

# Environmental Archaeology

## The Journal of Human Palaeoecology

ISSN: (Print) (Online) Journal homepage: <https://www.tandfonline.com/loi/yenv20>

## Reindeer Demographics at larte VI, Iamal Peninsula, Arctic Siberia

Tatiana Nomokonova, Robert J. Losey, Pavel A. Kosintsev & Andrei V. Plekhanov

To cite this article: Tatiana Nomokonova, Robert J. Losey, Pavel A. Kosintsev & Andrei V. Plekhanov (2021): Reindeer Demographics at larte VI, Iamal Peninsula, Arctic Siberia, *Environmental Archaeology*, DOI: [10.1080/14614103.2021.1995260](https://doi.org/10.1080/14614103.2021.1995260)

To link to this article: <https://doi.org/10.1080/14614103.2021.1995260>



Published online: 03 Nov 2021.



Submit your article to this journal 



View related articles 



CrossMark

View Crossmark data 



## Reindeer Demographics at larte VI, Iamal Peninsula, Arctic Siberia

Tatiana Nomokonova <sup>a</sup>, Robert J. Losey  <sup>b</sup>, Pavel A. Kosintsev<sup>c</sup> and Andrei V. Plekhanov<sup>d</sup>

<sup>a</sup>Department of Archaeology and Anthropology, University of Saskatchewan, Saskatoon, Canada; <sup>b</sup>Department of Anthropology, University of Alberta, Edmonton, Canada; <sup>c</sup>Palaeoecology Laboratory, Institute of Plant and Animal Ecology, Ural Division of the Russian Academy of Science, Ekaterinburg, Russian Federation; <sup>d</sup>Arctic Research Center, Salekhard, Russian Federation

### ABSTRACT

This study focuses on constructing a demographic profile for a large set of reindeer (*Rangifer tarandus*) remains from the Iron Age larte VI site on the Iamal Peninsula in Siberia. larte VI produced one of the largest reindeer assemblages in the entire Arctic, totalling ~22,000 specimens. Age assessment is conducted by examining teeth eruption sequences in 686 mandibular fragments. Sex identification is based on analysis of 595 os coxae through visual observation of the acetabulum ventro-medial rim or border. Our assessments demonstrate that inhabitants at larte VI accessed various reindeer age categories, with adults being the most often utilised group of animals. Adults were found in all excavated sections and cultural strata at the site and consisted of both males and females. Other age groups such as newborns, yearlings, and juveniles were also present but in smaller quantities. The majority of the sub-adult individuals were under six months of age, indicating the use of this location during the warmer seasons, most often in fall. This seasonal pattern of site use is similar to historic seasonal migrations by many Indigenous reindeer herding families, who move north to utilise the tundra of Iamal Peninsula during the spring, summer, and early fall.

### ARTICLE HISTORY

Received 11 August 2021  
Revised 10 October 2021  
Accepted 13 October 2021

### KEYWORDS

Reindeer; demographic profiles; seasonality; Iamal Peninsula; Arctic Siberia; teeth eruption

## Introduction

Reindeer or caribou (*Rangifer tarandus*) are a commonly-studied species in zooarchaeology, in part because these animals have sustained Indigenous populations of the Circumpolar North for millennia (e.g. Anderson 2002; Anderson et al. 2014; Binford 1978; Bjørklund 2013; Bogoras 1904–09; Golovnev 1995; Golovnev, Garin, and Kukanov 2016; Jackson and Thacker 1997; Khomich 1966; Krupnik 1993; Parlee and Caine 2018; Sharp and Sharp 2015; Spiess 1979; Stépanoff 2017; Vitebsky 2006). In both their wild and domestic forms, *Rangifer* have dramatically shaped peoples' ways of being, seasonal migration patterns, and even daily movements (Anderson 2002; Golovnev, Garin, and Kukanov 2016; Khomich 1966; Krupnik 1976, 1993; Randymova 2004; Vitebsky 2006). This is especially the case for the Iamal Peninsula of Arctic Siberia (Figure 1), where some Nenets travel yearly up to 1500 km across the tundra to ensure the well-being of their reindeer. These animals, in return, provide their bodies for use as food and materials for the construction of dwellings, clothing, ropes, and other household items (e.g. Golovnev et al. 2014, 2016; Khariuchi 2001; Khomich 1966; Kushlevskii 1863; Ravna 2018; Zhitkov 1913). This dependence on reindeer is long-term in Iamal, indicated in part by numerous reindeer remains and artefacts made from their body parts in the region's Late

Holocene archaeological sites (e.g. Aleksahenko 2002; Bachura et al. 2017; Fedorova 2006; Fedorova, Kosintsev, and Fitzhugh 1998; Gusev and Fedorova 2017; Gusev, Plekhanov, and Fedorova 2016; Nomokonova et al. 2018, 2020b, 2021; Plekhanov 2014; Vizgalov et al. 2013).

Several key issues drive most archaeological research in Iamal. The first involves the timing and processes of the emergence of reindeer domestication, and its development into large-scale pastoralism. Reindeer harnessing equipment is present in southern Iamal along the Ob' River as early as ~200 BCE, likely indicating the emergence of small-scale herding by this time (Gusev 2014; Gusev and Fedorova 2017; Gusev, Plekhanov, and Fedorova 2016; Losey et al. 2021). Genetic research on modern and archaeological reindeer indicates that this relationship involved local populations, with the direct ancestors of today's domestic reindeer herds in Iamal deriving from an introduced population sometime between the fifteenth- and eighteenth-century CE (Røed et al. 2020). Large-scale pastoralism is an even more recent practice, developing in the mid- to late-eighteenth-century CE (Krupnik 1993; Stépanoff 2017).

The second issue involves better understanding the processes of widespread occupation of the Iamal tundra. By at least 900 CE, multiple habitation sites are



**Figure 1.** Map of the Russian Federation with locations of the Yamal Peninsula and Iarte VI indicated.

found on the Yamal Peninsula, including several located inland (Fedorova 2014; Fedorova, Kosintsev, and Fitzhugh 1998; Gusev, Plekhanov, and Fedorova 2016; Plekhanov 2014; Vizgalov et al. 2013). The most thoroughly documented of the latter is Iarte VI on the Iuribei River (Plekhanov 2014; Nomokonova, Losey, and Plekhanov 2017a, 2018), which we examine here. Scholars have argued that domestic reindeer transport enabled such widespread occupation of the tundra (Fedorova 2000, 2006; Golovnev 1995; Gusev, Plekhanov, and Fedorova 2016). In other words, this period potentially witnessed the initial presence of long-distance migrations on the peninsula. Conversely, sites such as Iarte VI potentially show evidence for less mobility than seen today on the tundra. This evidence includes the presence of pit-dwellings, as opposed to the highly mobile tents used by Nenets today, and extensive midden deposits containing the remains of hundreds of reindeer. Both such traits characterise Iarte VI (see below).

The final issue involves the diachronic and seasonal nature of Late Holocene subsistence practices. In southern Yamal along the Ob' River, subsistence was seemingly broader than on the tundra, the former including significant reliance on riverine fishing and the hunting of reindeer, waterfowl, and grouse (Bachura et al. 2017; Losey et al. 2017). On the tundra, reindeer always predominate faunal assemblages, but coastal sites also show some use of pinnipeds (Fedorova, Kosintsev, and Fitzhugh 1998; Nomokonova, Losey, and Plekhanov 2017a, 2017b, 2018; Vizgalov et al. 2013). While seasonality information is mostly lacking for Yamal archaeological sites, those on the tundra are suspected to represent warm-season occupations. Heavy reliance on domestic reindeer for dietary needs is said to be associated only with the emergence of large-scale pastoralism (i.e. in the mid-to late-eighteenth-century CE). Historical documents indicate that as late as the seventeenth-century CE, subsistence in Yamal mostly involved wild reindeer hunting and fishing, despite the fact that domestic reindeer were kept by nearly all families (Krupnik 1993; Stépanoff 2017).

Reconstruction of reindeer demographic profiles is potentially useful for addressing many of these issues. Specifically, age and sex information could contribute to understanding seasonality and decision-making processes involved in hunting, processing, and herd management (Morrison 1997; Morrison and Whitridge 1997; Pasda 2009; Spiess 1979; Weinstock 2000a, 2000b, 2002). For example, the presence of only adult females and newborn animals at archaeological sites can indicate interaction with a breeding herd at or near its calving area in spring (Khomich 1966, 56). Demographic profiles that consist mostly of prime adults could suggest a preference towards these animals throughout the year, where reindeer were used for food and their hides utilised in constructing dwellings covers and sleeping mats (Gemuev, Molodin, and Sokolova 2005, 434; Golovnev, Garin, and Kukanov 2016, 60–61, 122; Khariuchi 2001, 48; Khomich 1966, 63–65, 86; Ravna 2018; Zen'ko-Nemchinova 2006, 80–81; Zhigunov and Terent'ev 1948, 161). Selectivity towards yearlings could indicate a strategy focusing on hides that are most suitable for clothing, similar to present domestic reindeer slaughtering strategies on the Yamal peninsula (Bogordaeva 2006, 23; Gemuev, Molodin, and Sokolova 2005, 438; Golovnev, Garin, and Kukanov 2016, 60–61, 122; Khomich 1966, 85; Randymova 2004, 67; Ravna 2018).

Several methods are used to reconstruct the age and sex of *Rangifer tarandus* remains. These include examination of teeth eruption patterns, teeth wear, bone epiphyseal fusion, and cementum annuli in teeth roots, as well as crown height measurements (e.g. Leader-Williams 1979; Miller 1972, 1974; Morrison 1997; Morrison and Whitridge 1997; Pasda 2006, 2009; Pike-Tay 1995; Pike-Tay, Morcomb, and O'Farrell 2000; Remers and Nordby 1968; Spiess 1979; Takken Beijersbergen 2017; Takken Beijersbergen and Hufthammer 2012; van den Berg, Loonen, and Çakırlar 2021). Sex estimation methods include mandibular and postcranial metric assessments and visual observation of the thickness and breadth of the acetabulum ventro-medial rim (Morrison 1997; Morrison and Whitridge 1997; Pasda 2009; Spiess 1979; Tyler 1987; Weinstock 2002). Among age assessment techniques, cementum studies can be the most accurate but are rarely used due to their destructive and time-consuming nature (e.g. Klevezal' 2007; Pasda 2006, 2009, 35–44). Examination of teeth eruption is perhaps the most reliable non-destructive method to identify young reindeer. Use of mandibular and postcranial bone measurements, epiphyseal bone fusion, and teeth wear patterns have provided mixed results (e.g. Pasda 2009, 12, 35, 48–49) and are generally considered less reliable than cementum studies and teeth eruption patterns.

In this article, we examine teeth eruption sequences and acetabulum ventro-medial rims to reconstruct

reindeer age and sex at the Iron Age Iarte VI site on the tundra of the Yamal Peninsula (Figure 1). This site is chosen for three reasons. First, the site has produced over 22,000 reindeer remains, making it one of the largest *Rangifer tarandus* assemblages in the Arctic (Nomokonova et al. 2018, 2020b). This provides a rare opportunity to examine reindeer demographic profiles using a large number of specimens. Second, Iarte VI is the most well-dated archaeological site in this region. Modelling of 32 radiocarbon dates from the site indicate that the primary occupation spanned from ~1016 to 1122 CE, overlapping well with a suite of dendrochronology dates for the site (Nomokonova et al. 2018). Further, several studies have already assessed reindeer remains from Iarte VI (e.g. Anderson et al. 2019; Nomokonova et al. 2018, 2019, 2020a, 2020b; Røed et al. 2020), providing baseline data for future integration of new evidence aimed at better understand people and reindeer relationships in this region.

## Materials

The study dataset consists of 686 reindeer mandibular and 595 os coxae fragments. These specimens were recovered during excavations of Iarte VI in the 1990s as well as in 2013 and 2015 (Brusnitsina and Oshchepkov 2000; Nomokonova et al. 2018; Plekhanov 2014; Shiiatov and Khamtemirov 2000; Vizgalov et al. 2013). The total excavated area of this settlement is 338 m<sup>2</sup>. Iarte VI contains remains of seven house pits and a ditch measuring 4 × 15 m, the latter located in the southeastern section of the site. The ditch was perhaps built initially to help to fortify the settlement, but over the course of occupation was also utilised for household waste disposal. The latter is suggested by the presence of midden strata in the ditch consisting of very dense concentrations of bones and other organic materials, particularly along the innermost sections of the ditch (Plekhanov 2014). Excavations at Iarte VI have produced just over 800 artefacts and almost 40,000 faunal remains. These artefacts include scrapers, knives, arrowheads, pottery fragments, rope, net, wool, clothing fragments, pendants, bracelets, combs, toys, hooks, boat paddle fragments, net-sinkers, and other objects (Plekhanov 2014). Reindeer comprise ~97% of the faunal specimens identified below class level (Nomokonova et al. 2018). The rest belong to arctic fox, wolf, dog, beaver, arctic hare, pinipeds, swans, geese, ducks, loons, ptarmigans, gulls, jaeger, pike, and taimen (Nomokonova, Losey, and Plekhanov 2017a, 2018; Vizgalov et al. 2013). Geoarchaeological and faecal biomarker research in the immediate Iarte VI area suggests living reindeer were confined in the site area, perhaps indicating the presence of small domestic reindeer herds (Anderson et al. 2019).

The excavations at Iarte VI in the 1990s and in 2013 and 2015 covered areas of 266 and 72 m<sup>2</sup>, respectively (Plekhanov 2014). They are analyzed here as two separate samples for two reasons. First, results of the 1990s excavations remain largely unpublished and therefore cannot be fully integrated with data generated in the later excavations. The 1990s collection is curated at the Institute of Plant and Animal Ecology, Ural Branch of the Russian Academy of Science in Ekaterinburg (Russian Federation). Access was provided only to the mandibles and pelvis elements from this assemblage, and information on other skeletal elements is unavailable. Second, the faunal collections from 2013 and 2015 have detailed contextual data, including stratigraphic information, and we analyzed all skeletal elements recovered from these contexts (Nomokonova, Losey, and Plekhanov 2017a, 2017b, 2018; Plekhanov 2014). These collections are stored at the Arctic Scientific Center of the Yamal-Nenets Autonomous District in Salekhard.

The 1990s mandibular sample is comprised of 555 fragments from a minimum of 149 reindeer, while the 2013 and 2015 excavations generated 131 mandibular fragments from a minimum of 56 animals (Table 1). Minimum number of individual (MNI) values were calculated for the 2013 and 2015 sample with the assumption that specimens from each stratum are independent (the maximum distinction method, following Lyman 2008). Collapsing these specimens into a single analytical unit (the minimum distinction method) would produce no meaningful differences in study outcomes. The analyzed 1990s os coxae sample includes 288 specimens from a minimum of 83 individuals, and the 2000s excavations produced 307 fragments from a minimum of 96 animals (Table 2). Reindeer mandibles and os coxae were found in almost every stratigraphic layer in the 2013 and 2015 excavation trenches, with the majority being from the bones and organics, and dark-brown sandy loam layers. These layers produced the most faunal remains and generated the largest number of artefacts (Nomokonova et al. 2017b, 2018, 2019). Spatially, these elements were spread throughout the excavated area and were found mixed with other artefacts and disarticulated animal bones. Several os coxae and mandibular fragments were modified, including butchering marks (Tables 1 and 2).

## Methods

Reindeer mandible age assessments involved examination of teeth eruption patterns following Pasda's (2009, 3, 33) data for Greenland reindeer, with a few adjustments. Here we focus our efforts mainly on molars. The methods developed by Pasda (2009), Miller (1974), and Spiess (1979) are designed for complete mandibles, but in most archaeological contexts

**Table 1.** Reindeer mandibular fragments at Iarte VI.

Year	Layers	NISP	MNE	MNI	# Eroded	# Gnawed	# Cut/chop
1990s	All layers	555	282	149	39		2
2013 & 2015	Dark-grey sandy loam	14	10	6	3		
2013 & 2015	Light-grey sandy loam	11	8	6			
2013 & 2015	Layer of bones & organics	55	38	23	3	1	1
2013 & 2015	Dark-brown sandy loam	44	34	18	2	2	1
2013 & 2015	Yellow-grey sandy loam	6	3	2	1		
2013 & 2015	On the bedrock	1	1	1			
2013 & 2015	All layers	131	94	56	9	3	2

Notes: NISP is Number of Identified Specimens (total of identified mandibular remains, both complete and fragmented). MNE is Minimum Number of Elements (minimum number of mandibles calculated with consideration of portion, size, side, and stratigraphic position). MNI is Minimum Number of Individuals (minimum number of reindeer based on mandibles' counts).

mandibles are fragmented, including at Iarte VI. Focusing on molars allows us to assess a larger proportion of the mandibles in the assemblages – molar sections produce the greatest minimum number of individual counts for the mandibles. Furthermore, the molar eruption sequences allow us to assess the ages of individuals until approximately 18 months of age, which is potentially useful for the season of death assessments. Finally, the eruption of permanent premolars in reindeer occurs at nearly the same time as the eruption of the third molar, meaning that their eruption patterns provide little additional detail beyond that revealed by the molars.

Iarte VI reindeer mandibles are assigned to five eruption stage categories that are then used to infer ages and seasons of death (Table 3). Age categories 1 and 2 are based on  $M_1$  eruption patterns and were found to be the most consistent across a number of *Rangifer tarandus* populations. Eruption of the first molar is typically assigned to 3–5 months of age for caribou populations in Canada and Alaska, and reindeer from Greenland and parts of the Russian Federation (Pasda 2009, 32, table 7). The only exception to this pattern is the recent information on Svalbard reindeer, where the eruption of this molar is said to occur anywhere from 0 to 12 months of age (van den Berg, Loonen, and Çakırlar 2021). Age categories 3–5 are based on  $M_2$  and  $M_3$  eruption patterns and should be used with caution, as more variability is reported for the eruption timing of these teeth (Miller 1972, 1974; Pasda 2009, 32, table 7; Spiess 1979). Possible seasons of death in Table 3 are given in months after calving. Domestic reindeer are born on the Yamal

Peninsula from mid-April till the beginning of June (Podkorytov 1995, 28). Wild reindeer typically calve about two weeks later than domestic animals (Baskin 2009, 147). For the purposes of this study, we use mid-May as the average time for calving.

Sex assessments of os coxae were made through visual observation of the thickness of the ventro-medial border of the acetabulum, which is noticeably broader in adult males than in females after one year of age (Figure 2; Pasda 2009, 11; Tyler 1987; Weinstock 2000b). Os coxae are generally considered one of the best indicators of sex in mammals, and similar methods to those used here have been applied to other ungulate species (e.g. Greenfield 2006). In some studies, this technique has been used in combination with the breadth measurement of the acetabulum rim (Tyler 1987). This measurement was not incorporated in this study as we, in agreement with Pasda (2009, 12), experienced difficulty in consistently measuring these element features.

## Results

Of the 686 mandibular fragments from Iarte VI, 267 had a complete or partial molar sets that could be used in age assessments (Table 4; Figure 3). These specimens are from a minimum of 120 reindeer from the 1990s excavations and at least 37 animals from the 2013 and 2015 sample. No age category 1 individuals (those without at least the  $M_1$  erupting) were present in either sample (Table 3). The majority of the mandibles were from adult reindeer in category 5. They comprised about 72% of the assessable 1990s

**Table 2.** Reindeer os coxae remains at Iarte VI.

Year	Layers	NISP	MNE	MNI	# Eroded	# Gnawed	# Cut/chop	# Burnt	MNI female	MNI males
1990s	All layers	288	163	83	4	89	42	1	26	22
2013 & 2015	Dark-grey sandy loam	19	11	8	4	4	3		1	
2013 & 2015	Light-grey sandy loam	22	12	9	1	2	3		2	1
2013 & 2015	Layer of bones & organics	166	74	43	6	52	12	3	5	1
2013 & 2015	Dark-brown sandy loam	90	61	30	1	11	6		4	3
2013 & 2015	Yellow-grey sandy loam	7	5	5		1	3		1	1
2013 & 2015	On the bedrock	3	2	1						
2013 & 2015	All layers	307	165	96	12	70	27	3	13	6

Notes: NISP is Number of Identified Specimens (total of identified os coxae remains, both complete and fragmented). MNE is Minimum Number of Elements (minimum number of os coxae calculated with consideration of portion, size, side, and stratigraphic position). MNI is Minimum Number of Individuals (minimum number of reindeer based on os coxae counts).

**Table 3.** Categories for assigning and interpreting reindeer age based on teeth eruption used here.

Age category	Eruption stages	Possible age group	Possible seasons
1	M <sub>1</sub> not erupting	Under 3 months	mid-May to mid-August
2	M <sub>1</sub> erupting	3–5 months	mid-August to mid-October
3	M <sub>2</sub> erupting	7–13 months	mid-November to mid-June
4	M <sub>3</sub> erupting	13–18 months	mid-June to mid-November
5	M <sub>3</sub> fully erupted	older than 18 months	unknown

individuals, and ~56% of 2013 and 2015 specimens. Age categories 2 and 4 were the second and third most abundant groups of animals in both samples. Reindeer with erupting M<sub>2</sub>, or category 3 specimens, were the least abundant and are represented by only a few individuals. In the 2013 and 2015 samples, almost all reindeer age categories were present in each cultural layer, with a few exceptions. First, the most recently deposited layer of dark-grey sandy loam contained only mandibles of animals older than one year (categories 4–5). Second, category 3 was represented only in the bones and organics layer, which produced more reindeer remains than any other stratum at the site.

The lower molar eruption sequences also allow us to assess the seasons during which people were interacting with reindeer at Iarte VI. The presence of animals with erupting M<sub>1</sub> teeth indicate late summer and early fall reindeer use. Such individuals were found in almost all layers at Iarte VI where assessable specimens were present (Table 3). This suggests that procuring reindeer during late summer or early fall was common for the inhabitants of Iarte VI. This

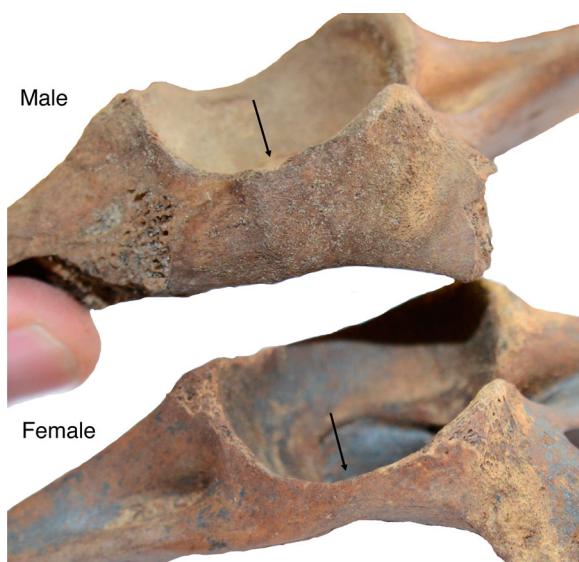
proposition is also supported by greater numbers of mandibles with erupting M<sub>3</sub> teeth in both samples, which also occurs during the warmer portion of the year. However, it is interesting that mandibles with erupting M<sub>2</sub> teeth are rare. This molar is the only one of the three that erupts mostly during the colder period of the animals' first year of life, indicating that hunting or culling animals of this age category at Iarte VI was minimal.

Analyses of the 595 os coxae fragments from Iarte VI allowed assignment of sex for 89 elements from at least 48 individuals from the 1990s excavations, and for 26 os coxae from at least 19 individuals from the 2013 and 2015 sample (Table 2). Overall, these were assigned to 39 females (including nine animals identified as probable females) and 28 males (including eight animals identified as probable males). These results demonstrate that both adult males and females were utilised at this settlement, perhaps with a slight preference for the latter. The sexed elements from the 2013 and 2015 sample showed little distinct patterning by stratigraphic layer, in part due to the small samples sizes involved when the sample is analyzed in this manner. The fragmentation of os coxae in this sample seemed to be higher than in 1990s collection, resulting in a low sexing rate.

## Discussion and Conclusion

One of the advantages of using teeth eruption methods for ageing reindeer is that eruption stages are relatively consistent across a variety of *Rangifer tarandus* populations. However, this method only allows one to identify animals in their first two years of life and assigns the remaining specimens to the category of >18 months of age (Table 3). To address this limitation, we compare results of the teeth eruption method with those from a previous examination of all Iarte VI reindeer skeletal remains from the 2013 and 2015 sample (Table 5; Nomokonova, Losey, and Plekhanov 2019). This earlier study focused on analyses of epiphyseal fusion sequences of long bones for ageing purposes.

Drawing on both ageing methods, it is clear that reindeer of various age categories were utilised at Iarte VI, but adults older than 2.5 years of age are most abundant. Remains of adults, from both males and females, were most abundant in the ditch deposits, being found in every cultural layer (Table 5). Remains of newborn reindeer, in contrast, are very rare despite the good preservation of organic materials, including leather and rope fragments (Plekhanov 2014). Remains of only three newborn individuals were found at the settlement. These are cranial fragments from two animals in the layer of bones and organics and one metacarpal from the dark-brown sandy loam layer (Nomokonova, Losey,



**Figure 2.** Examples of male and female reindeer os coxae portions from Iarte VI. Note the difference in thickness of the ventro-medial borders (rims).

**Table 4.** Reindeer age assessment for Iarte VI using mandibular molar eruption patterns.

Age category	1990s		Layer 1		Layer 2		Layer 3		Layer 4		All layers	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
1												
2	19	10			2	1	4	3	6	5	12	9
3	5	3					1	1			1	1
4	35	18	2	1	1	1	5	3	4	3	12	8
5	151	89	6	4	3	2	13	7	10	6	32	19
Totals	210	120	8	5	6	4	23	14	20	14	57	37

<sup>a</sup>1 – dark-grey sandy loam; 2 – light-grey sandy loam; 3 – layers of bones and organics; 4 – dark-brown sandy loam.

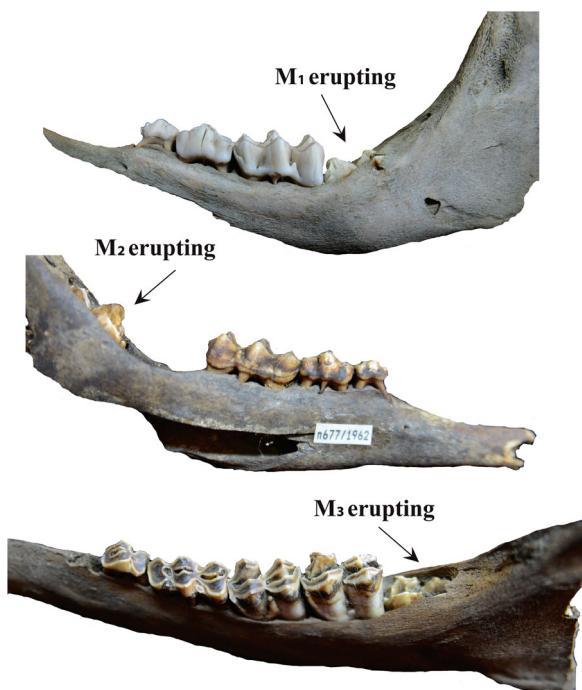
and Plekhanov 2019, 74). Their remains indicate that people at least occasionally inhabited Iarte VI in the late spring – early summer period, likely in the general area of the peninsula where calving was occurring. Conversely, animals under one year of age were present in most layers, with the vast majority being from reindeer under six months of age. The latter likely were procured and processed at Iarte VI throughout the late summer and early fall seasons. In other words, late summer or fall occupations are more strongly indicated in our data than spring or early summer. Clear indicators of winter site utilisation are not present in our data.

The reindeer ageing and sexing data provide several important insights about Iarte VI. First, the site inhabitants had access to various reindeer age groups and both sexes and overall showed a preference for adult individuals. These animals could provide meat and hides, the latter now used for dwelling covers, bedding, clothing, rope, and other materials in this region. The common occurrence of yearlings, especially those that were taken in late summer/early

fall, may suggest some focus on hide production. Today yearlings in Yamal are highly valued by Nenets for their hides, which are preferred for producing various forms of clothing (Ravna 2018). Extensive hide working is also indicated by the artefact assemblage at Iarte VI, where the most abundant tool type is a unique form of reindeer scapula implement (Nomokonova et al. 2020b; Plekhanov 2014). This tool may have been used to process strips of reindeer hide for use in the production of hide cordage, which today is used in making woven rope and strapping employed in various items of daily use, including clothing.

Second, a seasonal pattern of site use is suggested by our data. Warm season occupation is indicated, particularly late summer/early fall, with no clear evidence of winter occupation being found. The presence of midden deposits and pit houses at Iarte VI nonetheless suggests a somewhat different mobility pattern than seen today on much of the peninsula. Today, most herders use portable surface tents, and pit structures are entirely absent, with occupations at any given place seemingly too short to result in dense accumulations of faunal remains. Nenets reindeer herders who now utilise the Iarte VI landscape move north in spring on to the tundra to satisfy their domestic animals' grazing needs, but also to hunt wild reindeer (which now are quite rare) and fish (Brusnitsina and Oshchepkov 2000; Golovnev, Garin, and Kukanov 2016). The Iarte VI area along the Iuribei River is mostly utilised from May to October, where short-term (several days to a few weeks) summer camps are made in the vicinity of the site (Nomokonova et al. 2018). Such groups return south in fall to the southern sections of the Yamal-Nenets region to avoid the extreme winter weather on the tundra.

Somewhat in contrast, in a span of ~100 years in the eleventh- and twelfth-century CE, the inhabitants of Iarte VI accumulated over 22,000 reindeer remains while inhabiting dwellings excavated into the earth and overlooking the Iuribei River (Nomokonova et al. 2018). Significant portions of this site are unexcavated, meaning the bone counts underrepresent the extent of reindeer utilisation there in the past. Reindeer clearly were intensively used at the site. Intensive slaughter of domestic reindeer seems improbable at Iarte VI, in part because domestic



**Figure 3.** Examples of reindeer mandibular portions with erupting molars from Iarte VI (1990s sample).

**Table 5.** Reindeer age assessment summary from the 2013 and 2015 excavations of the ditch feature at Iarte VI.

Layers	Newborn	>6 months	6–12 months	1.5–2.5 years	<1.5 years	<2.5 years	<4.5 years	<6.3 years
Dark-grey sandy loam		1	1	1		8	2	1
Filling of the ditch					1			
Light-grey sandy loam		2		1		8	3	2
Layer of bones and organics	2	12	1	1	14	14		7
Light-yellow sandy loam						1		
Dark-brown sandy loam	1	8	1	1	9	3	6	3
Yellow-grey sandy loam		2	1			4		1
On the bedrock		1	1			3		
Total MNI	3	26	5	4	23	42	11	14
Total MNI = 34 for >1.5 years				Total MNI = 94 for <1.5 years				

Numbers are based on MNI counts of newborn remains and long bone epiphyseal fusion from Nomokonova, Losey, and Plekhanov (2019).

herds are thought to have been small at this time, and these animals' roles were primarily in transport. Recurrent slaughter of such valuable animals seems a very inefficient herd management practice. Hunting wild reindeer appears to more likely account for the patterns observed at Iarte VI. Most such reindeer were potentially intercepted as they migrated south in the late summer and fall. Iarte VI (along with a series of other habitation sites) overlooks the floodplain of the Iuribei, the largest river on the peninsula. This river likely was a focal point for intensively hunting of migratory reindeer herds and some fishing, with the site itself being a lookout point and animal processing station for a few months of the year.

Today Iarte VI is about 250 km north of forested landscapes that could provide significant amounts of fuel and shelter from the wind in winter. Presumably, the inhabitants of Iarte VI moved between the Iuribei area and these southern forest areas on a seasonal basis, requiring long distance travel over the open tundra. Wintering locations on the peninsula are presently undocumented, with all known sites suggested to be warm-season settlements (Fedorova, Kosintsev, and Fitzhugh 1998; Gusev, Plekhanov, and Fedorova 2016). Such mobility likely would have required at least some domestic transport reindeer, and their presence at Iarte VI is also suggested by the recovery of a few pieces of harnessing equipment and geoarchaeological data from the site (Anderson et al. 2019; Losey et al. 2021; Nomokonova et al. 2018). Dogs are present in the Iarte VI assemblage, but their numbers are too few to suggest extensive dog sledding, as seen in some parts of southern Yamal (Losey et al. 2018). If the inhabitants of Iarte VI were compiling processed reindeer furs (let alone meat) in the fall at Iarte VI, the loads to be transported back to the south could have been quite extensive. Reindeer transport would greatly aid in their transport.

To conclude, a dependence on reindeer continues to be a keystone feature of the vibrant lifestyles of many Nenets families in Yamal. Understanding past engagements with reindeer on the Yamal Peninsula provides a glimpse into the long-term histories of these relationships, which have clearly varied significantly, even over just the past few centuries. We

hope that this research will advance ancient reindeer age and sex assessment studies in Yamal and demonstrate the relevance of this region to broader studies in the Arctic. One clearly needed future step is the establishment of comparative datasets specific to Yamal wild and domestic reindeer populations. Such datasets potentially could refine our age and sex assessments, further refining our knowledge of Yamal's unique reindeer herding communities. Analysis of reindeer tooth wear at Iarte VI could provide additional details on animal preference, particularly in regard to the exploitation of adult individuals. Further, such analyses could provide insight on herd management strategies, as the reindeer remains at the site potentially derive from both wild and domestic animals.

## Acknowledgements

The following institutions are acknowledged for providing additional access to collections and logistical support: museum of IPAE UB RAS (Ekaterinburg) and Arctic Research Center (Salekhard).

## Disclosure Statement

No potential conflict of interest was reported by the author(s).

## Funding

Funding for this project was provided by grants from the European Research Council to David G. Anderson [#295458], Wenner-Gren Foundation [SFR1725] and Social Sciences and Humanities Research Council of Canada [#SSHRC IG 435-2014-0075] to Robert Losey, the JPI HUMANOR project [ESRC ES/M011054/1], and by the Ministry of Education and Science of the Russian Federation to the IPAE UB RAS [# AAAA-A19-119031890086-0].

## Notes on contributors

**Tatiana Nomokonova** is an Assistant Professor at the Department of Archaeology and Anthropology of the University of Saskatchewan in Canada. The main focus of her research is the study of human-animal relationships through the analysis of faunal remains and animal imagery from Siberia.

**Robert J. Losey** is a Professor at the Department of Anthropology of the University of Alberta in Canada. His main topics of interest are dog and reindeer domestication, dog sledding, human-animal relations in archaeology, and zooarchaeology. Dr. Losey primarily works in Siberia and the North American Arctic.

**Pavel A. Kosintsev** is a senior scientist at the Paleoecology Laboratory at the Institute of Plant and Animal Ecology in the Russian Federation. The main focus of his research is the study of Pleistocene and Holocene mammalian remains from various regions of Northern Eurasia.

**Andrei V. Plekhanov** is a senior scientist at the Department of Archaeology and History at the Scientific Centre of Arctic Studies in the Russian Federation. The main focus of his research is the study of medieval artefacts from archaeological sites of the Yamal-Nenets Autonomous District, especially at Iarte VI.

## ORCID

Tatiana Nomokonova  <http://orcid.org/0000-0002-8756-1681>

Robert J. Losey  <http://orcid.org/0000-0003-3615-8160>

## References

- Aleksahenko, N. A. 2002. "Kozhevennoe proizvodstvo na Iamale (arkheologiya i etnografia)." *Ural'skii Istoricheskii Vestnik* 8: 184–198.
- Anderson, D. G. 2002. *Identity and Ecology in Arctic Siberia: The Number One Reindeer Brigade*. Oxford: Oxford University Press.
- Anderson, D. G., L. Harrault, K. B. Milek, B. C. Forbes, M. Kuoppamaa, and A. V. Plekhanov. 2019. "Animal Domestication in the High Arctic: Hunting and Holding Reindeer on the Yamal Peninsula, Northwest Siberia." *Journal of Anthropological Archaeology* 55: 101079.
- Anderson, D. G., E. M. Ineshin, N. V. Kulagina, M. Lavento, and O. P. Vikovskaya. 2014. "Landscape Agency and Evenki-Iakut Reindeer Husbandry Along the Zhuia River, Eastern Siberia." *Human Ecology* 42: 249–266.
- Bachura, O. P., P. A. Kosintsev, D. O. Gimranov, O. M. Korona, A. E. Nekrasov, and A. P. Panteleev. 2017. "Ust'-Polui: khoziaistvennaia deiatel'nost' naselenii i prirodnoe okruzhenie." In *Ust'-Polui: Materialy i Issledovaniia. Arkheologiya Arktiki*, Vol. 4, Part 1, edited by A. V. Gusev, and N. V. Fedorova, 81–99. Ekaterinburg: Delovaia Pressa.
- Baskin, L. M. 2009. *Severnyi Olen'*. Upravlemie Povedeniem i Populiatsiiami. Olenevodstvo. Okhota. Moskva: Tovarishchestvo Nauchnykh Izdanii KMK.
- Binford, L. R. 1978. *Nunamiut Ethnoarchaeology*. New York: Academic Press.
- Bjørklund, I. 2013. "Domestication, Reindeer Husbandry and the Development of Sámi Pastoralism." *Acta Borealia* 30: 174–189.
- Bogoras, W. 1904–1909. *The Chukchi. Memoirs of the American Museum of Natural History*. Leiden, New York: E. J. Brill Ltd and G. E. Stechert & Co. Vol. 11, Parts 1–3.
- Bogordaeva, A. A. 2006. *Traditsionnyi Kostium Obskikh Ugrov*. Novosibirsk: Nauka.
- Brusnitsina, A. G., and K. A. Oshchepkov. 2000. "Pamiatniki arkheologii srednego Iamala (levoberezh'e nizhnego techeniiia r. Iuribei)." In *Drevnosti Iamala*, edited by Andrei V. Golovnev, Vol. 1, 79–111. Ekaterinburg-Salekhard: UrO RAN.
- Fedorova, N. V. 2000. "Olen', sobaka, kulaiskii fenomen i legenda o Sikhirtia." In *Drevnosti Iamala*, edited by Andrei V. Golovnev, Vol. 1, 54–66. Ekaterinburg-Salekhard: UrO RAN.
- Fedorova, N. V. 2006. "Kaslanie dlinoi v dve tysiachi let: chelovek i olen' na severe Zapadnoi Sibiri." *Ural'skii Istoricheskii Vestnik* 14: 149–156.
- Fedorova, N. V. 2014. "Regional'naiia ekonomika i strategii adaptatsii drevnego i srednevekovogo naselenia severa zapadnoi Sibiri." *Nauchnyi Vestnik Iamalo-Nenetskogo Avtonomnogo Okruga* 1 (82): 3–8.
- Fedorova, N. V., P. A. Kosintsev, and W. W. Fitzhugh. 1998. '*Ushedshie v Kholmy': Kul'tura Naselenei Poberezhii Severo-Zapadnogo Iamala v Zheleznom Veke*'. Ekaterinburg: Izd-vo Ekaterinburg.
- Gemuev, I. N., V. I. Molodin, and Z. P. Sokolova. 2005. *Narody Zapadnoi Sibiri: Khanty, Mansi, Sel'kupy, Nentsy, Entsy, Nganasany, Kety*. Moskva: Nauka.
- Golovnev, A. V. 1995. *Govoriashchie Kul'tury: Traditsii Samodiitsev i Ugrov*. Ekaterinburg: UrO RAN.
- Golovnev, A. V., N. P. Garin, and D. A. Kukanov. 2016. *Olenevody Iamala (Materialy k Atlasy Kochevykh Tekhnologii)*. Ekaterinburg: UrO RAN.
- Golovnev, A. V., S. V. Lezova, I. V. Abramov, S.Iu. Belorussova, and N. A. Babenkova. 2014. *Etnoekspertiza na Iamale: Nenetskie Kochevia i Gazovye Mestorozhdeniya*. Ekaterinburg: Izd-vo AMB.
- Greenfield, H. 2006. "Sexing Fragmentary Ungulate Acetabulae." In *Recent Advances in Ageing and Sexing Animal Bones*, edited by D. Rusillo, 68–86. Oxford: Oxbow Books.
- Gusev, A. V. 2014. "Kompleks predmetov, sviazannykh s olenevodstvom, po materialam sviatilishcha Ust'-Polui (Nizhnee Priob'e)." *Ural'skii Istoricheskii Vestnik* 2 (43): 53–62.
- Gusev, A. V., and N. V. Fedorova, eds. 2017. *Ust'-Polui: Materialy i Issledovaniia. Arkheologiya Arktiki* 4, Parts 1–2. Ekaterinburg: Delovaia Pressa.
- Gusev, A. V., A. V. Plekhanov, and N. V. Fedorova. 2016. "Olenevodstvo na severe Zapadnoi Sibiri: rannii zhelznyi vek – srednevekov'e." *Arkheologiya Artiki* 3: 228–39.
- Jackson, L. J., and P. T. Thacker, eds. 1997. *Caribou and Reindeer Hunters of the Northern Hemisphere*. Aldershot: Avebury.
- Khariuchi, G. P. 2001. *Traditsii i Innovatsii v Kul'ture Nenetskogo Etnosa (Vtoraia Polovina XX veka)*. Tomsk: Izd-vo TGU.
- Khomich, L. V. 1966. *Nentsy. Istoriko-Etnograficheskie Ocherki*. Moskva-Leningrad: Nauka.
- Klevezal', G. A. 2007. *Printsipy i Metody Opredeleniia Vozrasta Mlekopitaiushchikh*. Moskva: Tovarishchestvo Nauchnykh Izdanii KMK.
- Krupnik, I. I. 1976. "Stanovlenie krupnotabunnogo olenevodstva u tundraovykh Nentsev." *Sovetskaia Etnografia* 2: 57–69.
- Krupnik, I. 1993. *Arctic Adaptations: Native Whalers and Reindeer Herders of Northern Eurasia*. Hanover: University of Press of New England.
- Kushelevskii, Iu.I. 1863. *Severnyi Polius i Zemlia Iamal. Putevye Zapiski*. Sainkt-Petersburg: Tipografija Imeni Shtrenera.
- Leader-Williams, N. 1979. "Age Determination of Reindeer Introduced Into South Georgia." *Journal of Zoology* 188: 501–515.

- Losey, R. J., L. S. Fleming, T. Nomokonova, A. V. Gusev, N. V. Fedorova, S. Garvie-Lok, O. Bachura, P. A. Kosintsev, and M. V. Sablin. 2017. "Human and dog Consumption of Fish on the Lower Ob River of Siberia: Evidence for a Major Freshwater Reservoir Effect at the Ust'-Polui Site." *Radiocarbon* 60 (1): 239–260.
- Losey, R. J., T. Nomokonova, D. V. Arzyutov, A. V. Gusev, A. V. Plekhanov, N. V. Fedorova, and D. G. Anderson. 2021. "Domestication as enskilment: harnessing reindeer in Arctic Siberia." *Journal of Archaeological Method and Theory* 28: 197–231.
- Losey, R. J., T. Nomokonova, A. V. Gusev, O. P. Bachura, N. V. Fedorova, P. A. Kosintsev, and M. V. Sablin. 2018. "Dogs were Domesticated in the Arctic: Sacrifice, Consumption, and Dog Sledding at Ust'-Polui." *Journal of Anthropological Archaeology* 51: 113–126.
- Lyman, R. L. 2008. *Quantitative Paleozoology*. Cambridge: Cambridge University Press.
- Miller, F. L. 1972. "Eruption and Attrition of Mandibular Teeth in Barren-Ground Caribou." *Journal of Wildlife Management* 36 (2): 606–612.
- Miller, F. L. 1974. *Biology of the Kaminuriak Population of Barren-Ground Caribou*. Part 2: Dentition as an indicator of age and sex; composition and socialization of the population. Environment Canada, Wildlife Service, Ottawa.
- Morrison, D. A. 1997. *Caribou Hunters in the Western Arctic. Zooarchaeology of the Rita-Claire and Bison Skull Sites*. Mercury Series Archaeological Survey of Canada 157. Canadian Museum of Civilization, Hull.
- Morrison, D., and P. Whitridge. 1997. "Estimating the Age and sex of Caribou from Mandibular Measurements." *Journal of Archaeological Science* 24: 1093–1106.
- Nomokonova, T., R. J. Losey, N. V. Fedorova, A. V. Gusev, and D. V. Arzyutov. 2021. "Reindeer Imagery in Making at Ust'-Polui in Arctic Siberia." *Cambridge Archaeological Journal* 31 (1): 161–181.
- Nomokonova, T., R. J. Losey, A. R. Lieverse, and A. V. Plekhanov. 2020a. "Zubnye anomalii, travmy i markery aktivnosti severnogo olenia s poseleniia Iarte VI." *Arkeologiya Arkтики* 7: 258–272.
- Nomokonova, T. Iu., R. J. Losey, and A. V. Plekhanov. 2017a. Vidovoi i kolichestvennyi analiz faunisticheskikh materialov so srednevekovogo gorodishcha Iarte VI (p-ov Iamal). *Eurasia v Kainozoe. Stratigraffia, Paleoekologiya, Kul'tury* 6, 320–328.
- Nomokonova, T., R. J. Losey, and A. V. Plekhanov. 2019. "Postkranial'nye elementy severnogo olenia so srednevekovogo poseleniia Iarte VI (p-ov Iamal)." *Reports of the Laboratory of Ancient Technologies* 15 (4): 66–78.
- Nomokonova, T., R. J. Losey, A. V. Plekhanov, and H. J. McIntyre. 2018. "Iarte VI and Late Holocene Reindeer Remains from the Iamal Peninsula of Arctic Siberia." *Arctic Anthropology* 55 (2): 54–73.
- Nomokonova, T., R. J. Losey, A. V. Plekhanov, and H. J. McIntyre. 2020b. "The Variable Histories of Reindeer Scapula on the Iamal Peninsula of Arctic Siberia." *Archaeological Research in Asia* 21: 100176.
- Nomokonova, T., H. J. McIntyre, A. V. Plekhanov, and R. J. Losey. 2017b. "Ostatki zhivotnykh so srednevekovogo poseleniia Iarte VI, poluostrova Iamal (po materialam raskopa 2013g)." *Reports of the Laboratory of Ancient Technologies* 13 (3): 30–43.
- Parlee, B. L., and K. J. Caine. 2018. *When the Caribou do not Come. Indigenous Knowledge and Adaptive Management in the Western Arctic*. Vancouver: UBC Press.
- Pasda, K. 2006. "Assessment of Age and Season of Death of West Greenland Reindeer by Counting Cementum Increments in Molars." *Documenta Archaeobiologiae* 4: 125–140.
- Pasda, K. 2009. *Osteometry, and Osteological Age and Sex Determination of the Sisimiut Reindeer Population (Rangifer tarandus groenlandicus)*. BAR International Series 1947. Oxford: BAR Publishing.
- Pike-Tay, A. 1995. "Variability and Synchrony of Seasonal Indicators in Dental Cementum Microstructure of the Kaminuriak Caribou Population." *Archaeafauna* 4: 273–284.
- Pike-Tay, A., C. A. Morcomb, and M. O'Farrell. 2000. "Reconsidering the Quadratic Crown Height Method of age Estimation for *Rangifer* from Archaeological Sites." *Archaeozoologia* XI: 145–174.
- Plekhanov, A. V. 2014. *Iarte VI – Srednevekovoe "Gorodishche" na r. Iurubei (p-ov Iamal)*. Katalog Kollektii. Ekaterinburg: Delovaia Pressa.
- Podkorytov, F. M. 1995. *Olenevodstvo Iamala*. Leningrad: Tipografiia Lenigradskoi Atomnoi Elektrostantsii.
- Randymova, Z. I. 2004. *Olenevodcheskaia Kul'tura Priural'skikh Khantov*. Tomsk: TGU.
- Ravna, Z. V. 2018. "Nomadic Nenets Women's Sewing Skills: the Ethno-Pedagogical Process of Transferring Traditional Skills and Knowledge by Nenets Women Through the Generations as Part of Their Nomadic Culture." *Arctic Anthropology* 55 (2): 97–116.
- Remers, E., and Ø Nordby. 1968. "Relationship Between age and Tooth Cementum Layers in Norwegian Reindeer." *Journal of Wildlife Management* 32 (4): 957–961.
- Røed, K. H., K. S. Kvie, R. J. Losey, P. A. Kosintsev, A. K. Hufthammer, M. J. Dwyer, V. Goncharov, et al. 2020. "Temporal and Structural Genetic Variation in Reindeer (*Rangifer tarandus*) Associated with the Pastoral Transition in Northwestern Siberia." *Ecology and Evolution* 10 (17): 9060–9072.
- Sharp, H. S., and K. Sharp. 2015. *Hunting Caribou: Subsistence Hunting Along the Northern Edge of the Boreal Forest*. Lincoln: University of Nebraska Press.
- Shaiatov, S. G., and R. M. Khatemirov. 2000. "Dendrokronologicheskaja datirovka drevesiny kustarnikov iz arkheologicheskogo poselenija Iarte VI na poluostrove Iamal." In *Drevnosti Iamala*, edited by A. V. Golovnev, Vol. 1., 112–122. Ekaterinburg-Salekhard: UrO RAN.
- Spiess, A. E. 1979. *Reindeer and Caribou Hunters: An Archaeological Study*. New York: Academic Press.
- Stépanoff, C. 2017. "The Rise of Reindeer Pastoralism in Northern Eurasia: Human and Animal Motivations Entangled." *Journal of the Royal Anthropological Institute* 23: 376–397.
- Takken Beijersbergen, L. M. 2017. "Determining age and Season of Death by use of Incremental Lines in Norwegian Reindeer Tooth Cementum." *Environmental Archaeology* 24 (1): 49–60.
- Takken Beijersbergen, L. M., A. K. Hufthammer, et al. 2012. "Age Determination of Reindeer (*Rangifer tarandus*) Based on Postcranial Elements." In *A Bouquet of Archaeozoological Studies*, edited by D. C. M. Raemaekers, et al., 11–20. Barkhuis: Groningen Archaeological Studies 21, Groningen.
- Tyler, N. J. C. 1987. "Sexual Dimorphism in the Pelvic Bones of Svalbard Reindeer, *Rangifer tarandus Platyrhynchus*." *Journal of Zoology* 213: 147–152.
- van den Berg, M., M. J. J. E. Loonen, and C. Çakırlar. 2021. "Judging a Reindeer by its Teeth: a User-Friendly Tooth

- Wear and Eruption Pattern Recording Scheme to Estimate age-at-Death in Reindeer, *Rangifer tarandus*." *International Journal of Ostearchaeology* 31 (3): 417–428.
- Vitebsky, P. 2006. *The Reindeer People: Living with Animals and Spirits in Siberia*. Boston: Houghton Mifflin Harcourt.
- Vizgalov, G. P., O. V. Kardash, P. A. Kosintsev, and T. V. Lobanova. 2013. *Istoricheskaja Ekologija Naselenija Zapadnoj Sibiri*. Ekaterinburg: Izd-vo AMB.
- Weinstock, J. 2000a. "Demography Through Osteometry: sex Ratios of Reindeer and Hunting Strategies in the Late Glacial Site of Stellmoor, Northern Germany." *Archæozoologia* 11: 187–198.
- Weinstock, J. 2000b. "Osteometry as a Source of Refined Demographic Information: Sex-Ratios of Reindeer, Hunting Strategies, and Herd Control in the Late Glacial Site of Stellmoor, Northern Germany." *Journal of Archaeological Science* 27 (12): 1187–1195.
- Weinstock, J. 2002. "Reindeer Hunting in the Upper Paleolithic: Sex Ratios as a Reflection of Different Procurement Strategies." *Journal of Archaeological Science* 29 (4): 36–377.
- Zen'ko-Nemchinova, M. A. 2006. *Sibirskie Lesnye Nentsy: Istoriko-Etnograficheskie Ocherki*. Ekaterinburg: Basko.
- Zhigunov, P. S., and F. A. Terent'ev. 1948. *Severnoe Olenevodstvo..* Moskva: Ogiz-Sel'khoz.
- Zhitkov, B. M. 1913. *Poluostrov Jamal. Zapiski Imperatorskogo Geograficheskogo Obshchestva po Obshchei Geografii*, Sankt-Petersburg.