

Finding the Aurochs (*Bos primigenius* Bojanus 1825) in the Late Holocene of Asia

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Received April 23, 2020; revised September 19, 2021; accepted December 18, 2021

Abstract—An m3 tooth of a large bovid (*Bos*) was found at the Late Holocene (Subatlantic period 1) archaeological site of Abylay (49.15° N, 75.07° E) in Kazakhstan. The tooth, 47.3 mm in length, was compared to the size of similar teeth of the Holocene aurochs (*Bos primigenius*) from Europe and cattle (*Bos taurus*) from Eastern Europe and Western Siberia of the Middle and Late Holocene (Subboreal and Subatlantic periods; Eneolithic, Bronze Age, Iron Age, Middle Ages). Our results show the size of the tooth from Abylay as being noticeably larger than that of the cattle and similar to the size of the teeth of the aurochs. Based on this result, we came to the conclusion that the tooth belonged to an aurochs. This observation suggests that the aurochs lived in the area of the Kazakh Uplands during the Late Holocene (Subatlantic 1). This seems to have been the last area inhabited by aurochs in Asia.

Keywords: fossil aurochs, Kazakhstan, Asia, range, extinction, teeth

DOI: 10.1134/S1062359023070154

INTRODUCTION

The aurochs (*Bos primigenius* Bojanus 1825) is probably the first species that became extinct as a result of human activities and for which the exact date of death of the last individual is known—1627 (Bogolyubskii, 1959). In the Holocene (climatic-stratigraphic division of the Holocene is accepted according to the Blitt-Sernander scheme), it was widespread in Europe and to a much lesser extent in Asia (Vuure, 2005). The range of the aurochs in northern Asia occupied the territory of the modern steppe and southern forest—steppe zones and reached Baikal (Gromova, 1931). No Holocene aurochs have been found in China (Vuure, 2005). In the Early Holocene (Preboreal and Boreal periods) and Middle Holocene (Atlantic and Subboreal periods), it was relatively numerous in Western Asia and Transcaucasia (Vuure, 2005) and possibly survived in Central Asia (Batirov, 1987; Batyrov, 1995). In Europe, the aurochs survived, as already noted, until 1627, i.e., until the end of the Late Holocene (Subatlantic period 3). In Northern Asia, the latest remains of the aurochs date to the middle of the Subboreal period (SB 2) (Kosintsev and Kisagulov, 2018; Plasteeva et al., 2020); in Western Asia, the aurochs probably survived until the end of the Subboreal period (SB 3) (Vuure, 2005).

MATERIALS AND METHODS

The main problem in diagnosing the remains of the aurochs is their morphological similarity to remains of cattle, since the aurochs is the initial form for the latter (Clutton-Brock, 1999; Edwards et al., 2007; Loftus et al., 1994). The only diagnostic feature other than DNA is bone size. This is based on the fact that a decrease in bone size in domestic cattle occurred over time after the domestication of the aurochs (Tsalkin, 1970; Bökönyi, 1974). The proposed methods for distinguishing the aurochs and cattle in the fossil state are based on the size of horns, teeth, and bones (Gromova, 1931; Paaver, 1965; Tsalkin, 1970; Bökönyi, 1974; Vörös, 1987; Kobryn and Lasota-Moskalewska, 1989; Lasota-Moskalewska and Kobryn, 1990; Koenigswald and Menger, 2002; Vuure, 2005; Lynch et al., 2008; Prummel and Niekus, 2011; Wright and Viner-Daniels, 2013; Kosintsev and Kisagulov, 2018). But the differences in size are not absolute, but rather overlap. In particular, the bone sizes of domestic bulls largely overlap with the bone sizes of aurochs (Tsalkin, 1970). This phenomenon makes it difficult to attribute a significant number of remains of the genus *Bos* from the localities within the historical range of the aurochs to wild or domestic forms (Vuure, 2005). In these cases, the remains, the size of which exceeds the size of



Fig. 1. Image of m3 in the aurochs (*Bos primigenius*) from the settlement of Abylay. Chewing surface (top) and buccal side (bottom).

the corresponding remains of cattle, are attributed to the aurochs.

When studying bone remains from the Early Iron Age settlement of Abylay in Central Kazakhstan (49.15° N, 75.07° E), an m3 tooth (no. 2901/179, the storage place is the museum of the Institute of Ecology and Evolution, Ural Branch, Russian Academy of Sciences) of a very large representative of the genus *Bos* was found (Fig. 1). The tooth was found in the excavation of 2018, in the G/6 square, at a depth of 10–40 cm. The measurement was carried out according to the standard method (Driesch, 1976). Tooth crown, mm: length is 47.3, width is 17.1. The tooth is intact, yellowish gray in color, slightly fossilized, belonged to

an adult, but not an old individual. It does not differ in color or degree of fossilization from other teeth of large and small cattle found in the settlement. A representative collection of bone remains, almost all of which belong to domestic forms, was obtained from the excavations of this settlement (Table 1).

The settlement of Abylay is located on the territory of the Karkaraly district of Karaganda oblast in the Republic of Kazakhstan (49.15° N, 75.07° E). The monument has been studied under the guidance of A.Z. Beisenov since 2016. The settlement located on the southern slope of a hill has an area of more than 2000 m². Several small residential buildings and a large utility building, the preserved remains of which are stone foundations, were studied during archaeological excavations. Numerous fragments of pottery from flat-bottomed hand-made vessels as well as several hundred stone tools were found in the cultural layer. All archaeological material refers to the Tasmolin culture of the Early Iron Age (Beisenov et al., 2018), which is dated to the 8th–5th centuries BC based on archaeological materials and a series of calibrated radiocarbon dates (Beisenov, 2017, 2018). A radiocarbon AMS date of 2448 ± 33 (UBA-743) years ago was obtained from the bone from the Abylay settlement, which corresponds to the Late Holocene (the first stage of the Subatlantic period, SA 1).

To determine the taxonomic identity of this tooth, we analyzed the changes in the length of m3 in the aurochs of Western Europe (Paaver, 1965; Tsalkin, 1970; Wright, 2013; Wright and Viner-Daniels, 2015) and Eastern Europe (Gromova, 1931; Paaver, 1965; Tsalkin, 1970; Zhuravlev, 2001) and in cattle from archaeological sites of the Eneolithic Age, Bronze Age, Early Iron Age, and Middle Ages of Eastern Europe (Tsalkin, 1970, 1972; Timchenko, 1972; David and Chemyrtnan, 1979; Petrenko, 1984; Zhuravlev, 2001; Kosintsev, 2003) and Western Siberia (Akhinzhanov et al., 1992; Kosintsev, 2000; authors' data) (Table 2). The analysis includes samples from sites of a wide chronological range, from the Middle Holocene (Subboreal period, Eneolithic and Bronze ages) and the entire Late Holocene (Subatlantic period, Early Iron Age, Middle Ages) and from a very large territory. All this permits the possible influence of secular and geographical variability on the size of teeth to be taken into account.

This article uses uncalibrated radiocarbon dates and an updated Holocene periodization scheme by A. Blitt and R. Sernander (Khotinskii et al., 1991). According to this scheme, the boundary between the middle subboreal phase (SB 2) and the late subboreal phase (SB 3) passes around the date 3270 ± 60 (IGAS-734), the boundary between the subboreal and subatlantic periods passes between 2500–2700 radiocarbon years ago, and the boundary between early subatlantic (SA 1) and middle subatlantic (SA 2) phases goes

Table 1. Species composition of bone remains from the excavations of the settlement of Abylay

Taxa	Number of remains
Fox (<i>Vulpes vulpes</i> L. 1758)	2
Aurochs (<i>Bos primigenius</i> Bojanus 1825)	1
Saiga (<i>Saiga tatarica</i> L. 1758)	2
Dog (<i>Canis familiaris</i> L. 1758)	9
Domestic horse (<i>Equus caballus</i> L. 1758)	502
Bactrian camel (<i>Camelus bactrianus</i> L. 1758)	4
Cattle (<i>Bos taurus</i> L. 1758)	654
Sheep (<i>Ovis aries</i> L. 1758)	184
Goat (<i>Capra hircus</i> L. 1758)	8
Small cattle (<i>Ovis aries</i> L. 1758 and <i>Capra hircus</i> L. 1758)	826
Mammals that were not identified more accurately	3306

Table 2. Length of m3 of the aurochs (*Bos primigenius*), cattle *Bos taurus*, and aurochs (*Bos primigenius*) from the settlement of Abylay, mm

Taxon	<i>n</i>	min	max
Auroch (<i>Bos primigenius</i>) ¹	43	38.0	57.0
Cattle (<i>Bos taurus</i>) ²	872	27.0	45.0
Auroch (<i>Bos primigenius</i>) (Abylay)	1	47.3	

¹ (Gromova, 1931; Zhuravlev, 2001; Paaver, 1965; Tsalkin, 1970; Wright, 2013; Wright and Viner-Daniels, 2015); ² (Akhinzhanov et al., 1992; David and Chemyrntan, 1979; Zhuravlev, 2001; Kosintsev, 2000, 2003; Petrenko, 1984; Timchenko, 1972; Tsalkin, 1970, 1972; authors' data).

around the date 1880 ± 40 (IGAS-737) years ago (Khotinskii et al., 1991).

This study used osteological collections stored in the museum of the Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences, in Yekaterinburg.

RESULTS AND DISCUSSION

The length of the studied tooth from Abylay (no. 2901/179) was compared with the length of the teeth of the aurochs and cattle (Table 2). The greatest length of a tooth in cattle is 45.0 mm; in the aurochs, the minimum length is 38.0 mm, and the maximum length is 57.0 mm (Table 2). The length of the tooth from Abylay exceeds the largest tooth size in cattle by 2 mm and corresponds to the tooth size in the aurochs. This allows us to attribute the tooth from Abylay to the aurochs.

On the territory of the south of Western Siberia and Kazakhstan, bone remains from 79 settlements were studied, which date back to the end of the Middle Holocene (Subboreal period 2 and 3 (SB 2 and SB 3), Late Bronze Age, 4200–2600 years ago) and the beginning of the Late Holocene (beginning of the Subatlantic period (SA 1), Early Iron Age, 2600–1800 years ago) (Krivtsova-Grakova, 1947; Akh-

inzhanov et al., 1992; Kosintsev, 2003a; Outram and Kasparov, 2007; Devyashin and Kosintsev, 2013; Gaiduchenko and Loman, 2015; Beisenov et al., 2018). Bones of very large bulls were found earlier at a number of settlements of the Late Bronze Age in Central Kazakhstan. A humerus and a talus were found at the settlement of Alekseevskoye (Krivtsova-Grakova, 1947), four metacarpal bones were found at the settlement of Kent (Outram and Kasparov, 2007), a metacarpal bone was found at the settlement of Konezavod III, and a lower jaw was found at the settlement of Chaglinka (Akhinzhanov et al., 1992). All these finds were attributed by the authors of the study to the aurochs. In the Southern Trans-Urals, aurochs bones were found in several archaeological sites dating from the middle of the Subboreal period (SB2, the beginning of the Late Bronze Age; 3900–3700 years ago) (Kosintsev and Kisagulov, 2018). Two m3 teeth, which are 44.0 and 44.9 mm long, were found there. These values are on the border between the teeth of the aurochs and cattle, so the authors presumably attributed them to the aurochs, but some of the bones from these localities undoubtedly belong to this species (Kosintsev and Kisagulov, 2018).

The remains of the Holocene aurochs are known from several regions of northern Asia. The earliest find comes from the bank of the Chumysh River in Altai

and dates from the very beginning of the Holocene 10241 ± 404 , NSKA-01090 years ago (preboreal period, PB) (Vasiliev et al., 2016). A younger age was determined for the bone from Tuva, which has a radiocarbon date of 9860 ± 160 , SBAS-6336 years ago (Lavrov and Zabelin, 2007), and a bone from the Southern Trans-Urals, from which the date 8040 ± 160 , SBAS-5754 years ago was obtained (Plasteeva et al., 2020), which corresponds to the Early Holocene (PB). The easternmost find in the Baikal region is dated to 4966 ± 30 , OxA23949 and 4940 ± 30 , OxA23948 years ago (Lozei et al., 2014). In Northern Asia, a number of Holocene finds of the remains of the aurochs are known, which do not have a more accurate age determination. They were found in the Middle Holocene (Neolithic–Late Bronze Age) layers of the Ust-Narym archaeological site in East Kazakhstan (Chernikov, 1960). A less certain age (Holocene) was determined for finds from numerous localities in Kazakhstan (Kozhamkulova, 1969), from alluvial deposits of the Ural River (Vereshchagin and Gromov, 1952), and from lacustrine deposits of the Kulunda steppe (Vereshchagin, 1956). There are known images of aurochs on rocks that date back to the Middle Holocene (Marikovskii, 1953; Kadyrbaev and Maryashev, 1977; Francfort et al., 1993).

The above analysis of the remains of the aurochs in the Holocene of northern Asia shows that the latest reliable finds have been dated until now to the end of the Middle Holocene or the end of the Subboreal period (SB 3, the end of the Late Bronze Age). It is possible that the aurochs survived in Western Asia until the boundary of the Middle and Late Holocene (the boundary of the Subboreal and Subatlantic periods, SB3–SA1) (Vuure, 2005). The find from Abylay is dated to the beginning of the Late Holocene or Subatlantic period 1 (SA 1). This is the latest dated find of the aurochs in Asia.

There is an opinion about the possible habitat of the aurochs in the Altai steppes, near the city of Kuznetsk at the beginning of the 18th century (Vereshchagin, 1956; Geptner and Naumov, 1961). This conclusion was made on the basis of the information provided by the English traveler J. Bell in the description of his travels (*Belevy puteshestviya...*, 1776). Later, these data were critically analyzed by W. Kawecki (Kawecki, 1974). He showed that they were erroneous and this error was associated with an inaccurate translation. The Russian translation was not made from the original English edition, but from the translated French edition. The original text refers to yak bulls. As a result of two translations, “bulls” “turned” into aurochs. This is indirectly confirmed by the descriptions of travels in the 18th century on this area by other scientists. The diaries of meticulous researchers such as Messerschmidt (Messerschmidt, 1964), Gmelin (Gmelin, 1751, cited by Sokolov and Parnes, 1993), and Pallas (Pallas, 1786, 1788, 1788a) give a description of the yak, but there is no mention of the aurochs.

The above data show that the aurochs inhabited the area of the Kazakh uplands in the Late Holocene (Subatlantic period, phase 1 (SA1)). This is the last habitat of this species in Asia.

ACKNOWLEDGMENTS

We would like to thank the reviewer, whose comments and recommendations made it possible to improve the text of the article significantly.

FUNDING

This article was supported by the Ministry of Education and Science of the Republic of Kazakhstan, project no. AP08857177.

COMPLIANCE WITH ETHICAL STANDARDS

The authors declare that they have no conflicts of interest. This article does not contain any studies involving animals or human participants performed by any of the authors.

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Translated by L. Solovyova