wear facets on the anterior and posterior side of the molar. These are interpreted as the contact areas with the m1 on the anterior side and with the narrower m3 on its posterior side respectively. The morphology of the occlusal surface is as in Castor fiber specimens; however the lack of striae on the lingual side of the tooth is considered to be atypical for Castor.

Variability in size of beaver molars is largely due to differences in stage of wear, in stage of ontogeny, and due to influence of climate (Schreuder, 1929; Mayhew, 1978a; Stef en, 1997; Stef en & Mörs, 2008). In Castor fiber the growth of the molars is constant during the first 4 years, after that only a little size increase occurs. The presence of roots is indicative of an individual at least older than about 4 years (Stef en, 2009). The amount of cement on the lowermost part of the molar increases in age strongly and age determination of the individual can be made by the counting of annual cement layers (Klevezal, 1996). Variation in the length of the striae is known to occur in Castor molars (e.a. Stirton, 1935; Kretzoi, 1977; Mayhew, 1978a; Van de Weerd, 1978; Heinrich, 1991; Stef en, 2005). Kretzoi (1977), and later Heinrich (1989), argue that the distance between the base of the molar and the base of the striae changes through time (especially in the p4), and could be used to indicate relative age (Maul 2009). However, the absence or length of these striae and absence or presence of roots is also dependent on stage of ontogeny (Stef en, 2009). Moreover, it cannot be excluded that size and morphology are influenced by climate and/or location. Such variations are known in recent and Pleistocene mammals and are known to occur in the living Eurasian and North American beavers (Mayhew & et al., 2008).

Depéret (1897) described Castor praefiber from a Pliocene fauna from Roussillon (France). Schreuder (1928) argues that the bones and skull assigned to this new species represent at least two species: the bones a small Trogontherium species and the skull Castor fiber. Also Van de Weerd (1978) doubts the validity of C. praefiber since the variation in C. fiber teeth is large and morphological criteria are absent to distinguish these two species.

Dahlmann (2001) allocates a small collection of castor molars from Wölfersheim (Germany) to C. praefiber based on the smaller sizes, the flat occlusal surfaces and the roughened enamel in comparison to C. fiber. Barisone et al. (2006) use the presence of pronounced roots and the absence of striae on the lowermost part of the molar as argument to place the Wölfersheim specimens in Castor praefiber and not in Castor fiber. Although the means of the length and width are lower than in extant ones, the measurements do fall within the range of extant Castor fiber molars (Stef en, 2009), and as is discussed above, also in Castor fiber molars striae free areas are common. Concluding, the variation in size and in morphology does not support a differentiation into two species. Therefore we consider Castor praefiber as a junior synonym of Castor fiber, and only one fossil Castor species was present in Europe from the Late Miocene upwards.

The damage seen on this Castor fiber molar is not due to mastication and is probably caused by transport. Either the molar is transported by river or it is from older (Miocene) deposits, which were reworked during the sea level fluctuations at the latest Miocene. In both cases, the area of origin of the beaver is upriver; either Meuse or Rhine. The drainage area of these rivers is large and covers southwestern Germany, northern Switzerland, the northeastern tip of France and eastern Belgium.

Late Miocene beaver remains are unknown from this area, Early Pliocene beaver remains are only known from Wölfersheim (Germany; Castor fiber and two Trogontherium species; Dahlmann, 2001). Geologically younger beaver remains are described from Hambach 11 (Germany, Late Pliocene with C. fiber and T. minus; Mörs, 2002) and Tegelen (the Netherlands, Early Pleistocene with C. fiber and T. minus Schreuder, 1929, Mayhew 1978b). Late Pleistocene and Holocene beavers are known from many localities.

Both Castor and Trogontherium lived in riparian environments, but Trogontherium inhabited areas with very slow flowing rivers or still waters, whereas Castor prefers the more dynamic riverine environment. At the end of the Miocene and in the Pliocene the climate was warm and humid, with suitable areas in or near the river systems of Rhine and Meuse for Castor and Trogontherium to inhabit. In contrast to Castor, Trogontherium did not fell trees; it fed probably on herbaceous vegetation and therefore was more dependent on a stable and warm climate (Frieling in prep.). The generation of a stronger continental climate in the Pliocene, with arid conditions and lower annual mean temperatures (Fortelius et al., 2002), probably reduced the number of rivers and lakes and thus diminished the habitats of Trogontherium. The last occurrences of Trogontherium are reported from the Late Middle Pleistocene of Europe (Mayhew et al., 2008). In the future, we expect Trogontherium remains to be uncovered in Langenboom sediments.

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