

15. SEASONALITY AT MIDDLE AND UPPER PALAEOLITHIC SITES BASED ON THE PRESENCE AND WEAR OF DECIDUOUS PREMOLARS FROM NURSING MAMMOTH CALVES

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ABSTRACT

Middle and Upper Palaeolithic sites, where mammoths dominate the faunal assemblages, are mainly found in Central and Eastern Europe. At these sites concentrations of skulls, tusks and long bones, interpreted as deliberate constructions, often occur. Rare instances of weapon tip fragments embedded in mammoth bones provide direct archaeological evidence of human hunting. Indirect evidence, such as the accumulation of mammoth bones from multiple individuals with specific ontogenetic ages, occurs more frequently. Based on the eruption sequence and wear of deciduous premolars from mammoth calves, we examined whether a season of death could be deduced from the characteristics of the dentition. Our results

suggest that the mammoth hunt was not restricted to the cold half of the year.

15.1 INTRODUCTION

Middle and Upper Palaeolithic sites, where mammoth bones dominate the mammal assemblage, are often interpreted as the camps of mammoth hunters. These sites are mainly found in Central and Eastern Europe, such as Dolní Věstonice and Předmostí (Přerov-Předmostí) in the Czech Republic, Mezhirich and Mezin in the Ukraine, and Kostënki-1/I, Kostënki-11/Ia and Yudinovo in Russia, and date in general to the Gravettian and Epigravettian. At these sites, accumulations of mammoth skeletal elements have been interpret-



ed as the remains of architectural constructions, places of storage and/or middens (Soffer, 1985; Svoboda et al., 2005, 2019; Germonpré et al., 2008; Iakovleva, 2015; Pryor et al., 2020; Sablin et al., submitted). Some prehistorians assume that these mammoth bones are derived from animals that have been hunted and slaughtered, and then transported to the camp (Germonpré et al., 2008; Péan, 2015). Others have argued that Palaeolithic hunter-gatherers built their camps near the places, where mammoths died from a natural cause (Soffer, 1985). However, at several Upper Palaeolithic sites, direct evidence, such as a fragment of a weapon tip embedded in a bone, testifies to the violence of the mammoth hunt (e.g., Praslov, 2000; Nikolskiy and Pitulko, 2013). In addition, also indirect evidence, such as the accumulation of bones from a multitude of individuals with specific ontogenetic ages, suggests an intentional hunting of mammoths (e.g., Svoboda et al., 2005; Germonpré et al., 2008, 2014; Brugère, 2014; Péan, 2015; Reynolds et al., 2019). In this study, we adhere to the idea that Palaeolithic hunter-gatherers organized mammoth hunts.

Recent elephants create pathways between important places, such as water points, fodder places, mineral springs, and socializing sites (Haynes, 1991, 2017). In Canada, successive mammoth tracks following the bank of a palaeo-river valley indicate that mammoth herds used the same trails over a period of at least two centuries (McNeil et al., 2005). Mammoths probably followed traditional trails for generations. Palaeolithic hunters could have used these paths to track the animals. Alternatively, they could have sneaked up to mammoths that were grazing in moist meadows or drinking water at river shores and attacked while the herd was distracted (Velichko and Zelikson, 2005; Germonpré et al., 2008; Haynes, 2017; Wilczyński et al., 2019). Palaeolithic hunters could have targeted the matriarch first by attempting to strike the animal from the rear side, aiming to hit vital organs (cf. Nikolskiy and Pitulko, 2013) and could then have killed the younger members of the herd. According to Wilczyński et al. (2019), hu-

man hunting of mammoths was probably executed by groups of hunters using spear-throwers, throwing spears in sequence. The initial butchering of the hunted mammoths probably took place at the kill site (Germonpré et al., 2008). Body parts of the mammoth carcasses were then brought back to the camp, perhaps with the help of Palaeolithic dogs (Germonpré et al., 2012, 2020).

In this contribution, our goal is to determine whether mammoth hunting was limited to the cold half of the year or occurred as well during warmer seasons. To answer these queries, we assigned an age of death to the dental remains of mammoth calves that were found at several late Middle and Upper Palaeolithic sites, aiming to deduce their season of death. We first provide an overview of the theoretical basis for attributing an age to the dental remains from mammoths and list the material studied here. Then, we present a non-exhaustive list of Middle and Upper Palaeolithic sites in Western, Central and Eastern Europe that contain important mammoth assemblages. Subsequently, we provide the results of the palaeobiological analyses. In the discussion, we compare the obtained results from the studied sites with those from published resources, and summarize some archaeological and palaeobiological consequences. The final section provides our conclusions.

15.2 METHODS AND MATERIAL

Laws (1966) established 30 age groups (I–XXX) for the extant African elephant *Loxodonta africana*, based on the progress of eruption and wear of the cheek teeth, and allocated real ages in African Equivalent Years (AEY) to these groups. In this study, we follow Laws' groups in order to estimate the age at death of woolly mammoth (*Mammuthus primigenius*) calves from their deciduous premolars (DP; both for the upper and lower dentition). The anatomical position of the teeth was identified using the dimensions and number of plates, following Musil (1968), Maglio (1973) and Germonpré (1993), except for the mammoth decid-

LAWS' AGE GROUP	MAMMOTH CALF	REFERENCES	AGE IN MONTHS	SEASON OF DEATH	DESCRIPTION OF DECIDUOUS DENTITION
I	Lyuba	Rountrey et al. (2012)	0–1	early spring	DP2: no/little wear; DP3: germ with complete crown
II	Khroma	Grigoriev et al. (2012); Maschenko et al. (2013)	2	spring	DP2: completely worn; DP3: erupting with first plates in wear
III	-		ca. 3–6	summer	DP2: well worn; DP3: moderately worn
IV	Oimyakonskii	Boeskorov et al. (2007); Rountrey et al. (2012)	7.4	autumn/winter	DP2: lost; DP3: well worn; DP4: erupting/slightly worn
V	-		>12	-	DP3: completely worn; DP4: moderately worn
VI	-	Craig (table A2) in Haynes (1991)	52	-	DP3: almost lost; DP4: only last plates unworn
VII	-	Craig (table A2) in Haynes (1991)	60	-	DP3: lost; DP4: completely worn; M1: erupting

Table 15.1: Comparison of Laws' age groups of elephant deciduous premolars with mammoth calf dentition and their age attribution in months or years, for details see text.

uous premolars from Předmostí, for which the identifications and description by Musil (1968) were used. Complete and fragmentary mammoth deciduous premolars were counted in Number of Identified Specimens (NISP) and in Minimum Number of Individuals (MNI) (Lyman, 1994). Detailed analyses of the microstructure of mammoth tusks allowed to estimate that gestation in mammoths took about 20 to 22 months (Fisher et al., 2014; Grigoriev et al., 2017) and could have been slightly shorter than that of the recent African elephant, which usually has a gestational length of ~22 months (Poole et al., 2011). In mammoths, conception probably occurred in late spring and birth took place in early spring (Rountrey et al., 2012; Grigoriev et al., 2017). Inter-birth intervals had probably a length of ~4 years during which the previously born calf was nursing. Weaning likely occurred, like in elephants, shortly before the next calf was born (Grigoriev et al., 2017). The proposed length of the nursing period of mammoth calves fluctuates between 3 years (Metcalf et al., 2010) and 5 years (Rountrey et al., 2007). In our study, we will consider a nursing period of ~4 years, up to and including Laws' age group VI. The mammoth deciduous premolars discussed in this contribution

are compared with those described by Maschenko (2002), Rountrey et al. (2012), Maschenko et al. (2013), Fisher et al. (2014) and Grigoriev et al. (2017) to estimate their age. A thorough study of the mammoth calf Lyuba, found in the permafrost of the Yamalo-Nenets Autonomous region, Russian Federation, revealed that its DP2 displays little wear and has no cementum in the gaps between the plates. The germ of the DP3 has a fully developed crown but without fully developed enamel, while the germ of the DP4 is incomplete. A comparison with the African elephant age groups as defined by Laws (1966) suggests that this calf can be assigned to Laws' age group I with no/little wear of the DP2, and the DP3 not yet erupted. Based on the number of increments found on the DP2, this calf died when it was ~1 month old, likely in spring (Rountrey et al., 2012). Maschenko et al. (2013) described the deciduous dentition of the mammoth calf Khroma, discovered on the right bank of the Khroma River in Yakutia. The DP2 of this calf is completely worn; the DP3 is erupting with the first three plates in wear. These features correspond to Laws' age group II with slight wear on the protruding DP3. The number of increments on the deciduous premolar suggests that this calf

died at an age of ~2 months (Fisher et al., 2014). The detailed analyses of the deciduous premolars of the Oimyakonskii calf, found in the permafrost from Yakutia, Russian Federation (Boeskorov et al., 2007), showed that the DP2s were already lost, the DP3s show advanced wear and the DP4s are unworn. The features of the dentition of the Oimyakonskii calf could correspond with Laws' age group IV, characterized by well-worn DP3 and just erupted DP4. Based on the number of increments of the tusk, this mammoth died when it was 7.4 months old, during autumn or the beginning of winter (Rountrey et al., 2012). Based on these analyses, it seems that the wear of the deciduous premolars in mammoth is advanced compared to the extent of wear observed in recent elephants (Rountrey et al., 2012), as noted also by Haynes (1991). Moreover, it seems to be an accelerated replacement of the DP2s in mammoth compared with recent elephants, perhaps linked to an earlier transmission to a mixed diet or to feeding on mammoth dung (Maschenko, 2002; Maschenko et al., 2013). For Laws' age group VI and above, the age attributions proposed by Craig in Haynes (1991: tables A2, A8) are followed. A summary of the age estimation of nursing calves based on the eruption and wear of the deciduous premolars is presented in Table 15.1.

The mammoth deciduous premolars from Spy and Goyet are housed at the Royal Belgian Institute of Natural Sciences in Brussels (RBINS; Belgium), from Předmostí at the Moravian Museum (Brno, Czech Republic), those discovered at Yudinovo at the Zoological Institute RAS (Saint Petersburg, Russia), and those excavated at Kostënki-21 at the Institute for the History of Material Culture RAS (Saint Petersburg, Russia) and at the Zoological Institute RAS. The dental specimens discussed in this chapter from Spy, Goyet, Kostënki-21 and Yudinovo were studied by one or more of the authors of this contribution. Additional information for the mammoth dentition found at the Russian sites is from Maschenko (2002). The Laws' age group attributions of the deciduous premolars from Předmostí are based on

the individual description and figures of the DP2 in Musil (1968: pp. 122–125, pp. 178–179, plate I) and on the figures and description of the DP3 in Musil (1968: pp. 179–181, plates II–VI). Because only 23 of the total number of 73 DP3s are figured and described in Musil (1968), the NISP of the nursing calves less than 1 year old based on the DP2 and DP3 combined, here presented, is a minimum NISP of the Předmostí mammoth assemblage. However, for this contribution, we do not quantify the presence of calf remains by season of death, but we are only interested whether dead calves were present or absent in each of the seasons. In the discussion, we compare the results of the above-mentioned sites with results available from the literature.

15.3 SITES

15.3.1 SPY

Spy cave is one of the richest Palaeolithic sites in Belgium (Fig. 15.1). It was first excavated in the 19th century. Since then, many excavations have been carried out (Rougier et al., 2004; Semal et al., 2009). The discoverers recognized three main archaeological and fauna-bearing levels (Fraipont and Lohest, 1886, 1887; Rucquoy, 1886–1887; De Loë and Rahir, 1911). Spy, like the Goyet cave (see below), was used alternately by humans and carnivores. Each level represents likely a palimpsest. The most important Palaeolithic assemblages can be assigned to the Middle and Upper Palaeolithic, including the Mousterian, Lincombian-Ranisian-Jerzmanowician, Aurignacian and Gravettian (Semal et al., 2009; Flas, 2011). The presence of Middle and Upper Palaeolithic artifacts at Spy suggests that both Neanderthals and anatomically modern humans occupied the site, but Pleistocene human remains pertain only to Neanderthals (Semal et al., 2009). The faunal assemblages are dominated by remains of horse, cave hyena, mammoth, woolly rhino and cave bear (Germonpré et al., 2013). Some of the mammoth remains were

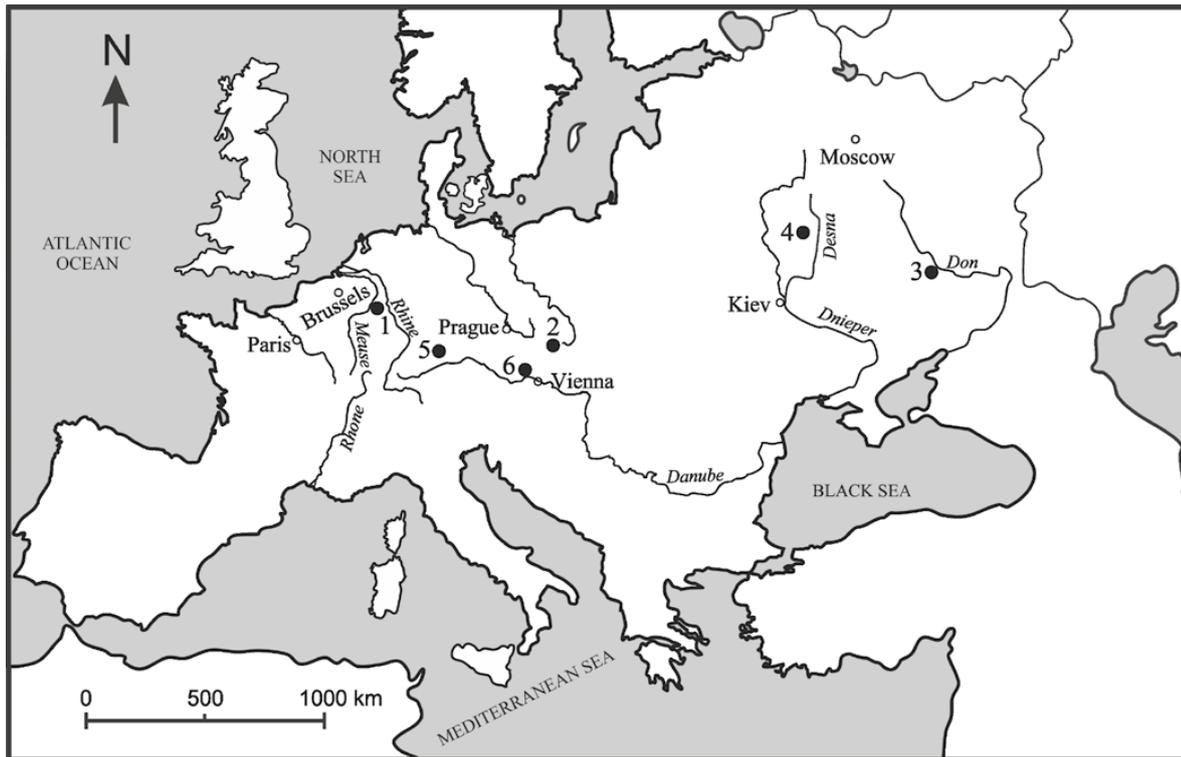


Figure 15.1: Map showing the most important sites discussed in the text. 1, Spy, Goyet; 2, Předmostí; 3, Kostënki; 4, Yudinovo, Elisievichi; 5, Geissenklösterle; 6, Krams-Wachtberg.

assigned to a fauna-bearing horizon also yielding Middle Palaeolithic lithics, the so-called “Deuxième niveau moustérien” (“Second Mousterian Level”) (Germonpré et al., 2013, 2014). In addition, AMS dates are available for two mammoth DP3s. The younger AMS date (37,010 \pm 440–380, GrA-37933) has a calibrated age range (95%, Oxcal 4.3) from 42,200 years BP to 40,800 years BP. The older AMS date (42,330 \pm 500–450; GrA-32616) has a calibrated age range (Oxcal 3) from 46,600 years BP to 44,800 years BP. The calibrated ages of these deciduous teeth allow us to consider them as contemporaneous with the Middle Palaeolithic (Germonpré et al., 2013, 2014). In this study, all the mammoth deciduous premolars from Spy are grouped together. The stable isotope analyses of the collagen from two Neanderthal individuals from Spy reveal that mammoth was the most important prey species with a possible proportion of mammoth meat in their diet between 30% and 40% (Wißing et al., 2016).

15.3.2 GOYET

The third cave of Goyet (Belgium; Fig. 15.1) was excavated in the 19th and 20th century (Otte, 1979). It has an exceptionally rich archaeological, faunal and anthropological record, covering large periods from the Middle to the Upper Palaeolithic. It is the only site in the world, where human remains from populations dating from the Mousterian, Aurignacian, Gravettian and the Magdalenian have been found at the same location. In addition, a skull from a large canid has been described as being from a Palaeolithic dog (Germonpré et al., 2009, 2012). With a calibrated age of \sim 35,700 years BP, this canid would be the oldest domesticated animal known so far (Germonpré et al., 2009, 2018). However, this attribution is subject to controversy (Boudadi-Maligne and Escarguel, 2014; Morey, 2014; Drake et al., 2015; Janssens et al., 2016, 2019; but see Galeta et al., 2021). Dupont (1871) distinguished five bone-bearing

horizons in the third cave of Goyet. He recovered numerous Pleistocene mammal bones, human remains, and large quantities of Middle and Upper Palaeolithic artifacts from these layers (Germonpré, 2001; Posth et al., 2016; Rougier et al., 2016). The dispersion of several AMS dates and the refitting of the human bones originating from different horizons, point out the mixed content of the horizons recognized by Dupont (Germonpré, 2001; Rougier et al., 2016). The faunal assemblages from the horizons are dominated by skeletal elements of reindeer, cave bear, cave hyena, horse and foxes (Germonpré, unpublished data). Here, the mammoth remains from the third cave of Goyet are grouped together, bearing in mind that they likely accumulated during an extended time span. The Goyet mammoth assemblage is less rich than that of Spy. This assemblage is dominated by ivory ornaments and fragments, likely dating from the Aurignacian and the Gravettian, several of which show ochre stains and cut marks (Germonpré, unpublished data). At Goyet, it seems that mammoth heads and, to a lesser extent, feet, were brought to the cave where the meat and fat could be consumed (Wißing et al., 2019a; Germonpré, unpublished data). Dietary reconstructions are available for several human individuals dating from the Middle Palaeolithic, Aurignacian and Gravettian assemblages (Wißing et al., 2016, 2019a, b). The results of the latter studies indicate that the diets of the analyzed Neanderthal individuals and those associated with Aurignacian assemblages included significant proportions of mammoth meat, whereas those associated with Gravettian assemblages relied more on horse and reindeer, and to a lesser extent on mammoth (Wißing et al., 2016, 2019a, b).

15.3.3 PŘEDMOSTÍ

Předmostí (Czech Republic; Fig. 15.1) is part of a series of large Gravettian open-air sites located in Central Europe, characterized by specific lithic tools (backed bladelets, geometric microliths, denticulated bladelets) (Polanská, 2018) and by the

presence of human burials, mammoth remains, and ivory implements, ornaments, portable art, and animal and human female representations. Mammoths played an important role in the Central European societies of Gravettian hunter-gatherers (Svoboda, 2001; Oliva, 2007, 2009; Wojtal and Wilczyński, 2015), both in life (e.g., ivory tools, ivory portable art, ornaments) and in death (several human burials were covered by mammoth scapulae) (Valoch, 1981, 1982; Einwögerer et al., 2006; Svoboda, 2008; d'Errico et al., 2011; Lázníčková-Galetová, 2016). At Předmostí, the mammal assemblage is dominated by mammoth. Musil (1958, 1968) examined in detail the mammoth teeth from this site. His descriptions and measurements of the deciduous premolars are used here to attribute an age to the very young calves (<12 months old). In all likelihood, mammoth formed the staple food for the Gravettian inhabitants from the site as can be deduced from the preponderance of mammoth in the faunal assemblage and the age distribution of the mammoth, dominated by young individuals (Absolon and Klíma, 1977; Oliva, 1997, Musil, 2008; Bosch, 2012). A recent study based on the analyses of stable isotopes showed that the proportional prey contribution of the mammoth to the human diet at this site amounted to ~40% (Bocherens et al., 2015). Large canids are the second most abundant group at Předmostí based on the MNI calculations (Pokorný, 1951; Musil, 2008), and include Pleistocene wolves and Palaeolithic dogs according to Germonpré et al. (2012, 2015). A new AMS analysis on a cut-marked femur of a large canid delivered a calibrated age range (95%) between 28,800 and 28,300 years BP (Germonpré et al., 2017).

15.3.4 KOSTĚNKI-21

The site of Kostěnki 21 (Russia) is located in the valley of the Don River at Kostěnki (Voronezh Oblast, Russia) (Fig. 15.1). The main archaeological horizon, layer III, has a calibrated age of ~27,500–24,500 years BP and contained six com-

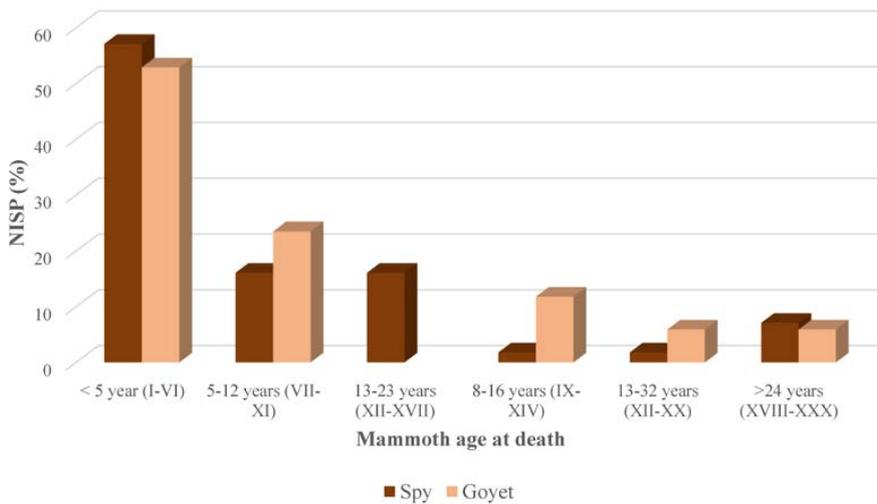


Figure 15.2: Age frequency distribution of all mammoth deciduous premolars from Spy and Goyet based on Laws' age groups (see text for details).

plexes of archaeological material with its lithic assemblages assigned to the Gravettian. The differences in the lithic typology and faunal assemblages of the six complexes permit their separation into two groups: a northern and a southern zone, which probably relate to separate phases of activity (Praslov and Ivanova, 1982; Praslov, 1985; Ivanova et al., 1987; Bessudnov, 2019; Reynolds et al., 2019). The mammal assemblage from the southern zone is dominated by mammoth remains, based on the MNI and NISP. The mammoth is the most abundant species in the northern zone based on the NISP. The diversity of the skeletal elements is much richer in the northern mammoth assemblage than in the southern one (Ivanova et al., 1987; Reynolds et al., 2019). An upper carnassial from a large canid found in the southern zone was described as dog-like in size (Reynolds et al., 2019).

15.3.5 YUDINOVO

The Epigravettian site Yudinovo (Russia) is situated on the right bank of the Sudost' River, a tributary of the Desna (Fig. 15.1). Dates for the main, lower layer suggest an age between 18,400 and 17,700 cal BP. Five complexes of mammoth skeletal elements characterize the site. Furthermore, large quantities of ivory hunting tools and

ivory ornaments were recovered (Germonpré et al., 2008; Khlopachev, 2019; Sablin, 2019; Sablin et al., submitted). Details on the taphonomic and palaeobiological characteristics of two of these complexes can be found in Germonpré et al. (2008) and Germonpré and Sablin (2017), who proposed that the mammoth bones were harvested from hunted mammoths. The ontogenetic age distribution of the mammoth assemblage based on a combination of cranial and postcranial material is dominated by remains from young mammoths, less than 13 years old. However, remains from adult mammoths are also very well represented and most of this material probably pertains to cows (Germonpré et al., 2008). A humerus from a large canid was described as dog-like in size (Germonpré and Sablin, 2017).

15.4 RESULTS

15.4.1 SPY

Young nursing mammoth calves (Laws' age groups I–VI, <5 years old) are the most frequent class in the age distribution of the mammoth assemblage from Spy (Fig. 15.2, Table 15.2). The age distribution based on Laws' age groups (I, II, III, IV, V) in months, of the nursing calves is given in Table 15.2 and Figure 15.3. These results permit us to

SPY STRATIGRAPHY	INVENTORY NUMBER	TOOTH	JAW	LAWS' AGE GROUP	AGE IN MONTHS	P	PA	L	W	H
-	17393	DP2	lower	I	0–1	5	0	16.2	15.1	10.3
-	-	DP2	upper	I	0–1	5	0	18.1	16.4	17.6
-	10261	DP2	lower	I	0–1	>3	0	>15	19.2	27.0
-	10621	DP2	upper	I	0–1	>3	0	>15	19.3	26.0
-	-	DP3	lower	II	2	8	3	52.6	34.2	-
-	1585	DP3	upper	II	2	8	4	56.9	30.8	40.1
- (AMS: 37,010 y BP)	5608	DP3	upper	II	2	8	4	58.4	37.0	39.7
-	16640	DP3	lower	III	3–6	8	5	52.9	28.1	33.2
Second level, Upper Mousterian	1038	DP3	lower	III	3–6	8	6	61.2	35.7	33.6
Cave	-	DP3	upper	III	3–6	9	5	60.8	35.6	35.3
Cave	1133	DP3	lower	IV	7	9	8	54.4	32.8	24.8
-	-	DP3	lower	IV	7	8	7	62.8	36.2	-
Second level, Upper Mousterian	-	DP3	lower	IV	7	8	7	53.1	31.3	37.2
Cave	-	DP3	?	IV	7	8	7	55.2	33.5	-
Second level, Upper Mousterian	1133	DP3	upper	IV	7	9	8	56.0	36.6	30.5
Second level, Upper Mousterian	-	DP3	upper	IV	7	8	7	52.8	30.6	34.6
Second level, Upper Mousterian	1585	DP3	upper	IV	7	10	9	57.7	33.6	40.0
Second level, Upper Mousterian	-	DP3	upper	IV	7	9	8	60.8	35.6	35.3
-	1133	DP3	upper	IV	7	8	8	57.3	34.1	36.0
Terrace	1133	DP3	upper	IV	7	8	8	56.0	36.6	30.5
-	-	DP4	upper	IV	7	14	6	96.8	49.8	73.0
Second level, Upper Mousterian	5608	DP3	lower	V	>12	8	8	61.9	36.6	28.0
Second level, Upper Mousterian	-	DP3	lower	V	>12	8	8	55.0	30.6	24.1
-	1133	DP3	lower	V	>12	8	8	57.5	33.9	34.5
-	1133	DP3	lower	V	>12	7	7	54.5	31.9	25.8
-	1133	DP3	lower	V	>12	7	7	54.3	31.7	24.9
-	B.1038	DP3	lower	V	>12	8	8	64.1	36.2	22.5
-	-	DP3	lower	V	>12	6	6	53.7	34.1	27.6
	1038	DP3	lower	V	>12	7	7	48.1	30.3	25.0
	16640	DP3	lower	II-V	3->12	>6	>6	>43	31.5	30.6
- (AMS: 42,330 y BP)	19B-121-1474	DP3	?	II-V	3->12	>4	?	34.3	-	-
Yellow earth	10261	DP3	lower	II-V	3->12	>3	>3	>15	31.2	30.4
Spy stratigraphy	Inventory number	Tooth	Jaw	Laws' age group	Craig AEY in Haynes (1991: table A2)	P	Pa	L	W	H
-	-	DP4	lower	VII	5 y	12	12	102.1	53.5	10.1
Cave	158x	DP4	lower	VII	5 y	11	11	98.0	53.2	36.6
Terrace	-	DP4	lower	VII	5 y	9	9	81.2	43.6	17.1
-	-	DP4	lower	VII	5 y	10	10	79.5	53.5	27.2
-	-	DP4	lower	VII	5 y	5	5	70.7	59.5	-
Terrace	-	DP4	upper	VII	5 y	14	13	106.1	55.1	87.1

Table 15.2: List of all mammoth deciduous premolars from Spy, adapted and corrected from Germonpré et al. (2014), that can be assigned to a Laws' age group, ages in months and in AEY (African Equivalent Years); see text and Table 15.1 for details; P: number of plates, Pa: number of abraded plates, L: length, W: width, H: height.

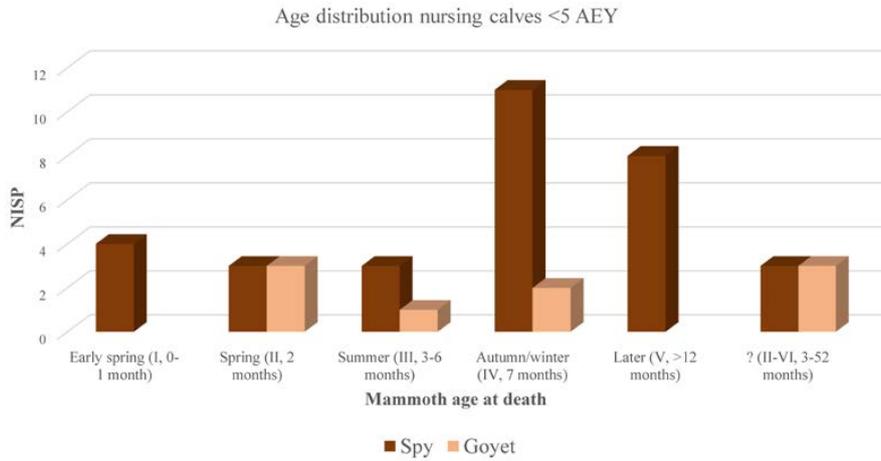


Figure 15.3: Age frequency distribution of mammoth deciduous premolars from Spy and Goyet based on Laws’ age groups I up to VI (see text and Tables 15.1–15.3 for details).

GOYET STRA-TIGRAPHY	INVENTORY NUMBER	TOOTH	JAW	LAWS’ AGE GROUP	AGE IN MONTHS	P	PA	L	W	H
A3	2777-6	DP2	upper	II	2	5	4	17.8	15.1	
A4	2860-4	DP3	lower	II	2	8	5	49.0	30.9	28.5
A3	2777-8	DP3	upper	II	2	8	3	63.5	34.0	37.9
A3	2777-10	DP4	upper	III	3–6	>7	3	65.0	50.6	70.6
A1	2815-10	DP3	upper	IV	7	6	6	47.0	37.2	12.8
A3	2777-9	DP3	lower	IV	7	8	8	54.2	34.4	21.8
A1	2815-13	DP4	lower	V	>12	8	5	>70	45.0	49.3
A3	2777-19	DP4	?	IV–VI	7–52	>1	0	-	39.3	52.9
A1	2815-11	DP4	upper	IV–VI	7–52	>3	2	-	43.0	64.0
GOYET STRA-TIGRAPHY	INVENTORY NUMBER	TOOTH	JAW	LAWS’ AGE GROUP	CRAIG AEY IN HAYNES (1991: TABLE A2)	P	PA	L	W	H
A4	2860	DP4	upper	VII–VIII	5–7	>8	>8	55.5	47.9	67.8

Table 15.3: List of all mammoth deciduous premolars from Goyet, adapted and corrected from Wißing et al. (2019a), that can be assigned to a Laws’ age group, ages in months and in AEY (African Equivalent Years); see text and Table 15.1 for details; P: number of plates, Pa: number of abraded plates, L: length, W: width, H: height.

conclude that mammoth calves died in the vicinity of Spy during all seasons.

15.4.2 GOYET

The age profile of the Goyet mammoth assemblage is dominated by young nursing calves (<5 years) (Fig. 15.2, Table 15.3). The Goyet mammoth assemblage contains a complete DP2. The wear of this tooth indicates that the animal died when it was ~2 months old (Laws’ age group II). The wear

of the other deciduous premolars, corresponding to Laws’ age groups III, IV and V, suggests that mammoth calves also perished near the Goyet cave during spring, summer and autumn/winter (Fig. 15.3; Table 15.3).

15.4.3 PŘEDMOSTÍ

Young mammoths, 12 years old or younger, dominate the mammoth assemblage from Předmostí according to Bosch (2012). The age distribution of the

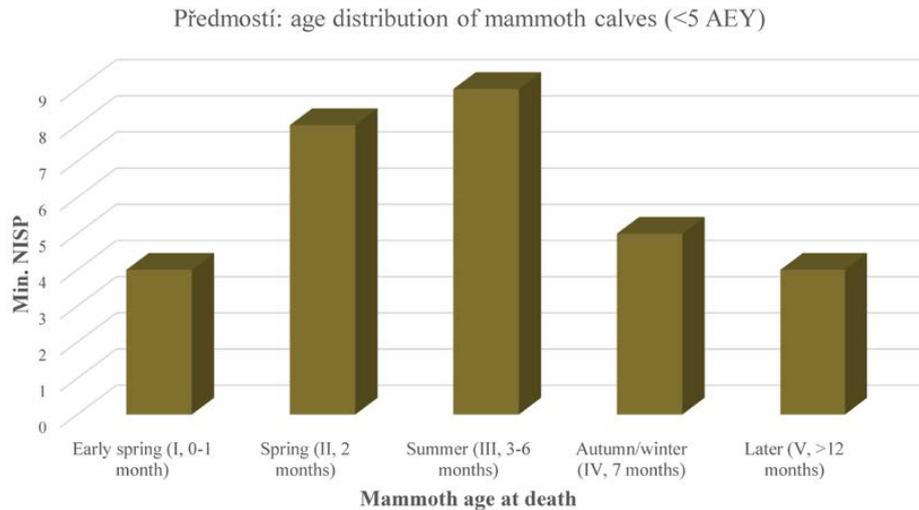


Figure 15.4: Age frequency distribution of mammoth deciduous premolars (DP2 NISP: 9; DP3 minimum NISP: 20) from Předmostí based on their description in Musil (1968); see text and Table 15.1 for details.

nursing mammoth calves from Předmostí is based on a minimum representation as deduced from the descriptions and figures in Musil (1968). Laws' age groups from I to V are represented among the dentition of juvenile mammoths (Fig. 15.4), suggesting that the calves died in every season.

15.4.4 KOSTĚNKI-21

In the mammoth assemblage from the southern zone, four age groups can be distinguished with remains from foetal, juvenile, subadult and adult mammoths (Reynolds et al., 2019). The first age group consists of a cut-marked humerus from a mammoth foetus that died at a gestation age of about 14–16 months (Maschenko, 2002). The juvenile age group contains two deciduous tusks from a calf that probably died at an age of less than 4 months based on its minimal wear, two milk tusks from a calf that probably died when it was between 6 and 9 months old on the basis of more extensive wear, and another deciduous tusk that can be attributed to an age of ~1 year old on the basis of its extensive wear and a closed root canal. Furthermore, a complete DP2 with the first two plates showing wear can be attributed to an age of ~2 months. Another DP2 with all its plates in wear was likely from a mammoth calf that died between 4 and 8 months old (Maschenko, 2002; Reynolds et al., 2019).

In the northern zone, a scapula of a mammoth calf is comparable in size to the scapula from Lyuba (Fisher et al., 2014: fig. 6); the Kostěnki scapula could have been from a calf that had died, like the Lyuba calf (Rountrey et al., 2012), when it was between 1 and 2 months old (Reynolds et al., 2019). Furthermore, a lower jaw with a DP4, in which the first plates are in wear, is probably from a nursing calf with an age of ~3 years (Maschenko, 2002).

15.4.5 YUDINOVO

The age distribution of the cranial remains of the mammoths from this site is dominated by animals with ages older than 22 AEY (Germonpré et al., 2008). Juvenile remains consist of both cranial and postcranial material. Three dental elements and one maxillary fragment are from nursing calves younger than one year old. An isolated, maxillary DP2 with some wear (Laws' age group I) belonged to a 1-month old baby mammoth (Sablin, 2019). The stage of wear of a DP2 and a DP3 in a maxillary fragment, as described by Maschenko (2002), allow us to assign this specimen to Laws' age group III. An isolated DP3 has wear (cf. Maschenko, 2002) that corresponds to Laws' age group IV. A deciduous tusk pertains to a calf of about 6 to 9 months old (Maschenko, 2002). The young animals died during spring, summer and autumn or winter.

15.5 DISCUSSION

Mammoth hunting has been directly attested at several Upper Palaeolithic sites all over northern Eurasia. The oldest evidence has been found in an early Upper Palaeolithic layer at Kostënki-14 with a fragment from an ivory point embedded in a mammoth rib (Sinitsyn et al., 2019). The Gravettian site Krakow Spadzista (Poland) yielded a distal part of a mammoth rib with a pointed fragment of a flint implement embedded (Wojtal et al., 2019). The mammoth assemblage of the Gravettian site Kostënki-1/I contains a rib with an inserted flint point fragment (Praslov, 2000; Nuzhnyi et al., 2014). Further to the east, at the Late Glacial site Lugovskoye in Siberia, a mammoth thoracic vertebra was discovered with an embedded quartzite point (Zenin et al., 2006). In Yakutia, at the mid-Upper Palaeolithic Yana site, fragments of spear points in several mammoth scapulae testify to successful mammoth hunts (Nikolskiy et al., 2013). Also in Yakutia, at the Late Glacial site Nikita, a mammoth rib with embedded lithic fragments was found (Pitulko et al., 2016). All this direct evidence pertains to adult mammoths. Indirect evidence of mammoth hunting suggests that mammoth herds, composed of cows with their calves were also hunted (Fladerer, 2003; Germonpré et al., 2008, 2014; Münzel et al., 2017).

Human hunting of elephants often targets calves (Reshef and Barkai, 2015; Agam and Barkai, 2018). Possibly, the young age of the calves made the transport of their carcasses easier so that their skeletal remains had more chance to end up in the faunal assemblages found at settlements. Carcasses of hunted adults could have been left at the kill sites, with their meat only taken to the living site. Furthermore, there could have been nutritional advantages for the Palaeolithic hunters from the eating of meat of young, nursing elephants (better taste, specific nutrients, higher quality fat, e.g., omega-3 fatty acids related to the intake of cow's milk) (Germonpré et al., 2014; Guil-Guerrero et al., 2014; Reshef and Barkai, 2015; Agam and

Barkai, 2016, 2018). Nevertheless, deliberate constructions and rich depositions of skeletal elements from adult mammoths have been found at many middle and late Upper Palaeolithic sites, especially in Central and Eastern Europe (Soffer, 1985; Piodoplichko, 1998; Svoboda et al., 2005, 2019; Oliva, 2007, 2009; Germonpré et al., 2008; Iakovleva, 2019; Sablin, 2019; Pryor et al., 2020; Sablin et al., submitted).

Below we compare our results with published data from the literature. Several published accounts, like the one from the Upper Palaeolithic site Boršice in the Czech Republic (Nývtová Fišáková et al., 2007), mention the presence of young mammoths, but here we focus on those articles that provide detailed descriptions of the deciduous premolars, which permit to deduce the season of death of the mammoth calves.

At the Belgian Spy and Goyet caves, nursing mammoth calves dominate the age profiles (Fig. 15.2). At Spy, it is very likely that several of these animals were killed and brought to the cave by Neanderthals as can be deduced from the fact that many of their remains were found in the "Second Mousterian Level" and that two premolars have calibrated ages in the time range of the Neanderthal presence in Belgium (Germonpré et al., 2013, 2014). It seems that the Neanderthals, which were occupying the site, went hunting for mammoths during all seasons (Fig. 15.3). In addition, analyses of the stable isotopes in the collagen from Neanderthal remains found at the cave show that the diets of these individuals contained significant proportions of mammoth meat (Wißing et al., 2016). At Goyet, nursing mammoth calves were probably hunted during spring, summer and autumn or winter (Fig. 15.3). For both the Neanderthal and early Upper Palaeolithic humans found at the Goyet cave, the mammoth was an important food source (Wißing et al., 2019a).

At Geissenklösterle cave (Germany), the Aurignacian layers contain dental remains from mammoth calves not older than 1 month when they died, indicating that mammoth hunting took place repeatedly in spring. The relatively

good representation of the skeletal elements indicates that large portions of the calves' carcasses were brought to the cave where they were consumed, as attested by their cut-marked bones (Münzel et al., 2017).

At the Gravettian site Předmostí, the mammoth age profile is dominated by young individuals less than 12 AEY (Bosch, 2012). The detailed descriptions in Musil (1968) of the DP2 and DP3 permit us to infer that killed mammoth calves were brought to the site in all seasons, from early spring until winter (Fig. 15.4). This is in accordance with the idea of a year-round occupation of this major site, as also indicated by cementochronological studies (Nývltová Fišáková, 2013) and the extraordinary richness of the archaeological assemblage (Oliva, 1997). Furthermore, a recent study on the stable isotopes of the collagen of a human lower jaw from the site revealed that this individual ate frequently mammoth meat (Bocherens et al., 2015). Oliva (1997) proposed that this rich site, with its unique location near the Moravian Gate, functioned as an important gathering point, where humans from the region assembled for social contacts and ritual activities.

In both the northern and the southern zones of the Gravettian site Kostěnki-21, the mammoth assemblages contain remains from mammoth calves that were still nursing at the time of their death. In the southern zone, mammoth calves were found that died when they were ~2 months old, between 4 and 9 months old and when they were ~1 year old (Maschenko, 2002; Reynolds et al., 2019). Furthermore, as conception probably took place in late spring (Rountrey et al., 2012; Grigoriev et al., 2017), the mammoth cow carrying a 14–16-month-old foetus likely died during spring/early summer. The above implies that during the occupation of the southern zone of Kostěnki-21, mammoths were hunted during the spring and the beginning of the summer, and also at autumn and/or during winter. In the northern zone, a young calf died when it was about 1 to 2 months old, so it was probably hunted in spring. An older calf was killed at an age of ~3 years old,

probably while it was still nursing (Reynolds et al., 2019). Interestingly, there is now also evidence for the killing of a nursing mammoth at the Gravettian Kostěnki-9 site. The very elevated $\delta^{15}\text{N}$ value (12.3 ‰) of a mammoth calf, that has an age of ~29,000–27,000 cal BP, suggests that it was still nursing when it was killed (Reynolds et al., in press).

At the Gravettian site Milovice (Czech Republic), several areas yielded remains from newborn mammoth calves that were hunted in early spring (Brugère and Fontana, 2009). In addition, dental cement microstructures from mammoth molars found in several sectors of the site indicates that a number of animals died during autumn (Nývltová Fišáková, 2013). The evidence of the same seasonalities in mammoth deaths in different sectors of the site suggests recurrent hunting patterns (Brugère and Fontana, 2009).

The faunal assemblage from the Gravettian Pavlov site I Southeast, also in the Czech Republic, is dominated by bones from canids (foxes and large canids), hare and reindeer. Nevertheless, mammoth was an important animal for the prehistoric people who occupied this location. The hunters skinned, dismembered and filleted mammoth carcasses as testified by the cut marks on several elements, suggesting that the mammoths were eaten, and that their bones and ivory were used to fabricate tools and ornaments (Wojtal and Wilczyński, 2015). Several mammoth teeth were discovered at the site, including unworn and worn DP2 and DP3 (Musil, 1959; Wojtal and Wilczyński, 2015), suggesting that the calves were killed during early spring, spring and summer.

At the nearby site Dolní Věstonice I, also dated to the Gravettian, the fauna is dominated by mammoth, but comprises also taxa like horse, large canids, reindeer and hare (Klíma, 1963; Svoboda et al., 2019). Here, several mammoth deciduous premolars were discovered, including unworn and worn DP2, pointing to mammoth hunting in early spring and spring (Klíma, 1963).

The living floor residue of the Gravettian open-air site of Krems-Wachtberg (Austria) cor-

responds probably to a single occupation episode. Remains from two adult mammoths, a cow and a bull, and from several subadult and juvenile mammoths, suggest that at least one mammoth herd was hunted (Fladerer, 2003). The attribution of the calf dental remains to Laws' age groups II and IV (Fladerer, 2003) makes an occupation during the winter months and spring likely.

At the Epigravettian site Yudinovo, the wear stages of the dentition (Laws' age groups I, III and IV) from the nursing mammoth calves suggest that they died during early spring, summer, and autumn and/or winter, and that the inhabitants of this site hunted mammoths during both warm and cold seasons.

The Epigravettian site Eliseevichi 1 is, like Yudinovo, located in the Desna valley (Russia). The faunal spectrum is mainly composed of woolly mammoth, reindeer, wolf and polar fox (Demay et al., 2019). Two canid skulls were previously described as those of Palaeolithic dogs (Sablin and Khlopachev, 2002; Germonpré et al., 2009). Cut marks on juvenile and adult bones of the mammoths indicate that the animals were skinned, disarticulated and defleshed. The dental remains of several mammoth calves allowed Demay et al. (2019) to assign them to Laws' age groups I–II and III. This suggests that the calves were killed during the spring and summer months.

From the short and non-exhaustive review above, we can conclude, based on the ontogenetic age attribution of the dentition of mammoth calves, that during the Middle and Upper Palaeolithic, mammoth hunting was not limited to the cold part of the year. This type of hunting could take place in all seasons. At some sites, the hunt was restricted to one or a few seasons, at other sites mammoth calves died year-round. It is possible that Palaeolithic hunters consumed fresh mammoth meat and fat at social gatherings and feasts that included not only people of their own settlements, but also those of neighboring groups (cf. Barkai, 2019; Lewis, this volume; Tanner, this volume), who were invited in order to share and consume as much meat as possible before it was spoiled, and

to enjoy together the great abundance provided by the killing of the proboscidean (cf. Lewis, 2015, this volume; Tanner, this volume). Furthermore, the storage of mammoth meat and fat from animals killed during the warm half of the year must have involved other methods than freezing. Probably, the mammoth meat was also dried and/or smoked (see also Demay et al., this volume). Interestingly, isotopic investigations showed that the consumption of mammoth meat by small (polar fox, wolverine) or large (brown bear) predators was higher for individuals found where prehistoric humans ate a lot of mammoths, as in Předmostí, than at other sites (Bocherens et al., 2015). This suggests that some parts of the carcasses of mammoths hunted by the Upper Palaeolithic hunter-gatherers were also available to predators. Furthermore, it can be presumed that at the Upper Palaeolithic sites with evidence of mammoth hunting, Palaeolithic dogs would have been helpful to transport body parts of the hunted mammoths from the kill sites to the settlements and to protect the stored mammoth resources against plunderers (Germonpré et al., 2020). Remains from Palaeolithic dogs or large canids dog-like in size found at sites with mammoth assemblages have been described from the early Upper Palaeolithic in Western Europe (Goyet; Germonpré et al., 2009), from the middle Upper Palaeolithic in Central and Eastern Europe (Předmostí and several Kostěnki sites; Germonpré et al. 2012, 2015; Germonpré and Sablin, 2017; Reynolds et al., 2019) and from the late Upper Palaeolithic in the Russian Plain (Mezin, Mezhirich, Eliseevichi, Yudinovo; Pidoplichko, 1998; Sablin and Khlopachev, 2002; Germonpré et al., 2009; Germonpré and Sablin, 2017).

Predation pressure on female mammoths and their calves by the Upper Palaeolithic hunters could have led to a population decline and opened the mammoth ecological niche to other herbivorous species, such as horses (Drucker et al., 2015). It may also have enabled the immigration of the Siberian clade of mammoths into Europe between 30,000 and 20,000 years ago (Palkopoulou et al., 2013; Fellows Yates et al., 2017). It appears that

the ecological effects of mammoth hunting are visible for the Upper Palaeolithic, but not for the Middle Palaeolithic. This is possibly due to the higher intensity of hunting by modern humans compared to Neanderthals, perhaps related to the lower population density of the latter. This aspect is discussed in more detail by Bocherens and Drucker (this volume).

15.6 CONCLUSIONS

Combining all this evidence allows us to propose that nursing mammoth calves (and possibly their mothers) were killed and that their carcasses, heads or other body parts were transported to Middle and Upper Palaeolithic settlements by human hunters. The age at death of these calves implies that mammoth hunting took place during all seasons and was not limited to the cold part of the year. However, it must be pointed out that at Spy, Goyet and Předmostí, and likely at some other sites as well, the mammoth assemblages represent palimpsests and could reflect several hunting episodes (cf. Germonpré et al., 2014).

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