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

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Abstract

At least 10 early Upper Paleolithic (EUP) open-air sites are found in the Kostenki-Borshchevo area 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-butchery 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-butchery events, and the partial skeleton of a sub-adult mammoth excavated during 2004-2007 in EUP Layer V at Kostenki 1 yields traces of tool damage. The taphonomy of these large-mammal assemblages—combined with the analysis of artifacts and features—suggest that both habitation areas and kill-butchery locations are represented in an "EUP landscape" at Kostenki-Borshchevo.

Keywords: zooarchaeology, kill-butchery 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 importantly, 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-Borshchevo area on the Middle Don River. Many decades of excavation at these open-air sites has 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 they have been interpreted to a large degree within a framework derived from the research traditions of the Franco-Cantabrian region, the Kostenki-Borshchevo 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-Borshchevo sites

2.1 Location and Setting

Kostenki and Borshchevo are located on the Middle Don River near the city of Voronezh in the Russian Federation at 51^{o} 40' N and 39^{o} 10' E. The villages lie on the west bank of the river at an elevation of approximately 100 meters above mean sea level. The village of Borshchevo is situated several kilometers southeast of Kostenki. The area is within the modern forest-steppe zone and experiences a continental climate with mean July and January temperatures of 19^{o}C and -8^{o}C, respectively, and an average rainfall of 520 mm per year.

Twenty-one Upper Paleolithic sites have been investigated at Kostenki and at least five more sites have been discovered at Borshchevo. 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 that are incised into the high 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-Borshchevo 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-Borshchevo 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 and tusks 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, Borshchevo 1, and other sites (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 20 EUP occupation layers are known from at least 10 sites.

2.3 Geology of Kostenki-Borshchevo

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 base of the second terrace (15-20 m above the Don River floodplain) is composed of coarse sand with gravels and cobbles that fine upward into medium and fine sand with chalk gravel (Velichko 1961: 201-202; Lazukov 1982: 21). Above these deposits lies a sequence of alternating thin 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.

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-Borshchevo are buried in the humic beds or their stratigraphic equivalent on the second terrace level (see Fig. 2). 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 Y5, which is dated to c. 39,000 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. 30,000-38,000 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-Borshchevo

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, 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 stored collections.

3.1 Kostenki 15 (K 15)

The site 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 square meters was exposed in 1952 and it appears that little of the site now remains (Fig.3).

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) yield calibrated estimates of 26,083±852 cal BP and 30,768±406 cal BP (quickcal2007 ver 1.5), 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. 3).

A total of 1,501 bones and teeth excavated in 1952 were assigned to broad-toed horse (*Equus latipes*) representing an estimated 11 minimum number of individuals or MNI (Vereshchagin and Kuz'mina 1977: 107). Horse comprised roughly 95% of the identified number of specimens (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 were not heavily weathered for an open-air site. Most of those examined in 2008 were "very pale brown" according to *Munsell Soil Color Charts* (e.g., 10YR 8/3). Many bone surfaces exhibited staining (chiefly manganese). Among a sample of 133 bones assigned to defined weathering stages (following Behrensmeyer 1978; Johnson 1985: 87-188), most fell into *Stage 1/2* (53%) or *Stage 2* (35%). According to Rogachev and Sinitsyn (1982a: 163), the bones recovered from the concentration in the northern part of the occupation area were significantly less weathered than others. In sharp contrast to bones from other Kostenki sites (see below), there are virtually no traces of *root etching* on the horse bones from K 15.

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. 4). Especially noteworthy were several distal humeri that exhibit a percussion blow, deep incision, and sheared-off bone (see Table 1).

In terms of breakage, the K 15 horse bones reflect a preponderance of green or fresh fractures. A sample of skeletal parts that are readily classified in terms of fresh versus dry breakage (humeri, radii, femora, tibiae, and metapodials) was examined at ZIN in 2008. Among this sample (n = 85), 47 specimens (55%) exhibited classic green fractures (e.g., sawtooth, V-shaped, Type II spiral) (Morlan 1980; Shipman 1981; Johnson 1985). 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 2. 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—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 skeletal 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 several unfused specimens, indicating the presence of at least four juvenile horses (based on the calcanea). Heavy wear on some of the permanent cheek teeth indicated the presence of at least one old individual. Size variations among fused specimens in several part categories suggest that both males and females are represented (see Kuz'mina 1980).

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 this site is constrained by the age of the excavations and reduced sample of materials currently available for study. Both the published descriptions of these bones and examination of collections at ZIN nevertheless indicate a pattern consistent with the expectations of an assemblage produced by butchery of horses at or near the kill location. This pattern includes: (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); and (e) traces of tool damage in the form of both percussion and cut marks (and association with both the shallow depression feature and artifacts).

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 hacked off the carcass and not subjected to further processing; 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 or after 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 several carcasses. The population data are broadly consistent with a living group (e.g., mare band), although many of the horse bones from other parts of the occupation area could represent material brought to the site at other times—unrelated to the bone mass in the depression.

The horse bones at K 15 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 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 15, 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 14, Layer II (K 14-II)

Kostenki 14 (aka *Markina gora*) is located in the upper reaches of Pokrovskii Ravine on the south side of the main ravine and adjacent to a smaller tributary ravine. The site was discovered by P.P. Efimenko in 1928, who identified the uppermost (middle Upper Paleolithic) layer but did not publish his results (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, which is the most important EUP level at the site (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 39,000 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*) (Vereshchagin and Kuz'mina

1977). Layer II also yielded more than 800 remains of hare (*Lepus* sp.), and some bones of red deer (*Cervus elaphus*), woolly rhinoceros (*Coelodonta antitquitatis*), reindeer (*Rangifer tarandus*), mammoth (*Mammuthus primigenius*), and others. As at Kostenki 15, horse represents more than 95% of the large mammal remains in this level, and Rogachev (1957: 78-80) reported almost complete fragmentation of bones, the presence of bones in anatomical order, and numerous cut marks.

A total of 40 square meters of K 14-II were exposed in Excavation III in 1954 (Fig. 5). 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 1,600 bones and teeth of horse recovered from K 14-II in 1954 were examined at ZIN in March 2008 by the senior author. Also briefly examined were several hundred fragments—mostly if not exclusively horse—exhibiting various forms of tool damage or utilization that are stored at the Institute of the History of Material Culture (IIMK), Russian Academy of Sciences in St. Petersburg. These included rib fragments with cut marks and metapodial shaft fragments used for flaking stone (described by Rogachev [1957: 78-80]).

The bones from Layer II are remarkably well preserved for a late Pleistocene open-air site. Many of the bones examined in 2008 were "very pale brown" or "light yellowish brown" (10YR 7/4 – 10YR 6/4); some exhibited a light reddish brown color (5YR 6/3), which may be related to the presence of red mineral pigment (Rogachev 1957: 78). The majority could be classified as weathering *Stage 1* or less with minor corrosion (i.e., chemical weathering) and occasional cracking (see Behrensmeyer 1978: 151). Most of the bones apparently were not exposed to a protracted period of subaerial weathering prior to burial.

Many bones exhibited traces of *root etching* (Morlan 1980: 56-57; Binford 1981: 49-50; Johnson 2006: 60), which is characterized by "dendritic patterns of shallow grooves" caused by release of humic acids from roots or fungi associated with plant decomposition (Behrensmeyer 1978: 154). Root etching was typically—although not always—on one side of the bone; the traces of etching were not deep and sometimes required a hand lens for confirmation.

No clear traces of gnawing or chewing—tooth furrows, pitting, gouging, scoring, or other typical forms of carnivore damage—were observed on the horse bones examined at ZIN in 2008. On the other hand, tool damage in the form of cut and percussion marks were observed on many specimens. Rogachev (1957: 78) noted the large number of "ribs, vertebrae, and other bones of horse with incisions, reflecting, apparently, processes of dismembering animal carcasses." 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 represent traces of dismemberment (Binford 1981: 107-142) (Fig. 6a). Cut marks also were observed on distal rib fragments stored at IIMK (also probably related to dismemberment). 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).

With respect to fragmentation, Rogachev (1957: 80) commented that—with the exception of a single metapodial—not one large bone was intact. As in the case of Kostenki 15, bones that are particularly indicative of fresh versus dry breakage were examined (including humeri, radii, tibiae, and metapodials) at ZIN. The majority exhibited shaft fractures typical of fresh or green breakage—most commonly sawtooth, V-shaped, and Type II spiral fractures (Fig. 6b). Green breakage also was observed on large fragments of the pelvis. It is apparent that a substantial proportion of the horse bone assemblage was broken while fresh.

The distribution of skeletal parts is presented in Table 2. The NISP values for each part are based on counts performed at ZIN in 2008. It should be noted that—as in the case of K 15—few cranial parts were observed at ZIN, but Rogachev (1957: 78) describes a large quantity of skull fragments in the center of Excavation III. Also not reflected in the NISP counts presented in Table 2 are a large number of rib fragments and metapodial shaft fragments curated at IIMK (and mentioned above). As at K 15, virtually all skeletal parts are represented, but part frequencies in K 14-II probably are influenced by better preservation of bone. For example, in contrast to K 15 (as well as Kostenki 12, Layer III), the 3rd phalanx is almost as well represented as the other two phalanges despite significant differences in bone density (see Lyman 1994: 235-258).

From a total of 2,083 bones and teeth assigned to horse, Vereshchagin and Kuz'mina (1977: 107) estimated a minimum of 19 individuals. For many of the skeletal-part categories examined at ZIN in 2008, the estimated MNI is roughly 12 individuals (which accounts for significant size and/or age variations among specimens in each part category). Examples of unfused or not fully fused epiphyses were observed among many skeletal parts. A sample of distal radii yielded 8 unfused (4 right and 4 left) specimens, indicating a minimum of four juveniles or sub-adults represented by this part. As in the case of the K 15 horse bones, the presence of some significant size differences among fused specimens suggests that both males and females are represented (Kuz'mina 1980: 99-109).

Discussion: Excellent bone preservation reduces the ambiguities in the interpretation of the large concentration of horse remains in K 14-II. A low degree of weathering has limited the effects of differential preservation on the representation of skeletal parts. The number and distribution of tool cut marks on bone surfaces are more visible, while the scarcity of gnaw marks is less easily accounted for by weathering.

Although the general pattern observed in K 14-II is similar to that described for K 15, the evidence is stronger for butchery of a number of horses—both adults and young—at or near the site. It may be summarized as follows: (a) large concentration of bones and teeth representing a dozen or more 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) evidence of carnivore damage is almost entirely absent; and (d) high proportion of bones fractured when fresh and a high number of percussion and cut marks (cut marks frequently observed in anatomically significant locations), apparently reflecting multiple phases of a butchering process.

As in the case of K 15, the pattern suggests a catastrophic death—perhaps of a mare band comprising several adults 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). 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.

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 square meters 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 square meters in units Ш through Ы between lines 74 and 82 within a larger block of units excavated in 2001-2003 (see Fig. 7). The bones were recovered from these units 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 (Rogachev and Anikovich 1982: 138-139; Holliday et al. 2007: 198-200)

(Fig. 8a). 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^{o} (Hoffecker et al. 2005: 162; Holliday et al. 2007: 190-191, table I).

Analysis of sediment overlying the unit that contains the bones yielded concentrations of volcanic glass shards that are presumably derived from the Y5 tephra (dated elsewhere to ca. 39 cal ka) (Pyle et al. 2006). Both OSL and calibrated radiocarbon dates on charcoal suggest an age of 41-42 cal ka or greater, and the chronology is supported by the position of the *Laschamp paleomagnetic excursion*, which has been tentatively identified in this unit (Anikovich et al. 2007b: fig. 3; Holliday et al. 2007). The bones are associated with artifacts of Cultural Layer III (see Rogachev and Anikovich 1982: 138-140).

The majority of bones excavated in 2002-2003 identified to taxon are reindeer and horse (81% of NISP). The only other common species is mammoth. The taxonomic representation (identified by IEK) is as follows:

TAXON	**NISP**
Mammuthus primigenius Blum. (woolly mammoth)	59
Equus latipes Grom. (broad-toed horse)	127
Alces alces L. (elk)	2
Rangifer tarandus L. (reindeer)	132
undetermined	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 have been 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) (see Voorhies 1969; Saunders 1977; Johnson 2006: 60). The measurements were taken within a 180^{o}-arc and grouped into intervals of 10^{o} (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^{o} (see Table 3), 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 are more heavily weathered than those from K 15 and K 14-II (especially the latter) (Fig. 8b). 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%), revealing little or no evidence of groundwater staining. Reindeer and horse bones were classified in accordance with the defined weathering stages (described above), after being subdivided by taxon and body part (see Gifford 1981; Lyman 1994: 361). Most fell into *Stage 2* (i.e., some cracking and flaking of the surface [Behrensmeyer 1978: 151]) or into intermediate stages between *Stage 2* and either *Stage 1* or *Stage 3* (see Table 4). The range of stages recorded within each taxon/body-part category is consistent with a "wave model" of weathering for remains deposited at the same point in time (Lyman and Fox

1989: 300-302). The bones are likely to have been exposed to at least two or three years of subaerial weathering prior to burial (Behrensmeyer 1978: 157; Lyman 1994: 364-365).

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):

TAXON	PRESENT	ABSENT	TOTAL
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. Grayson (1988: 29-31) attributed significant contrasts in root etching among bones from different levels in Danger Cave (Utah, USA) to environmental differences, but 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 (Ъ-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 1 mammoth bone (vertebra) and 10 shaft fragments that could not be identified to taxon. Possible examples of damage from stone tools were recorded on 7 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. Although specific types of breakage have been defined (e.g., "perpendicular smooth" [Shipman 1981: 105]), their identification is somewhat subjective (Lyman 1994: 320), and a simple subdivision according to green (or fresh) versus dry breakage is equally useful (e.g., Saunders 1977: 105-108; Morlan 1980: 48-49). A sample of reindeer and horse bones (n = 102) yielded the following distribution:

TAXON	UNBROKEN BONE	FRESH BREAKAGE	DRY BREAKAGE	UNDETERMINED
horse	3	20	10	6
reindeer	1	29	29	4
Total	4	49	39	10

The results indicate that substantial breakage occurred both when the bones were fresh and dry. Some specimens exhibited a combination of green and dry breakage, apparently reflecting a complex history.

In order to assess the representation of skeletal parts for reindeer and horse, NISP counts were converted to estimates of the minimum number of elements (MNE) for each skeletal part (e.g., distal femur). The MNE estimates were divided by the number of times that each element occurs in the skeleton (Minimal Animal Unit [MAU]) and each

MAU was calculated as a percentage of the maximum number represented for each taxon (%MAU) (see Binford 1978; 1984). Skeletal-part distributions for reindeer and horse are presented in Table 5. Most of the mammoth parts represent tooth and long-bone shaft fragments (more easily identified for mammoth than other large mammals); the remaining specimens include lower limb bones (n = 10), foot bones (n = 3), and rib fragments (n = 2).

Analyses were undertaken to assess the role of weathering versus human behavior in the distribution of skeletal parts, because the assemblage characteristics described above indicate that both factors affected the bones to some degree. Weathering could account for the abundance of various high-density bones (e.g., astragalus, metacarpal) and its effects could have been compounded by the high level of fragmentation (described above), which accelerates the process by exposing more surface area (Lyman and O'Brien 1987). Skeletal element abundance (%MAU) for reindeer (sample size for horse was too small) was measured against a bone-density index for artiodactyls (Lyman 1985: 227, table 2). The correlation was not significant ($R^2 = 0.19$), and indicates that density-mediated attrition does not account well for the distribution of reindeer body parts (Fig. 9a).

Skeletal part abundance for reindeer also was measured against an index of food value or utility (FUI) for *Rangifer* (Metcalfe and Jones 1989: 492, table 2), which provides a means of assessing the potential impact of selective treatment of body parts by humans (e.g., Speth 1983; Grayson 1988; Klein 1989). At kill-butchery sites, parts with high food value may be removed, while the reverse pattern is expected at habitation sites (e.g., Binford 1978). Despite the scarcity of some high-value parts such as femora, proximal tibiae, ribs, and scapulae—and relative abundance of some low-value parts such as calcanea, astragali, distal radii, and second phalanges—the results were not significant ($R^2 = 0.004$). Because the FUI does not reflect the wide range of variation among individuals, the data also were converted to ordinal scale for rank-order correlation (Lyman 1994: 231), but yielded comparable results ($r_s = 0.077$) (Fig. 9b).

The lack of significant correlations between the distribution of body parts and both bone-density and food-utility indices might be due to the effects of fluvial sorting by water flowing on the 5^o 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 (IEK) collected some population 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 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 15 and K 14-II: (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 (e.g., narrow canyon subject to periodic flash flooding) or possess the characteristics of a carnivore accumulation.

On the other hand, the distribution of body parts does not match the expectations of either a kill-butchery location or habitation site and direct evidence of butchering (e.g., tool cut marks) is limited. If the bones at K 12-III represent two or more kill-butchery events that have been affected by slope action and weathering, the distribution of body parts should be a subset of the K 15 and K 14-II assemblages—the differences accounted for by sorting and weathering. A comparison of represented appendicular skeletal parts for horse among the three sites is shown in Fig. 10. With the axial parts removed, the differences between K 12-III and the other two assemblages may be due largely to sampling (i.e., relatively small sample size for K 12-III).

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 (opposite K 12 and roughly 1 km downstream from K 14). Although situated on the second terrace, it is actually several meters lower than other sites on this terrace (Holliday et al. 2007). As noted above, K 1 was subject to major excavations in the 1920s and 1930s that were 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 Ь between lines 71 and 76, inclusive) exposing new areas of Layer V (Anikovich et al. 2006). The most surprising finds were 576 bones and teeth of mammoth—from a layer that had previously yielded only isolated faunal remains (Vereshchagin and Kuz'mina 1977: 100). 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. 11). 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). As at K 12, the Y5 tephra was identified on the basis of concentrations of volcanic glass shards in sediment overlying the b3 soil. However, subsequent research yielded traces of magnetic sediment in units below this soil, raising the possibility that Layer V might postdate the tephra (Anikovich et al. 2006; Hoffecker et al. 2008). The soil exhibits a slope of approximately 5^{o} 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 pelves. 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*, and were 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 Б-72) and a left humerus (unit Ь-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. As in the case of carnivore damage, a few highly probable examples were observed. The most likely are two linear cut marks and a possible hack mark recorded on an ulna shaft fragment from unit Б-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. 12b); 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. Another example of tool damage may be present on a carpal bone (lunar) from unit Ь-73 (2004 excavation), which exhibits two possible gouge marks on the margin of the articular surface (see Fig. 12a). Similar marks have been observed on mammoth ulnae and lunars from archaeological sites in North America (Saunders and Daeschler 1994: 15-17; Saunders 2007: 165-167; Johnson 2007: 67-72), and apparently reflect the use of pry bars or levers to separate joints and heavy elements during dismemberment (the use of levers has been reported in ethnographic accounts of elephant butchery [Fisher 1992: 68]).

The mammoth remains in K1-V represent only a subset of the skeleton (roughly 25%) (Table 6). 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 6). 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 Э-72 (2005 excavation), the second author (IEK) 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-Borshchevo 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.

3.5 Other possible EUP kill-butchery events at Kostenki-Borshchevo

Several other EUP occupation layers in the Kostenki-Borshchevo sites contain large-mammal remains that represent possible kill-butchery events, but have not been investigated in the context of this problem.

One of these is K 12-I, which is deposited in the upper UHB (above K 12-III and roughly contemporaneous to K 14-II) and yielded the largest assemblage of horse remains (NISP = 3,262) found to date in any occupation layer at Kostenki-Borshchevo (Vereshchagin and Kuz'mina 1977: 106; Rogachev and Anikovich 1982: 134-137). Although a skeletal-part inventory is not available, Rogachev (1957: 63) notes the presence of various axial and appendicular elements; many intact bones and large fragments are reported. Much of the K 12-I occupation debris is thought to have been redeposited by slope processes (Rogachev and Anikovich 1982: 135).

Recent excavations at Borshchevo 5 have revealed another possible example in Layer III, which is deposited immediately below the Y5 tephra. B 5-III has yielded a concentration of weathered horse bones, along with other taxa, associated with a small number of artifacts (Lisitsyn 2006).

4. EUP Large-Mammal Procurement at Kostenki-Borshchevo

4.1 Large-mammal procurement during the later EUP (38,000-30,000 cal BP)

EUP occupation layers that lie between the 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-Borshchevo (Averianov 1998), suggest that climates were very mild during at least some of the interstadials.

The concentrations of horse bone at K 15 and K 14-II 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 15 and K 14-II 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 Sâone Valley during seasonal migrations (Levine 1983: 40; Olsen 1989: 323-324). At Kostenki-Borshchevo, groups of horses could have been driven up into the ravine systems from the main valley of the Don River (see Fig. 13), or alternatively, driven down off the steep slope of the eastern margin of the Central Russian Upland. In either case, some form of coral 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 15 and K 14-II 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 ésquillées*. 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 15 and K 14-II artifacts also may be interpreted in functional terms—as assemblages associated with both a kill-butchery 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 artifacts are found in large mammal kill-butchery 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 artifacts* often produced at the kill from local raw materials for processing carcasses (Fig. 14b). The one category of artifacts listed above that is not clearly represented at K 15 and K 14-II 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; see Fig. 14a).

The artifact assemblages associated with evidence for EUP kill-butchery events at Solutré exhibit differences and similarities to the K 15 and K 14-II 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 or heavy tools are reported (Combier 1955: 190-19115; Montet-White 2002: 227-229).

The combined evidence of the artifact assemblages and the taphonomy of the horse bone concentrations suggest that both kill-butchery and habitation areas are represented at K 15 and K 14-II. It seems highly unlikely, however, that a habitation and kill-butchery 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-butchery and habitation areas were occupied at different times, presumably the kill-butchery 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-Borshchevo 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-butchery locations in North America (e.g., Wheat 1978; Jodry and Stanford 1992; Holliday 1997), and this pattern would seem to be present in the later EUP on the central East European Plain.

4.2 Large-mammal procurement during the earlier EUP (45,000-39,000 cal BP)

Occupation layers that underlie the Y5 tephra at the Kostenki-Borshchevo 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-butchery 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 15 and K 14-II, but have been disturbed by post-depositional processes.

The concentration of reindeer bones at K 12-III is unique for Kostenki-Borshchevo, and may indicate greater focus on this taxon on the central East European Plain during an interval that probably was somewhat cooler than the later EUP. 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 (see Haynes 1991: 195-208), and most probably represents a carcass that was butchered by human occupants of the Kostenki-Borshchevo 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-Borshchevo 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. 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 15 and K 14-II, 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-Borshchevo contain traces of both habitation areas and locations where large mammals were killed and/or butchered assigned to the EUP and dating between ca. 45,000 and 30,000 cal BP. This conclusion is based on a combined analysis of artifact assemblages and the taphonomy of large mammal remains in layers at several sites. Although the taphonomy of the small and medium mammals (and non-mammalian vertebrates) lies outside the scope of this paper, it may be noted that the analysis of these data contribute to the pattern. Concentrations of small/medium mammal remains, 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-Borshchevo 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-Borshchevo 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 a rare example is found at the open-air site of Solutré in central France. Both the taphonomy of the large mammals and associated artifacts exhibit some similarities to the EUP landscape at Kostenki-Borshchevo. Much of the variability in artifact assemblages at the latter probably reflects differences in site function that are not represented in the Franco-Cantabrian EUP record.

Acknowledgments

The authors are grateful to G. F. Baryshnikov and M. V. Sablin (Zoological Institute, Russian Academy of Sciences), who provided access to the K 15 and K 14-II collections, and to S. Holen (Denver Museum of Nature and Science), who made the mammoth remains from the Dent site available for study. Figure 1 was prepared by the University of Wisconsin Cartography Lab and revised by I. T. Hoffecker. Supported by NSF grants

BCS-0132553, BCS-0442164, and BCS-0715519; Leakey Foundation 2001, 2004, and 2007 general grants; National Geographic Society scientific research grant 8528-08; and multiple grants from the Russian Foundation for Basic Research. The Leakey Foundation grants were administered by the Illinois State Museum.

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Table 1. 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
З-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 2. Skeletal elements for horse in Kostenki 15 and Kostenki 14, Layer II (based on counts of bones and teeth at ZIN).

SKELETAL ELEMENT	KOSTENKI 15	KOSTENKI 14-II
CRANIUM	X	3
MAXILLA	2	?
MANDIBLE	8	152
ISOLATED TEETH	~145	285
ATLAS	2	--
AXIS	0	--
OTHER VERTEBRAE	56	X
RIBS	63	180
SCAPULA	4	51
HUMERUS		30
PROXIMAL HUMERUS	1	--
DISTAL HUMERUS	13	--
RADIUS		47
PROXIMAL RADIUS	6	--
DISTAL RADIUS	13	--
ULNA	7	14
CARPALS	X	X
METACARPAL		15
PROXIMAL METACARPAL	1	--
DISTAL METACARPAL	0	--
INNOMINATE	10	15
FEMUR		19
PROXIMAL FEMUR	7	--
DISTAL FEMUR	7	--
PATELLA	9	21
TIBIA		34
PROXIMAL TIBIA	13	--
DISTAL TIBIA	20	--
CALCANEUS	14	18
ASTRAGALUS	10	20
TARSALS	X	X
METATARSAL		31
PROXIMAL METATARSAL	4	--
DISTAL METATARSAL	2	--
PHALANGES		
1^{ST} PHALANX	18	39
2^{ND} PHALANX	25	44
3^{RD} PHALANX	2	37

X = present but no quantitative information available

Table 3. Frequencies of long bones and elongate bone fragments in Kostenki 12, Layer III by 10^{o} orientation class.

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

Table 4. 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 5. Representation of skeletal elements for reindeer and horse from Kostenki 12, Layer III (2002-2003 excavations).

	REINDEER			HORSE		
SKELETAL ELEMENT	**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%
PHALANGES						
1ST PHALANX	25	3.125	48%	6	1.5	60%
2ND PHALANX	10	1.25	17%	4	1.0	20%
3RD 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 6. 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	

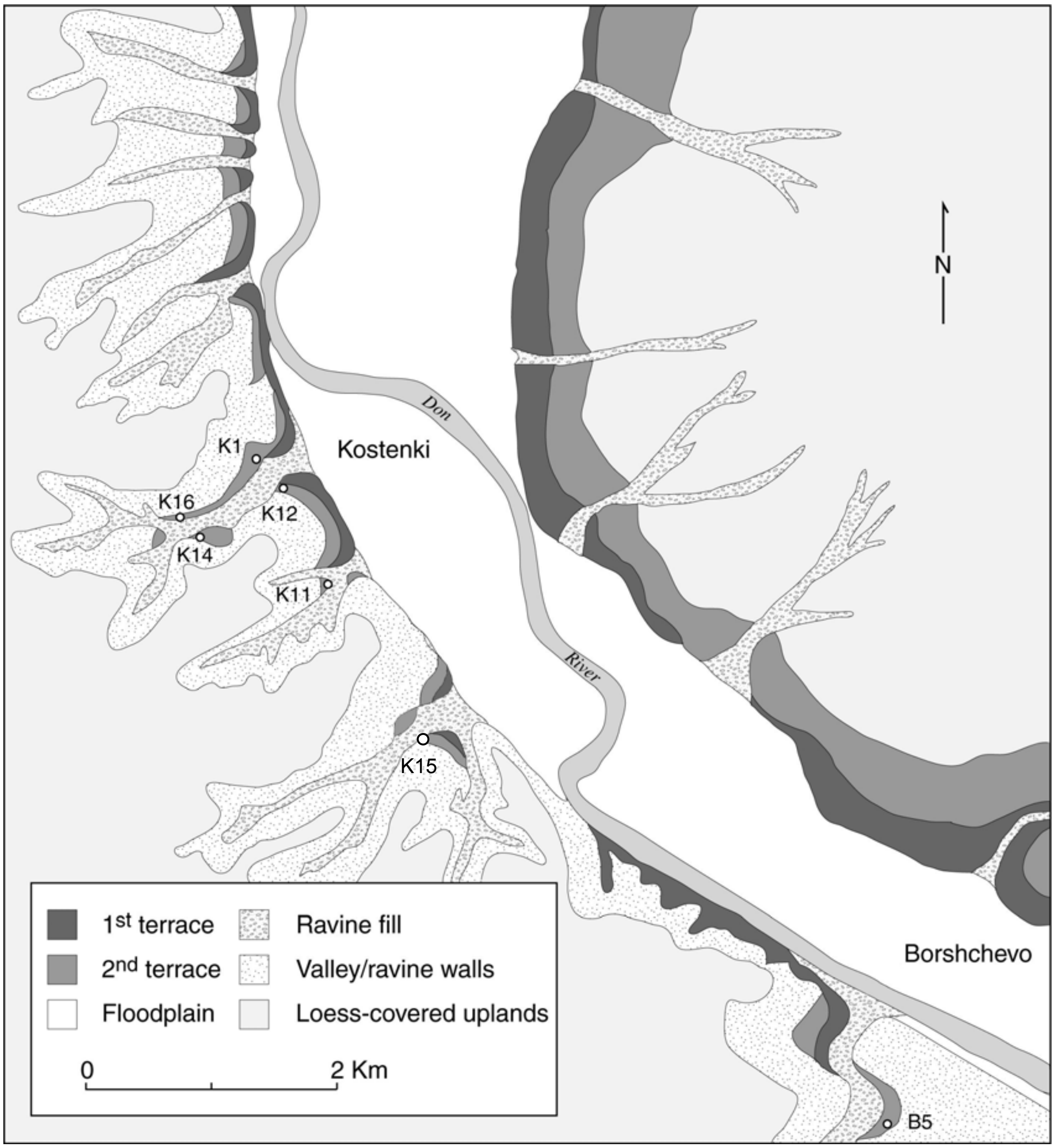

Fig. 1. Map of the Kostenki-Borshchevo area sowing location of sites mentioned in the text, as well as the topography of the ravine systems on the banks of the Don River.

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).

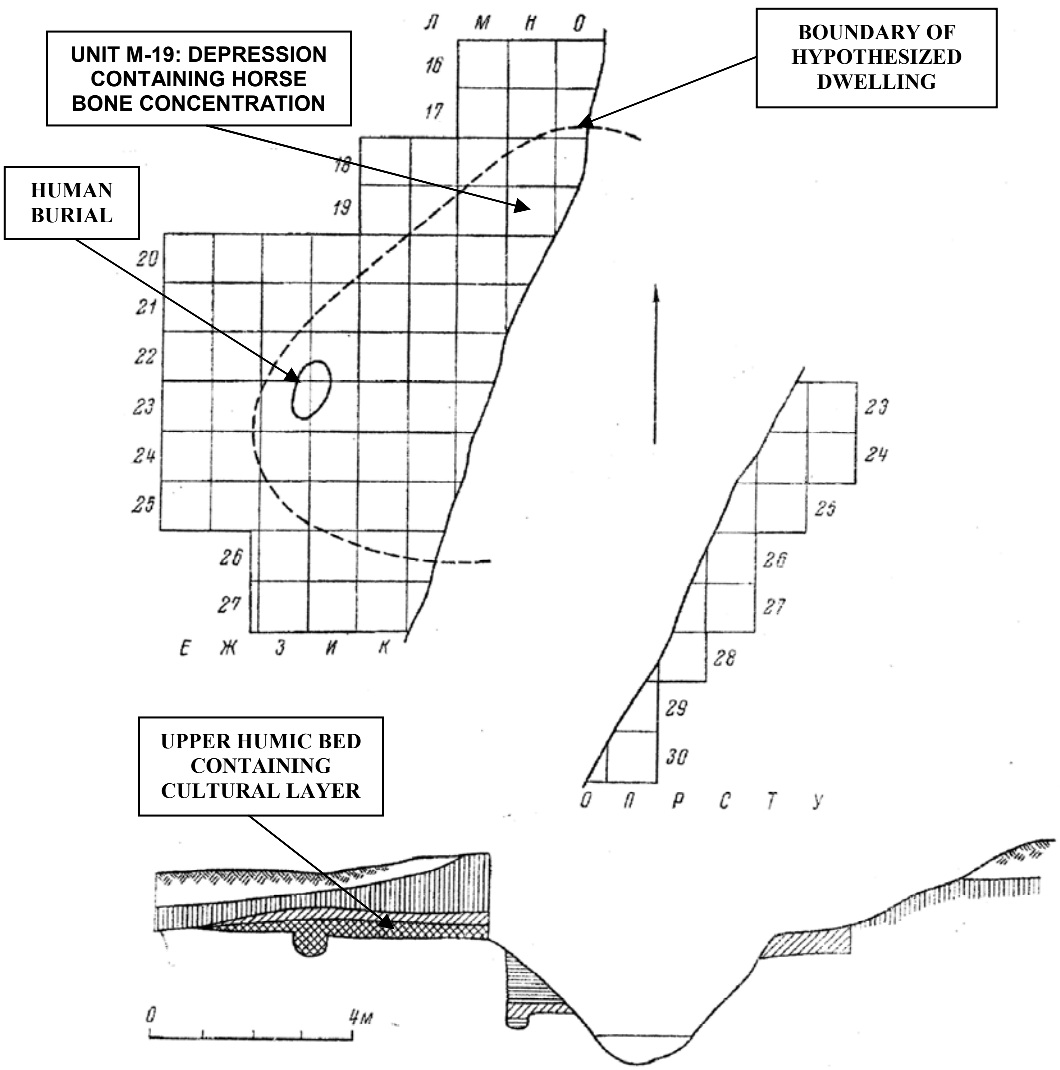

Fig. 3. Kostenki 15: Plan of excavated units (upper) and generalized stratigraphic profile (lower) (adapted from Rogachev 1957: 107, fig. 55).

Fig. 4a. K 15 horse bone (humerus) with cut mark (photo by JFH March 2008).

Fig. 4b. K 15 horse bone (femur) exhibiting percussion mark (photo by JFH March 2008).

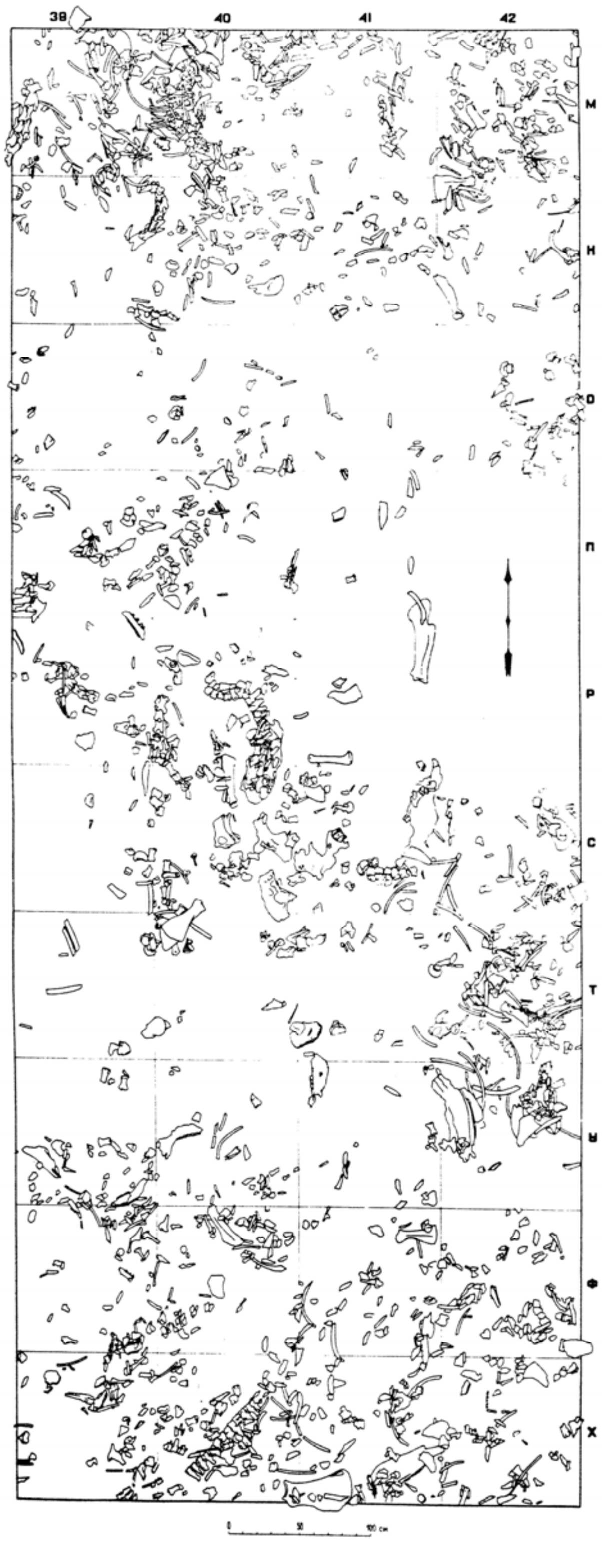

Fig. 5. Kostenki 14, Layer II: Excavation III (1954) containing horse bones and associated artifacts (from Sinitsyn 1996: 303, fig. 7).

Fig. 6a. K 14-II horse bone (tibia) with cut marks (photo by JFH March 2008).

Fig. 6b. K 14-II horse bones (humeri) exhibiting green breakage and cut marks (photo by JFH March 2008).

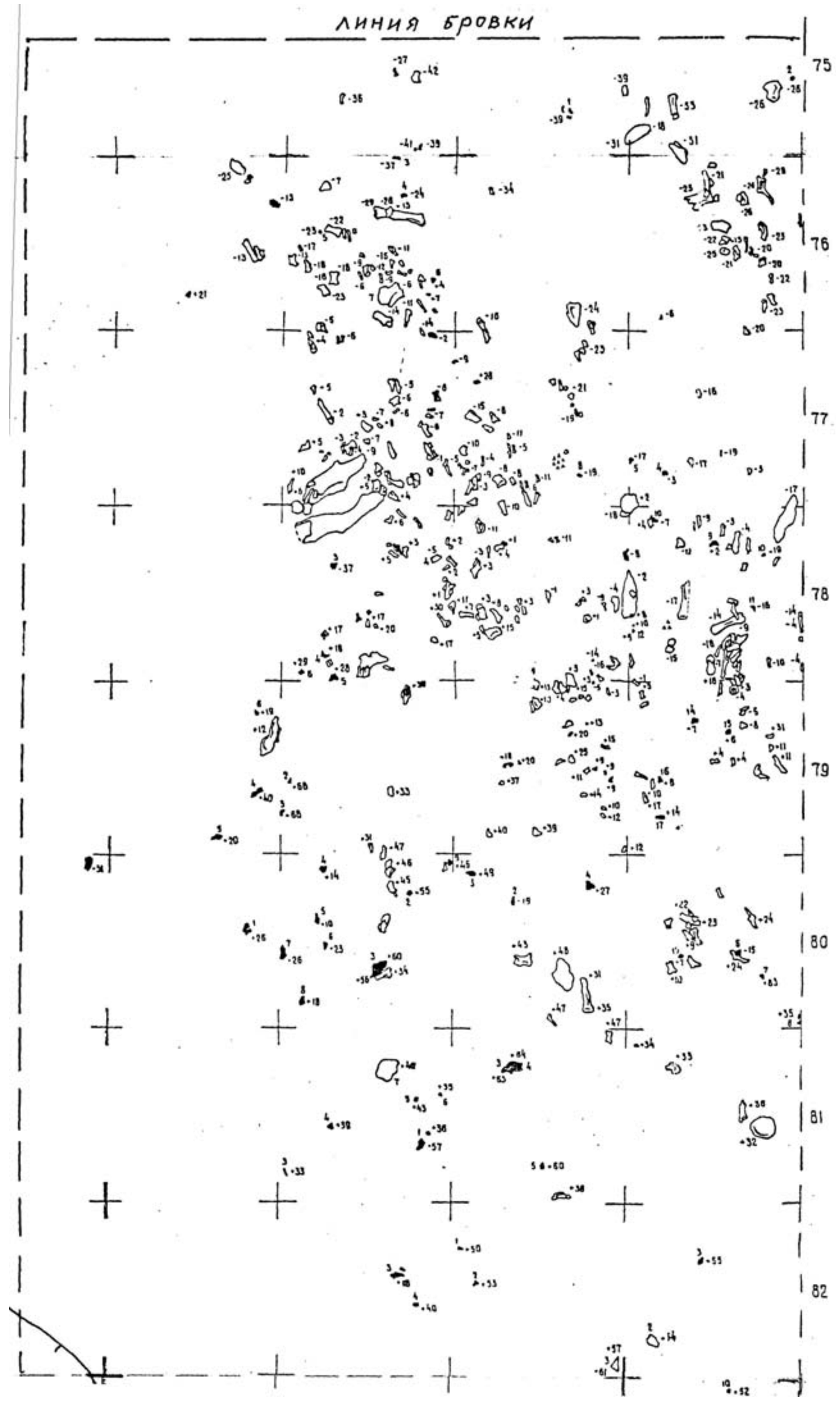

Fig. 7. Kostenki 12: Layer III floor plan for units Ш through Ы between lines 75 and 82, inclusive, which contained many of the reindeer and horse bones excavated in 2002-2003 (adapted from Anikovich 2003: fig. 47).

Fig. 8a. K 12-III horse bones in situ in units Ы-78 and Ы-79 (photo by JFH August 2002).

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

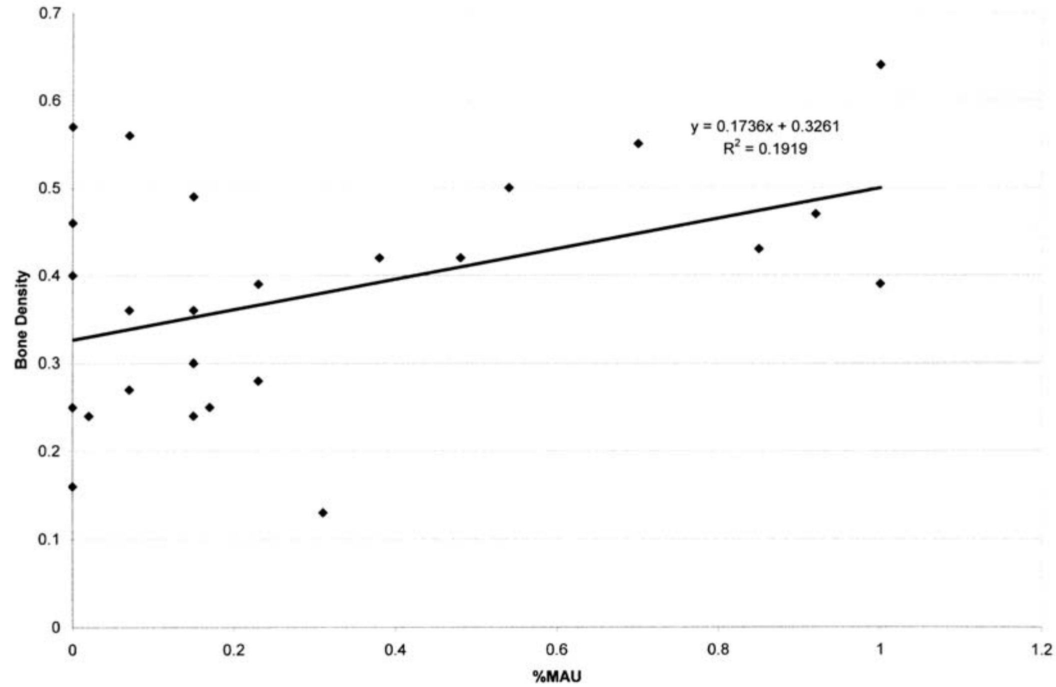

Fig. 9a. Scatter plot of bone density index and %MAU for reindeer bone in K 12-III.

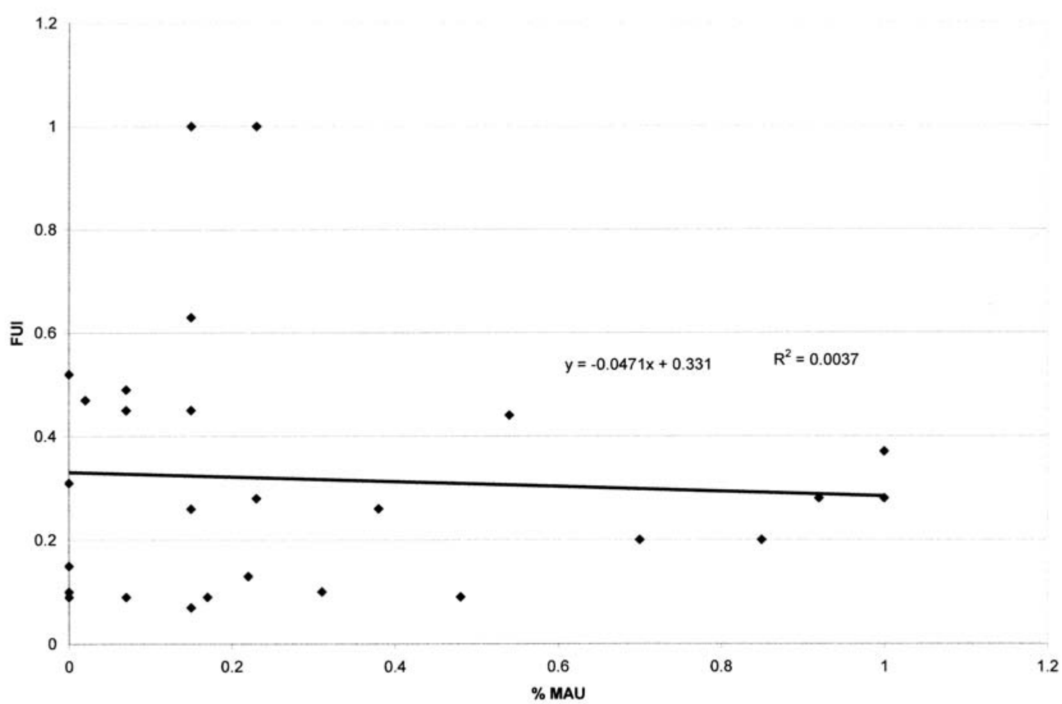

Fig. 9b. Scatter plot for Food Utility Index (FUI) and %MAU reindeer bone from K 12-III.

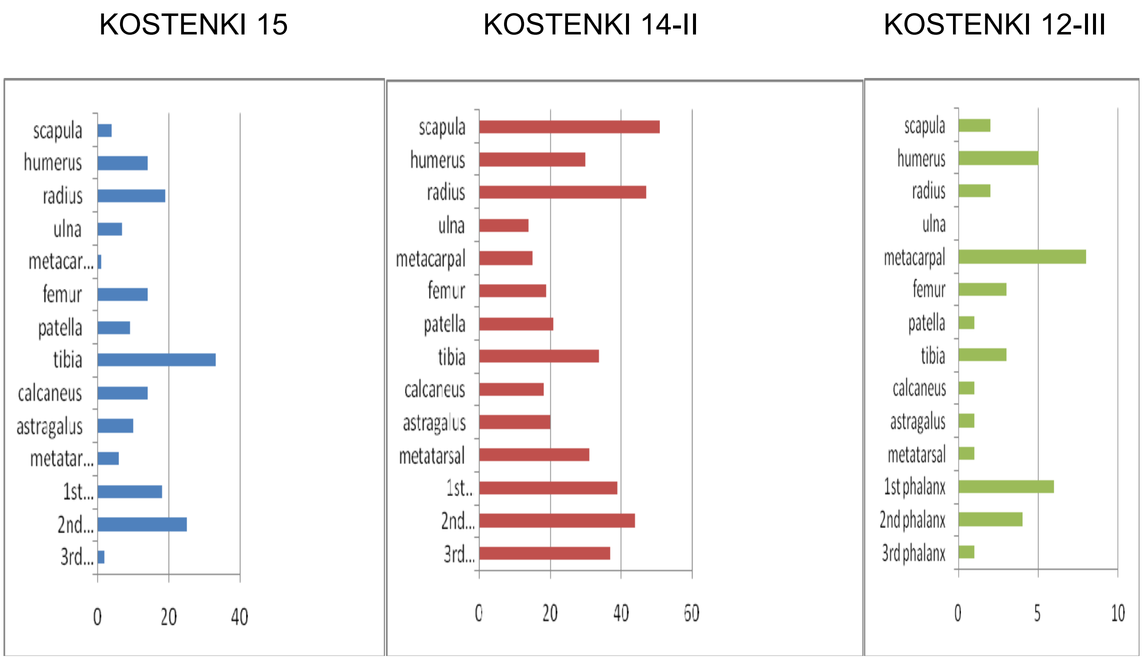

Fig. 10. Comparative representation of appendicular body parts for horse (NISP counts) from K 15, K 14-II, and K 12-III. (Axial parts were excluded because cranial fragments, ribs, and probably vertebrae had been removed from the K 15 and K 14-II collections at ZIN.)

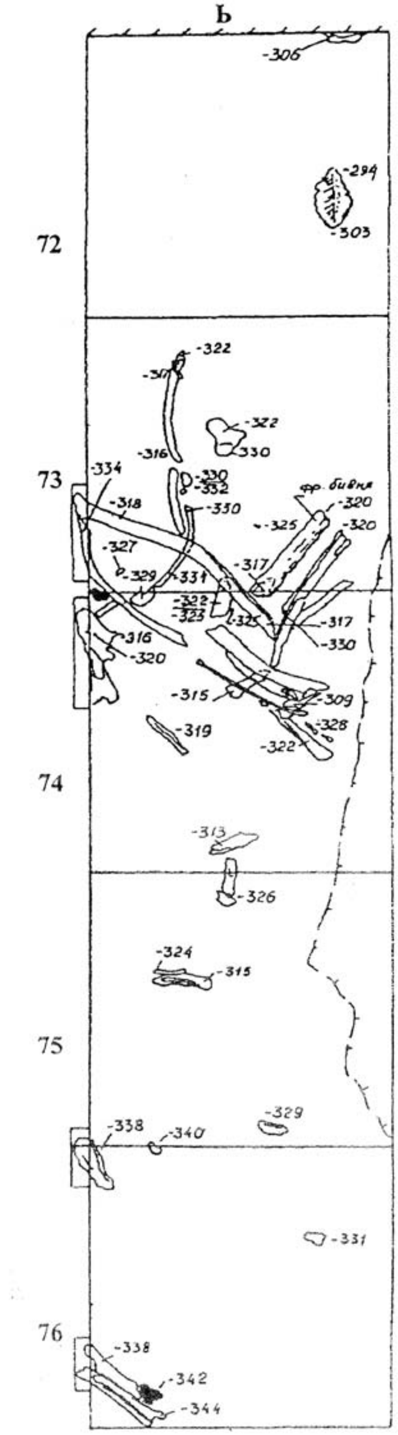

Fig. 11. K 1 2004 trench: Layer V showing distribution of mammoth bones (primarily ribs) (from Anikovich et al. 2006: 96, fig. 8).

Fig. 12a. Mammoth lunar from K 1-V exhibiting possible gouge mark (photo by JFH March 2008).

Fig. 12b. Mammoth ulna from K 1-V exhibiting cut marks (photo by JFH August 2008).

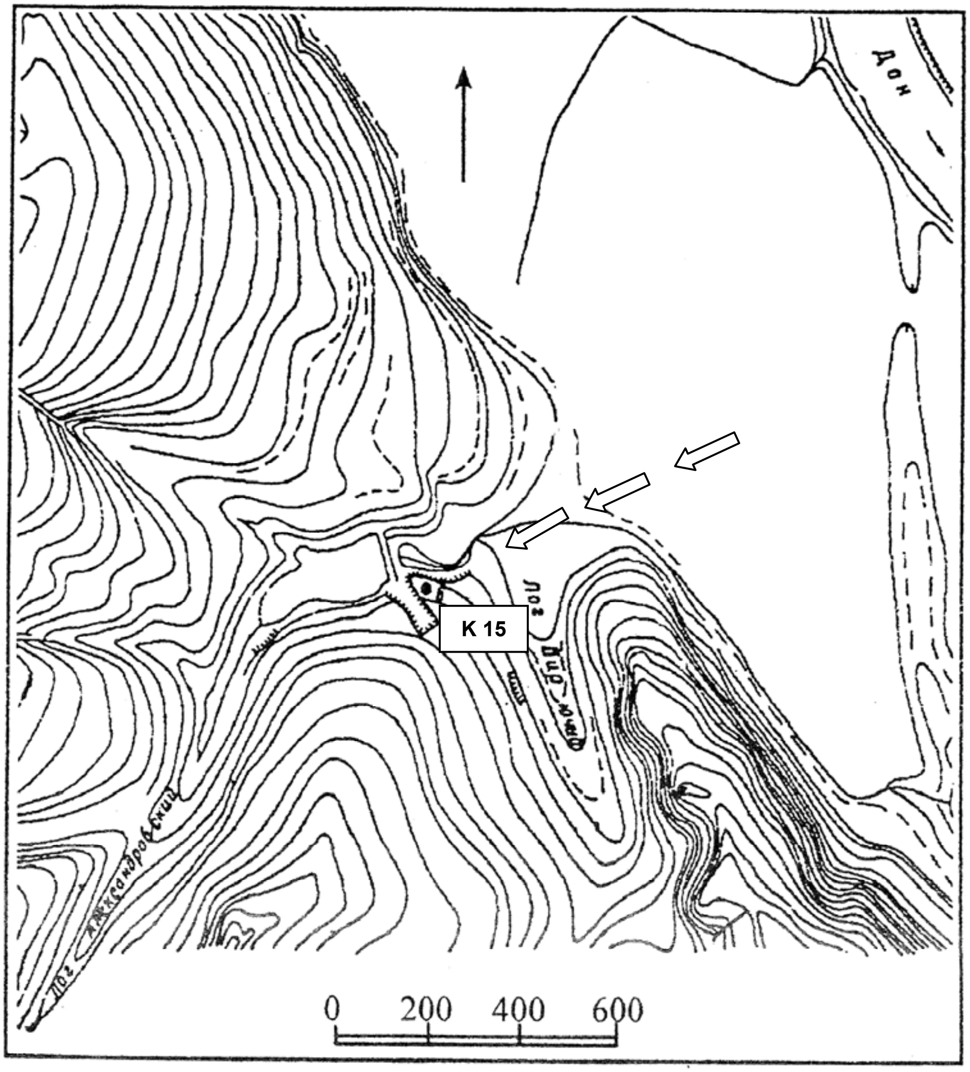

Fig. 13. Topography of Aleksandrovka Ravine and setting of K 15. Arrows illustrate hypothesized route of horses driven up into the ravine from the main valley.

Fig. 14a. Triangular bifacial points from K 14-II (1954 Excavation III).

Fig. 14b. Side-scrapers from K 14-II (1954 Excavation III).