

Evidence for kill-butchery events of early Upper Paleolithic age at Kostenki, Russia

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Abstract

At least 10 early Upper Paleolithic (EUP) open-air sites are found at Kostenki on the west bank of the Don River in Russia. During the 1950s, A.N. Rogachev excavated concentrations of horse bones and teeth from EUP layers at Kostenki 14 and 15 exhibiting the characteristics of kill-butcherly assemblages. Excavations at Kostenki 12 in 2002-2003 uncovered a large quantity of reindeer and horse bones in EUP Layer III that also might be related to kill-butcherly events, and the partial skeleton of a sub-adult mammoth excavated during 2004-2007 in EUP Layer V at Kostenki 1 yields traces of butcherly. The character of these large-mammal assemblages—combined with the analysis of artifacts and features—suggest that both habitation areas and kill-butcherly locations are represented in an “EUP landscape” at Kostenki.

Keywords: zooarchaeology, kill-butcherly sites, Eastern Europe, early Upper Paleolithic

1. Introduction

The landscape of the East European Plain differs significantly from that of southwestern Europe (Franco-Cantabria), and it has yielded a different archaeological record for the Middle and Upper Paleolithic. The fundamental difference lies in the scarcity of natural shelters on the East European Plain. Although some rockshelters are found on its southwestern margin, they are virtually absent from the central plain and archaeological sites on the latter are almost entirely confined to open-air settings.

Most major Middle and Upper Paleolithic sites in the Franco-Cantabrian region are natural shelters and this biases the archaeological record in several ways. To begin with, caves and rockshelters provide high visibility for Paleolithic sites, which are more likely to be preserved and discovered in such settings. Non-stone artifacts and faunal remains tend to be less well preserved in open-air sites. Perhaps most important, natural shelters typically were used as habitation sites. Short-term occupations—such as locations where animals are killed and butchered—are less likely to be found in a rockshelter. An exclusive or heavy focus on habitation sites probably skews the archaeological record towards certain types of artifacts, features, and faunal remains.

For the early Upper Paleolithic (EUP), the contrast in archaeological records is especially pronounced. In Franco-Cantabria, this period is represented by rockshelter occupations assigned to the Aurignacian and Chatelperronian industries, although a major open-air site—and likely kill-butchery location—is found in central France at Solutré (Olsen, 1989). For particular historical reasons (discussed below), most EUP occupations on the central East European Plain are concentrated in the Kostenki area on the Middle Don River. Many decades of excavation at these open-air sites have revealed what

appears to be an “EUP landscape” containing traces of habitations, as well as locations where large mammals were killed and/or butchered. Although interpreted to a large degree within a framework derived from the research traditions of the Franco-Cantabrian region, the Kostenki sites—as well as other EUP sites on the central East European Plain—provide a very different picture of life during this period.

2. The Kostenki sites

2.1 Location and setting

Kostenki is located on the Middle Don River near the city of Voronezh in the Russian Federation at 51° 40' N and 39° 10' E. The village lies on the west bank of the river at an elevation of approximately 100 meters above mean sea level. The area is within the modern forest-steppe zone and experiences a continental climate with mean July and January temperatures of 19°C and -8°C, respectively, and an average rainfall of 520 mm per year (<http://www.weatherbase.com>).

Twenty-one Upper Paleolithic sites have been investigated at Kostenki, and at least five more sites have been discovered at Borshchevo (located ~5 km southeast of Kostenki). Although several sites are found in the main valley, most are situated at the mouths or in the upper courses of large side-valley ravines incised into the west bank of the Don River (see Fig. 1). Springs are active today in the ravines, and primary carbonate deposits in the sites indicate that they were active during Upper Paleolithic times as well (Holliday et al., 2007: 217-219). The sites are found primarily on the first (10-15 meters) and second (15-20 meters) terrace levels, although several sites are located above the second terrace (Lazukov, 1982: 21-35).

2.2 History of research and the EUP

The large concentration of EUP occupations at Kostenki seems to be a consequence of two factors. First, local conditions created a recurring attraction for large mammals—including people—during at least some phases of the interstadial preceding the Last Glacial Maximum or the age-equivalent of MIS 3, and these almost certainly included active springs in the ravines. Second, later Upper Paleolithic people also camped in the Kostenki area and concentrated large quantities of mammoth bone at their sites. These mammoth bones were buried near the modern ground surface and were discovered centuries ago. Archaeologists investigating these later Upper Paleolithic sites eventually probed into older sediments and encountered the EUP occupations, which otherwise probably would remain unknown.

Although mammoth bones had been reported from the area at least as early as the eighteenth century, stone artifacts were first discovered in 1879 (following similar discoveries in other parts of Europe) at the location of Kostenki 1. Major excavations began in the 1920s and 1930s and were focused primarily on the large middle and late Upper Paleolithic occupations at Kostenki 1 and others (Klein, 1969: 231-232; Praslov, 1982: 9-11). The presence of an EUP occupation at Kostenki 1 (Layer V) was known by 1938, but substantive investigation of the EUP was inaugurated by A. N. Rogachev (1957), who discovered EUP occupations at Kostenki 8, Kostenki 12, Kostenki 14, and other locations during the decade following World War II. After over half a century of research and excavation, more than 25 EUP occupation layers are known from at least 10 sites.

2.3 Geology of Kostenki

The high west bank of the Don Valley, which represents the eastern margin of the Central Russian Upland, is composed of Cretaceous marl (chalk) and sand that unconformably overlie Upper Devonian clay (Lazukov, 1982: 15-17). The alluvium at the base of the second terrace is composed of coarse sand with gravels and cobbles that grade upward into medium and fine sand with chalk gravel (Velichko, 1961: 201-202; Lazukov, 1982: 21). Above these deposits lies a sequence of alternating lenses of silt, carbonate, chalk fragments, and organic-rich loam (Holliday et al., 2007: 184-186). At many localities, they are subdivided by a volcanic tephra horizon.

Traditionally, the organic-rich lenses below and above the tephra have been termed the Lower Humic Bed and Upper Humic Bed, respectively (e.g., Velichko, 1961: 210). Soil micromorphology indicates that *in situ* soil formation occurred in these lenses (Holliday et al., 2007: 190-192, table I). The carbonate bands formed as calcium carbonate precipitated (also *in situ*) from the discharge of springs and seeps that were active on the second terrace level at this time (Holliday et al., 2007: 217-218). The chalk fragments are derived from upslope exposures of eroding Cretaceous bedrock. The humic beds thus represent a complex interplay of colluviation, spring deposition, and soil formation (see Fig. 2).

At some sites, spring activity and/or other disturbances were absent and normal soil profiles developed in place of the characteristic humic bed sequence. For example, three buried soils have been observed below the tephra horizon (i.e., stratigraphic equivalent of the Lower Humic Bed) at Kostenki 14 (Holliday et al., 2007: 202-203). At

Kostenki 1, well-developed soil profiles are present in place of both humic beds (Holliday et al., 2007: 209). Like the humic beds, all of these soils were formed during the age equivalent of MIS 3 (prior to c. 30,000 cal BP).

All EUP occupations at Kostenki are buried in the humic beds or their stratigraphic equivalent on the second terrace level. These include occupations buried in loam that is deposited between the two humic beds (e.g., Kostenki 15), and—in one case—in the volcanic tephra horizon (at Kostenki 14 [Sinitsyn, 2003]). The tephra has been identified as the Campanian Ignimbrite (CI) Y5, which is dated to c. 40,000 cal BP (Pyle et al., 2006; Anikovich et al., 2007) and provides a chrono-stratigraphic marker for the EUP occupations below, above, and within it. Radiocarbon and OSL dating of the occupations indicate that the Upper Humic Bed dates to c. 30,000 – 39,000 cal BP, while the Lower Humic Bed dates to c. 40,000 – 45,000 cal BP and possibly earlier (Holliday et al., 2007; Hoffecker et al., 2008).

3. Evidence for kill-butchery events at Kostenki

In 1952, Rogachev excavated a large concentration of horse bones at the single-component EUP site of Kostenki 15. Although most bones were fragmented, some intact vertebrae and extremities were found in anatomical order (Rogachev, 1957: 109). Two years later, he encountered another mass of horse bones in the second layer (EUP) at Kostenki 14. These bones also contained groups of vertebrae and extremities in anatomical order; other bones were heavily fragmented and exhibited numerous examples of tool cut marks, which were interpreted as evidence of “dismemberment of animal carcasses” (Rogachev, 1957: 78). Although associated with probable traces of long-term

occupation episodes, the horse bone concentrations at Kostenki 14, Layer II and Kostenki 15 have long represented the most plausible examples of large-mammal butchery at Kostenki (e.g., Hoffecker, 2002: 181).

A new program of interdisciplinary field research at Kostenki began in 2001 with a focus on the EUP (Anikovich et al., 2007b). During the course of new excavations at several sites, more examples of suspected large-mammal butchery locations emerged. These included a concentration of bones—reindeer, horse, and mammoth—in Layer III at Kostenki 12 (excavated during 2002 – 2003), and a group of mammoth bones—apparently representing a single adult—in Layer V at Kostenki 1 (excavated during 2004–2007) (Hoffecker et al., 2005; Anikovich et al., 2006). The senior author (JFH) participated in the excavations during 2002 – 2003 and 2004 & 2007, examining all of the bones recovered from Kostenki 12 and many of the bones from Kostenki 1. The second author (IEK) also examined all of the bones recovered from Kostenki 12 and most of the mammoth bones from Kostenki 1.

In March 2008 and April 2009, the senior author also examined many of the horse bones recovered by Rogachev at Kostenki 15 and Kostenki 14, Layer II in 1952 and 1954, respectively. These materials are stored at the Zoological Institute (ZIN), Russian Academy of Sciences in St Petersburg; they were originally studied by the second author (Vereshchagin and Kuz'mina, 1977, 1982: 227–229). The depositional context of the horse bone concentration—i.e., the Upper Humic Bed—has been observed at Kostenki 14 by the senior author in the field. Brief descriptions of the *in situ* bone concentrations are presented in Rogachev (1957). The analysis and discussion below is therefore based on a

synthesis of information in the published literature and observation of materials in the field and among stored collections.

3.1 *Kostenki 14, Layer II (K 14-II)*

Kostenki 14 (aka *Markina gora*) is located in upper Pokrovskii Ravine adjacent to a smaller tributary ravine. The site was discovered in 1928 by P. P. Efimenko, who identified the uppermost (middle Upper Paleolithic) layer (Sinitsyn, 1996: 273). The EUP layers were discovered by Rogachev (1957: 73), who opened several test units at K 14 in 1953 and excavated two large areas during the following year. The larger block of units (Excavation III) yielded a substantial quantity of artifacts and faunal remains in Layer II (Rogachev and Sinitsyn, 1982b).

Some additional excavations at Kostenki 14 were undertaken in the years between 1958 and 1994, and investigations have continued since 1998 with specific focus on the lower EUP levels (Sinitsyn et al., 2004). The upper EUP levels include Layer II and Layer III in the Upper Humic Bed, which overlies the CI Y5 tephra (Pyle et al., 2006). Radiocarbon dates on wood charcoal suggest an age of roughly 32,000 – 34,000 cal BP for Layer II and 34,000 – 37,000 cal BP for Layer III (Sinitsyn et al., 1997; Haessaerts et al., 2004; Holliday et al., 2007: 193, table II). The lower EUP levels are deposited below the tephra horizon and date to more than 40,000 cal BP (Sinitsyn and Hoffecker, 2006; Anikovich et al., 2007b; Hoffecker et al., 2008).

The large quantity of material excavated from K 14-II in 1954 included more than 2,000 identified bones and teeth of horse (*Equus latipes*) representing > 95% of the large mammal remains in this level. Layer II also yielded more than 800 remains of hare

(*Lepus* sp.), and some bones of red deer (*Cervus elaphus*), woolly rhinoceros (*Coelodonta antiquitatis*), reindeer (*Rangifer tarandus*), mammoth (*Mammuthus primigenius*), and others (Vereshchagin and Kuz'mina, 1977).

A total of 40 m² of K 14-II were exposed in Excavation III in 1954 (Fig. 3). According to Rogachev (1957: 77-80), the occupation layer was thicker in the upslope or southern half of this area—up to 60 cm—and interstratified with lenses of loam containing few or no artifacts, but only about 20-25 cm thick in the downslope or northern half of Excavation III. Groups of horse bones in anatomical order—both extremities and vertebrae—were found in upslope and downslope areas “at the base of the cultural layer and on its surface” (Rogachev, 1957: 78). The vertebral groups included sequences of cervical, thoracic, and lumbar vertebrae.

Roughly 1,500 bones and teeth of horse recovered from K 14-II in 1954 were examined at ZIN in April 2009 by the senior author. Also examined were ~100 fragments—mostly if not exclusively horse—exhibiting various forms of tool damage or utilization stored at the Institute of the History of Material Culture (IIMK), Russian Academy of Sciences in St. Petersburg. They comprised rib and long-bone shaft fragments (described by Rogachev [1957: 78-80]), as well as isolated specimens of several other skeletal parts.

The bones are relatively well preserved for a Pleistocene open-air site. The sample of long-bones yielded the following distribution of specimens assigned to weathering stages defined by Behrensmeyer (1978: 151-152) and Johnson (1985: 87-188):

	STAGE 1	STAGE 1/2	STAGE 2	STAGE 2/3
HUMERUS	24 (63%)	9 (24%)	4	1
RADIUS	26 (59%)	18 (41%)	0	0
FEMUR	15 (65%)	7 (30%)	1	0
TIBIA	18 (55%)	13 (39%)	2	0

The overwhelming majority of these bones, as well as the majority of other bones in the assemblage, fall into *Stage 1* or *Stage 1/2* (some cracking of surface), reflecting a limited degree of sub-aerial weathering prior to burial. In terms of color, a random sample of bones (n = 35) examined in 2009 were classified almost entirely as “pink” (7.5YR8/4 – 8/3 and 7.5YR7/4 - 7/3) or “pinkish white” (7.5YR8/2) and “pinkish gray” (7.5YR7/2 & 6/2), following *Munsell Soil Color Charts*. Many bones exhibited traces of *root etching* (cf., Behrensmeyer, 1978: 154; Binford, 1981: 49-50; Johnson, 2006: 60). The etching—often observed on only one side of the bone—was not deep and sometimes required a hand lens for confirmation.

Traces of gnawing or chewing—tooth furrows, pitting, gouging, scoring, or other typical forms of carnivore damage—were rare on the horse bones examined at ZIN in 2009. Probable or possible examples of tooth damage were observed on a mandible ramus, two rib fragments, and three long-bone shaft fragments. On the other hand, tool damage in the form of cut and percussion marks was observed on many specimens (see Table 1). Incisions antedating the time of excavation (based on lack of color differentiation) with V-shaped walls were identified with the aid of a hand lens (16 x) on distal limb bones in anatomical locations that probably reflect dismemberment (e.g., Binford, 1981: 107-142) (Fig. 4a & 4b). Damage related to marrow extraction was evident on metapodial shaft fragments in the form of typical percussion marks with microscopic linear striations (Blumenschine and Selvaggio, 1988).

Rogachev (1957: 80) noted that all large bones were fragmented with the exception of one metapodial (a left metatarsal from an unspecified unit that differs in degree of weathering and color from most of the horse assemblage and might be unrelated to the latter.) Most of the bones were broken in a green or fresh condition, exhibiting typical forms of green breakage (e.g., sawtooth, V-shaped, Type II spiral fracture [e.g., Morlan, 1980; Shipman, 1981; Johnson, 1985; Villa and Mahieu, 1991]). Parts that are especially indicative of fresh versus dry breakage yielded the following distribution:

SKELETAL PART	GREEN BREAK	DRY BREAK	CANNOT DETERMINE
HUMERUS	23 (64%)	1 (3%)	12 (33%)
RADIUS	24 (69%)	8 (23%)	3 (9%)
METACARPAL	40 (95%)	2 (5%)	0
FEMUR	5 (28%)	6 (33%)	7 (39%)
TIBIA	23 (74%)	2 (6%)	6 (19%)
METATARSAL	40 (85%)	7 (15%)	0

The representation of skeletal parts is shown in Table 2. No numbers are given for crania or vertebrae because Rogachev's (1957: 78-80) description of the 1954 excavations indicates that significant quantities of these elements were encountered, but only isolated specimens were found at ZIN and IIMK in 2009. Values for astragali and phalanges are given in parentheses; these values reflect inventory numbers recorded on boxes at ZIN and not the (smaller) number of bones observed in 2009. Finally, it should be kept in mind that most of the long-bone shaft fragments probably were discarded after excavation.

The minimum number of elements (MNE) and minimal animal units (MAU) were calculated for each part (for which data were available); the latter was standardized

(%MAU) by dividing it by the MNE for the most common part (i.e., distal tibia) (see Binford, 1978, 1984; Lyman, 1994: 102-110). Although the %MAU values in Table 2 indicate that most portions of the appendicular skeleton are well represented, some elements (especially proximal humerus, innominate, and proximal tibia) are less common.

Table 2 also contains values for bone mineral density (BMD) (Lam et al., 1999: 351-353, table 1) and estimated food utility (FUI) (Outram and Rowley-Conwy, 1998: 845, table 6) for each part of the horse skeleton. Comparison of the skeletal-part frequencies for K 14-II with these indices helps assess the degree to which the variations in representation may be explained by the differential survival of denser bones or part selection by consumers based on meat/marrow values (e.g., Speth, 1983; Lyman, 1985; Grayson, 1988; Klein, 1989). The MAU values yield correlation coefficients for BMD ($r_s = 0.5448$) and FUI ($r_s = -0.3548$) suggesting that neither weathering/trampling nor food value accounts well for the variations in skeletal-part frequency. Bone density does appear to be a factor, however, perhaps combined with the effects of sampling and fragmentation.

On the basis of distal tibia, Vereshchagin and Kuz'mina (1977: 107) estimated a minimum of number of individuals (MNI) of 19, including 5 right distal tibia with unfused epiphyses representing younger horses (i.e., 26%). The remaining well represented skeletal parts yielded MNIs of 11 – 14 (see Table 2), and most include one or more unfused or partially fused specimens (left distal radii also contain 5 unfused ends). A sample of upper first molars ($n = 6$) with an MNI of 5 provided a range of crown-height measurements between 75 mm (young) and 20 mm (old) (cf. Levine, 1982). Size

differences among fused bones suggest that both males and females were present (Kuz'mina 1980: 99-109) and the scarcity of canines (only two worn specimens) suggests that a significant percentage were females (Turner, 2002: 204; Niven, 2007: 373). In sum, demographic data indicate that the bones and teeth at K 14-II represent a group of 14 or more horses of varying age and sex with a high percentage of females.

Discussion: The assemblage of horse remains excavated by Rogachev from K 14-II in 1954 probably constitutes the best evidence for a kill-butcher event in the EUP of Eastern Europe. The unusually good preservation of the bone—for an open air site of this age—is an important factor and provides for supporting evidence that might otherwise be lacking. A low degree of weathering has limited the loss of lighter bones and its effect on skeletal-part representation as well as preserving tool cut marks; at the same time, the scarcity of gnaw marks is less easily accounted for by weathering.

The evidence for butchery of a group of horses—both old and young—at or near the site may be summarized as follows: (a) large concentration of bones and teeth representing more than a dozen individual horses of varying age and sex; (b) virtually all skeletal parts represented and multiple groups of bones in anatomical order, including vertebrae (cervical, thoracic, and lumbar) and foot bones; (c) traces of carnivore damage almost entirely absent; and (d) high proportion of bones fractured when fresh and a number of percussion and cut marks (cut marks frequently observed in anatomically significant locations) apparently reflecting multiple phases of a butchering process.

The pattern suggests a catastrophic death—perhaps of a *mare band* comprising an adult male, several adult females, and young—and the possibility of a natural catastrophe cannot be eliminated (i.e., there is no direct evidence of human hunting such as a spear

point imbedded in a vertebra) (see Levine, 1983; Olsen, 1989; Niven, 2007). However, the absence of an obvious local setting for a catastrophe (e.g., box canyon subject to flash floods) and lack of carnivore damage—suggesting that humans were first on the scene—suggests that most or all of the horses represented in K 14-II were hunted by humans.

The horse bones at K 14-II exhibit a pattern similar to that in the EUP samples at the open-air site of Solutré in central France. Aurignacian units M12 and L13 at the latter contain 1,495 (MNI = 22) and 989 (MNI = 21) bones and teeth assigned to horse, respectively (Olsen, 1989: 300, table 2). The representation of skeletal parts is comparable to K 14-II, anatomical sequences of vertebrae and foot-bones are common, and cut marks were observed on various axial and appendicular elements (Olsen, 1989: 305-314).

3.2 *Kostenki 15 (K 15)*

Kostenki 15 (aka Gorodtsovskaya) is located on the second terrace level near the mouth of Aleksandrovka Ravine. It represents a rare example of a single-component EUP locality that was *not* discovered by excavating below a younger Upper Paleolithic horizon. The site was found in 1951 during construction of a small reservoir and excavated by Rogachev during the following year; much of the site apparently was destroyed by spring flooding prior to excavation (Rogachev, 1957: 106-107). A total of 70 m² was exposed in 1952 and it appears that little of the site now remains (Fig.5). The EUP occupation layer was found in non-humic loam underlying a band of humic loam that is thought to represent the Upper Humic Bed (Rogachev and Sinitsyn, 1982a: 162). Two radiocarbon dates on bone (Sinitsyn et al., 1997: Table I; M. Otte, pers. comm.)

yielded calibrated estimates of c. 30,000 cal BP, and there is another slightly younger bone date, all of which appear somewhat young given the stratigraphic context.

A large quantity of horse bones was excavated from K 15. Many were concentrated in and near a shallow “bowl-shaped” depression measuring 70 cm in diameter and up to 20 cm below the level of the occupation layer (Rogachev, 1957: 109). These bones were described as a breccia-like mass comprising hundreds of horse bone fragments and as many as six groups of bones in—or close to—anatomical order “primarily extremities or vertebrae” (Rogachev and Sinitsyn, 1982a: 163). Some bones were found outside the northeast (downslope) margin of the former depression, and appeared to represent material that had been washed partly down the “steep slope” from the latter. Although the depression was found in the northern part of the main occupation area (unit M - 19), provenience data on more than 200 bones examined in 2008 at ZIN suggested that horse remains were widely distributed across this area (see Fig. 5).

A total of 1,501 bones and teeth excavated in 1952 were assigned to broad-toed horse (*Equus latipes*) representing an MNI of 11 (Vereshchagin and Kuz'mina, 1977: 107) and comprising roughly 95% of NISP among mammals; other taxa included bison (*Bison* sp. or *Bos* sp.), hare (*Lepus tanaiticus*), wolf (*Canis lupus*), arctic fox (*Alopex lagopus*), mammoth (*Mammuthus primigenius*), and red deer (*Cervus elaphus*). Approximately 700 bones and teeth of horse from K 15 (47% of total reported NISP) were available for study at ZIN in 2008.

The K 15 horse bones are more heavily weathered than those from K 14-II. Among a sample of 133 bones assigned to weathering stages (see above), most fall into Stage 1/2 (53%) or Stage 2 (35%). Bones recovered from the concentration in the

northern part of the occupation area were reportedly less weathered than others (Rogachev and Sinitsyn, 1982a: 163). In contrast to bones from K 14-II, there are almost no traces of root etching. Most bones examined in 2008 were “very pale brown” (e.g., 10YR 8/3), although many were stained (chiefly manganese).

Traces of carnivore damage are relatively uncommon. Among the roughly 700 bones examined in 2008, tooth scoring, tracks, pits, and punctures were observed on only 12 specimens, and some of these were problematic. Most evidence of gnawing or chewing was observed on first and second phalanges. Traces of tool damage, including percussion marks, cut marks in the form of V-shaped incisions, and damage caused by hacking or shearing of bone, were more common, although not abundant (see Fig. 6a & 6b). Especially noteworthy were several distal humeri that exhibit a percussion blow, deep incision, and sheared-off bone (see Table 3).

The K 15 horse bones reflect a preponderance of green or fresh fractures. Among a sample ($n = 85$) of humeri, radii, femora, tibiae, and metapodials, 47 specimens (55%) exhibited classic green fractures (e.g., sawtooth, V-shaped, Type II spiral). Only 18 specimens (21%) exhibited dry fractures (e.g., step or columnar fracture with splits); the remaining bones were either unbroken or failed to yield a clear breakage pattern.

The roughly 700 bones and teeth available at ZIN were classified according to skeletal part, and the results are presented in Table 4. Because they comprise only 47% of the total NISP for horse—and it is not clear that they represent an unbiased sample of the latter—estimates of skeletal-part distribution and comparative analyses with bone density and food utility indices were not performed. Nevertheless, the distribution of parts recorded among this sample provides some information. Virtually all parts of the

skeleton are present and there are few major discrepancies in the number of individuals represented by each part (although proximal humeri and distal metapodials are scarce). While no whole crania or cranial fragments were observed, Rogachev (1957: 109) mentions a large number of skull fragments recovered in units И/К - 20/21.

Some information on the age and sex of the animals was collected from the sample at ZIN as well. Many of the represented skeletal parts include unfused specimens, indicating the presence of at least four juvenile horses (based on calcanea). Crown-height measurements on a sample of right lower third molars ($n = 9$), which erupt during the second year among modern equids (Levine, 1982), are shown in Table 5 and indicate at least a couple of older adults. Size variations among fused specimens in several part categories suggest that both males and females are represented (see Kuz'mina, 1980) and canines are completely absent among the sample of teeth, suggesting a high percentage of females, as at K 14-II.

Discussion: Reviewing K 15 several decades later, Rogachev suggested a “functional and structural difference” between the large concentration of horse bones in the northern part of the occupation area and remains found in other parts of the excavated area (Rogachev and Sinitsyn, 1982a: 163). The analysis and interpretation of the horse bones at K 15 is constrained by the reduced sample of materials currently available for study and the higher degree of weathering compared to K 14-II. Both the published descriptions of these bones and examination of collections at ZIN nevertheless indicate a pattern similar to that observed at K 14-II: (a) the dense concentration of bones of one taxon comprising virtually all parts of the skeleton; (b) presence of several anatomical sequences of bones including vertebrae and foot bones; (c) preponderance of green or

fresh breakage of the bones; (d) very limited traces of carnivore damage (suggesting that others extracted meat and marrow from the bones before carnivores had access to them); (e) traces of tool damage in the form of both percussion and cut marks (and association with both the shallow depression feature and artifacts); and (f) demographic data consistent with a living group (mare band?).

The presence of bones in anatomical sequence suggests the horses died near or even at K 15. This applies especially to the foot-bones, which are low food-utility parts probably hacked off the carcass and not subjected to further processing (e.g., Lam et al., 1999); they are unlikely to have been transported any distance from the location(s) at which the horses died. The provenience of these anatomical groups—in a shallow pit or depression filled with other horse bones—suggests that they were discarded along with other parts as waste during butchering. The “breccia-like” mass of bones in the depression—which represents at least several individual horses—does not appear to reflect a gradual accumulation over an extended period of time (based on the description provided by Rogachev [1957] and lack of evidence for variations in weathering). They seem more likely to have been deposited at one time, and possibly as a result of the more or less simultaneous butchery of several carcasses.

3.3 Kostenki 12, Layer III (K 12-III)

Kostenki 12 (aka *Volkovskaya*) occupies the second terrace level on the south side of the mouth of Pokrovskii Ravine. The site was discovered and initially investigated in 1950 – 1954 by Rogachev, who undertook additional excavations in the 1960s and eventually exposed several hundred square meters (Rogachev and Anikovich, 1982: 132).

Field research at K 12 was resumed by M. V. Anikovich in the 1970s and early 1980s. During 1999 – 2003, contiguous blocks of units totaling 144 m² in the southern (upslope) portion of the site were excavated (Anikovich et al., 2004).

The concentration of large mammal bones uncovered in 2002 – 2003 occupies an area of approximately 25 m² in units III through BI between lines 74 and 82 within a larger block of units excavated in 2001 – 2003 in Cultural Layer III (see Fig. 7). The bones were recovered at a depth of roughly 3.5 meters below the surface; most were found in a zone approximately 20 cm in thickness. They lay in a sequence of thin lenses of organic-rich loam, brown loam, and carbonate traditionally assigned to the Lower Humic Bed, dating to more than 40,000 cal BP (Rogachev and Anikovich, 1982: 138-139; Holliday et al., 2007: 198-200). The inclusion of chalk fragments derived from the local bedrock and analysis of soil micromorphology indicates that at least some of the sediment containing the bones was deposited by colluviation (i.e., slope action), and the bones exhibit a slope of approximately 5° (Hoffecker et al., 2005: 162; Holliday et al., 2007: 190-191, table I).

The majority of bones excavated in 2002 – 2003 identified to taxon are reindeer and horse. The only other common species is mammoth. The taxonomic representation (identified by IEK) is as follows:

<u>TAXON</u>	<u>NISP</u>
<i>Mammuthus primigenius</i> Blum. (woolly mammoth)	59 (18%)
<i>Equus latipes</i> Grom. (broad-toed horse)	127 (40%)
<i>Alces alces</i> L. (elk)	2 (1%)
<i>Rangifer tarandus</i> L. (reindeer)	132 (41%)
unidentified	658

In terms of spatial provenience, the reindeer, horse, and mammoth bones exhibit overlapping horizontal patterns of distribution in K 12-III. With respect to vertical provenience and taphonomic history, however, the reindeer and horse bones appear to represent separate depositional events (see below).

The orientation of the bones indicates that they probably were affected by moving water—presumably flowing on the slope. Bone orientation on a horizontal plane was measured with a protractor on a sample of specimens ($n = 111$) recorded on the 2002-2003 excavation unit maps (dip was not measured) (Voorhies, 1969; Saunders, 1977; Johnson, 2006: 60). The measurements were taken within a 180° -arc and grouped into intervals of 10° (e.g., Shipman, 1981: 73-77). Significant deviations from expected frequencies were determined by analysis of standardized residuals, which are normally distributed with a mean of zero and a standard deviation of one (e.g., Everitt, 1992: 46-48). A similar approach was used to identify preferred orientation of bone at Lubbock Lake (Texas, USA) (Kreutzer, 1988: 225-227). The results indicated a preferred orientation of northwest/north within an arc of 50° (see Table 6), which corresponds to the direction of the modern slope. The wide range of the arc may reflect multiple flow events and/or some variation in channel direction (e.g., Johnson 1995).

The bones at K 12-III are more heavily weathered than those from both K 14-II and K 15 (Fig. 8). Reindeer and horse bones classified by weathering stage were subdivided by taxon and body part (see Gifford, 1981; Lyman, 1994: 361). Most fell into Stage 2 or into intermediate stages between Stage 2 and either Stage 1 or Stage 3 (see Table 7). In terms of color, most of the bones from a sample ($n = 189$) recovered in 2003

were classified as “very pale brown” (42%) or “white” (33%) with little evidence of groundwater staining.

Many of the reindeer and horse bones in K12-III have been subject to surficial modification in the form of root etching, for which the following NISP counts were observed on a large sample (n = 221):

<u>TAXON</u>	<u>PRESENT</u>	<u>ABSENT</u>	<u>TOTAL</u>
horse	37	44	81
reindeer	103	37	140

The distribution yields a χ^2 value of 17.2, which is significant at the .001 level with $df=1$, and indicates that the reindeer bones probably were more heavily root-etched than the horse bones. Although Grayson (1988: 29-31) attributed significant contrasts in root etching among bones from different levels in Danger Cave (Utah, USA) to environmental differences, an equally important conclusion at Kostenki 12 is that the horse and reindeer bones reflect different taphonomic histories. This probably indicates that they were not deposited at the same time. Although the vertical distribution exhibits overlap between the two taxa, horse bones were concentrated 5-10 cm below reindeer in one excavation unit (B-77) where both are represented (Hoffecker et al., 2005: 163).

Some surface modification of bone also is evident in the form of damage from carnivores and possibly stone tools. Tooth tracks or punctures were observed on 31 reindeer bones (25% of total NISP for this taxon) and 10 horse bones (10% of total NISP for this taxon). For both taxa, carnivore marks were recorded on long-bones and smaller compact bones. Possible carnivore damage also was observed on one mammoth bone (vertebra) and 10 shaft fragments that could not be identified to taxon. Possible examples of damage from stone tools were recorded on seven bones (all recovered during 2002)

belonging to horse, reindeer, and mammoth respectively. In all cases, the damage appears in the form of percussion blows or marks (see Blumenschine and Selvaggio, 1988), and in at least one case, microscopic striations, which are especially diagnostic of percussion blows, were observed (Hoffecker et al., 2005: table 3). No examples of incisions or cuts were recorded, although this might reflect the degree of surficial weathering (Lyman, 1994: 306).

With the exception of many of the small compact bones (e.g., tarsals, carpals), most large mammal bones recovered from K 12-III in 2002 – 2003 are broken. A sample of reindeer and horse bones ($n = 102$) yielded the following distribution:

TAXON	UNBROKEN BONE	FRESH BREAKAGE	DRY BREAKAGE	UNDETERMINED
horse	3 (8%)	20 (51%)	10 (26%)	6 (15%)
reindeer	1 (2%)	29 (46%)	29(46%)	4 (6%)
Total	4	49	39	10

The results indicate that substantial breakage occurred both when the bones were fresh and dry.

Skeletal part representation for reindeer and horse is presented in Table 8. (Most of the mammoth parts represent tooth and long-bone shaft fragments, which are more easily identified for mammoth than other large mammals, along with some lower limb bones [$n = 10$], foot bones [$n = 3$], and rib fragments [$n = 2$]). Skeletal-element frequencies for reindeer (MAU) were measured against indices of bone mineral density (BMD) (Lam et al., 1999: 351-353, table 1) and food utility (FUI) (Metcalf and Jones, 1989: 492, table 2) for this taxon. The correlation coefficients for BMD ($r_s = 0.3334$) and FUI ($r_s = 0.1551$) were low and suggested that neither weathering effects nor selection of

parts by consumers accounted well for the variations in reindeer part representation. The samples of horse and mammoth remains were too small for statistical analyses.

The lack of significant correlations between the distribution of reindeer body parts and bone-density and food-utility indices might be due to the effects of fluvial sorting by water flowing on the 5° slope of Layer III. This was assessed qualitatively by assigning the skeletal parts to *Voorhies Groups*, which are based on water transportability (see Voorhies, 1969; Behrensmeyer, 1975). The observed parts primarily comprise elements of intermediate transportability (or *Voorhies Group II*), while both the heaviest elements (crania and mandibles) and the lightest elements (ribs, vertebrae, and sacrum) are relatively scarce. The head parts might have been left as “lag deposits” on the upper slope at K 12 (which remains unexcavated) (e.g., Voorhies, 1969: 69).

The second author collected some demographic data on reindeer, horse, and mammoth. Reindeer are represented by a minimum of 5 adults and 1 subadult. Horses are represented by a minimum of 4 adults, 1 subadult, and 1 yearling. A minimum of 1 adult mammoth is present. Season of death cannot be determined (the absence of reindeer antler may simply reflect the general lack of head parts).

Discussion: The large accumulations of reindeer and horse bone in K 12-III may reflect two or more kill-butchery events that took place nearby (i.e., upslope from the area excavated in 2002 – 2003), but the transportation and sorting of bones on the slope complicates their interpretation. It is unclear whether the bones have been concentrated or dispersed—and if parts have been selectively removed or not—by the action of gravity and water. Anatomical sequences of bone (unless still conjoined by musculature) would

have been disarticulated. Weathering could have erased traces of both tool and carnivore damage on bone surfaces.

The interpretation that the bones represent kill-butchery events at K 12-III is supported by some but not all of the characteristics observed at K 14-II and K 15: (a) the large number of bones representing one taxon (reindeer and horse each represented by a separate accumulation) and comprising a wide range of body parts; (b) evidence for substantial green breakage and possible tool-percussion marks; and (c) association with artifacts and other traces of human occupation. And as at the other two sites, the bones do not lie in a likely context for recurring natural catastrophe or possess the characteristics of a carnivore accumulation.

3.4 Kostenki 1, Layer V (K 1-V)

The site of the original Kostenki archaeological discovery (aka *Polyakov's Site*) is located on the north side of the mouth of Pokrovskii Ravine. K 1 was subject to major excavations in the 1920s and 1930s focused primarily on post-EUP occupation (Efimenko, 1958). An EUP level (Layer V) was identified in 1938, and this and other EUP levels (Layers III-IV) were investigated in 1948 – 1951 and 1979 (Rogachev, 1957: 19-20; Rogachev et al., 1982: 42). Some additional area in the southwestern portion of the site was excavated between 1986 and 1994 (Anikovich et al., 2006: 87).

In 2004 – 2005, a 4 x 5 meter block was excavated on the southwestern margin of K 1 (units Я through Б between lines 71 and 76, inclusive) exposing new areas of Layer V and 576 bones and teeth of mammoth—from a layer that had previously yielded only isolated faunal remains (Vereshchagin and Kuz'mina, 1977: 100; Anikovich et al., 2006).

The overwhelming majority (87%) of the bones and teeth recovered in 2004 – 2005 were rib fragments that could have been derived from one individual (see Fig. 9). Additional units in the same area of K 1 were opened up in 2006 – 2007, producing another 58 mammoth bones, along with some bones of horse (n = 25) and reindeer (n = 5) from Layer V.

The artifacts and faunal remains of K 1-V are contained in a yellowish-brown silt loam and an underlying dark brown loam (3.3-3.7 meters below the surface) representing a weakly developed buried soil (b3) that may constitute the stratigraphic equivalent of the Lower Humic Bed (Holliday et al., 2007: 209-210), but alternatively may represent a younger layer (Anikovich et al., 2006; Hoffecker et al., 2008). The soil exhibits a slope of approximately 5° towards Pokrovskii Ravine.

Most available weathering data on the mammoth remains were obtained on the material recovered during 2006 – 2007, which comprise long-bones and several fragments of ribs, scapula, and pelvis. The majority of these were “white” (10YR8/2) or “very pale brown” (e.g., 10YR7/3) in color; slightly less than half exhibited black surface staining (presumably manganese from groundwater). The bones were more weathered than those from other sites described above. Most of the long-bones and rib fragments excavated in 2006 – 2007 were classified as Stage 2/3 or Stage 3, characterized by corrosion and exfoliation of bone surfaces (cf., Frison and Todd, 1986: 33-41).

The comparatively high degree of weathering may have obscured evidence of breakage, as well as traces of tool and carnivore damage. Fresh or green breakage was observed on three of the fragments recovered in 2006 – 2007 (tibia, scapula, and ulna with Type II spiral fracture). The remainder of the sample either exhibited typical dry

breakage (e.g., step fracture) or were indeterminate. A right femur (unit B-72) and a left humerus (unit B-68) were essentially complete, although the humerus had been broken (dry) into several large fragments. Traces of carnivore damage in the form of tooth punctures or furrows were observed on opposing sides of a large rib fragment (2005 excavation), another rib fragment, and a humerus fragment.

All available bones were examined for traces of tool damage and these included several specimens from 2004 – 2005, as well as the materials excavated in 2006 – 2007. The most likely examples are two linear cut marks and a possible hack mark recorded on an ulna shaft fragment from unit B-73 (2006 excavation). The cut marks are roughly 20 mm and 30 mm in length, and exhibit U-shaped troughs 1.5 mm and 2.5 mm in width, respectively (see Fig. 10); the latter possesses a flared terminus (see Johnson, 2007: 67). The hack mark—located near the articular end of the bone—is 16 mm in width and up to 5 mm in depth. Similar marks are described on mammoth ulnae from the Clovis type-site in New Mexico USA (Saunders and Daeschler, 1994: 14-18). Damage also was observed on a carpal bone (lunar) from unit B-73 (2004 excavation) in the form of two possible gouge marks on the margin of the articular surface. Although similar marks have been observed on mammoth lunars from archaeological sites in North America (Saunders and Daeschler, 1994: 15-17; Johnson, 2007: 67-72) apparently reflecting the use of pry bars or levers to separate joints and heavy elements during dismemberment—as described in ethnographic accounts of elephant butchery (cf. Fisher, 1992: 68)—the K 1-V specimen is problematic.

The mammoth remains in K1-V represent only a subset of the skeleton (roughly 25%) (Table 9). Although mandible and tusk fragments are present, the cranium is

absent; rib fragments are very common (80% of NISP), along with some vertebrae fragments, and most of the limb bones are represented, but—with the exception of the carpal mentioned above—foot-bones are lacking (including metapodials, tarsals, and phalanges). What might account for this selective distribution of skeletal parts? Because all three Voorhies Groups are well represented (Voorhies, 1969; Frison and Todd, 1986: 67-68) sorting by water transport does not account for the pattern (see Table 9).

Ethnographic accounts of elephant butchery indicate that the scarcity of foot-bones could reflect selective removal of these parts by humans (see Crader, 1983; Fisher, 1992: 71), but the presence/absence of other parts does not conform to observed patterns of retrieval or abandonment. At present, the distribution of parts may be explained by sampling—at least some of the missing elements probably lie in unexcavated units.

Analysis of the mammoth remains recovered in 2004 – 2005 revealed that no more than one individual was necessarily represented (Anikovich et al., 2006). The additional bones and teeth excavated in 2006 – 2007 did not alter this conclusion with respect to body parts or the age of the individual. On the basis of a mandible fragment containing a complete first molar recovered from unit Θ -72 (2005 excavation), the second author identified a sub-adult mammoth aged 10-15 years.

Discussion. Although earlier excavations yielded few faunal remains in K1-V, the units opened in 2004 – 2007 revealed the partial skeleton of a sub-adult mammoth. The bones were more heavily weathered than most recovered from the Kostenki sites, but some exhibited traces of carnivore and tool damage. The latter included marks with U-shaped troughs that have been found on proboscidean bones from other archaeological sites and appear to reflect dismemberment techniques specific to this heavy-boned taxon.

At least some of the bones were broken when fresh. Many parts of the skeleton, including the cranium and most of the foot-bones, were missing, but the reason(s) for their absence is unknown.

It appears unlikely that the mammoth remains at K 1-V were accumulated by either geologic processes (water transport) or biological agents (i.e., carnivores and/or humans). The geomorphic setting (similar to the other Kostenki sites already described) lacks evidence for the high-energy stream flow necessary to move intact mammoth long-bones such as the femur (see Frison and Todd, 1986: 61-80), and the distribution of skeletal parts in terms of Voorhies Groups does not indicate fluvial sorting.

Assuming that a single mammoth is represented, it is more likely that the animal died at or near the location of the bones and teeth, and that portions of the carcass were subsequently exploited by humans and carnivores. The bones probably were exposed to subaerial weathering for several years. A similar pattern is evident at several sites in North America, where the partial carcass of one or two mammoths is found—with traces of tool damage on some of the bones—associated with a small quantity of artifacts (e.g., Saunders and Daeschler, 1994; Johnson, 2006, 2007). At these sites—as at K 1-V—it is not always clear if the mammoth was hunted or simply scavenged by humans.

4. EUP large-mammal procurement at Kostenki

4.1 Large-mammal procurement during the later EUP (39,000–30,000 cal BP)

EUP occupation layers that lie between the CI Y5 tephra and the base of the loess-like loams that were deposited during the Upper Pleniglacial (MIS 2 age equivalent) are contemporaneous to the early Aurignacian in southwestern Europe. They

date to a cold phase (Heinrich Event 4) following the CI eruption, and one or more interstadial periods at the end of MIS 3 (broadly correlated with GI 8-6) (Hoffecker et al., 2008). Various lines of evidence, including the small body size of the hares found in these later EUP occupations at Kostenki (Averianov, 1998), suggest that climates were very mild during at least some of the interstadials.

The concentrations of horse bone at K 14-II and K 15 probably represent the remains of animals that were killed and butchered at or near these sites. The large quantity of bones and teeth from one taxon, nearly complete representation of skeletal parts, high percentage of fresh-fractured bone, multiple anatomical sequences of vertebrae and foot-bones, lack of carnivore damage, and presence of percussion and cut marks on the bones (especially on the less weathered specimens from K 14-II) support this conclusion. The dense accumulation of bone in the depression at K 15 suggests processing of multiple carcasses at one time, and at both sites, male and female adults, as well as juveniles, appear to be present. Although a group of horses at either site might have been killed by a natural catastrophe, human hunting appears to be a more likely cause of death in this topographic setting.

The concentrations of horse bone at K 14-II and K 15 are similar to those in broadly contemporaneous EUP units at the open-air site of Solutré in central France (Olsen, 1989). The latter are interpreted as the remains of small groups—perhaps similar to mare bands comprising 6-12 individuals—driven up into the cul-de-sac where the site is located from the Sône Valley during seasonal migrations (Levine, 1983: 40; Olsen, 1989: 323-324). At Kostenki, groups of horses could have been driven up into the ravine systems from the main valley of the Don River (see Fig. 11), or alternatively, driven

down off the steep slope of the eastern margin of the Central Russian Upland. In either case, some form of corral or artificial barrier may have been necessary to channel the horses into the area where they were killed (see Olsen, 1995: 73).

The artifact assemblages found in K 14-II and K 15 are similar and both contain a variety of stone and non-stone artifacts. Although the percentage of retouched items is high (10-12%), there is much flaking debris present and the overall density of artifacts is high (especially at K 14-II). The stone tools include end-scrapers (39-45% of tools), side-scrapers, points (including some bifacial forms), and *pièces esquillées*. Some heavy pieces (“hammer-stones”) are present at both sites. Among the non-stone items are needles, awls, rods, shovel-shaped implements and others, as well as decorated pieces and ornaments (Rogachev, 1957; Rogachev and Sinitsyn, 1982a, 1982b). Both assemblages have been assigned to the *Gorodtsov archaeological culture* (Rogachev and Anikovich, 1984: 183-185; Sinitsyn, 1996: 282-283; Anikovich et al., 2007a: 248-265), which is characterized by a high percentage of end-scrapers, many typical Mousterian forms—side-scrapers, points, and bifaces—and a diverse bone inventory that includes the diagnostic shovel-shaped implements.

The K 14-II and K 15 artifacts also may be interpreted in functional terms—as assemblages associated with both a kill-butcher event and a habitation. Although the overall composition of the assemblages is characteristic of a habitation site (as well as the composition of the fauna other than horse, which comprise a diverse array of large and small mammals and some bird remains [Vereshchagin and Kuz'mina, 1977: 107]), many of the stone artifact types are found in large mammal kill-butcher sites of North America

(e.g., Hester, 1972: 102-106; Frison, 1974: 92-95, 1987: 245-255; Speth, 1983: 27-45; Frison and Todd, 1986: 96-100; Holliday, 1997; Johnson, 2007: 66):

- (a) projectile points and point fragments (for tipping spears)
- (b) flake scrapers and utilized flakes (for cutting hide and muscle)
- (c) small bifaces (for skinning)
- (d) hammer-stones and large cutting/chopping tools (for severing major joints and breaking bone for marrow)
- (e) end-scrapers (for cleaning and scraping hide)

While technologically and typologically similar to Mousterian forms, the flake scrapers (side-scrapers) and small bifaces appear to represent *expedient tools* often produced at the kill from local raw materials for processing carcasses. The one category of artifacts listed above that is not clearly represented at K 14-II and K 15 is projectile points, although both assemblages contain small triangular bifacial points that fall at least broadly into this category (Rogachev and Sinitsyn, 1982b: 168-169).

The artifact assemblages associated with evidence for EUP kill-butchery events at Solutré exhibit differences and similarities to the K 14-II and K 15 artifacts. The Aurignacian assemblages at this site (including units M12 and L13) are small and yield limited evidence for core reduction. The tools include end-scrapers on blades, laterally retouched blades, and utilized blades; some are described as thick and crude (*lames brutes*) and could represent expedient forms. However, neither bifaces nor heavy tools are reported (Combiér, 1955: 190-195; Montet-White, 2002: 227-229).

The combined evidence of the artifact assemblages and the taphonomic characteristics of the horse bone concentrations suggest that both kill-butchery and habitation areas are represented at K 14-II and K 15. It seems highly unlikely, however,

that a habitation and kill-butcher site would be occupied in the same time and place and, as noted earlier, Rogachev and Sinitsyn (1982b: 163) saw a “functional and structural difference” between the horse bone concentration and other debris at K 15. At K 14-II, a separation between the horse bones and other remains is less apparent, but Rogachev (1957: 78) observed that the anatomical sequences of bone were deposited “at the base of the cultural layer and on its surface,” suggesting possible micro-stratigraphic separation.

If the kill-butcher and habitation areas were occupied at different times, presumably the kill-butcher event occurred first. Perhaps the killing of a group of horses created a sufficient food surplus for an extended habitation. In a landscape devoid of natural shelters, the choice of a long-term camp location would have been a more flexible one—less influenced by the location of caves and rockshelters. Active springs in the ravine systems of Kostenki area during the EUP would have increased its suitability for a camp (Holliday et al., 2007: 221). There are a number of examples of short-term and long-term campsites established adjacent to kill-butcher locations in North America (e.g., Wheat, 1978; Jodry and Stanford, 1992; Holliday, 1997; Haynes and Huckell, 2007) and this pattern would seem to be present in the later EUP on the East European Plain.

4.2 Large-mammal procurement during the earlier EUP (45,000–40,000 cal BP)

Occupation layers that underlie the CI Y5 tephra at the Kostenki sites contain remains of an early phase of the EUP that antedates the CI eruption and Heinrich Event 4 in the climate stratigraphy of the North Atlantic (Hoffecker et al., 2008). Two possible kill-butcher sites—K 12-III and K 1-V—provide evidence for large-mammal

procurement in this time range, which is characterized by several brief intervals of milder climate tentatively correlated with Greenland Interstadials 11-9 [GI 11-9]).

A mass of reindeer and horse bones deposited on the slope of the second terrace level and associated with artifacts of Layer III at K 12 apparently represent two or more groups of large mammals killed and butchered at or near the site. The effects of geochemical weathering and movement downslope by water and gravity (which probably sorted the bones) complicates analysis. The horse bones at K 12-III may represent the same kill-butchery pattern found in the younger occupations at K 14-II and K 15, but have been disturbed by post-depositional processes.

The concentration of reindeer bones at K 12-III is unique for Kostenki, and may indicate greater focus on this taxon on the central East European Plain during an interval that probably was relatively cool. In the later EUP (i.e., after 40,000 cal BP), reindeer are relatively common in sites of the southwest region of the East European Plain (Hoffecker, 2002: 179). Reindeer also are well represented at Sungir' in northern Russia (which appears to be terminal EUP), where all skeletal parts are present—along with anatomical sequences of vertebrae and extremities—and some bones exhibit cut marks (Gromov, 1966; Bader, 1978).

The partial mammoth skeleton at K 1-V is similar to those found at several sites of terminal Pleistocene age in North America (cf. Haynes, 1991: 195-208), and probably represents a carcass that was butchered by human occupants of the Kostenki area during this interval. As in the case of many of the North American sites (e.g., Saunders and Daeschler, 1994; Johnson, 2007), it is unclear whether the sub-adult mammoth was killed by humans or simply scavenged after death from other causes. Once again, the presence

of active springs in the ravine systems around Kostenki may be significant; many mammoth kill and/or butchery sites in North America are associated with spring deposits (Holliday, 1997; Haynes and Huckell, 2007).

The artifact assemblages at K 12-III and K 1-V chiefly comprise small bifaces (including triangular bifacial points), end-scrapers, side-scrapers, and small quantities of other tools forms (see Fig. 12). Among the latter are heavy bifacial tools that resemble large bifaces of the Lower Paleolithic (Anikovich et al., 2004: 29, fig. 8; Anikovich et al., 2006: 100, fig. 11). Non-stone implements are absent and the overall quantity of flaking debris is low. Local stone of poor-to-medium quality predominates, although some imported chert of good quality is present.

Both artifact assemblages are assigned to the *Strelets archaeological culture* (Rogachev and Anikovich, 1984: 179-184; Anikovich et al., 2007a: 236-248), although, as in the case of K 14-II and K 15, the artifacts also may be interpreted in functional terms. All of the elements of a kill-butchery assemblage are present (as described above), including likely stone-tipped projectile points in the form of the diagnostic triangular points (“Streletskaya points”) (Bradley et al., 1995). In contrast to the other occupations, K 12-III and K 1-V lack evidence for a major habitation area or long-term camp. Both contain, however, traces of former hearths and other debris that indicate at least short-term camps that might have been associated with the kill-butchery events (Rogachev, 1957: 35-41; Anikovich et al., 2004: 27-28).

5. Conclusions

The open-air sites at Kostenki contain traces of both habitation areas and locations where large mammals were killed and/or butchered assigned to the EUP and dating to 45,000 – 30,000 cal BP. This conclusion is based on a combined analysis of artifact assemblages and the taphonomic characteristics of large mammal remains in layers at four sites. Although the small and medium mammals (and non-mammalian vertebrates) lie outside the scope of this paper, it may be noted that the analysis of these remains contribute to the pattern. Concentrations of small/medium mammal bones, including hare and arctic fox, are found in several EUP sites/layers (e.g., K 14-IV, K 16 [Vereshchagin and Kuz'mina, 1977, 1982: 231-232; N. D. Burova, pers. comm.]) and probably represent animals that were harvested for food and/or pelts over an extended period of time (Hoffecker, 2002: 183). The artifacts and features associated with these remains suggest that they were habitation areas.

The Kostenki sites appear to represent an EUP landscape in which people engaged in a variety of social and economic activities—perhaps at varying times of the year. Large mammals, including apparently small groups of horses and occasionally reindeer, were hunted locally—possibly driven up from the main valley into the ravine systems on the west side of the Don River. Habitation areas, which probably included both long-term and short-term camps, were occupied along the ravines and sometimes adjacent to the kill-butchery locations. Active springs and some locally available lithic material probably contributed to the attraction of the area.

The Kostenki EUP landscape provides a broader view of human society and economy than the rockshelters of the Franco-Cantabrian region occupied during this

period. The rockshelters appear to represent habitation areas. EUP kill-butchery sites are rare in Western Europe, although an example is found at the open-air site of Solutré in central France, where both the taphonomic characteristics of the large mammals and associated artifacts exhibit some similarities to the EUP landscape at Kostenki. Much of the variability in Kostenki artifact assemblages probably reflects differences in site function that are not represented in the Franco-Cantabrian EUP record.

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Table 1. Traces of artifact damage on bones of horse from Kostenki 14, Layer II observed on specimens at ZIN and IIMK during April 2009.

UNIT	ELEMENT	DESCRIPTION
M-40 Y-42	vertebra (spinous process) rib fragment	longitudinal cuts along base of spine several incisions on ventral surface
H-42 M-39 X-40 H-40 П/T-39/42	scapula distal humerus distal radius (unfused) distal radius (unfused) distal radius	deep cut-mark around glenoid cavity parallel cut-marks on medial condyle transverse cut-marks on anterior face transverse cut-marks on anterior face light sub-parallel cut-marks on anterior face
M-40 X-39 M-42	distal femur distal tibia distal tibia	cut-marks on lateral and medial condyles percussion mark on anterior surface percussion mark with crushed margins and cut-marks on posterior surface
T-41	long-bone shaft fragment	percussion mark with microscopic striations and crushed bone around impact area
H-42	long-bone shaft fragment	percussion mark with microscopic striations and crushed bone around impact area
X-39 Y-41 Y-40	long-bone shaft fragment long-bone shaft fragment long-bone shaft fragment	percussion mark with microscopic striations percussion mark (without striations) percussion mark/cone fracture

Table 2. Skeletal elements for horse in Kostenki 14, Layer II (based on counts of bones and teeth at ZIN and IIMK in April 2009).

SKELETAL ELEMENT	NISP	Left	Right	MNE	MAU	%MAU	BMD	FUI
CRANIUM	?	--	--	?	?	?	--	8.0
MANDIBLE	44	7	9	13	6.5	46.4	--	3.3
HYOID	1	--	--	1	1	0.7	--	--
ISOLATED TEETH	103	--	--	--	--	--	--	--
VERTEBRAE	?	--	--	?	?	?	--	--
RIBS	~250	?	?	?	?	?	--	--
SCAPULA	51	14	13	23	11.5	82.1	1.03	6.7
HUMERUS								
PROXIMAL HUMERUS	12	5	1	6	3.0	21.4	0.33	6.7
DISTAL HUMERUS	27	7	16	22	11.0	78.6	1.05	6.3
RADIUS								
PROXIMAL RADIUS	22	11	11	17	8.5	60.7	1.04	3.9
DISTAL RADIUS	21	10	11	20	10.0	71.4	1.00	2.7
ULNA	16	5	11	15	7.5	53.6	0.70	3.9
CARPALS	111	32	79	--	--	--	--	1.4
METACARPAL								
PROXIMAL METACARPAL	18	7	11	17	8.5	60.7	1.03	0.7
DISTAL METACARPAL	17	?	?	17	8.5	60.7	0.60	0.3
INNOMINATE	14	3	4	5	2.5	17.9	0.65	23.7
FEMUR								
PROXIMAL FEMUR	12	6	6	9	4.5	32.1	0.35	20.3
DISTAL FEMUR	11	7	4	10	5.0	35.7	0.30	20.3
PATELLA	21	13	8	21	10.5	75.0	--	--
TIBIA								
PROXIMAL TIBIA	5	2	3	5	2.5	17.9	0.77	11.3
DISTAL TIBIA	28	9	19	28	14.0	100.0	1.05	6.8
CALCANEUS	20	8	12	20	10.0	71.4	0.72	3.4
ASTRAGALUS	(20)	?	?	(20)	10.0	71.4	0.67	3.4
TARSALS	87	42	44	--	--	--	--	3.4
METATARSAL								
PROXIMAL METATARSAL	26	13	13	20	10.0	71.4	1.07	1.7
DISTAL METATARSAL	17	?	?	17	8.5	60.7	0.60	0.8
PHALANGES								
1 ST PHALANX	(39)	--	--	39	9.8	70.0	0.67	0.4
2 ND PHALANX	(44)	--	--	44	11.0	78.6	0.62	0.4
3 RD PHALANX	(37)	--	--	37	9.3	66.4	0.57	0.4

NISP = Number of Identified Specimens (values in parentheses represent bone counts recorded on boxes at ZIN)

MNE = Minimum Number of Elements

MAU = Minimal Animal Units

%MAU = percent Minimal Animal Units

BMD = Bone Mineral Density (based on scan sites in Lam et al. 1999: 348-353)

FUI = Food Utility Index (from Outram and Rowley-Conwy 1998: 845, table 6)

Table 3. Traces of artifact damage on bones of horse from Kostenki 15 observed on sample of bones at ZIN during March 2008.

UNIT	ELEMENT	DESCRIPTION
--	rib	possible cut mark
--	distal radius (unfused)	sheared-off bone
И-23	distal humerus (fused)	deep and wide cut mark
К-25	distal humerus	percussion mark
Л-22(?)	distal humerus (fused)	shear mark posterior surface cut on anterior surface
3-24	pelvic fragment	flake scar near acetabulum
Л-20	distal femur (fused)	hack marks
М-19	distal femur (fused)	possible percussion blow with cracks
--	patella (adult size)	flake scar
К-22	distal tibia (fused)	flaked fracture surface on diaphysis
К-23	distal tibia (fused)	percussion marks? flaked fracture edges
К-23	astragalus (adult size)	hack marks on condyle
Л-23	first phalanx (fused)	sheared-off bone proximal anterior surface
Л-25	first phalanx (fused)	sheared-off bone proximal

Table 4. Skeletal elements for horse in Kostenki 15 (based on counts of bones and teeth at ZIN in March 2008).

SKELETAL ELEMENT	NISP
CRANIUM	x
MAXILLA	2
MANDIBLE	8
ISOLATED TEETH	~145
ATLAS	2
AXIS	0
OTHER VERTEBRAE	56
RIBS	63
SCAPULA	4
HUMERUS	
PROXIMAL HUMERUS	1
DISTAL HUMERUS	13
RADIUS	
PROXIMAL RADIUS	6
DISTAL RADIUS	13
ULNA	7
CARPALS	x
METACARPAL	
PROXIMAL METACARPAL	1
DISTAL METACARPAL	0
INNOMINATE	10
FEMUR	
PROXIMAL FEMUR	7
DISTAL FEMUR	7
PATELLA	9
TIBIA	
PROXIMAL TIBIA	13
DISTAL TIBIA	20
CALCANEUS	14
ASTRAGALUS	10
TARSALS	x
METATARSAL	
PROXIMAL METATARSAL	4
DISTAL METATARSAL	2
PHALANGES	
1 ST PHALANX	18
2 ND PHALANX	25
3 RD PHALANX	2

NISP = Number of Identified Specimens

x = present

Table 5. Crown-height measurements on right lower third molars of horse from Kostenki 15.

UNIT	CROWN HEIGHT	DESCRIPTION/COMMENTS
Л-20	--	base of crown absent; not fully in wear representing young adult
?	>70 mm	base of crown absent; not heavily worn
И-22	67 mm	damage to roots; crown-height estimated
И-23	57 mm	reassembled from two fragments
К-20	>55 mm	base of crown absent
Л-24	>55 mm	base of crown absent; heavily damaged
И-22	>50 mm	base of crown absent, minimum measurement
И-22	25 mm	some damage to roots
Л-21	23 mm	complete tooth representing old adult

Table 6. Frequencies of long bones and elongate bone fragments in Kostenki 12, Layer III by 10° orientation class.

ORIENTATION CLASS	EXPECTED VALUE	OBSERVED VALUE	STANDARDIZED RESIDUAL
270-279°	6.2	2	-1.69
280-289°	6.2	5	-0.48
290-299°	6.2	4	-0.88
300-309°	6.2	2	-1.69
310-319°	6.2	4	-0.88
320-329°	6.2	12	+2.33
330-339°	6.2	16	+3.94
340-349°	6.2	11	+1.93
350-359°	6.2	20	+5.54
0-9°	6.2	16	+3.94
10-19°	6.2	3	-1.29
20-29°	6.2	0	-2.49
30-39°	6.2	1	-2.09
40-49°	6.2	1	-2.09
50-59°	6.2	2	-1.69
60-69°	6.2	3	-1.29
70-79°	6.2	2	-1.69
80-89°	6.2	7	+0.32

Table 7. Weathering stage classification for a sample of reindeer and horse bones from Kostenki 12, Layer III (2002-2003 excavations).

REINDEER				
	STAGE 1/2	STAGE 2	STAGE 2/3	STAGE 3
HUMERUS	4	7	3	1
RADIUS	7	7	4	0
FEMUR	3	3	1	0
TIBIA	5	4	2	0
CARPALS/TARSALS	9	16	10	2
METAPODIALS	1	3	1	0
FIRST PHALANX	11	6	5	1
HORSE				
	STAGE 1/2	STAGE 2	STAGE 2/3	STAGE 3
HUMERUS	3	3	4	2
RADIUS	0	1	1	0
FEMUR	0	3	0	0
TIBIA	1	1	1	1
CARPALS/TARSALS	8	7	0	2
METAPODIALS	4	3	1	2
FIRST PHALANX	3	2	0	1

Table 8. Representation of skeletal elements for reindeer and horse from Kostenki 12, Layer III (2002-2003 excavations).

SKELETAL ELEMENT	REINDEER			HORSE		
	MNE	MAU	%MAU	MNE	MAU	%MAU
CRANIUM	0	0.0	0	0	0.0	0
MANDIBLE	0	0.0	0	2	1.0	40
ISOLATED TEETH	0	0.0	0	11	0.275	11
ATLAS	2	2.0	31	0	0.0	0
AXIS	0	0.0	0	0	0.0	0
OTHER VERTEBRAE	2	0.15	2	1	0.03	1
RIBS	0	0.0	0	1(?)	0.03(?)	1
SCAPULA	1	0.5	7	2	1.0	40
HUMERUS						
PROXIMAL HUMERUS	2	1.0	15	0	0.0	0
DISTAL HUMERUS	13	6.5	100	5	2.5	100
RADIUS						
PROXIMAL RADIUS	5	2.5	38	2	1.0	40
DISTAL RADIUS	11	5.5	85	0	0.0	0
ULNA	2	1.0	15	0	0.0	0
CARPALS	7	0.58	9	8	0.57	23
METACARPAL						
PROXIMAL METACARPAL	1	0.5	7	5	2.5	100
DISTAL METACARPAL	2	1.0	15	4	2.0	80
INNOMINATE	1(?)	0.5(?)	7(?)	1	1.0	40
FEMUR						
PROXIMAL FEMUR	2	1.0	15	2	1.0	40
DISTAL FEMUR	3	1.5	23	1	0.5	20
PATELLA				1	0.5	20
TIBIA						
PROXIMAL TIBIA	2	1.0	15	1	0.5	20
DISTAL TIBIA	7	3.5	54	2	1.0	40
CALCANEUS	13	6.5	100	1	0.5	20
ASTRAGALUS	12	6.0	92	1	0.5	20
TARSALS	3	0.5	8	3	0.375	15
METATARSAL						
PROXIMAL METATARSAL	1	0.5	7	1	0.5	20
DISTAL METATARSAL	0	0.0	0	1	0.5	20
PHALANGES						
1 ST PHALANX	25	3.125	48	6	1.5	60
2 ND PHALANX	10	1.25	17	4	1.0	20
3 RD PHALANX	0	0.0	0	1	0.25	10

MNE = Minimal Number of Elements

MAU = Minimal Animal Units (MNE divided by number of times element occurs in skeleton)

%MAU = percentage of maximum MAU value

Table 9. Representation of skeletal elements for mammoth from Kostenki 1, Layer V (2004-2007 excavations) and classification by *Voorhies Group* (Voorhies 1969).

SKELETAL ELEMENT	NISP	VOORHIES GROUP
CRANIUM	0	III
MAXILLA	0	III
MANDIBLE	20	III
TUSKS	3	
ISOLATED TEETH	1	
isolated tooth fragments	17	
ATLAS	0	
AXIS	0	
OTHER VERTEBRAE	5	I
RIBS	505	I
SCAPULA	1	I/II
HUMERUS	1	II
PROXIMAL HUMERUS	1	
DISTAL HUMERUS		
RADIUS	0	II
PROXIMAL RADIUS		
DISTAL RADIUS		
ULNA	3	I/II
FIBULA	1	
CARPALS	1	
METACARPAL	0	II
PROXIMAL METACARPAL		
DISTAL METACARPAL		
INNOMINATE	7	II
FEMUR	1	II
PROXIMAL FEMUR		
DISTAL FEMUR		
PATELLA	1	
TIBIA	2	II
PROXIMAL TIBIA		
DISTAL TIBIA		
CALCANEUS	0	
ASTRAGALUS		
TARSALS	0	
METATARSAL	0	II
PROXIMAL METATARSAL		
DISTAL METATARSAL		
PHALANGES	0	I
LONGBONE FRAGMENTS	21	
UNIDENTIFIED FRAGMENTS	40	
TOTAL	630	

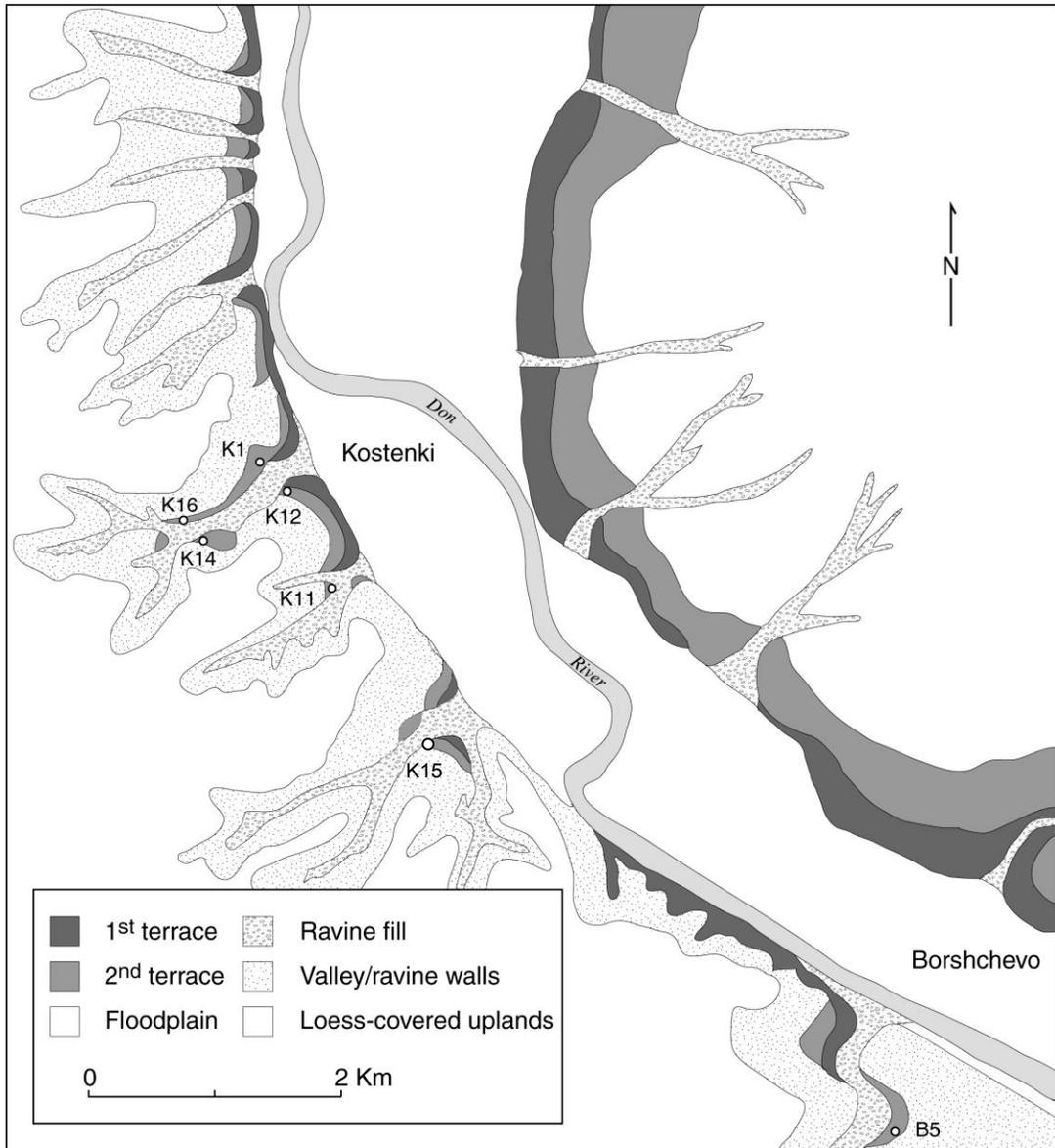


Fig. 1. Map of the Kostenki-Borshchevo area showing location of sites mentioned in the text, as well as the topography of the ravine systems on the banks of the Don River (modified from Lazukov 1982: plate I).



Fig. 2. Depositional context of EUP large mammal remains: Lower Humic Bed surface exposed in Cultural Layer III at Kostenki 12 (K 12-III), showing horse and reindeer bone fragments *in situ* (photo by JFH August 2002).

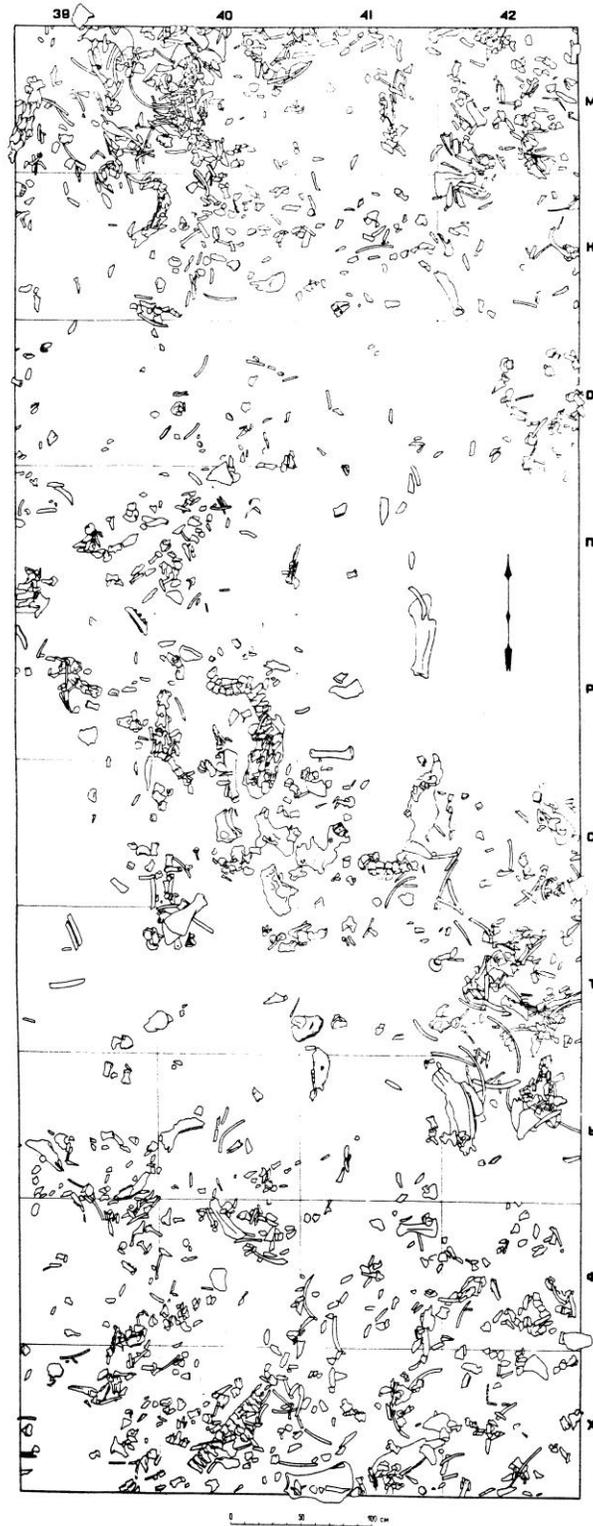


Fig. 3. Kostenki 14, Layer II: Excavation III (1954) containing horse bones and associated artifacts (from Sinitsyn 1996: 303, fig. 7).



Fig. 4a. K 14-II horse bone (tibia) with cut marks (photo by JFH March 2008).



Fig. 4b. K 14-II horse bones (humeri) exhibiting green breakage and cut marks (photo by JFH March 2008).

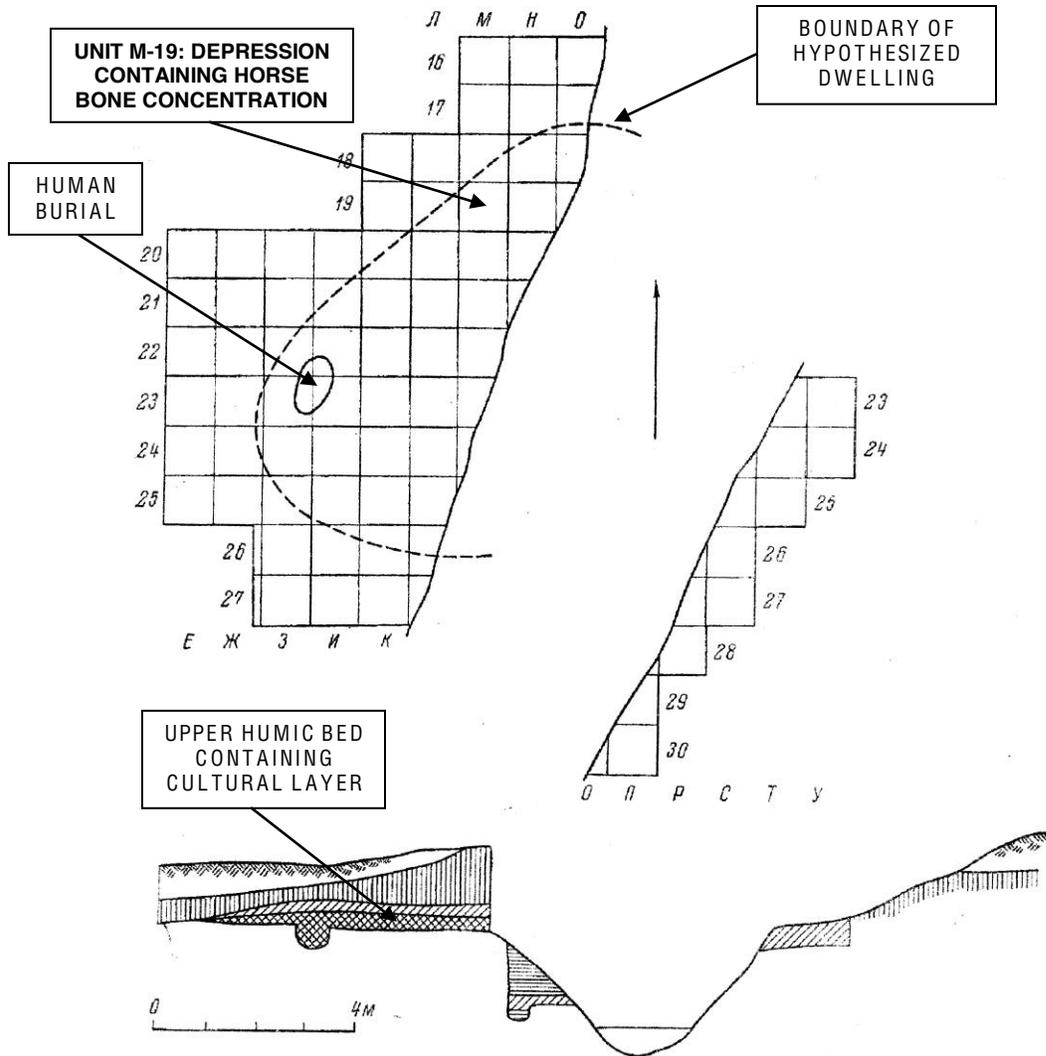


Fig. 5. Kostenki 15: Plan of excavated units (upper) and generalized stratigraphic profile (lower) (adapted from Rogachev 1957: 107, fig. 55).



Fig. 6a. K 15 horse bone (humerus) with cut mark (photo by JFH March 2008).



Fig. 6b. K 15 horse bone (femur) exhibiting percussion mark (photo by JFH March 2008).

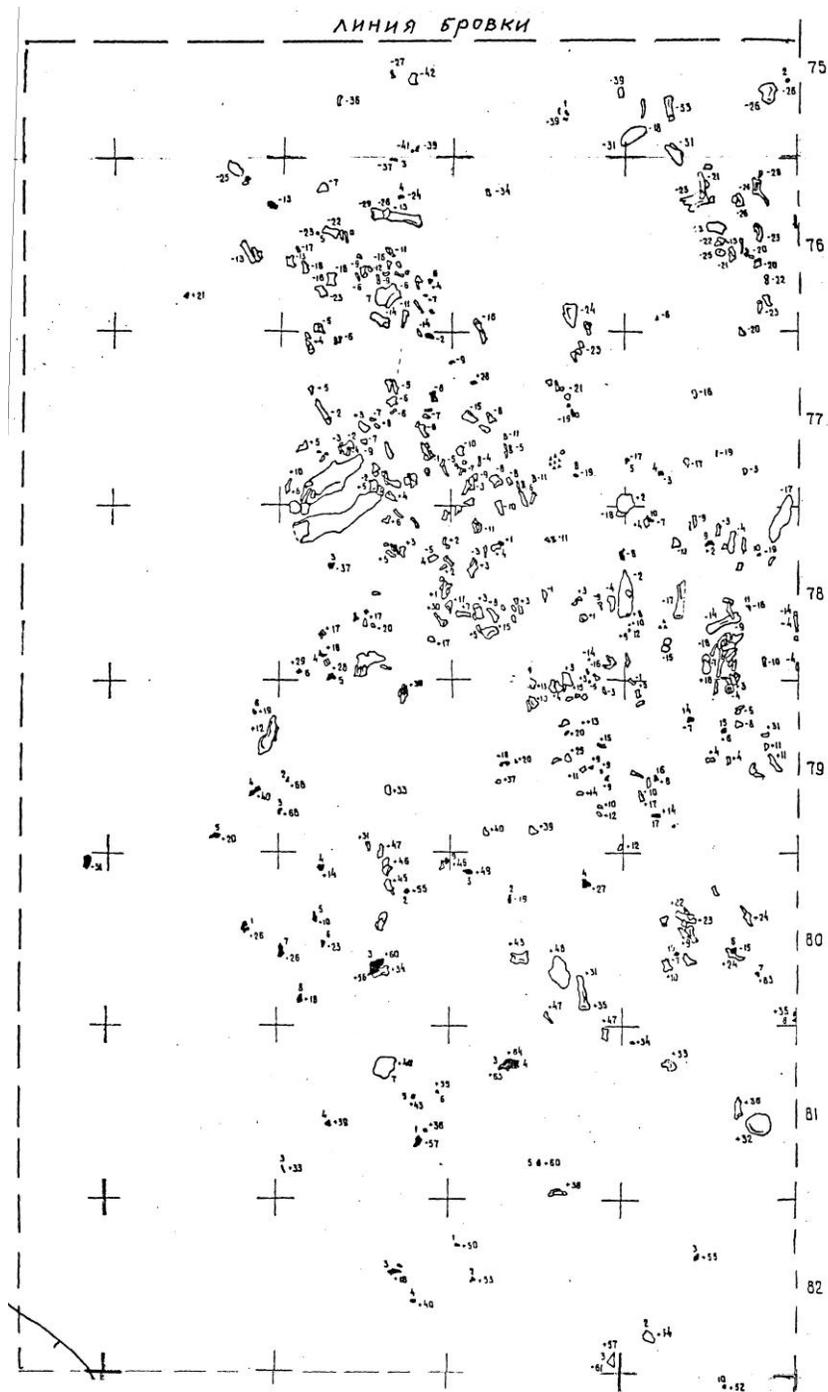


Fig. 7. Kostenki 12: Layer III floor plan for units III through bI between lines 75 and 82, inclusive, which contained many of the reindeer and horse bones excavated in 2002-2003 (adapted from Anikovich 2003: fig. 47).



Fig. 8. K 12-III reindeer bones showing weathering and breakage (photo by JFH August 2002).

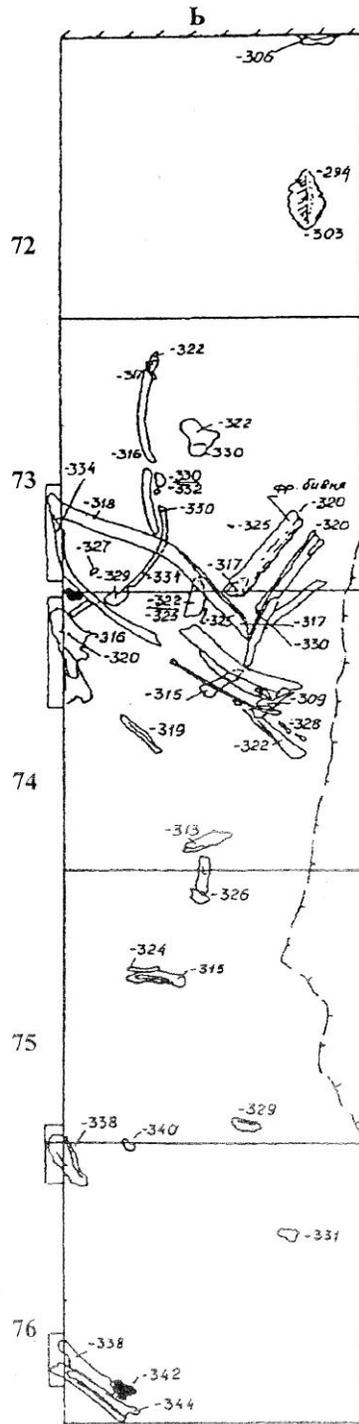


Fig. 9. K 1 2004 trench: Layer V showing distribution of mammoth bones (primarily ribs) (from Anikovich et al. 2006: 96, fig. 8).



Fig. 10. Mammoth ulna from K 1-V exhibiting cut marks (photo by JFH August 2008).



Fig. 11. Topography of Aleksandrovka Ravine and setting of K 15. Arrows illustrate hypothesized route of horses driven up into the ravine from the main valley.

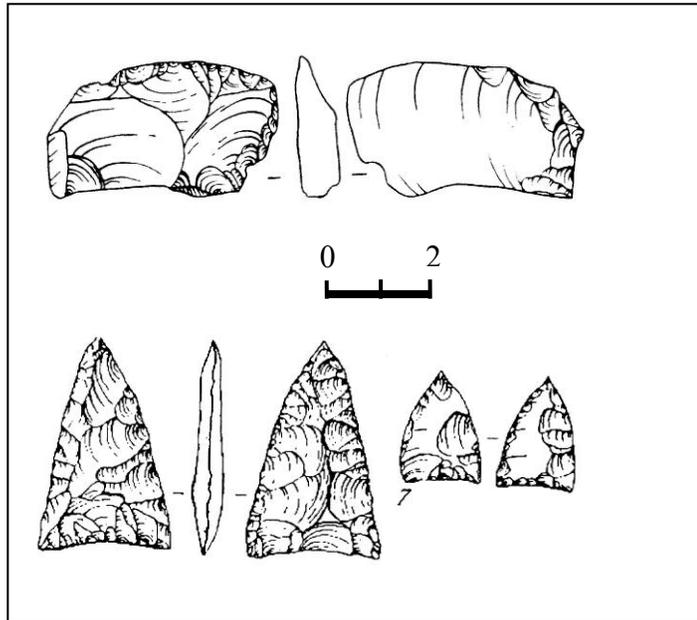


Fig. 12. Artifacts from K 1-V, including side-scraper (upper) and small bifacial points (lower) (from Anikovich et al. 2007a: p. 241, Fig. 118).