The medieval mammoth: Biomolecular identification of mammoth remains from a Dutch medieval context

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Abstract: As part of a research project on medieval whaling activities in the Netherlands and Flanders, Belgium, Zooarchaeology by Mass-Spectrometry (ZooMS) was performed on 40 medieval archaeological "cetacean" specimens from those regions in order to find out what species the specimens represented. Interestingly, a specimen from the early medieval site of Leiderdorp-Plantage was identified as belonging to a member of the Elephantidae family. Upon closer morphological analysis of the specimen, it turned out to be the proximocaudal fragment of a right tibia of a woolly mammoth (*Mammuthus primigenius*). The specimen contained a hole, indicating that it probably had been used as a tool or artefact by the medieval people who found the bone.

Keywords: ZooMS, whale, zooarchaeology, The Netherlands.

Introduction

Bones of large mammalian species are occasionally found in medieval context in the Netherlands. These osseous remains often belong to cetaceans and seem to suggest that cetacean exploitation was already being undertaken during the medieval period. It remains unclear, however, which species were exploited. Biomolecular analysis, using peptide mass fingerprinting of bone collagen (also known as Zooarchaeology by Mass-Spectrometry or ZooMS), is a useful method for identifying zooarchaeological cetacean remains to the species level. Van den Hurk et al. (2020) analysed 40 medieval specimens from the Netherlands and Flanders using ZooMS and in 39 cases these were indeed identified as a cetacean species. A terrestrial identification was observed, however, in the case of one specimen deriving from the medieval site of Leiderdorp-Plantage, located in Zuid-Holland, the Netherlands.

Material and methods

Over 100,000 faunal remains were unearthed during excavations at the settlement site of Leiderdorp-Plantage in 2013 (Moesker & Cavallo 2016). The majority derive from Merovingian and Carolingian contexts, dating to approximately AD 650-850. As part of the

zooarchaeological assessment of the material by Moesker & Cavallo (2016), six specimens of the site of Leiderdorp-Plantage were identified as "whale", based on their size. Following the completion of the project, the zooarchaeological material was moved to the archaeological depot of the province of Zuid-Holland in Alphen aan den Rijn.

At the depot of Alphen aan den Rijn, a search for medieval cetacean remains was conducted in order to select specimens on which ZooMS would be conducted (van den Hurk et al. 2020). Eventually, three specimens from three different archaeological sites were selected and sampled. One of these three specimens was a specimen deriving from the site of Leiderdorp-Plantage. A search for the remaining five specimens from Leiderdorp-Plantage was also conducted, but unfortunately, due to time constraints and the fact that over 100,000 bones derive from the site, only one of the six specimens identified as whale was located. This one specimen, from trench 36, has find number V1790 and dates to the Carolingian period (AD 750-900). The specimen was identified as a scapula by Moesker and Cavallo (2016), measured about 30 by 20 cm and had a hole of 1.5 cm in diameter in it, suggesting it had been worked. A sample of approximately 30 mg was taken of the bone for ZooMS analysis.

ZooMS uses the persistence and slow evolution of collagen as a molecular barcode to read the identity of bones. The method uses peptide mass fingerprinting allied to high throughput Time of Flight Mass Spectrometry. Bones are subsequently identified by differences in the mass of the peptides which arise as a result of sequence differences between species. It is therefore a time-efficient and cheap species identification method (Buckley et al. 2009).

This sample from Leiderdorp Plantage (WH620) was processed together with the other 39 specimens at the BioArCh facilities at the University of York, UK. Collagen extraction, purification, mass spectrometry and peptide mass fingerprint identification followed the method outlined in Rodrigues et al. (2018), and is described in van den Hurk et al. (2020). Obtained spectra were compared to published *m/z* markers (which in mass spectrometry is the ratio of an ion's mass (m) in atomic mass units (amu) to its formal charge (z)) for mammals, as presented in Buckley et al. (2009), Buckley & Collins (2011), Kirby et al. (2013), Buckley et al. (2014) and Hufthammer et al. (2018) for species identification.

Results

While the other 39 specimens were identified as cetaceans (van den Hurk et al. 2020), the ZooMS spectra for specimen WH620, showed *m/z* peptide markers at 1453, 2115, 2853, 2999, and 3015 (figure 1) and was identified as a member of the family Elephantidae (Buckley et al. 2009, Buckley & Collins 2011). As the specimen derived from a medieval context from the Netherlands, this immediately drew attention as elephants are not endemic to the Netherlands. Historical sources, however, indicate that captive elephants sometimes made their way to the Netherlands and other parts of North-western Europe.

One of the first thoughts was that the specimen derived from Abul Abbas, the Asian elephant (*Elephas maximus*) of the Carolingian Emperor Charlemagne, which died in AD 810 near Lippeham (probably near modern Wesel, Germany), located on the Rhine River. Several claims have been made that the osseus remains of Abul Abbas had been found (Nünning & Cohausen 1974), and though Leiderdorp is located near the estuary of the Rhine River as well, the theory that the specimen derived from Abul Abbas was quickly abandoned on closer inspection of the bone, which turned out to be sub-fossilised, and thus of far greater antiquity.

Morphological comparison was therefore conducted with woolly mammoth (*Mammuthus primigenius*) specimens present at the zooarchaeological collection of the Gronin-

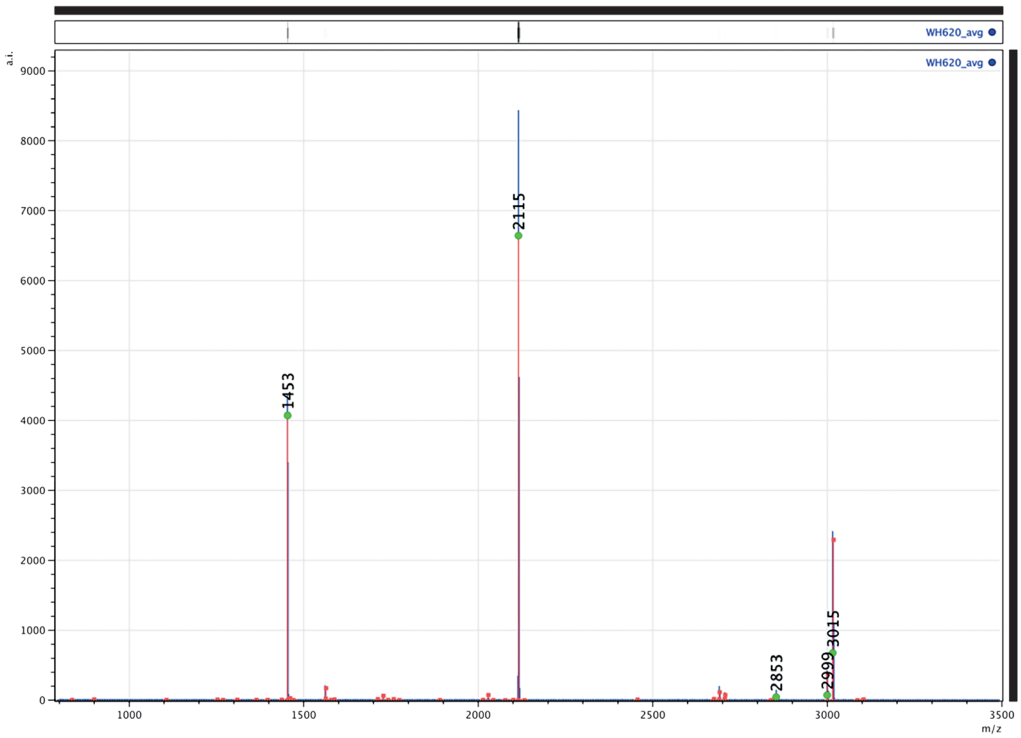

Figure 1. ZooMS spectra obtained from specimen WH620; *m/z* peptide markers at 1453, 2115, 2853, 2999 and 3015 identify the specimen as a member of the family Elephantidae (Buckley et al. 2009, Buckley & Collins 2011).

gen Institute for Archaeology, University of Groningen, the Netherlands. Based on anatomical comparisons the specimen was identified as a proximocaudal fragment of a right tibia (figure 2).

Discussion

Remains of Late Pleistocene mammals such as the woolly mammoth are relatively frequently found along the shoreline of the Netherlands and numerous mammoth remains have been identified and intensively studied (Glimmerveen et al. 2004). An interest in Late Pleistocene mammal remains in the Netherlands seems therefore to date as far back as the medieval period. It seems unlikely that medieval people of the site Leiderdorp-Plantage were aware that the bone belonged to a long extinct mammoth, but the sheer size of the bone might have been the reason it drew attention. The presence of a hole within the bone suggests the specimen was used as a tool, potentially as a weight for nets. At the site of Leiderdorp-Plantage, bone appears to have been used for the creation of a variety of tools and artefacts, including needles, spindle whorls, spoons, rings, skates, and over 300 combs (Verhoeven 2016), though none were the size of the specimens analysed herein. It remains unclear whether the other five specimens tentatively identified as "whale" from Leiderdorp-Plantage, might also actually represent remains of mammoth or other species of Pleistocene megafauna, or indeed derive from a species of whale.

Bones of cetaceans and mammoths have been confused before. During excavations at the medieval castle Gravensteen in Ghent, Belgium, Achilles Gautier misidentified several fragments of whale bones as mammoth

Figure 2. Specimen WH620 (right) in comparison to a right tibia of the woolly mammoth at the Groningen Institute for Archaeology.

bones (Van de Walle 1982, Ervynck et al. 2012). Gautier soon realised his mistake and retracted his previous identification and concluded the specimens were whale bones with several indications of tool marks (Ervynck et al. 2012). This anecdote reinforces the notorious difficulty in identifying cetacean remains and the need for biomolecular methods such as ZooMS to be conducted more frequently in order to develop a better idea of past cetacean exploitation activities, as well as the use of (sub-)fossilised faunal remains by past societies.

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Samenvatting

Biomoleculaire identificatie van mammoetresten in een Nederlandse middeleeuwse context

Als onderdeel van onderzoek naar middeleeuwse walvisvaart in Nederland en Vlaanderen werden 40 middeleeuwse archeologische restanten van walvisachtigen onderzocht aan de hand van Zooarchaeology by Mass-Spectrometry (ZooMS) om deze restanten op diersoort te identificeren. Van deze 40 restanten werden er 39 tot een walvisachtige soort, genus of familie geïdentificeerd. Echter, één van de vondsten werd geïdentificeerd als een soort uit de familie Elephantidae. Dit bot is afkomstig uit een Karolingische context (daterende tot circa 750-900 n. Chr.) uit de opgraving bij Leiderdorp-Plantage in Zuid-Holland. Bij nader morfologisch onderzoek bleek het te gaan om een proximocaudaal deel van een scheenbeen van een wolharige mammoet (*Mammuthus primigenius*). De vondst van een mammoetbot in een middeleeuwse context kan als uiterst merkwaardig worden getypeerd. Het fragment had ook een ronde perforatie wat er op lijkt te wijzen dat het bot in de middeleeuwen is gebruikt als een artefact of als werktuig.

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