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Zooarchaeology of the layers from Dorochivtsy III (Ukraine)

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A B S T R A C T

Palaeolithic archaeological sites of the Western Ukraine are clustered along the Prut and Dniester Rivers. Different sites provided data enabling reconstruction of the paleoenvironment, chronology and cultures of human group during the Upper Paleolithic (notably Molodova V). During the second part of the Pleniglacial, between 23 000 and 20 000 years BP, palaeoclimatic variations took place. The intensification of cold and arid conditions is liable to force human groups to adapt to a changing environment. Little is known about this period, with only a few assemblages. Ongoing excavations continue to provide new data. The archaeological site of Dorochivtsy III has an important sequence stratigraphy with several archaeological layers. Among the seven Upper Palaeolithic layers, layers 6, 5, 4 and 3 testify to activities of a human group during the Upper Pleniglacial. We studied the faunal assemblages applying zooarchaeological methods, identifying mammoth (*Mammuthus primigenius*), reindeer (*Rangifer tarandus*), horse (*Equus* sp.) and fox (*Alopex lagopus/Vulpes vulpes*). The Gravettian layers 3, 4, 5 have anthropogenic clues in connection with subsistence activities oriented on reindeer, then horses, and finally fox. Concerning mammoths, we cannot define the modes of acquisition and use. These occupations have been interpreted as recurrent hunting occupations linked to procurement of local flint and lithic production for butchering activities. Layer 6 dated to 22 330 ± 100 BP is remarkable because of previously unseen practises. The lithic assemblage combined with bone industry and engraved tusk is a novel set of cultural elements in this area, called ancient Epigravettian. This layer testifies to the diversity of human activities during the Upper Pleniglacial and to the particular status of mammoth ivory as an artistic medium. Palynological data and taphonomic observations on bones indicate the persistence of relatively moist conditions during some periods, which could favour the movement of human groups. Although little is known about the Upper Pleniglacial period, Dorochivtsy III testifies to the continuity of a large exploitation of the territory of the Dniester valley.

1. Introduction

Molodova V, Mitoc-Malu-Galben and Cosăuţsi provided important stratigraphic information about paleoclimate, chronology and Paleolithic cultures between 33 000 and 10 000 BP (Fig. 1) (Chernysh, 1959; Ivanova and Tzeitlin, 1987; Otte et al., 1996; Damblon and Haesaerts, 1997; Noiret, 2004; Haesaerts et al., 2007). Molodova V (l. 10–9), showed the first Gravettian occupations of the Moldovian region during the last glacial maximum.

Around 25 000 BP, the environment was a steppe-forest type. Human groups hunted bisons, cervids, horses, and focused their establishment on exploiting flint deposits (Soffer, 1985; Noiret, 2009). Predation was often secondary. Subsequently, climatic deterioration took place. The phase between 23 000 and 20 000 BP was characterized by more arid conditions, and the faunal spectrum was more restricted (Haesaerts et al., 1998, 2003). The hunter–gathers changed their modes of subsistence with their environment. Occupations are few, with some concentrations of archaeological remains. There is limited information concerning human occupations during this period. This is interpreted as movement of human groups through the southern area. But we know that some groups made incursions to the north. To better understand a part of these adaptations, the results concerning Dorochivtsy III are presented here.

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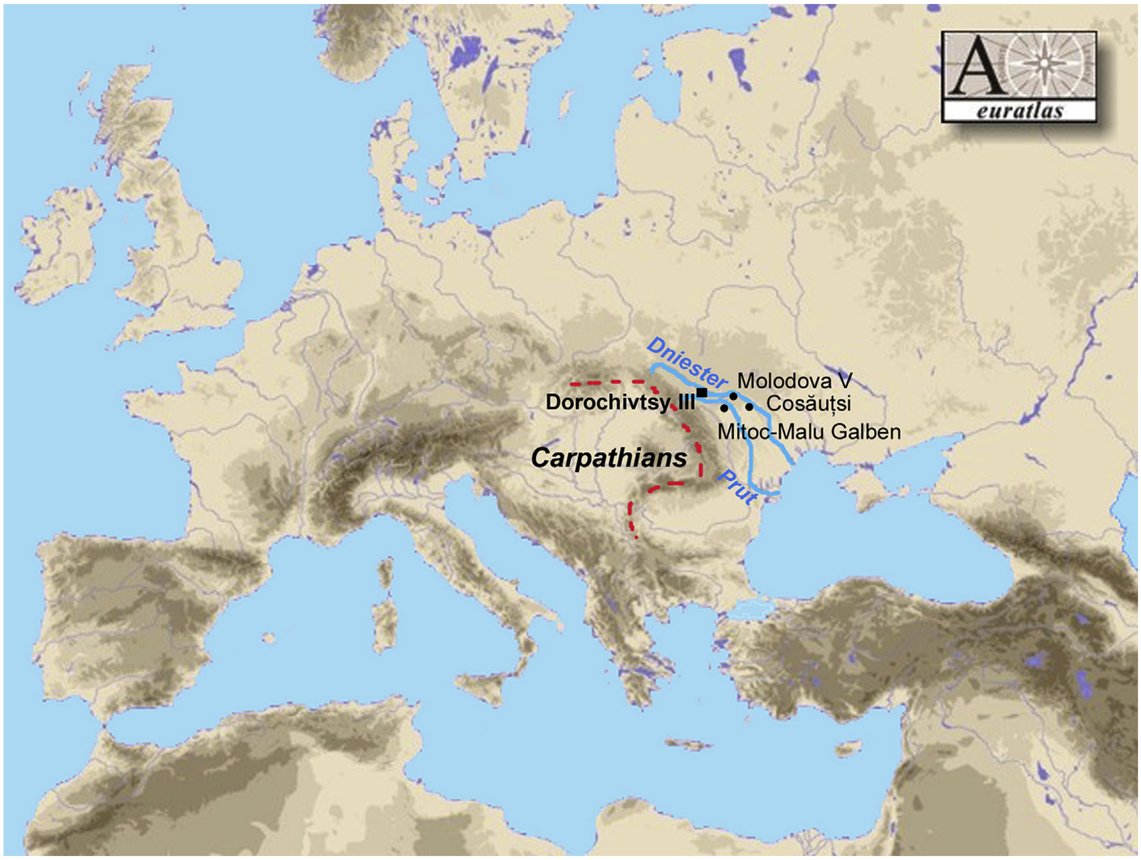

Fig. 1. Location of the mentioned sites.

In 1951, A.P. Chernysh prospected in Dorochivtsy. He discovered two Paleolithic sites: Dorochivtsy I (Gorbi) and Dorochivtsy II (Toloka) (Chernysh, 1954). In 1968, he discovered another site, Dorochivtsy III (Chernysh, 1985) (Fig. 2). The study has been led by L. Koulakovska since 2006 (Kulakovska et al., 2008).

Dorochivtsy III is an open-air site located on the first terrace of the Dniester, 26 m above the river, in the middle Dniester area, Ukraine (Fig. 3). The valley is characterized by ingrown meanders. The lateral valleys are suitable for herds of great mammals and for human groups. The site presented seven Upper Paleolithic cultural layers. The planar surface area is 42 m^2.

2. Geology

The geological study was made by P. Haesaerts (Koulakovska et al., 2012). The cultural layers are in sandy loam deposits (Fig. 4):

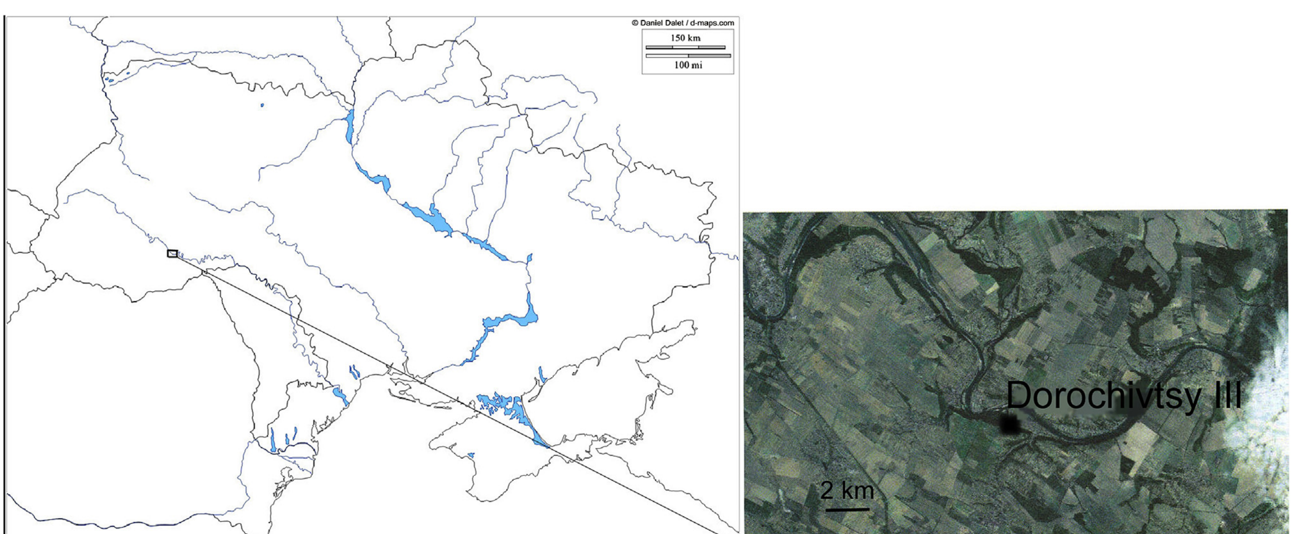

Fig. 2. Location of Dorochivtsy III.

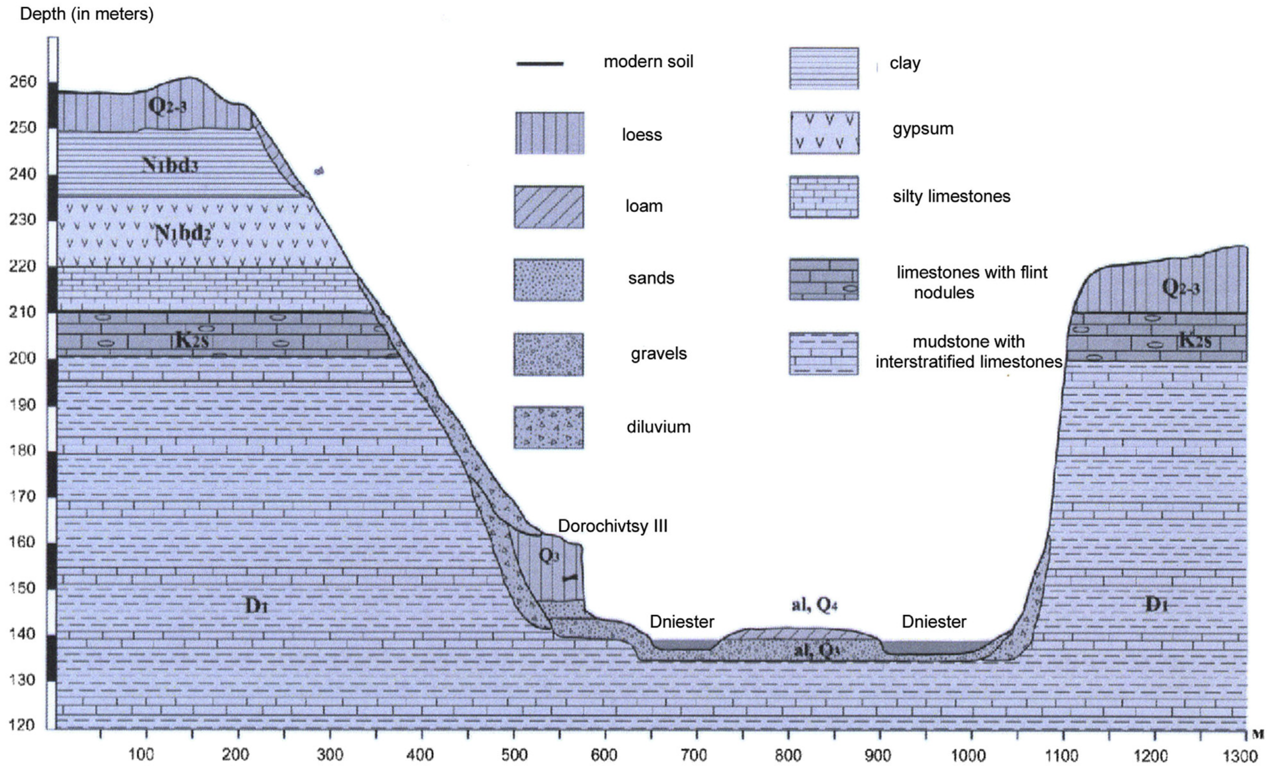

Fig. 3. Location of Dorochivtsy III on the terrace of the Dniester (from Koulakovska et al., 2011).

Layer 1 – on loess loam and biogalleries, covered by loess.
Layer 2 – loess loam
Layer 3– loess loam
Layer 4 – gray silt
Layer 5 – loess loam, sandy loess
Layer 6 – loess loam, solifluction and incursion of cryoturbation
Layer 7 – loess loam, gray silt

The paleogeomorphology of the site plays a part in determining preservation of the bones assemblage. The three main factors of degradation are hydrolysis (water), oxidation (oxygen), and dissolution (mineral and organic acids).

Dorochivtsy III is localised on the external bank of a fluvial terrace. It has favourable conditions for the preservation of archaeological material. Sediments and pedological processes are primordial because they determine the fossilisation.

The stratigraphy shows that the archaeological layers from Dorochivtsy III are located in sandy clays. Loess situated above the surface is composed of thin sands which can be compacted to leave few gaps, minimizing water effects. However, the rough structure and acidity of sands are destructive to bones. The increased presence of sand was observed in layer 6.

The clay leaf-moulds favour organic amounts and absorption of water, favourable to plant growth. Roots produced marks on the bones situated in the sub-surface. We observed cryoturbation effects between layers 3 and 4, 4 and 5, and 5 and 6.

Layer 6 was dated to 22 330 ± 100 BP, from charcoals (Koulakovska et al., 2011). Layer 3 was dated to 20 070 ± 90 BP.

3. Lithic remains

The study of lithic remains was made and discussed by Koulakovska et al. (2012). A total of 27 920 stone artifacts have been recorded (Table 1). Layers 1 and 7 do not contain remains. Layers 2 and 5 have some tools, in particular burins related to the Gravettian cultures.

Table 1
Lithic artifacts of the archaeological layers. Dorochivtsy III.

Archaeological layer	Depth (meters)	Number of artifacts
1	6.3–6.5	5
2	6.6–6.7	19
3	6.7–6.9	3981
4	6.9–7.15	604
5	7.3–7.5	19
6	7.9–8.1	23 286
7	8.4–8.6	6

Layers 3 and 4 contain numerous flint remains, allowing a techno-typological analysis. The technological processes are characterised by longitudinal débitage and bilongitudinal parallel débitage with hard and soft strikers. Tools are scrapers, burins, retouched blades, bladelets, and retouched backed microblades. These artefacts are referred to the Gravettian culture.

Layer 6 has many flint remains. The technological processes are characterised by longitudinal and bipolar parallel débitage with hard strikers. Tools are blades, bladelets, retouched backed microblades, scrapers, and shouldered points (Fig. 5). The lithic industry is combined with a bone industry.

The sites of the Dniester area do not contain Aurignacian tools or Mousterian artefacts. Moreover, shouldered points are narrow and almost unmarked, differing from Pavlovian and Kostienkian cultures, an original culture of the Dniester valley called Molodovian

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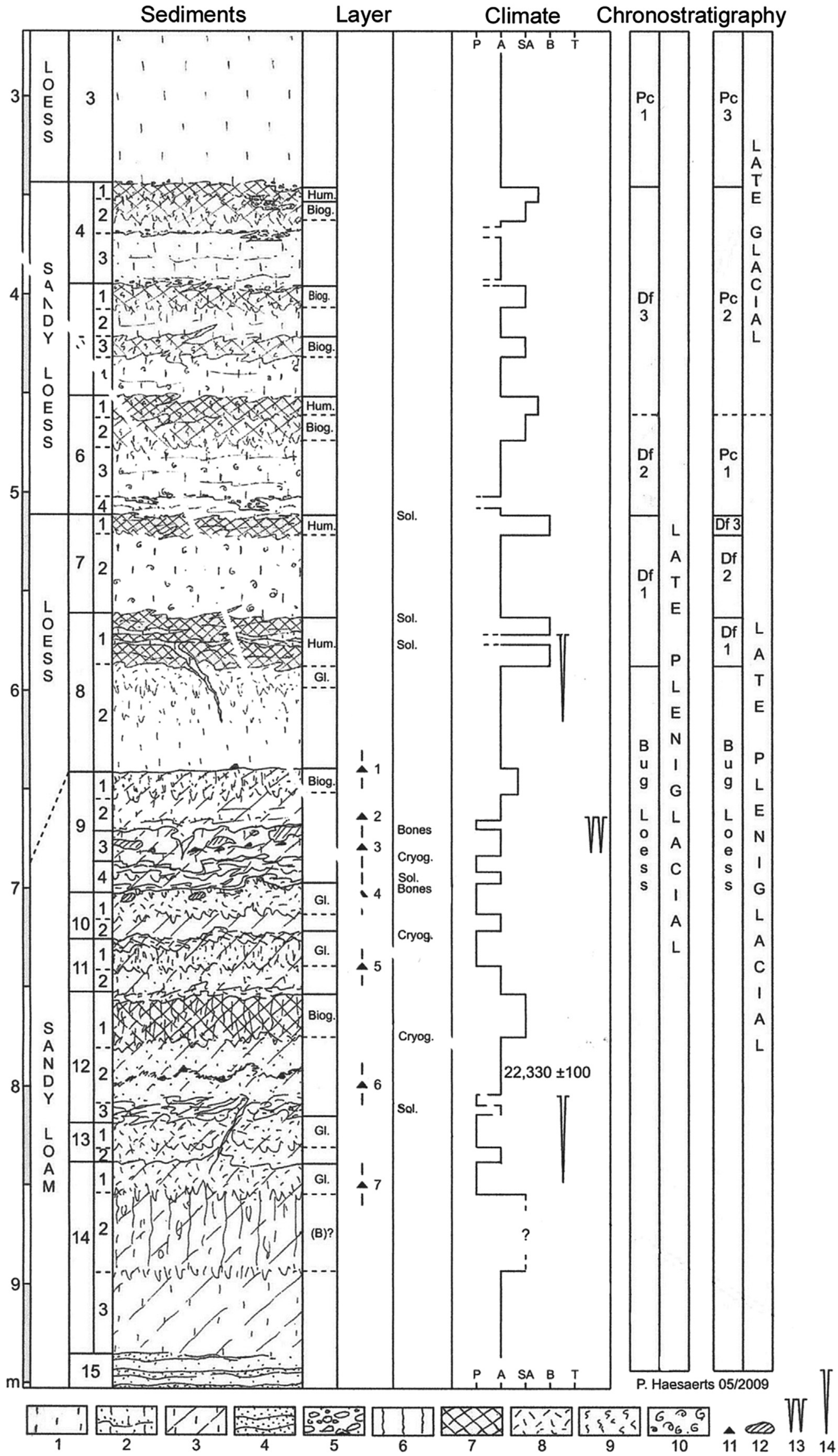

Fig. 4. Stratigraphic data of Dorochivtsy III (Haesaerts, 2009, in Koulakovska et al., 2011). Abbreviations: Hum: top soil; Biog: biogaleries; Sol.: solifluction; Cryot: cryoturbation. T: temperate; B: boreal; SA: sub-arctic; A: arctic; P: permafrost; 1: loess; 2: sandy loess; 3: loess loam; 4: sand; 5: gravel; 6: ochre clay; 7: humus loam; 8: gray silt (tundra gley); 9: biogalleries; 10: molluscs; 11: artifacts; 12: bones; 13: frost crack; 14: piece of ice.

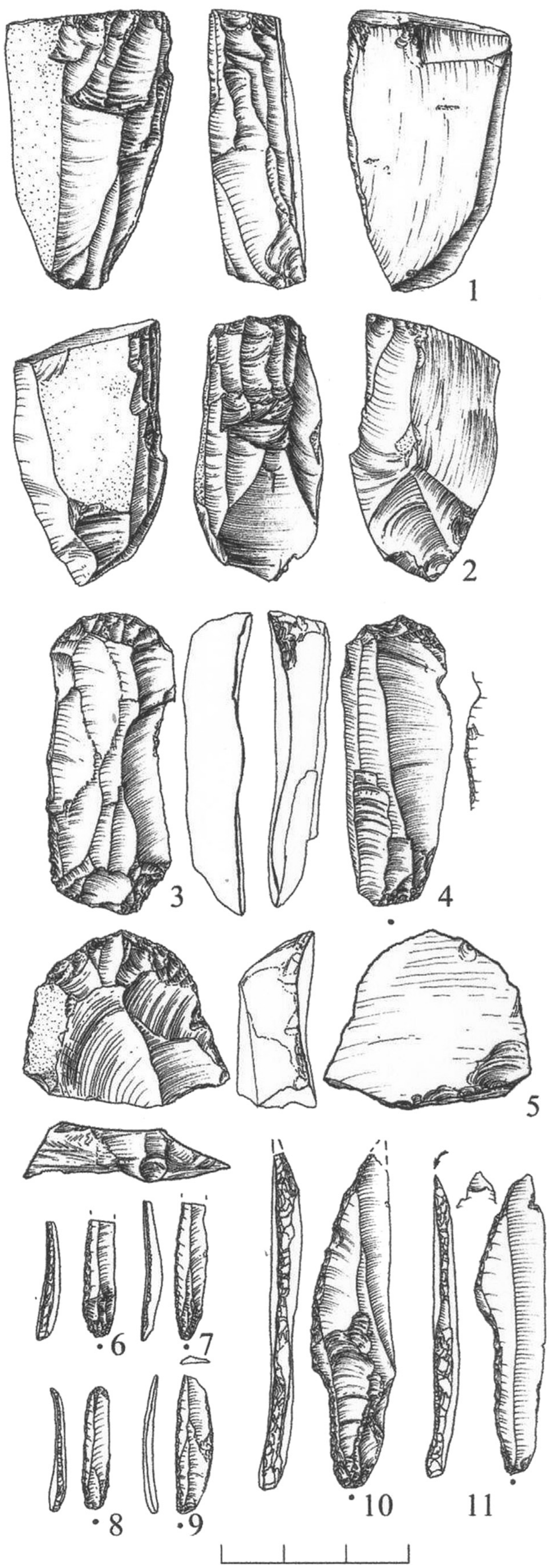

Fig. 5. Lithic remains of layer 6 from Dorochivtsy III. 1–2: cores; 3–4–5: end scrapers; 6–9: non-geometric microliths; 10–11: retouched bladelet.

or Eastern Gravettian (Boriskovsky, 1953; Grigor'ev, 1970; Chernysh, 1973; Otte et al., 1996; Borziac and Koulakovska, 1998; Borziac and Chirica, 1999; Djindjian, 2002; Noiret, 2004, 2007; Nuzhnyi, 2009).

Concerning layer 6, this kind of technocomplex differs compared with the knowledge about other sites of the Dniester valley. This profile corresponds to an ancient Epigravettian.

Dorochivtsy III is located in an area which corresponds to a narrow canyon containing lithic deposits. Owing to the fluvial erosion of the Cretaceous stratigraphic units, flint nodules were rolled. This flint of good quality was easy for human groups to reach. We can find this flint in Molodova V, Babin I, and Voronovitsa I (Kozlowski, 1986). We know that the human groups from Dorochivtsy III directly used this local flint of good quality (Otte, 1981) to make tools left on the site.

4. Zooarchaeological study

4.1. Materials and methods

Bones remains are those of the excavations from 2007 to 2010. They are conserved in the Museum of Archaeology in the National Museum of Natural History in Kiev.

The study was made from zooarchaeological methods including paleontology, taphonomy and palethnography (Poplin, 1976; Binford, 1979; Patou-Mathis, 1994; Lyman, 1994; O'Connor, 2000; Reitz and Wing, 2008). Taxonomic references and systematics were taken from the Code of Zoological Nomenclature (2000). The vernacular anatomical terms are from Barone (1986).

To identify the faunal remains, we used comparative anatomy (Lavocat, 1966; Lessertisseur and Saban, 1967a,b; Pales and Lambert, 1971; Schmid, 1972; Olsen, 1979; Pales and Garcia, 1981; Barone, 1986), and osteological collections (Collections of the Institute of Human palaeontology – National Museum of Natural History from Paris). Measurements were taken from von den Driesch (1976). To determine age, we used stages of bone growth and stages of eruption and tooth wear.

Concerning paleontology, we used Cornevin and Lesbre (1894) and Hillson (1986) as generalized reference sources. Specialized reference sources focused on *Rangifer tarandus*: (http://www.sciencedirect.com/science/article/pii/S1616504708000244Bouchud, 1953, 1966; Miller, 1972, 1974; Hufthammer, 1995; Enloe, 1997; Weinstock, 2000), *Equus* sp. (Barone, 1986; Eisenmann, 1991; Guadelli, 1998), *Mammuthus primigenius* (Coppens, 1965; Laws, 1966; Roth, 1984; Haynes, 1991; Averianov, 1996; Lister, 1996; Shoshani and Tassy, 1996; Beauval et al., 1998; Lister, 1999), and *Alopex lagopus* and *Vulpes vulpes* (Altuna, 2004). Quantitative measures followed Poplin (1976) and Lyman (2008), where:

NR: Number of remains;

NISP: Number of identified specimens;

MNE: Minimum number of elements, defining the representation of skeletal elements preserved for a taxon, taking into account reassemblies, pairings, age, and sex;

cMNI: Minimum Number of Individuals in combination, taking into account reassemblies, pairings, age, and sex;

Qsp: specific coefficient, obtained from the frequency of occurrence of an element in the anatomy of a species;

MAU: Minimum Animal Unit, specifying the degree of preservation of different anatomical elements of a species, where MAU = MNE/Qsp, and MAU frequency (%) = MAU × 100/MAUmax;

Ps: percent survivorship, involving observation on three levels: each element; each anatomical region; and the overall deficit (total) of the species. It is calculated by element. It takes into account the MAU which is based on the Minimum Number of Individuals evaluated by the cMNI. Ps = MNE × 100/Qsp × MNI max = MAU × 100/MNI max.

The skeletal preservation %MAU by anatomical segments related with bone density (from Lam et al., 1998) indicates the kind of preservation (natural/intervention of an agent).

We conducted an assessment of nutritional strategies, based on the work of Binford (1978, 1987), Metcalfe (1988), Jones (1988), Lyman (1994), and Faith and Gordon (2007). Nutritional values were obtained from the food utility index after the %MAU. The indices "meat", "marrow" and "grease" were also evaluated using the same methods. This is to assess the representation of anatomical parts according to their wealth of meat, bone, and fat.

Fig. 6. Skull of fox (*Vulpes vulpes*), layer 3, Dorochivtsy III (Photo: L. Demay).

4.2. Results

Up to 2007, 3025 bone remains were found, and it was possible to identify 1411 remains. Taking all layers took into account, the faunal spectrum is composed of *R. tarandus*, *Equus* sp., *M. primigenius*, *V. vulpes*/*A. lagopus*, and *Lepus timidus*.

Layers 3, 4, 5 and 6 are the richest in bone remains (Table 2). The contrast between the Number of Remains and the Minimum number of elements is varied according to the modalities of preservation. The remains of layer 6 showed the most fragmented and damaged bones. The increased presence of sand in this layer may explain the poorer preservation of bone remains.

Table 2
Number of remains, Minimum number of elements, and Minimum number of individuals by combination for each layer. Dorochivtsy III.

Layer	NR	MNE	cMNI	Depth (m)
1	57	16	2	6.3–6.5
2	53	24	3	6.6–6.7
3	662	134	6	6.7–6.9
4	1023	116	8	6.9–7.15
5	104	50	5	7.3–7.5
6	1118	49	8	7.9–8.1
7	8	6	2	8.4–8.6
Total	**3025**	**395**	**34**	

M. primigenius is present in all layers (Table 3). *Rangifer tarandus* is the most represented in layers 2, 3, 4, 5, 6, and 7 in terms of remains and elements. *Equus* sp. is represented by a few elements in layers 1, 3, 4, 5, and 6. Fox is present in layers 3, 4, and 6.

4.2.1. Paleontological characteristics

One skull and teeth of fox (Fig. 6) enabled us to perform measurements to identify the species, from Altuna (2004) and Lanoe (2012) (Table 4). The data indicates *Vulpes vulpes*.

Table 4
Measurements of the skull of fox of layer 3. Dorochivtsy III.

Measurements (mm)		Species
Condylo-basal length (LCB)	132	*Vulpes vulpes*. Limits to separate other species
Minimum width of the occipital condyls	None	
Width of mastoids	None	
Minimum width of interorbit	40	*Vulpes vulpes*
Length from P1 to M2	51.8	*Vulpes vulpes*
Length P4	12.8	*Vulpes vulpes*
Length M1 + M2	15.7	*Vulpes vulpes*
Length M1	9.5	*Vulpes vulpes*
Width M1	12.2	*Vulpes vulpes*

Although there are quite a few elements, and therefore it is necessary to consider this data with care, measures of articular ends of metapodials of reindeers indicate the size of individuals (Table 5). Based on the work of Delpech (1983, 2003), Pleistocene reindeer were greatly reduced in size between 25 000 and 14 000 BP. In comparison with studies by Stefaniak et al. (2012), it seems that reindeer at Dorochivtsy III are more robust than those usually found in Ukraine. Rather, they correspond to Moldovan populations.

Table 3
Number of remains totally determined, anatomical elements and Minimum Number of Individuals by combination for each species of all layers. Dorochivtsy III.

Layer	*M. primigenius*			*R. tarandus*			*Equus* sp.			*V. vulpes*/ *A. lag.*			*Lepus* sp.			TOTAL		
	NR	**MNE**	**cMNI**	**NR**	**MNE**	**cMNI**	**NR**	**MNE**	**cMNI**	**NR**	**MNE**	**cMNI**	**NR**	**MNE**	**cMNI**	**NR**	**MNE**	**cMNI**
1	55	14	1				1	1	1							56	15	2
2	51	22	2	2	2	1										53	24	3
3	172	20	1	217	82	3	7	7	1	25	25	1				421	134	6
4	128	11	1	308	84	4	6	6	2	7	7	1				449	108	8
5	3	3	1	66	44	3	1	1	1							70	48	5
6	73	9	2	241	21	2	34	7	2	4	4	1	2	2	1	354	43	8
7	7	5	1	1	1	1										8	6	2
TOTAL																**1411**	**378**	**34**

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Table 5
Measurements (mm) of articular ends of metapodials of reindeer. Dorochivtsy III.

Metapodials	Layers	Proximal		Distal	
		Width	Thickness	Width	Thickness
Metacarpal	6			44	20
Metacarpal	5	20			
Metacarpal	5		29		
Metacarpal	5	40	33		
Metatarsal	5	30			
Metatarsal	5			38	23
Metatarsal	5	29	22		
Metatarsal	5	33	32		
Metacarpal	3	39	26		
Metacarpal	3			15	11
Metacarpal	3	32	24		
Metatarsal	3	31	34		
Metatarsal	3		30		

Similarly, measurements were made on the metacarpal of *Equus* sp. of layer 6 (Table 6). Based on the work of Eisenmann (1991), Eastern European horses are larger than their contemporaries in Western Europe. Here from these measurements, it is a large individual, similar to horses of Mezin and Kostenki 1 (Eisenmann, 1991).

Table 6
Measurements (mm) of articular end of metacarpal of horse of layer 6. Dorochivtsy III.

Metapodial	Layer	Proximal	Distal	
			Width	Thickness
Metacarpal	6	/	55	35

4.2.2. Taxonomic composition

Layer 7 contains few remains of reindeer and mammoth (Table 3). Layer 6 presents inflected and fragmented faunal remains. The determined species are woolly mammoth, reindeer, horse, fox, and *Lepus* sp. Mammoth, reindeer and horse are equal in terms of Minimum Number of Individuals. In term of MNE and NR, reindeer is the most represented (Table 7).

Table 7
Faunal remains of layer 6. Dorochivtsy III.

Species	NR	MNE	cMNI
Mammuthus primigenius	73	9	2
Rangifer tarandus	241	21	2
Equus sp.	34	7	2
A. lagopus/V. vulpes	4	4	1
Lepus sp.	2	2	1
Small mammal	6	3	
Medium sized/Large mammal	44	2	
Splinters	713		
Total	1118	48	8

Layer 5 contained few bone remains but with good preservation. The determined species are reindeer, horse, and mammoth. In term of individuals, reindeer are the most represented. In term of MNE and NR, reindeer is the most represented (Table 8).

Table 8
Faunal remains of layer 5. Dorochivtsy III.

Species	NR	MNE	cMNI
Mammuthus primigenius	3	3	1
Rangifer tarandus	66	44	3
Equus sp.	1	1	1
Large mammal	11	2	
Medium sized mammal (*Rangifer tarandus*?)	22		
Splinters	1		
Total	104	50	5

Layer 4 is abundant in faunal remains. The determined species are mammoth, reindeer, horse, and fox. In term of individuals, reindeer are the most represented. In term of MNE and NR, reindeer is the most represented (Table 9).

Table 9
Faunal remains of layer 4. Dorochivtsy III.

Species	NR	MNE	cMNI
Mammuthus primigenius	128	11	1
Rangifer tarandus	308	84	4
Alopex lagopus/Vulpes vulpes	7	7	1
Equus sp.	6	6	2
Large mammal	76	7	
Medium sized mammal (*Rangifer tarandus*?)	270	1	
Splinters	228		
Total	1023	116	8

The bones from layer 3 are relatively well preserved. The faunal spectrum is composed of woolly mammoth, reindeer, fox (*V. vulpes*) and one great mammal which could be horse. In term of individuals, reindeer are the most represented. In term of MNE and NR, reindeer is the most represented. Comparing the MNE and NR by species, the mammoth bones are the most fragmented (Table 10).

Table 10
Faunal remains of layer 3. Dorochivtsy III.

Species	NR	MNE	cMNI
Mammuthus primigenius	172	20	1
Rangifer tarandus	217	82	3
Alopex lagopus/Vulpes vulpes	25	25	1
Large mammal (*Equus* sp.?)	7	7	1
Indeterminates	88		
Splinters	153		
Total	662	134	6

Layer 2 presents remains of at least two mammoths and of an artiodactyl, probably reindeer (Table 3). Layer 1 has a few bones of mammoth and horse (Table 3).

4.2.3. Paleoclimate

We used actualist theory with faunal species to determine the paleoenvironment from Dorochivtsy III. The woolly mammoth (*M. primigenius*) is typical of a cold dry climate in an open landscape with herbaceous vegetation. The reindeer (*Rangifer tarandus*) can live in forest or in open landscape, typical of cold climate. The horse lives generally in open landscape, despite the presence of some populations in tree-filled territories, or uneven landscapes, with varied climates. The polar fox (*A. lagopus*) is adapted to extremely cold climate. The red fox (*V. vulpes*) can be found in cold contexts.

According to the fauna, the different layers from Dorochivtsy III refer to an open landscape in a cold dry climate. From the geological and malacologic data from the region, the period between 23 000 and 20 000 B.P. is characterized by a cold and dry climate, and open vegetation was dominant (Łanczont and Madeyska, 2005). From N. *Gerasimenko* (in progress), the Upper Paleolithic layers of Dorochivtsy III are characterized by a steppe-tundra environment with presence of forests and moisture.

4.2.4. Skeletal preservation

Layer 7 presents two thoracic vertebrae, a lumbar vertebra, a rib and fragment of flat bone (scapula/pelvis) of a young mammoth and a fragment of rib of reindeer. Layer 6 presents bone remains of mammoth, horse, fox, *Lepus* sp. and reindeer.

Mammoth is represented by two individuals. One is represented by a tooth (left Dp_3) and a fragment of pelvic bone. The other is represented by a tooth (left M_2), a tusk, a thoracic vertebra, and a humerus. We have also fragments of teeth and ivory, a fragment of a long bone, a fragment of another tooth, and part of another tusk.

Horses are represented by two individuals. One is represented by a tibia. The other is represented by two ribs, a metacarpal, a distal phalanx and a femur. We have also a fragment of long bone and a fragment of tibia. Fox is represented by a left and a right patella and two carpals. *Lepus* sp. is represented by two lower incisors.

Concerning the reindeer, according to the Minimum number of elements and the number of remains by anatomical parts, ribs are the most represented and the most fragmented. We have remains of skulls, vertebrae, scapula and long bones from the hindlimbs. Bones from the limb extremities are absent. Maxillar and mandibula with teeth are absent (Table 11).

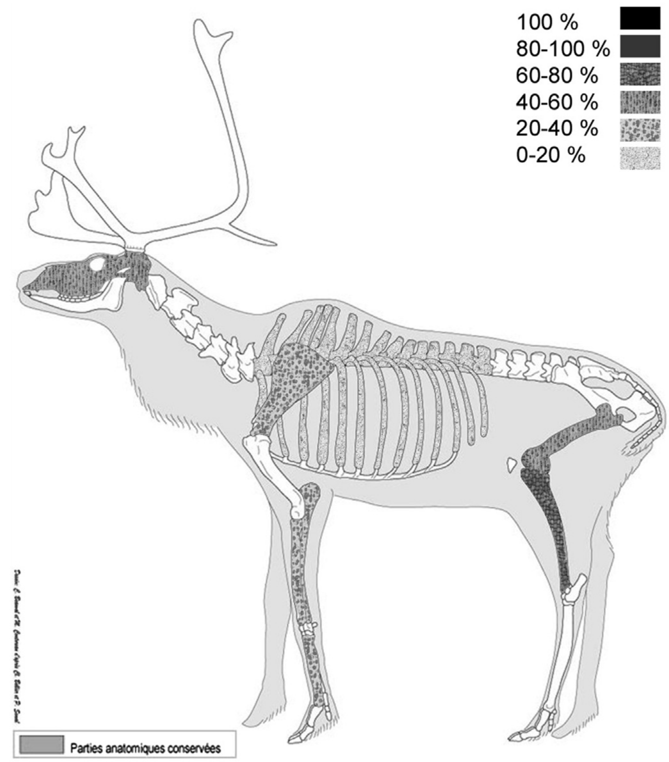

Fig. 7. Representation in %survivorship of reindeer of layer 6, Dorochivtsy III.

Layer 5 presents bone remains of mammoth, horse, and reindeer. A mammoth is represented by a rib and an ulna. A horse is represented by a fragment of humerus.

Table 11
Quantification of the remains of reindeer of layer 6. Dorochivtsy III.

Elements	Qsp	NR	MNE				MNIf	cMNI							MAU	%MAU	Ps%
			G	D	Ind.	Tot.		J.	Y. A.	I.A.	M.A.	O.A.	Ind	Tot.			
Skull	1	6			1	1	1						1	1	1.00	66.67%	50.00%
Cranial skeleton	43	6			1	1	1						1	1	0.02	1.55%	1.16%
Ind. Vertebra	38	3			1	1	1		1					1	0.03	1.75%	1.32%
Thoracic vertebra	14	2			1	1	1						1	1	0.07	4.76%	3.57%
Rib	28	73	5	1	3	9	1						1	1	0.32	21.43%	16.07%
Axial skeleton	67	78	5	1	5	11	1		1					1	0.16	10.95%	8.21%
Scapula	2	1	1			1	1						1	1	0.50	33.33%	25.00%
Radius	2	3		1		1	1						1	1	0.50	33.33%	25.00%
Radius DE	2	3		1		1							1	1	0.50	33.33%	25.00%
Ulna	2	2	1			1	1						1	1	0.50	33.33%	25.00%
Anterior upper part	8	3	2	1		3	1						1	1	0.38	25.00%	18.75%
Main metacarpal	2	1		1		1	1						1	1	0.50	33.33%	25.00%
Mtc DE	2	1		1		1	1						1	1	0.50	33.33%	25.00%
Basipod and metapod	18	1		1		1	1						1	1	0.06	3.70%	2.78%
Femur	2	5	1	1		2	1						1	1	1.00	66.67%	50.00%
Tibia	2	4	1	2		3	2		1		1			2	1.50	100.00%	75.00%
Tibia DE	2	2		2		2	2		1		1			2	1.00	66.67%	50.00%
Tibia and tarsus	12	4	1	2		3	1		1		1			2	0.25	16.67%	12.50%
Posterior upper part	10	9	2	3		5	2		1		1			2	0.50	33.33%	25.00%
Ind. Metapodial		4			3	3	1						1	1			

The skeletal preservation of the reindeer from layer 6 is expressed in percentage survivorship. This indicates representation of skull, long bones, scapula and some ribs and vertebra. The anterior and posterior upper parts are well represented (Fig. 7). We can conclude that reindeer were butchered at the kill site and quarters were brought to the camp, without pelvic bones.

The reindeer, according to the Minimum number of elements and the number of remains by anatomical parts, shows that long bones, metapodials, some carpals and tarsals, some phalanxes, some ribs, skulls, and antlers are the most represented. Skulls and antlers are the most fragmented (Table 12).

Table 12
Quantification of the remains of reindeer of layer 5. Dorochivtsy III.

Elements	Qsp	NR	MNE				MNIf	cMNI							MAU	%MAU	Ps%
			G	D	Ind.	Tot.		J.	Y. A.	I.A.	M.A.	O.A.	Ind	Tot.			
Antler	2	15	1	1	4	6	3		1					1	3.00	100.00%	100.00%
Skull	1	10	1		1	2	2						2	2	2.00	66.67%	66.67%
Cranial skeleton	43	25	2	1	5	8	1		1				1	2	0.19	6.20%	6.20%
Rib	28	1			1	1	1						1	1	0.04	1.19%	1.19%
Axial skeleton	67	1			1	1	1						1	1	0.01	0.50%	0.50%
Humerus	2	1			1	1	1						1	1	0.50	16.67%	16.67%
Radius	2	3	1	1	1	3	2				1			1	1.50	50.00%	50.00%
Radius PE	2	2	1	1		2	1				1			1	1.00	33.33%	33.33%
Radius DE	2	1		1		1	1				1			1	0.50	16.67%	16.67%
Ulna	2	2	1	1		2	1				1			1	1.00	33.33%	33.33%
Anterior upper part	8	6	2	2	2	6	1				1			1	0.75	25.00%	25.00%
Hamatum	2	1	1			1	1						1	1	0.50	16.67%	16.67%
Capitato-trapezoid	2	2	2			2	2						1	1	1.00	33.33%	33.33%
Lunatum	2	1	1			1	1						1	1	0.50	16.67%	16.67%
Scaphoid	2	1	1			1	1						1	1	0.50	16.67%	16.67%
Triquetrum	2	1		1		1	1						1	1	0.50	16.67%	16.67%
Pisiform	2	1		1		1	1						1	1	0.50	16.67%	16.67%
Carpals	12	7	5	2		7	1						2	2	0.58	19.44%	19.44%
Main metacarpal	2	5	2	1		3	2						2	2	1.50	50.00%	50.00%
Mtc PE	2	5	2	1		3	2						2	2	1.50	50.00%	50.00%
Femur	2	2	1		1	2	1		1					1	1.00	33.33%	33.33%
Femur PE	2	1	1			1	1		1					1	0.50	16.67%	16.67%
Tibia	2	1	1			1	1						1	1	0.50	16.67%	16.67%
Tibia and tarsus	12	11	11	2		13	2		2		1				1.08	36.11%	36.11%
Posterior upper part	10	3	2		1	3	1		1		1			2	0.30	10.00%	10.00%
Talus	2	2	2			2	2						2	2	1.00	33.33%	33.33%
Calcaneus	2	5	3	2		5	3		2		1			3	2.50	83.33%	83.33%
Naviculo-cuboid	2	2	2			2	2				1			1	1.00	33.33%	33.33%
Int.-lat. cuneiform	2	1	1			1	1						1	1	0.50	16.67%	16.67%
Tarsals	10	10	10	2		12	2		2		1			3	1.20	40.00%	40.00%
Tarsals wth. tal. and calcan.	6	3	6			6	2		2					2	1.00	33.33%	33.33%
Main metatarsal	2	5	3	1		4	3						3	3	2.00	66.67%	66.67%
Mtt PE	2	4	3			3	3						3	3	1.50	50.00%	50.00%
Mtt DE	2	1		1		1	1						1	1	0.50	16.67%	16.67%
Basipod and metapod	12	15	11	3	1	15	2		2		1			3	1.25	41.67%	41.67%
Proximal phalange	8	4			2	2	1						1	1	0.25	8.33%	8.33%
phalanges	48	4			2	2	1						1	1	0.04	1.39%	1.39%
Acropod	60	4			2	2	1						1	1	0.03	1.11%	1.11%

The skeletal preservation of the reindeers from layer 5 is expressed in percentage survivorship. This indicates representation of a skull with antlers, long bones, and basipods, with a good representation of limbs. The shoulder girdle, pelvis and axial skeleton are absent (Fig. 8).

We can conclude that human groups removed only limbs. They took also skulls with antlers.

Layer 4 has bone remains of mammoth, horses, fox, and reindeer. A mammoth is represented by fragments of teeth, ivory, a thoracic vertebra, a caudal vertebra, two ribs, a fragment of radius, a right triquetrum, a fragment of tibia, a fragment of short bone, and a fragment of long bone.

The horses are represented by two individuals. One is represented by a left M^3 and a right femur, the other one by a right humerus. We found also a fragment of metapodial and fragments of at least two other long bones. A fox is represented by three ribs, a metapodial, a right triquetrum, a coccyx and a diaphysis of long bone.

Concerning the reindeer, according to the Minimum number of elements end the number of remains by anatomical parts, there are skulls, antlers, mandibulas with teeth, scapula, long bones, metapodials, carpals and tarsals, some phalanxes, ribs, and some vertebra. Skulls and ribs are the most fragmented (Table 13).

Table 13
Quantification of the remains of reindeer of layer 4. Dorochivtsy III.

Elements	Qsp	NR	MNE				MNIf	cMNI							MAU	%MAU	Ps%
			G	D	Ind.	Tot.		J.	Y. A.	I.A.	M.A.	O.A.	Ind	Tot.			
Antler	2	2			1	1	1		1					1	0.50	25.00%	12.50%
Skull	1	13			1	1	1						1	1	1.00	50.00%	25.00%
Upper teeth	12	9	3	1	5	9	1		2		1			3	0.75	37.50%	18.75%
Mandibule	2	6	3		1	4	3	1			1			2	2.00	100.00%	50.00%
Lower teeth	12	15	9	2	4	15	2	1	1		1			3	1.25	62.50%	31.25%
Incisors	6	5	3	2		5	1		1					1	0.83	41.67%	20.83%
Canine	4	3	1	2		3	1		1				1	2	0.75	37.50%	18.75%
Cranial skeleton	43	53	20	8	12	40	1	1	2		1			4	0.93	46.51%	23.26%

(*continued on next page*)

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Table 13 (*continued*)

Elements	Qsp	NR	MNE				MNIf	cMNI							MAU	%MAU	Ps%
			G	D	Ind.	Tot.		J.	Y. A.	I.A.	M.A.	O.A.	Ind	Tot.			
Cervical vertebra	5	1			1	1	1						1	1	0.20	10.00%	5.00%
Rib	28	80	3	2	3	8	1						1	1	0.29	14.29%	7.14%
Axial skeleton	67	81	3	2	4	9	1						1	1	0.13	6.72%	3.36%
Scapula	2	1	1			1	1						1	1	0.50	25.00%	12.50%
Humerus	2	1			1	1	1						1	1	0.50	25.00%	12.50%
Humerus DE	2	1			1	1	1						1	1	0.50	25.00%	12.50%
Radius	2	2			2	2	1						1	1	1.00	50.00%	25.00%
Anterior upper part	8	4	1		3	4	1						1	1	0.50	25.00%	12.50%
Lunatum	2	1	1			1	1						1	1	0.50	25.00%	12.50%
Pisiform	2	1		1		1	1						1	1	0.50	25.00%	12.50%
Carpals	12	2	1	1		2	1						1	1	0.17	8.33%	4.17%
Basipod and metapod	18	2	1	1		2	1						1	1	0.11	5.56%	2.78%
Femur	2	12	1	1		2	1				1			1	1.00	50.00%	25.00%
Femur PE	2	2	1	1		2	1				1			1	1.00	50.00%	25.00%
Tibia	2	7	2			2	2				1		1	2	1.00	50.00%	25.00%
Tibia PE	2	1	1			1	1				1			1	0.50	25.00%	12.50%
Tibia and tarsus	12	10	2	3		5	1				1		1	2	0.42	20.83%	10.42%
Posterior upper part	10	19	3	1		4	1				1		1	2	0.40	20.00%	10.00%
Talus	2	1		1		1	1						1	1	0.50	25.00%	12.50%
Calcaneus	2	1		1		1	1						1	1	0.50	25.00%	12.50%
Naviculo-cuboid	2	1		1		1	1						1	1	0.50	25.00%	12.50%
Tarsals	10	3		3		3	1						1	1	0.30	15.00%	7.50%
Tarsals wth. tal. and calcan.	6	1		1		1	1						1	1	0.17	8.33%	4.17%
Main metatarsal	2	4	1	2	1	4	2						2	2	2.00	100.00%	50.00%
Mtt PE	2	3	1	2		3	2						2	2	1.50	75.00%	37.50%
Mtt DE	2	2		1	1	2	1						1	1	1.00	50.00%	25.00%
Basipod and metapod	12	7	1	2	1	4	1		1					1	0.33	16.67%	8.33%
Intermediate phalange	8	2			2	2	1	1						1	0.25	12.50%	6.25%
Phalange	48	2			2	2	1	1						1	0.04	2.08%	1.04%
Acropod	60	2			2	2	1	1						1	0.03	1.67%	0.83%
Ind. Carp./tars.		1			1	1							1	1			
Ind. Metapodial		16			3	3		1	1					2			

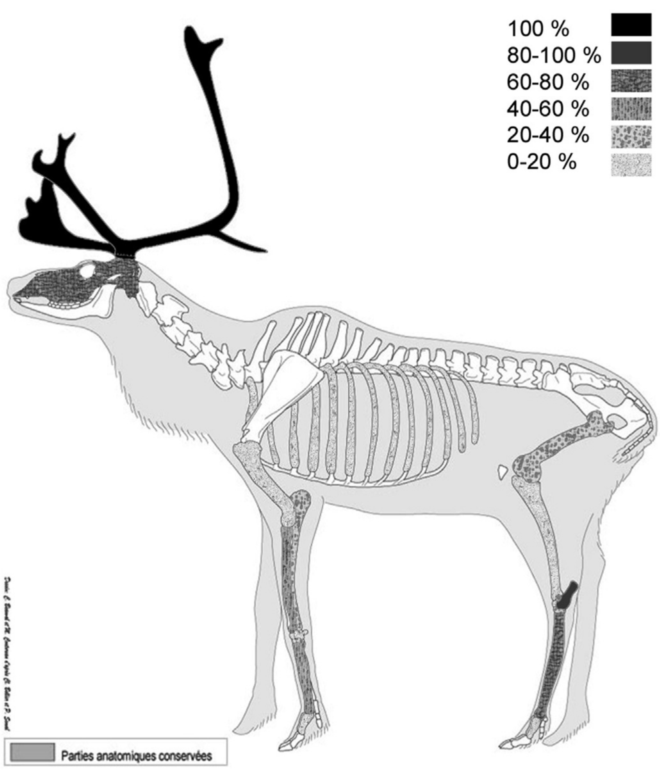

Fig. 8. Representation in %survivorship of reindeer of layer 5, Dorochivtsy III.

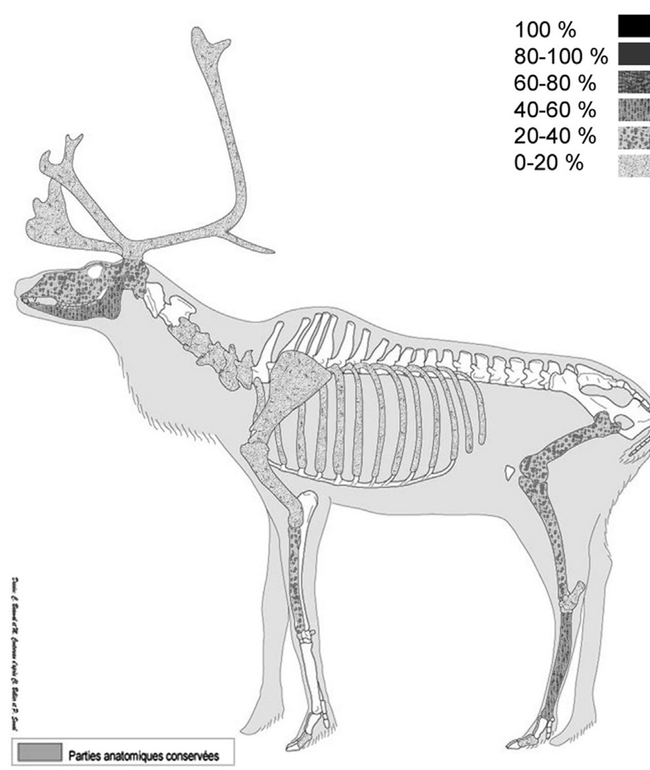

Fig. 9. Representation in %survivorship of reindeer of layer 4, Dorochivtsy III.

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The skeletal preservation in %survivorship indicates good preservation of all parts, except for pelvis and phalanxes. Cranial skeleton and limbs are the most represented (Fig. 9).

We can conclude that human groups took away limbs and some axial parts. They took also skulls with antlers.

Layer 3 shows bone remains of mammoth, horses, fox, and reindeer. Mammoth is represented by fragments of tooth and ivory, mandibula, and skull. There are twelve ribs, a fragment of scapula, a radius, a fragment of coxal, and a fragment of tibia. A horse is represented by four ribs and fragments of at least three long bones. A fox is represented by an almost complete skull with eighteen teeth (I^1G; I^1D; I^3G; I^3D; CG; CD; P^1G; P^1D; P^2G; P^2D; P^3G; P^3D; P^4G; P^4D; M^1G; M^1D; M^2G; M^2D), a fragment of mandibula with two incisors, a rib, a fragment of coxal, and a glenoid cavity of scapula.

Concerning the reindeer, according to the Minimum number of elements end the number of remains by anatomical parts, skulls, antlers, upper teeth, mandibulas with teeth, ribs, scapula, long bones, some carpals and tarsals and metapodials are represented. Ribs are the most fragmented (Table 14).

Table 14
Quantification of the remains of reindeer of layer 3. Dorochivtsy III.

Elements	Qsp	NR	MNE				MNIf	cMNI							MAU	%MAU	Ps%
			G	D	Ind.	Tot.		J.	Y. A.	I.A.	M.A.	O.A.	Ind	Tot.			
Antler	2	18	1	1	1	3	2	1	1					2	1.50	60.00%	50.00%
Skull	1	34	1		1	2	2	1	1					2	2.00	80.00%	66.67%
Maxillar	2	4	2	2		4	2		1		1			2	2.00	80.00%	66.67%
Upper teeth	12	22	12	10		22	2		1		1			2	1.83	73.33%	61.11%
Mandibule	2	6	3	1		4	3		1					1	2.00	80.00%	66.67%
Lower teeth	12	10	4	6		10	1		1					1	0.83	33.33%	27.78%
Cranial skeleton	43	94	21	20		41	1	1	1		1			3	0.95	38.14%	31.78%
Rib	28	79	3	1	1	5	1		1					1	0.18	7.14%	5.95%
Axial skeleton	67	79	3	1	1	5	1		1					1	0.07	2.99%	2.49%
Scapula	2	3		1	2	3	2		1					1	1.50	60.00%	50.00%
Humerus	2	1	1			1	1		1					1	0.50	20.00%	16.67%
Humerus DE	2	1	1			1	1		1					1	0.50	20.00%	16.67%
Radius	2	5	1	3		4	3	1	1		1			3	2.00	80.00%	66.67%
Radius PE	2	3				3	3	1	1		1			3	1.50	60.00%	50.00%
Ulna	2	2		2		2	2	1	1					2	1.00	40.00%	33.33%
Anterior upper part	8	11	2	6	2	10	2	1	1		1			3	1.25	50.00%	41.67%
Hamatum	2	1		1		1	1	1						1	0.50	20.00%	16.67%
Lunatum	2	1	1			1	1		1					1	0.50	20.00%	16.67%
Carpals	12	2	1	1		2	1	1	1					2	0.17	6.67%	5.56%
Main metacarpal	2	4		4		4	4	1	1		1			3	2.00	80.00%	66.67%
Mtc PE	2	2		2		2	2	1	1		1			3	1.00	40.00%	33.33%
Mtc DE	2	2		2		2	2	1	1		1			3	1.00	40.00%	33.33%
Basipod and metapod	18	6	1	5		6	1	1	1		1			3	0.33	13.33%	11.11%
Femur	2	3			1	1	1							0	0.50	20.00%	16.67%
Tibia	2	4	3		1	4	3	1	1		1			3	2.00	80.00%	66.67%
Tibia PE	2	2	2			2	2	1	1					2	1.00	40.00%	33.33%
Posterior upper part	10	7	3		2	5	1	1	1		1			3	0.50	20.00%	16.67%
Naviculo-cuboid	2	5	2	3		5	3	1	1		1			3	2.50	100.00%	83.33%
Int.-lat. cuneiform	2	6	1	1		2	1		1					1	1.00	40.00%	33.33%
Tarsals	10	11	3	4		7	1	1	1		1			3	0.70	28.00%	23.33%
Tarsals wth. tal. and calcan.	6	11	3	4		7	2	1	1		1			3	1.17	46.67%	38.89%
Main metatarsal	2	3	2	1		3	2	1	1					2	1.50	60.00%	50.00%
Mtt PE	2	3	2	1		3	2	1	1					2	1.50	60.00%	50.00%
Basipod and metapod	12	14	5	5		10	1	1	1		1			3	0.83	33.33%	27.78%
Tibia and tarsus	12	15	6	4	1	11	1	1	1		1			3	0.92	36.67%	30.56%

The skeletal preservation of the reindeers from layer 3 is here expressed in percentage survivorship. This indicates a representation of skull, antlers, hindlimbs, and forelimbs. Then we have some ribs. Vertebra and pelvis are lacking. Cranial skeleton, hindlimbs and forelimbs are well represented (Fig. 10). We can conclude that human group took limbs. They took also skulls with antlers.

Layer 2 contains bone remains of mammoth and reindeer. Mammoths are represented by two individuals. A juvenile is represented by a left scapula. A young adult is represented by a cervical vertebra, six ribs, two metapodials and a left femur. We have also fragments of ivory, fragments of at means two thoracic vertebrae, fragments of at means four ribs, a part of a metapodial, and fragments of at least three long bones. A non-juvenile reindeer is represented by a rib and a fragment of long bone.

Layer 1 contains bone remains of mammoth and horse. A juvenile mammoth is represented by fragments of ivory, eight vertebrae (cervical, thoracic and lumbar vertebra), three ribs, a humerus, and a scapula. A non-juvenile horse is represented by a rib.

4.2.5. Age classes

4.2.5.1. Mammoths. Layer 6 contained two mammoths. One of them is represented by a deciduous tooth. This is a third inferior left deciduous tooth corresponding to stages III–V (around 2–3 years old) (Fig. 11). The tooth displays 10 lamellae, 4 of which are worn, with 90 mm length, 40 mm width, and 78 mm height.

Another is represented by a molar with a minimum of 12 lamellae in eruption, with 114 mm length, 60 mm width, and 100 mm height. This is a broken second inferior left molar corresponding to stages XIV–XVI (around 18–20 years old).

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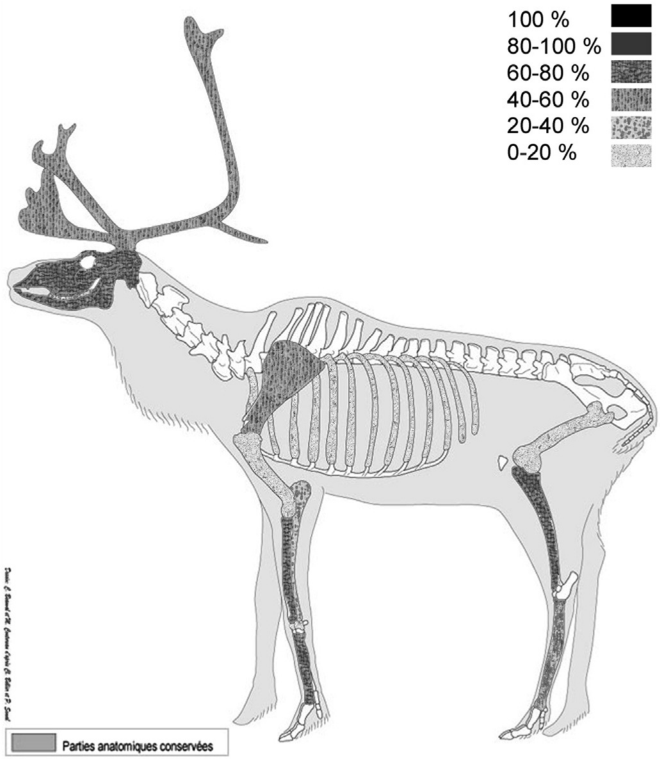

Fig. 10. Representation in %survivorship of reindeer of layer 3, Dorochivtsy III.

The age of the mammoth from layer 5 cannot be determined. Within layer 4, the remains of mammoth are attributed to a young adult, notably by the small-sized dimensions of a right triquetrum, 100 mm long, 85 mm wide, and 50 mm thick.

From the epiphysation stages from a pelvis of mammoth in layer 3, this individual is related to stage IXa (around 10 years old). All the mammoths of Dorochivtsy III are young individuals (Fig. 12).

4.2.5.2. Horses. Concerning the horses from layer 6, one is represented by a proximal extremity of a left femur which is epyphised, corresponding to age of more than 36 months. It is associated with a rib, a metacarpal, and a phalange of adult size. Another is represented by a distal extremity of a tibia which is not epyphised, corresponding to age growth less than 24 months. So, we have a juvenile individual and a mature individual. The age of a horse from layer 5 cannot be determined.

The remains of horses from layer 4 are from two individuals. One is represented notably by a right upper third molar, 65 mm high, 30 mm wide, and 25 mm thick, with enamel thickness of 2 mm. This individual was more than 2.5–5 years old.

A proximal extremity of a right femur is not totally epyphised, so this individual was slightly less than 36 months old. If this femur is associated with the same individual represented by the upper third molar, this individual would be around 3 years old.

Another one is represented by a right humerus, of which the distal extremity is not epyphised, corresponding to age of less than 15–18 months. Therefore, we have a juvenile individual and a young individual. The age of the individual horse from layer 3 cannot be determined (Fig. 13).

4.2.5.3. Reindeer. The reindeer from layer 6 are represented by two individuals. One is represented by a left tibia, of which the distal extremity is not totally epyphised, meaning this individual was slightly less than 18–30 months old. Another one is represented by a right tibia, of which the distal extremity is epyphised, meaning this individual is more than 18–30 months old.

Layer 5 contained three reindeer. Two were around two years old. A shed antler indicates a young individual, perhaps a female (base: width: 15 mm; thickness: 11 mm; crown: width: 13 mm; thickness: 19 mm).

Another individual is represented by a left ulna, of which the proximal extremity is epyphised, meaning that this individual is more than 43–76 months old. It is associated with a right radius, of which the proximal and distal extremities are epyphised (width: 45 mm thickness: 25 mm). A scapho-cuboid and a cuneiform are fused corresponding probably to a mature individual. A metacarpal is associated with this individual (proximal extremity: width: 40 mm thickness: 33 mm). A non-shed antler is present (base: width: 34 mm thickness: 33 mm). The size of bones could suggest that is a male mature adult.

Reindeer from layer 4 are represented by four individuals. Stages of eruption and tooth wear indicate that two individuals were slightly more than 2 years old. One individual, based on teeth and non-epyphised vertebrae and phalanges, was less than 18 months old. Another individual is represented by a left femur of which the proximal extremity is epyphised, meaning it was more than 36–48 months old, associated with a left tibia of which the proximal extremity is epyphised, indicating more than 48–60 months, and a left mandibula with M_1 and M_3 and right M^3, the stages of eruption and tooth wear indicating this individual was around 4 years old.

Layer 3 contained three reindeer. One is represented by a skull with an antler of less than 6–10 months associated with a right radius, of which proximal and distal extremities are not totally epyphised meaning this individual was around 5–8 months old. Another individual is represented a right maxillary and teeth (P^2, dP^3, P^3, dP^4, P^4, M^1, M^2) of which stages of eruption and tooth wear mean this individual is slightly less than 2 years old. Another is represented by maxillaries with teeth, the stages of eruption and tooth wear indicating this individual is 5–8 years old. We have generally more young individuals with some female and male adults (Fig. 14).

4.2.6. Taphonomical study: climato-edaphic and non-anthropogenic biological agents

Analyses of bone modifications indicate different events. Bones of layer 7 are oxidised (manganese and iron) and are damaged by

Fig. 11. Third inferior left decidual tooth of *M. primigenius* of layer 6 (Photo: L. Demay).

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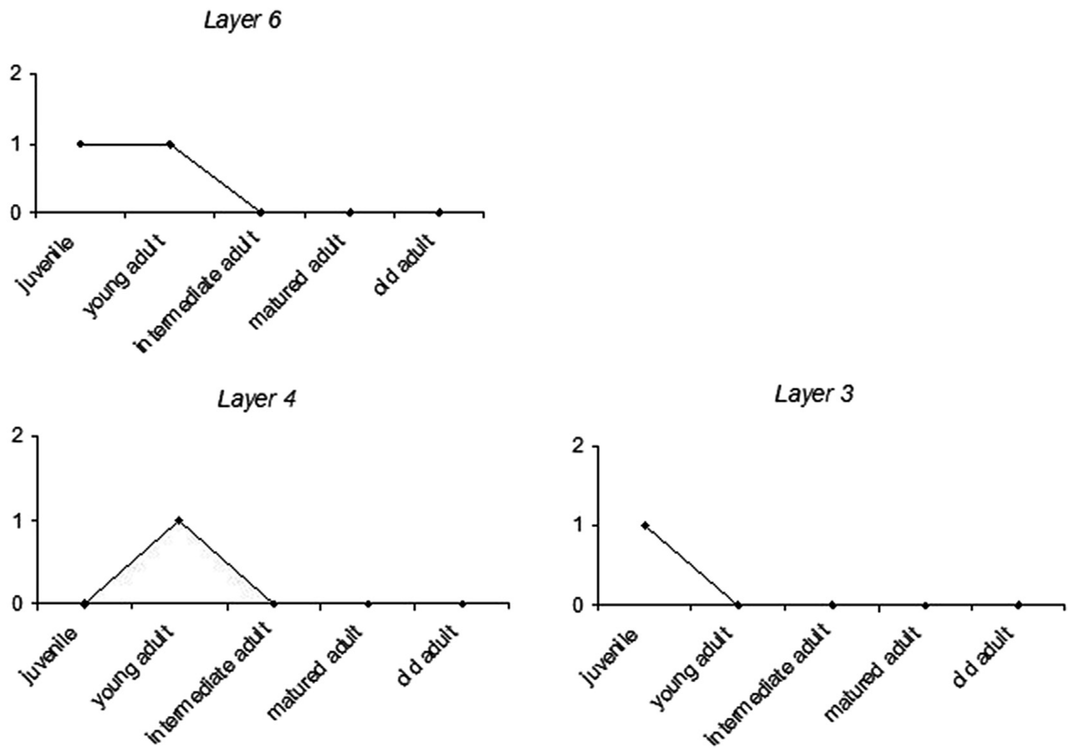

Fig. 12. Age classes of *M. primigenius*, Dorochivtsy III.

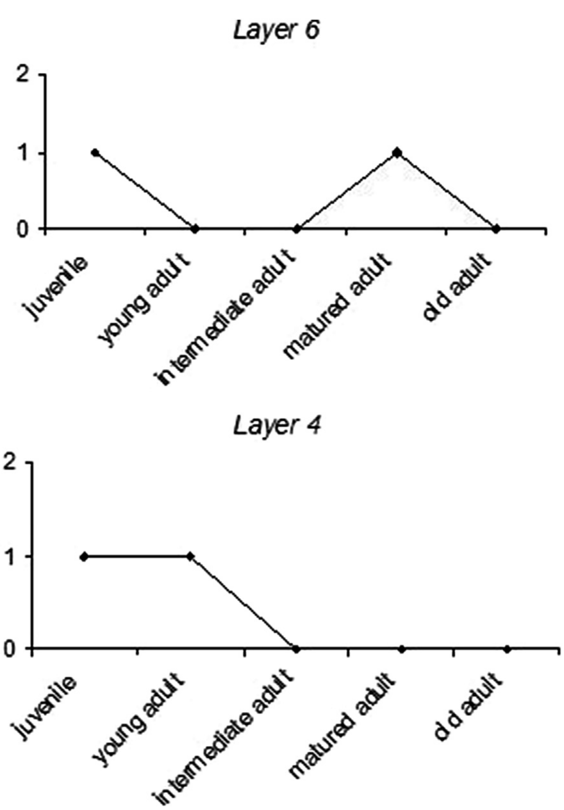

Fig. 13. Age classes of *Equus* sp., Dorochivtsy III.

weathering processes and slightly by *charriage-à*-sec. They are not affected by plants, carnivores, or rodents. Bones of layer 6 are very oxidised. They are slightly damaged by weathering, *charriage-à*-sec and plant root marks. Bones of layer 5 are very oxidised. They are damaged by weathering, water flow, and more by *charriage-à*-sec and plant root marks. Two fragments of antlers of reindeer were chewed by reindeer. A calcaneum of reindeer was chewed by a carnivore.

Bones of layer 4 are very oxidised. They are slightly damaged by weathering, water flow, and more by *charriage-à*-sec and somewhat by plant root marks. A metapodial of reindeer bears rodent teeth marks. Bones of layer 3 are very oxidised. They are somewhat damaged by weathering, water flow, *charriage-à*-sec, and plant root marks. In this layer, bones of large mammals are characterized by *differential bone* preservation. Fox remains include concretionary and oxidised bones. Remains of mammoth are slightly affected by weathering and water flow. Reindeer bones are affected by oxidation and weathering. Bones of layer 2 are all oxidised and most of them are damaged by weathering. They are slightly damaged by water flow, *charriage-à*-sec and plant root marks. Layer 1 is similar to layer 2, with more *charriage-à-sec* (Table 15).

4.2.7. Palethnography

Layers 1, 2 and 7 do not contain any bone remains with anthropogenic marks. Layer 6 shows anthropogenic activities relied to butchering and worked bone.

Bones of horses and reindeer show impacts of fracturing, cutmarks for disarticulation, and defleshing. Concerning horse, a metacarpal shows an impact of fracturing and two perpendicular cutmarks for disarticulation. One rib had a cutmark of defleshing (Fig. 15). One tibia of juvenile is characterized by an impact of fracturing.

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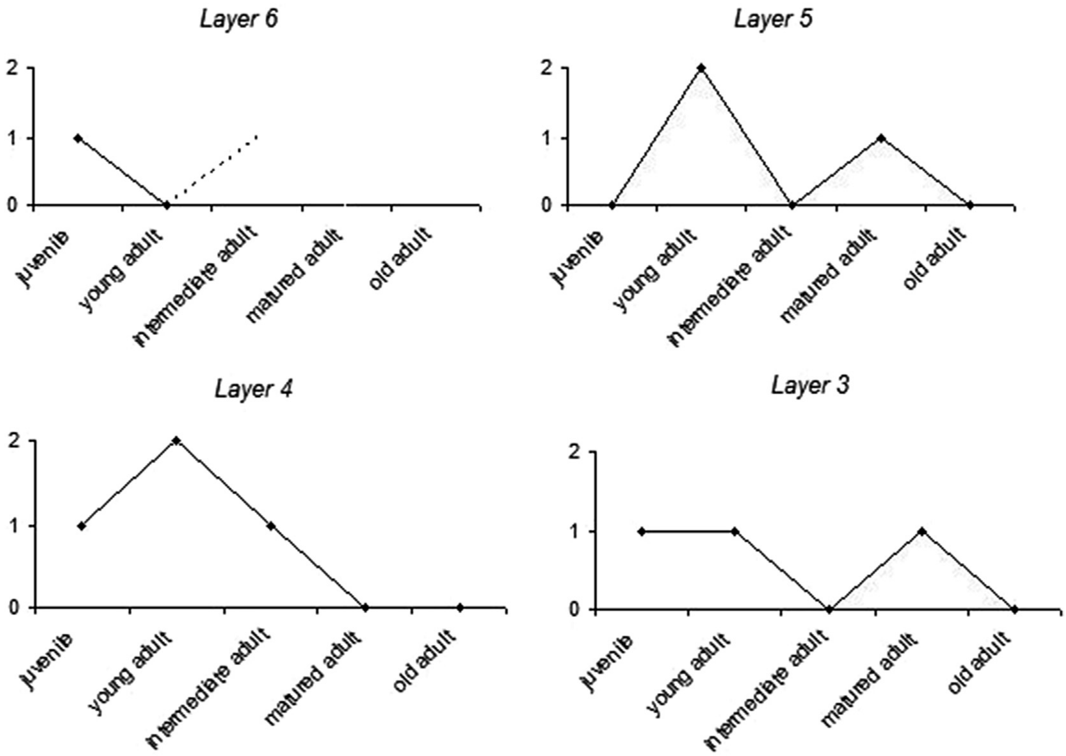

Fig. 14. Age classes of *R. tarandus*, Dorochivtsy III.

Table 15
Alterations due to climatoedaphic and non-anthropogenic agents (%NRt of the layers), Dorochivtsy III.

Layer	Weathering	Percolation	Water flow	*Charriage-à-sec*	Root etching	Carnivores	Rodents
1	93	100	5.3	56.1	3.5	0	0
2	72.2	100	9.4	24.5	24.5	0	0
3	11.7	93.2	5.6	12.4	2.4	0	0
4	2.5	86.3	1.5	9.5	0.9	0	0.09
5	11.5	85.6	15.4	37.5	29.8	0.01	0.01
6	7.8	88.9	16.7	7.7	3.3	0	0
7	37.7	100	12.5	37.5	0	0	0

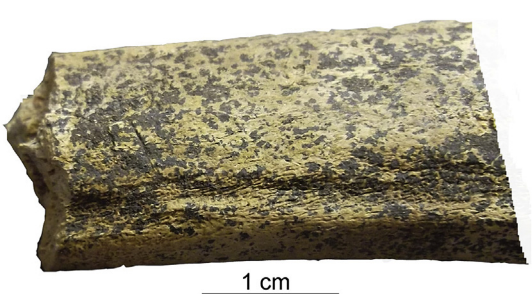

Fig. 15. Rib of horse with cutmarks, layer 6, Dorochivtsy III (Photo: L. Demay).

Fig. 16. Awls made on metapodial of reindeer, layer 6, Dorochivtsy III (Photo: L. Demay).

Fig. 17. Mammoth ivory point, layer 6, Dorochivtsy III (Photo: L. Demay).

A fragment of a long bone of a large mammal bears an impact of fracturing. Another one bears three impacts of fracturing.

Concerning reindeer, two ribs each have two cutmarks of defleshing. A fragment of long bone shows impact of

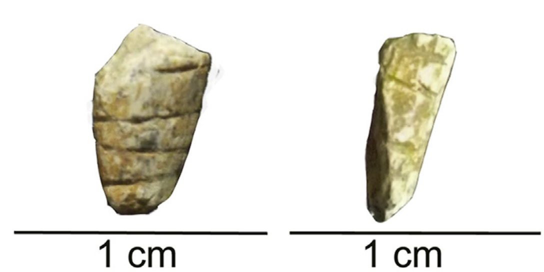

Fig. 18. Mammoth ivory points, layer 6, Dorochivtsy III (Photo: L. Demay).

Fig. 19. Mammoth tusk with engravings, layer 6, Dorochivtsy III.

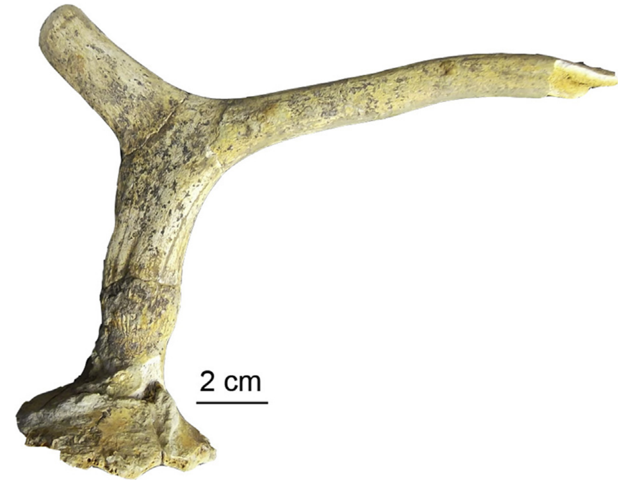

Fig. 20. Non-shed antler with cutmarks of skinning, layer 5, Dorochivtsy III (Photo: L. Demay).

Fig. 21. Reassembly of the left tarsus and metatarsal of reindeer, layer 5, Dorochivtsy III (Photo: L. Demay).

fracturing and four cutmarks of disarticulation/defleshing. A radius, a femur, and two tibias of a juvenile reindeer show impacts of fracturing. One fragment of skull shows cutmarks of skinning.

Five artefacts were found. Two awls were made from metapodials of reindeer (Fig. 16).

Concerning mammoth, we found three ivory points (Fig. 17). Two points present grooves (Fig. 18). One tusk was engraved with meanders and a figure (Fig. 19). The engravings were processed with thin carving (Ridush, 2008; Koulakovska et al., 2012). We observed many burned bones including some fragments of diaphysis of large mammals (Table 16).

Table 16
Anthropogenic activities (number of remains), layers 6–3. Dorochivtsy III.

Layer	Species	Anthropogenic activities					
		Skinning	Disarticulation	Defleshing	Fracturing	Worked bones	Burned bones
6	Mammoth					4	1
	Reindeer	2		3	7	2	2
	Horse		1	1	2		
	Fox						1
	Large mammal						4
	Ind. fragments						148
5	Reindeer	1	1		2	2	
4	Mammoth						3
	Horse				1		
	Reindeer				6		4
	Fox	1					
	Small mammal						1
	Ind. fragments						106
	Large mammal						34
3	Mammoth					1	52
	Reindeer		2	1	10	1	2
	Large mammal				1		5
	Ind. fragments						89

Fig. 22. Femur of reindeer with impact of fracturing, layer 4, Dorochivtsy III (Photo: L. Demay).

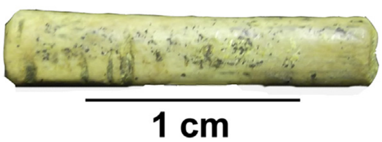

Fig. 23. Metapodial of fox with cutmarks of skinning, layer 4, Dorochivtsy III (Photo: L. Demay).

Layer 5 shows activities of butchering on bones of reindeer. A non-shed antler of a young individual or of a female has cutmarks of skinning (Fig. 20). Some long bones show cutmarks of disarticulation and impacts of fracturing. The reassembly of metatarsal and tarsals (calcaneum, talus, scapho-cuboid) of a male indicate that the disarticulation was processed between radius and the first carpals row and between the tibia and the first tarsals row (Fig. 21).

Layer 4 shows activities of butchering on bones of reindeer, horse and fox. Several long bones of reindeer bear impacts of fracturing (Fig. 22). The reassemblies of carpals and tarsals of reindeers showed the same processes of disarticulation as in layer 5. A metapodial of fox shows cutmarks of skinning probably to remove fur (Fig. 23). Bones of reindeer, large mammal, mammoth, and small mammals were burned (Table 16).

Layer 3 shows activities of butchering on bones and worked bones. A diaphysis (probably *Equus* sp.) bears an impact of fracturing. Reindeer show different modes of treatment. A scaphoid has two cutmarks of disarticulation (Fig. 24). An individual around two years old showed a humerus with a fracturing impact. A radius of a young adult presented an impact of fracturing and a series of parallel cutmarks from defleshing. A part of a juvenile antler showed an impact. A metacarpal of a young or mature adult showed two impacts of fracturing.

Fig. 24. Right scaphoid of reindeer with cutmarks of disarticulation, layer 3, Dorochivtsy III (Photo: L. Demay).

Fig. 25. Fragment of ivory of mammoth resulting from anthropogenic impact, layer 3, Dorochivtsy III (Photo: L. Demay).

A diaphysis of a long bone (femur?) showed an impact of fracturing. A diaphysis of another long bone (tibia?) showed two impacts of fracturing. Three parts of another diaphysis bear an impact of fracturing. A lunatum bears a cutmark of disarticulation on the dorsal side, cutting the Testut ligament.

A fragment of ivory of mammoth presents a smooth and corrugated surface, which could result from an anthropogenic impact (Fig. 25). Some bones of reindeer, large mammals, and mammoth were burned (Table 16).

5. Discussion

5.1. Preservation of Dorochivtsy III layers

Archaeological data of the initial Upper Pleniglacial in the Dniester valley are known through some concentrations of archaeological remains, commonly scattered. Dorochivtsy III contains four relatively well preserved layers, permitting an understanding of the activities of human groups during this period.

Taphonomic studies indicate that the layers are generally not damaged by weathering, except for layers 1, 2 and 7. From these observations, the bones of layers 6, 5, 4 and 3 were rapidly buried, and those of layers 1, 2, and 7 were exposed at length on the surface before their burial. Layers 6, 5, 4 and 3 were well protected, but with some soil movements in particular in layer 6. The faunal remains have not been imported by soil processes. The skeletal preservation on %MAU by anatomical segments related with bone density (from Lam et al., 1998) indicates the degree of preservation: either a natural process or influenced by predators. For layers 6, 5, 4 and 3, the index number of correlation was obtained from the statistical relationship between variables. Coefficients close to extreme values −1 and 1 indicate high correlations between variables. A coefficient close to zero means that variables are not correlated. The index numbers of correlation of all the layers do not show differential preservation (Tables 17).

Table 17
Correlation coefficient from the skeletal preservation by anatomical segments related with bone density of Dorochivtsy III.

Layer	R =
6	0.237
5	0.142
4	0.295
3	0.358

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This is non-natural preservation, confirming the intervention of a predator. Absence of evidence of their potential activities suggests that carnivores were not *responsible* for the accumulation of *bone* material. Despite the alteration of the layers, part of the material is in situ.

5.2. Modalities of exploitation of fauna by human groups

Through these modalities of preservation, Dorochivtsy III provides new information about the activities and faunal exploitation through the territory during the first part of the Upper Pleniglacial. Four species were exploited in Dorochivtsy III: *M. primigenius*, *Rangifer tarandus*, *Equus* sp. and fox. They were exploited for fur, for food, for industry and as artistic support.

All the layers show exploitation of reindeer and horse for food, probably also for their pelts. The main exploited taxa in terms of food are reindeer and horse. There is no evidence indicating the exploitation of mammoth for food. Some fox were exploited for their pelts, as highlighted in layer 4.

Ivory of mammoth was used, as shown by a flake in layer 3 and particularly by the points in layer 6. A reindeer antler in layer 3 bears anthropogenic marks, and bones of reindeer in layer 6 were also used to make awls. In layers 6, 4, and 3, bones of large mammals (reindeer, mammoth) were used as combustibles.

The status of mammoth in the Dniester valley is imprecise. The Dorochivtsy III bone remains do not indicate the modalities of acquisition and exploitation of this taxon. It is possible that meat of mammoth was consumed without taking bones, but there is no information about the modalities of acquisition. However the engraved tusk is new evidence about human behavioural activities in this region involving mammoth ivory.

Estimation of the nutritive strategy concerning reindeer was attempted (from Binford, 1978, 1987; Jones, 1988; Metcalfe, 1988; Lyman, 1994; Faith and Gordon, 2007). The nutritive values were obtained from the Food utility index (meat, marrow and grease) compared with Minimum Animal Unit (%).

The Meat and Marrow Indexes are higher than the Grease index (Figs. 26–29). Human groups either oriented their consumption to

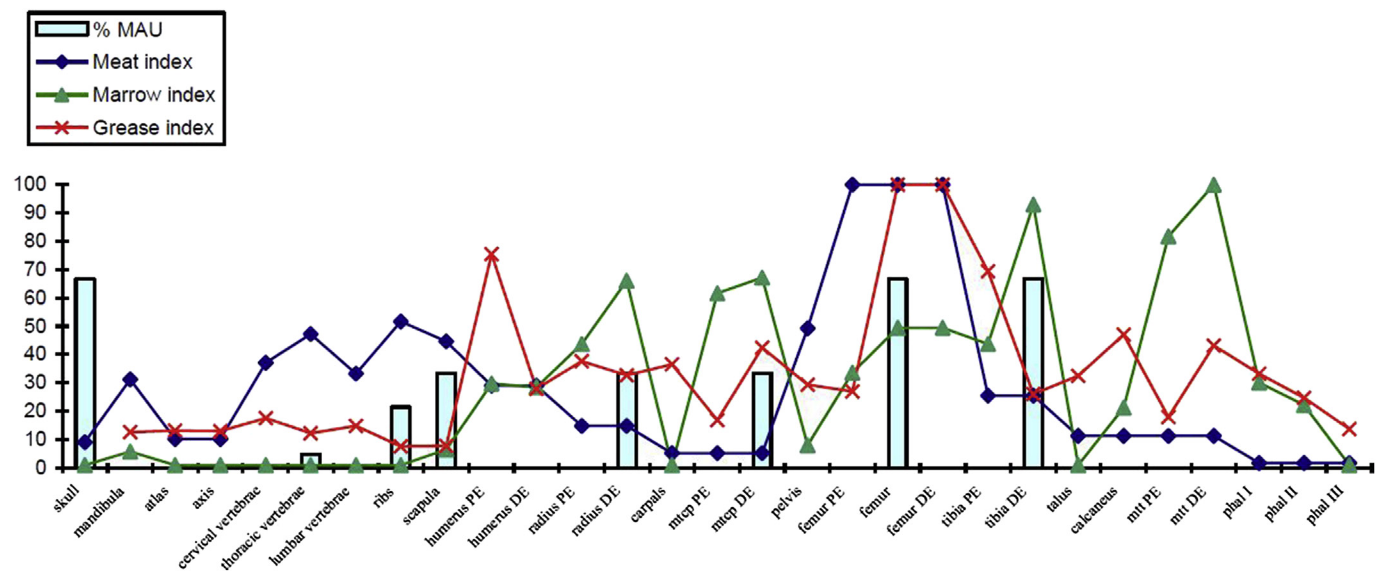

Fig. 26. Skeletal preservation of reindeer (%MAU, by anatomical parts) from Meat, Marrow and Grease indexes, layer 6, Dorochivtsy III.

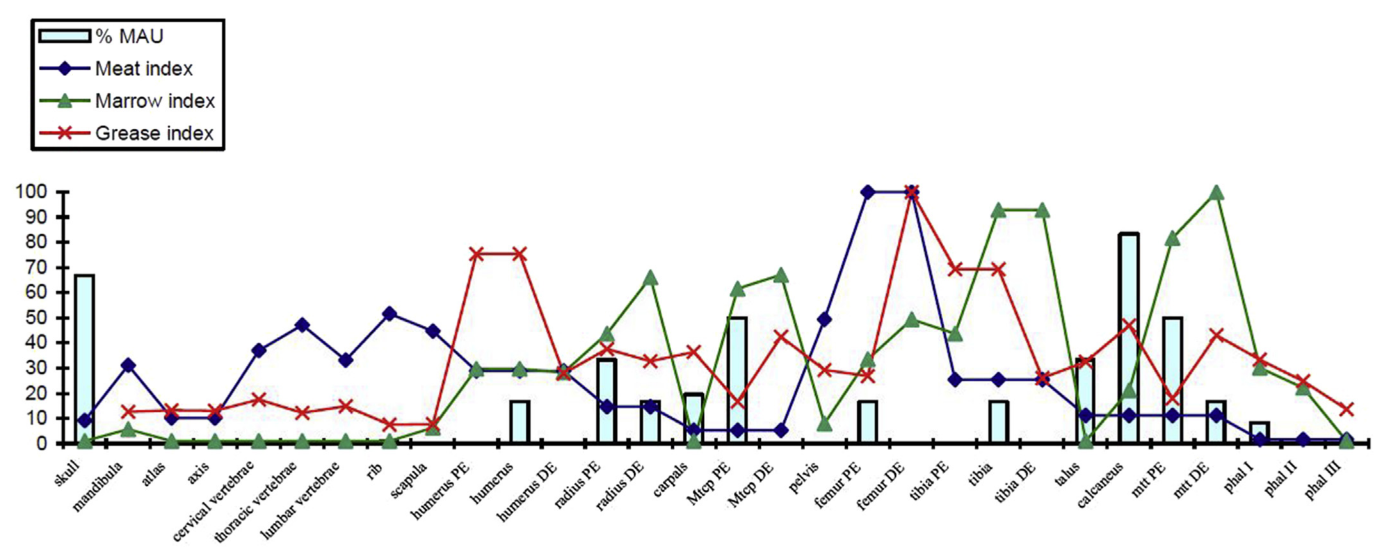

Fig. 27. Skeletal preservation of reindeer (%MAU, by anatomical parts) from Meat, Marrow and Grease indexes, layer 5, Dorochivtsy III.

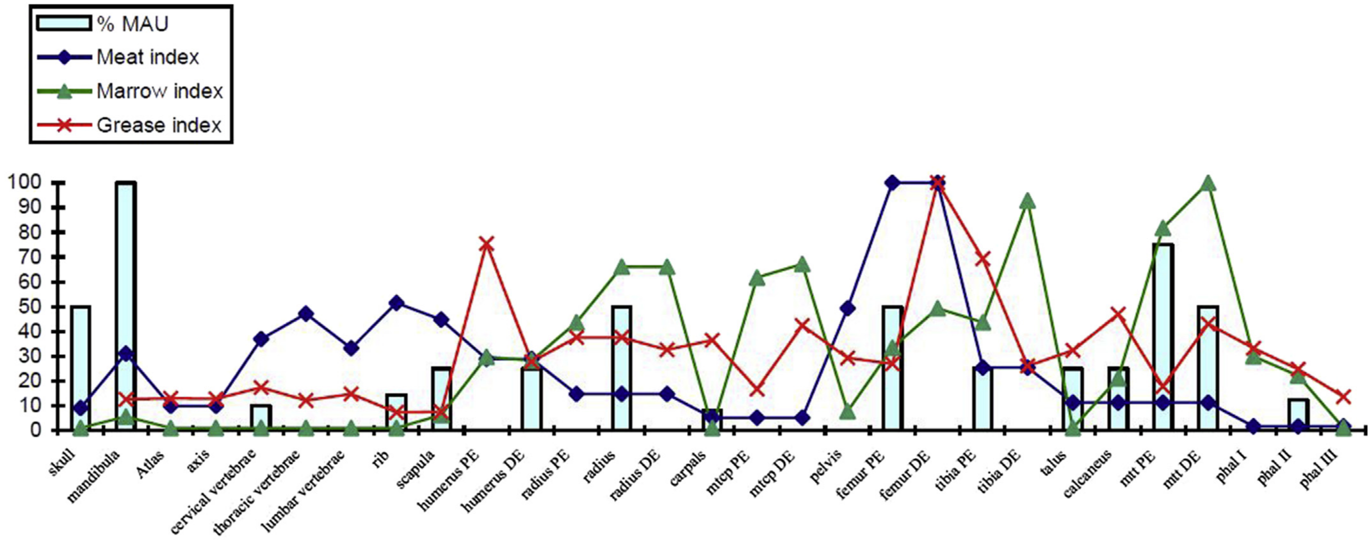

Fig. 28. Skeletal preservation of reindeer (%MAU, by anatomical parts) from Meat, Marrow and Grease indexes, layer 4, Dorochivtsy III.

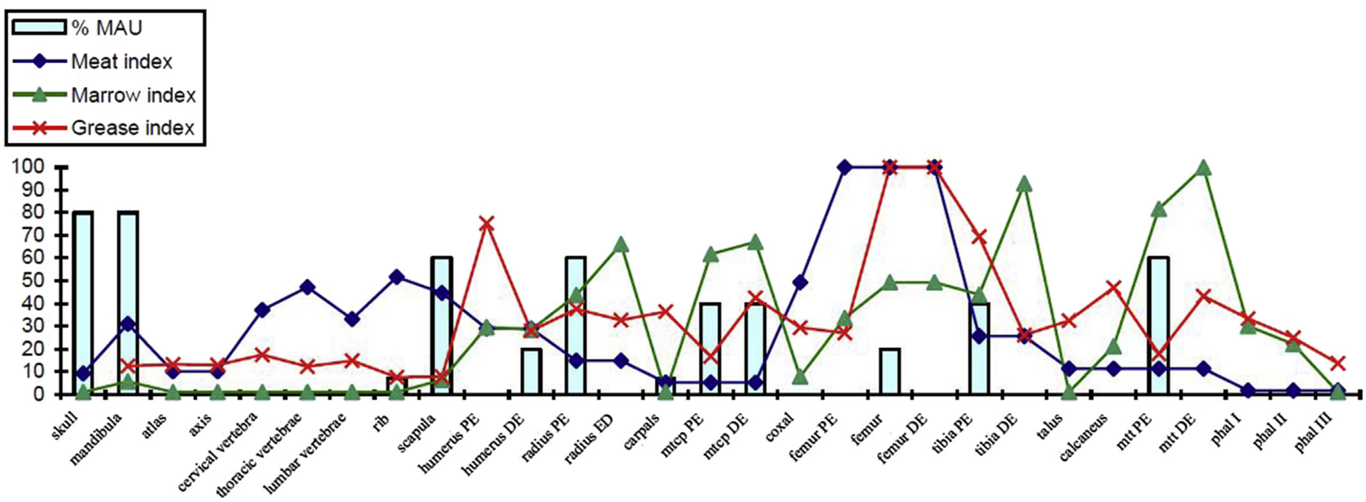

Fig. 29. Skeletal preservation of reindeer (%MAU, by anatomical parts) from Meat, Marrow and Grease indexes, layer 3, Dorochivtsy III.

meat and marrow or did not favour a particular type of consumption. Layers 6, 5, 4, and 3 are lacking some rich anatomical parts, but we can notice the presence of the richest parts, femurs. We can propose two hypotheses. On the one hand, reindeer could have been consumed on the site and the absence is probably due to the scattering of bones. On the other hand, parts of the carcasses were moved to another place.

5.3. Seasonal slaughter

It is generally accepted that the movements in the northern areas could take place during the warm season. Dorochivtsy III highlighted recurrent occupations in the northern area, during different seasons.

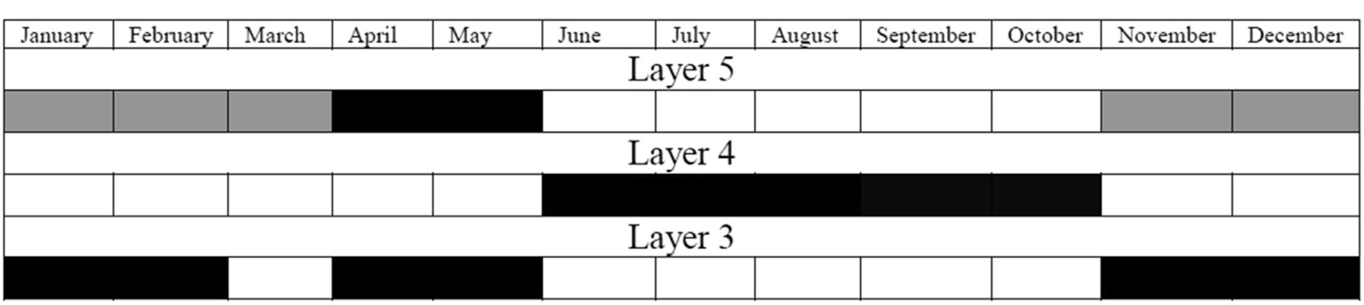

Fig. 30. Seasonal slaughter of the reindeer, Dorochivtsy III.

The bone remains of large mammals, in particular reindeer, inform us about seasonal slaughter and human occupations, from birth seasonality and antler growth (Lincoln and Tyler, 1994; Markuson and Folstad, 1997). No antlers were found in layer 6. On the one hand, it is possible that these reindeers were slaughtered during the summer. On the other hand, none of the antler remains were preserved and we cannot clarify the seasonality. Layer 5 contains non-shed antlers of young reindeer with cutmarks. These individuals were slaughtered during the winter season. Males could have been slaughtered when reindeer were in separate small groups or during migration. Therefore, the reindeer of layer 5 were slaughtered at the end of the winter season.

Layer contains two reindeer aged at least two years. Births take place in June, so these individuals were slaughtered during the summer. In layer 3, a juvenile reindeer is 5–8 months old. From the birth season, this individual was slaughtered between November and February. Another reindeer with a non-shed antler is around two years old. Therefore, the reindeer in layer 3 were slaughtered during the winter season. The reindeer of Dorochivtsy III were slaughtered during different seasons of the year (Figs. 26 and 30).

5.4. Activities and function of the sites

The few occupations of this period are characterised by exploitation of local flint and do not present clear areas of activities (Noiret, 2009). The occupations are oriented towards the exploitation of local flint in relation with hunting activities. Layer 6 shows more varied activities than expected. In all the layers, the small number of animals indicates short human occupations.

Layer 6 is characterized by varied activities: lithic industry, butchering, bone industry, and aesthetic artifacts. This layer is characterised by short-termed occupation(s), but longer than in other layers. Layer 6 contains charcoals, but was disturbed by erosion, cryoturbation and soils movements, and the remains are divided. Therefore, we cannot obtain reliable information about possible areas of activities.

Layer 5 is based on exploitation of flint and mainly on hunting of reindeers. It is a very short term occupation of a small human group. The site does not show any area of activities or any charcoals.

Layer 4 is based on exploitation of flint and on hunting and butchering of reindeer and probably horses, together with exploitation of fox fur. It represents a short-term occupation. The layer contains charcoals but does not show obvious areas of activities.

Layer 3 is based on exploitation of flint, and hunting and butchering of reindeer. Some fragments of antler and a fragment of ivory bear anthropogenic impacts. This layer contains a hearth with a concentration of lithic artifacts and bones (Fig. 31) (Tables 18).

5.5. Climate

The absence of human occupations during this period is interpreted as a movement of human groups through the southern area. However, we know that some groups made incursions to the north. These movements through the southern area are due to the cold climate. However, the taphonomical data, combined with geological and palynological data, indicate humid conditions.

From the taphonomical data, we observed that all the layers are affected by percolation, forming oxide deposits about bones. The indices of desiccation and cryoturbation and the low representations of plants and dissolution show a somewhat drier climate but not extremely arid conditions. The geological data show the presence of humus loam which is characteristic of a more humid environment. The palynological data showed the presence of some episodes of humidity and the presence of trees. The period was relatively cold and arid, but sufficiently moist to permit herds of large mammals and human groups to continue to move along the valleys.

5.6. Culture

Concerning the culture of the Moldavia area, during the Gravettian and the Epigravettian, called Molodovian, the main features are the acquisition of local flint, with few settled camp sites, bounded with reindeer hunting, and there are few artifacts reflecting bone industry or artistic pieces (Noiret, 2009). The site of Ciuntu, dated to 18 510 ± 200 BP (OxA-4125), 21 000 ± 220 BP (OxA-4426), 22 100 ± 220 BP (OxA-4774) testifies to several short-termed occupations oriented on hunting of reindeers and horses (David, 1980). This site furnished an awl on a metapodial of reindeer.

The site of Crasnaleuca-Stanişte, layer VII, dated to 21 700 ± 800 BP (GrN-12671), is a flint workshop. Bones remains are inflected, including some bones of bovid (Păunescu, 1999). The site of Climăuţsi II, upper layer, dated around 20 350 ± 230 BP, furnished some pieces on ivory (Fig. 32).

The layers of Dorochivtsy III are correlated to the Molodovian features. Layer 6 differs from what we knew before. It is possible that we have a continuity of occupations and cultural features through time, but probably problems of preservation of the archaeological occupations in the Dniester valley.

6. Conclusion

Among the seven Upper Palaeolithic layers, layers 6, 5, 4 and 3 of Dorochivtsy III indicate activities of human groups during the little known Upper Pleniglacial.

Table 18
Anthropogenic activities in layers 6, 5, 4, and 3. Dorochivtsy III.

L.	Utilisation				Seasonality	Occupation	Function
	Species	Population	Food	Use			
6	Reindeer	Young and adult	Meat and marrow	- awls (antlers) - combustible		Short term	Temporary camp - butchering
	Horse	Young	Meat and marrow	/			- bone industry
	Mammoth	Young	/	- points (ivory) - engraved tusk - combustible			- aesthetics
5	Reindeer	Young and adult	Meat and marrow	- antlers	End of the cold season	Very short term	Hunting and butchering
4	Reindeer	Young and adult	Meat and marrow	- combustible	Warm season	Short term	Hunting and butchering
	Horse	Young	Meat and marrow	/			
	Fox	/	/	- fu			
	Mammoth	Young	/	- combustible			
3	Reindeer	Young and adult	Meat and marrow	- antlers - combustible	End of the cold season	Short term	Hunting and butchering
	Mammoth	/	/	- ivory			

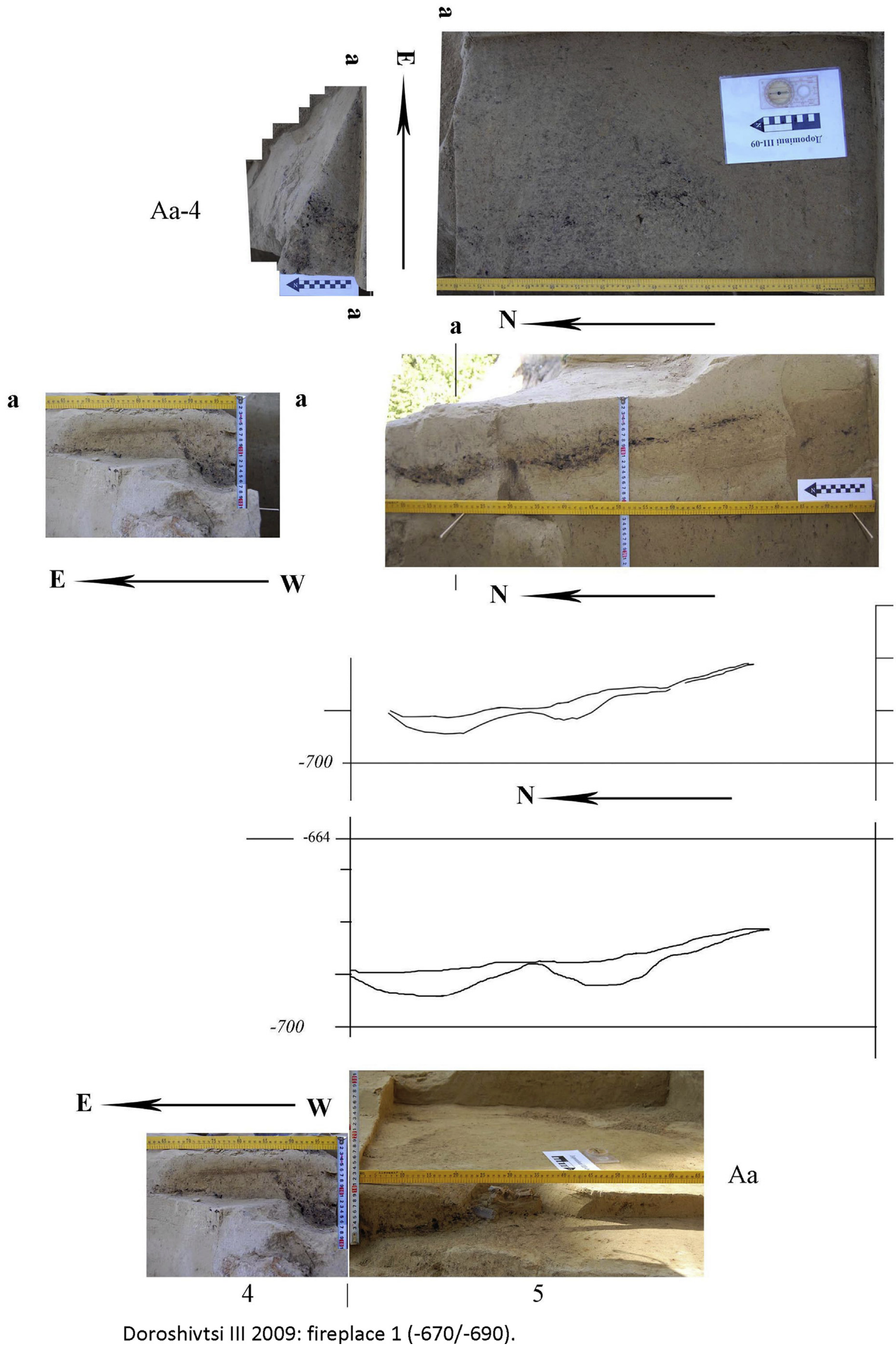

Fig. 31. Hearth of the layer 3, Dorochivtsy III (L. Koulakovska).

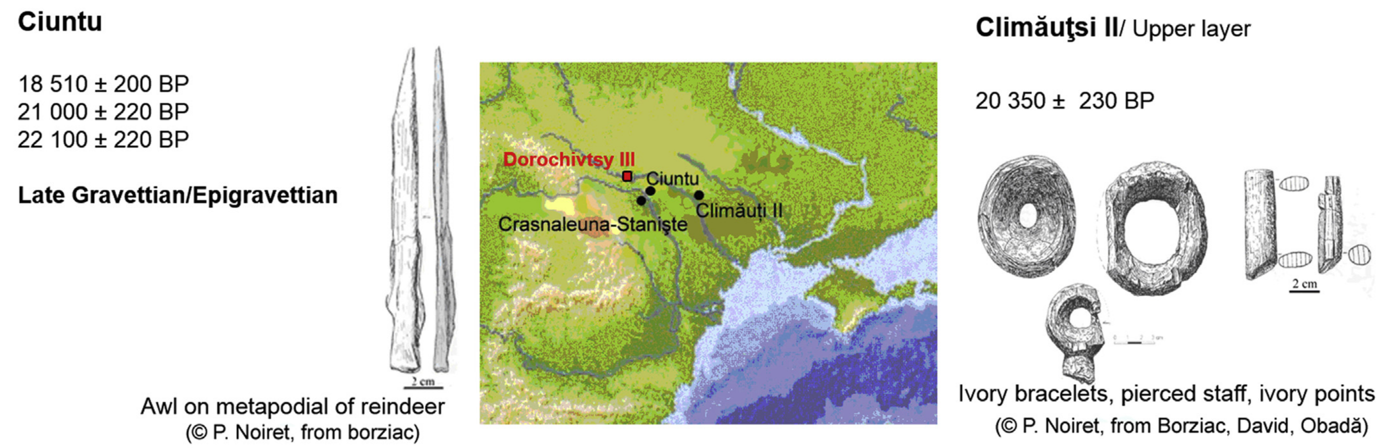

Fig. 32. Archaeological sites and bone industry.

The zooarchaeological study allowed us to recognize reindeer, horse, mammoth, and fox. Within layers 5, 4 and 3, the human activities are connected with use of the local flint and hunting of great mammals, in particular reindeer, then horses. Concerning mammoths, we do not know the modalities of acquisition and exploitation. Fox was exploited for fur. We suggest recurrent short-termed occupations during different seasons. These behavioural activities are quite typical of the Molodovian complex.

Layer 6 is remarkable because of previously unseen practises. The lithic assemblage combined with bone industry and engraved tusk is a new set of cultural elements in this area. This layer testifies to the diversity of human activities during the Upper Pleniglacial and to the particular status of mammoth ivory as an artistic medium.

The Dniester valley is suitable for movements of population. The intensification of cold weather could make the living conditions too difficult. However, the palynological data and taphonomic observations on bones indicate the persistence of relatively moist conditions during some periods, which could favour the movement of human groups. Although little is known about the Upper Pleniglacial period, Dorochivtsy III testifies to the continuity of a large exploitation of the territory of the Dniester valley and the geographic area of Moldavia, open through the Russo-Ukrainian Plain.

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