# Landscape Archaeology and the Dispersal of Modern Humans in Eastern Europe

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## ABSTRACT

*Homo sapiens* dispersed into Eastern Europe before 40,000 cal BP and both the genetics of living humans and the archaeological record indicate that they may have arrived in two or more migratory waves. The archaeological record of the arrival and early settlement of modern humans in Eastern Europe (45,000–30,000 cal BP) is dominated by open-air sites on the large lowland plain that extends from the Carpathian to the Ural Mountains. The record exhibits many parallels to the terminal Upper Paleolithic (or Paleoindian) sites of the North American Plains and Southwest. Traces of large-mammal kill-butchery events and carcass-processing areas are common, although they often are associated with a habitation area (which is known but less common in the North American sites). The earliest movement of modern humans in Eastern Europe may be represented by an archaeological proxy in the form of many Levallois blade and point assemblages that appear to date to the same interval as the Bohunician assemblages of Central Europe (~45,000 cal BP). Direct migration from the Near East via the Caucasus Mountains is documented by bladelet assemblages in the Caucasus and on the central plain at roughly the same time the Proto-Aurignacian industry moved into southern Europe (i.e., 43,000–42,000 cal BP). These sites provide evidence of major technological innovations that probably were critical to successful *Homo sapiens* adaptation to the cooler and less productive environments of the East European Plain. After the disruptive impact of the CI volcanic ashfall (~40,000 cal BP), sites containing diagnostic elements of both the early Gravettian and Aurignacian techno-complex are present in Eastern Europe. Many of these sites contain large-mammal carcass-processing areas associated with artifact types commonly found in analogous Paleoindian sites, including bifacial projectile points, flake scrapers, bifaces, and hammer-stones.

Anatomically modern humans (*Homo sapiens*) evolved in sub-Saharan Africa and migrated into Eastern Europe as part of a wider global dispersal. The recent African origin (RAO) and global dispersal of modern humans is based on three lines of evidence (Endicott et al. 2009; Klein 2009; Stringer 2012; Wells 2007): (a) the skeletal remains of *Homo sapiens*, which date to at least 200,000 years ago in sub-Saharan Africa, but date to more recent time periods in North Africa, Eurasia, Australia, and other parts of the world (e.g., Bräuer 1989); (b) the genetics of living humans (e.g., Ingman et al. 2000; Underhill et al. 2000), which exhibit a pattern of decreasing diversity as a function of distance from sub-Saharan Africa (and which may be "ground-truthed" with ancient DNA [aDNA] extracted from human skeletal remains, where preservation conditions permit [e.g., Krause et al. 2010]); and (c) archaeological data (e.g., Hoffecker 2009; Roberts 2009). All three categories of evidence (including some aDNA) are available to address the issue of modern human dispersal in Eastern Europe.

When diagnostic human skeletal remains (or aDNA) are absent, archaeological data may provide a proxy for migrating groups of modern humans during the period of the global dispersal. Thus, for example, the earliest dated archaeological remains in Australia, although not associated with skeletal materials or any sources of aDNA, may be assumed to represent an early movement of *Homo sapiens* into Australia (there is no evidence for pre-modern humans in Australia). The attribution of archaeological remains to a specific form of *Homo* may be problematic in some cases, however, when the artifacts and/or features are not diagnostic of modern humans; there are a number of sites in Eastern Europe that fall into this category (e.g., Byzovaya [Slimak et al. 2011]). Eventually, it may be possible to assign particular groups of artifacts to specific genetic units, such as an mtDNA haplogroup, but this cannot be done at present anywhere in northern Eurasia.

The archaeological evidence also provides insights as to how modern humans were able to rapidly colonize a wide variety of habitats and climate zones. The rapid pace of the global dispersal was achieved to a significant degree through equally rapid technological innovation (Hoffecker 2005: 187–190). Modern humans designed their own adaptive traits by translating information in the brain to novel and often complex technologies (e.g., sewing needles) in manner analogous to the translation of genetic information to phenotypes. Modern human skeletal remains sometimes underscore the critical importance of a capacity for technological innovation; in Europe, they reveal retention of anatomical adaptations to the tropical zone (e.g., high brachial index) many thousands of years after the arrival of modern humans in cold regions (e.g., Hoffecker 2002: 153–158).

The archaeological record of modern human dispersal (which corresponds to the "early Upper Paleolithic" or EUP in Europe) differs significantly in some regions from that of other regions, however, and the differences must be accounted for in the interpretation of the evidence for the global dispersal. In each part of the world, archaeological remains must be placed into a regional landscape context (i.e., "landscape archaeology" perspective [Butzer 1971, 1982; Roberts 1987]). The contrast in archaeological records is pronounced between Eastern Europe and the region in Western Europe (Franco-Cantabria), where most of the interpretive concepts and classificatory units that pertain to the archaeological data were developed in the late 19$^{th}$ and early 20$^{th}$ centuries.

The principal EUP sites in Franco-Cantabria are caves and rock shelters, which bias the archaeological remains in several ways. To begin with, natural shelters represent an enduring and visible point of attraction on the landscape; they are a magnet for human settlement and archaeological survey. Natural shelters often accumulate lengthy sequences of occupation,

buried in sediments that are protected from erosion; the geochemical environment of the sediments usually is favorable to preservation of non-stone materials. Caves and rock shelters are typically used as habitation areas, rather than kill-butchery locations or quarry-workshop sites, and this affects the types or artifacts, features, and associated food debris that are recovered from them.

Most EUP sites in Eastern Europe are open-air localities found on the immense plain that occupies most of Europe east of the Carpathian Mountains. In many respects, the EUP sites of the East European Plain exhibit a pattern more similar to the early prehistoric sites of the North American Plains (and Southwest) than to the natural shelters of the Franco-Cantabrian region. The EUP sites of the East European Plain are comparatively scarce (especially per unit area); they are often deeply buried and difficult to discover. They do not reflect the strong bias towards habitation areas evident in Franco-Cantabria (as well as other parts of Western Europe where caves and rock shelters are common). Many East European Plain sites contain evidence of large-mammal butchery and carcass-processing, along with the artifacts and features that are typically found in such sites (Hoffecker 2011).

## LANDSCAPES OF EASTERN EUROPE

The dominant landform of the European continent is a vast lowland plain that lies between the Carpathian and Ural Mountains, and extends from the Arctic Ocean to the Black and Caspian Seas in the south. The East European Plain represents a stable platform of Precambrian igneous and metamorphic rock that crops out in the glacially scoured northwest of the plain and along the Dnepr River in south-central Ukraine. The Precambrian basement complex is mantled with thick sedimentary rock units that fill the troughs and basins and create a relatively level surface.

The most significant topographic relief on the southern half of the East European Plain is provided by several low plateaus composed of blocks of pre-Quaternary sediment uplifted by tectonic processes generated by movements of the platform. These plateaus include the Volyn-Podolian Upland, which adjoins the eastern slope of the Carpathian Mountains on the southwest margin of the plain and averages 200–400 meters above sea level in elevation. Near the center of the plain is the Central Russian Upland, which averages only about 200 meters in elevation, and further east lies the Volga Upland (200–300 meters above sea level). In the south-central plain, near the Sea of Azov, is the smaller Donets Ridge, which averages 200–250 meters in elevation.

Between the upland plateaus lie major southward-flowing river systems that empty into the Black and Caspian Seas. Although the Dnestr River has incised deeply into the Volyn-Podolian Upland, creating many terraces, the major rivers on the central plain (Dnepr-Desna Basin, Don River, and Volga River) have created shallow valley systems (much of the topographic relief in these valleys is provided by the margins of the low plateaus described above). Along the rivers, ravine systems have formed in the low terraces and in the bedrock plateaus.

Although there are a number of natural shelters in the valleys of the Volyn-Podolian Upland, caves and rock shelters in the central plain are extremely rare. An isolated exception is *Novgorod-Severskii* on the Desna River, which apparently represents a collapsed rock-shelter (Gromov 1948: 152–153). Paleolithic sites—including long-term habitation areas—are found in open-air settings, typically located on the low terraces and often associated with side-valley ravines. Occasionally, they are found on the former floodplain surface. At least some sites are associated with active springs (e.g., Holliday et al. 2007), which would have attracted large mammals (Figure 1). In an open landscape, springs provide a rare example of a point of a

recurring attraction for human settlement, similar to a natural shelter in other settings, and a consistent association between springs and both kill-butchery sites and habitation areas is found in the North American Plains and Southwest (e.g., Holliday and Mandel 2006).

Climate and biota on the East European Plain differ from those of other parts of mid-latitude Europe, and the differences also factor into modern human dispersal in the region. While Western Europe receives warm, moist air from the North Atlantic Ocean, Eastern Europe is characterized by a more continental climate. Winter temperatures on the East European Plain are significantly lower than those at comparable latitudes in Western Europe. Reduced available moisture also accounts for lower primary productivity, especially on the arid southern plain. Both Neanderthals and modern humans were compelled to adapt to seasonally lower temperatures and less productive habitat on the East European Plain.

## LANDSCAPE ARCHAEOLOGY OF THE EUP IN EASTERN EUROPE

Several major EUP sites are found in the natural shelters of the southern upland margins of Eastern Europe. In southern Crimea (Crimean Mountains), these include *Syuren' I* and *Buran-Kaya III* (Demidenko et al. 2012; Otte et al. 1996; Prat et al. 2011). In the Northern Caucasus, an important EUP occupation has been investigated at *Mezmaiskaya Cave* (Golovanova et al. 2010a). Several other EUP sites are known in the caves of the western Ural Mountains. The majority of EUP sites in Eastern Europe, however, are open-air localities on the East European Plain.

The largest concentration of sites is at *Kostenki-Borshchevo* on the Middle Don River (Anikovich et al. 2008; Klein 1969; Praslov and Rogachev 1982). Another group of EUP sites is concentrated along the Middle Dnestr Valley (i.e., *Molodova* group) (Chernysh 1987). At least

one EUP site is known in the Dnepr Basin near Zaporozhiye (*Mira*), while a major stratified EUP site is found near the confluence of the Severskii Donets and Don Rivers at *Biryuch'ya Balka* (Matyukhin 2002, 2006; Stepanchuk 2005). In the northern portion of the plain, the famous site of *Sungir'* is located along an Oka River tributary near Vladimir (Bader 1978). Further north, in the Pechora Basin, are the sites of *Byzovaya* and *Mamontovaya Kurya* (Pavlov et al. 2001).

Overall, the density of known EUP sites in Eastern Europe is low, especially for the East European Plain, where the quantity of sites per square kilometer is small in comparison to the Franco-Cantabrian region, as well as other parts of Western Europe that contain caves and rock shelters. EUP site density on the plain also is low in comparison to later Upper Paleolithic sites in the same geographic setting, and it is low in comparison to early prehistoric sites on the North American Plains. Despite the reduced primary productivity of the East European Plain, the low density of EUP sites seems unlikely to reflect a correspondingly low human population density, given the large-mammal bone beds (e.g., Kostenki 14, Mira) and wealth of occupation debris, including art objects and elaborate grave offerings at some sites (e.g., Sungir'), especially later EUP sites. The reason appears to be the significantly greater age and often deeper burial of EUP remains on the East European Plain (Figure 2). A comparatively small sample is therefore available to address issues related to the dispersal of modern humans on the East European Plain.

As is the case among the terminal Upper Paleolithic (or Paleoindian) sites of the North American Plains (and Southwest), the open-air EUP sites of the East European Plain contain a high proportion of localities associated with the killing and butchering of large mammals, and the processing of large-mammal carcasses. This inference is based chiefly on the taphonomic characteristics of the faunal remains, but is supported by the landscape context of the sites, as

well as the types of artifacts represented. The latter comprise a high proportion of expedient tools (e.g., flake scrapers, unretouched flakes, utilized cobbles) and other forms typically found at locations where large mammals were killed and/or butchered (e.g., large cutting tools, bifaces, end-scrapers). Although such artifacts are rarely diagnostic of specific cultural entities, an exception is the pressure-flaked bifacial projectile point, which is one of the most important diagnostic types on the North American Plains and Southwest (e.g., Folsom, Plainview). Bifacial projectile points also represent a major diagnostic artifact type in the EUP sites of the East European Plain (e.g., Anikovich et al. 2007; Bradley et al. 1995).

In a number of cases, traces of kill-butchery events or carcass-processing activities are associated with evidence for a long-term encampment; this pattern also is recognized in the North American Plains and Southwest (e.g., Haynes and Huckell 2007; Hester 1972; Hill et al. 2011). In these sites, the faunal remains, features and artifacts exhibit a combination of forms typical of both large-mammal kill-butchery and extended habitation (e.g., articulated sequences of bone and traces of a shelter). The assemblages usually contain typical kill-butchery implements (described above), as well as those more characteristic of a long-term occupation, such as bone-working tools, digging equipment, and personal ornaments. Examples among the EUP sites of the East European Plain include Kostenki 15, Mira, and Sungir'. Finally, there are also examples of EUP open-air sites that represent long-term camps without evidence for kill-butchery activities, such as at Kostenki 8, Molodova 5, and Kulychivka. It should be noted that most evidence for technological innovation in the EUP is found in sites that reflect extended habitation (with or without associated traces of kill-butchery).

After 30,000 cal BP (i.e., following the EUP), kill-butchery sites and traces of large-mammal carcass-processing are relatively scarce in Eastern Europe with isolated exceptions

(e.g., Amvrosievka in Ukraine [Krotova and Belan 1993]). The reason for the change in the archaeological record is not clear, but seems likely to reflect a shift in land-use strategy: habitation areas apparently were no longer established at or near kill sites or carcass-processing locations. The expedient tool types associated with large-mammal kill-butchery are present but less common in campsites of the middle and later Upper Paleolithic (e.g., side-scrapers in the uppermost level at Kostenki 1 [Efimenko 1958: 283–287], Levallois flakes at Ciuntu rock-shelter in Moldova [Borziac et al. 1997]). The reduced visibility of kill-butchery activities after 30,000 cal BP accounts for the overall low percentages of these artifact types in post-EUP industries.

A descriptive overview of EUP sites in Eastern Europe is presented below, with an emphasis on sites that contain evidence for the killing and butchering of large mammals (Figure 3). Open-air sites that lack such evidence, as well as EUP sites that are found in natural shelters on the margins of the East European Plain, are briefly summarized. The purpose of this review is to show that a significant percentage of EUP sites on the East European Plain represent locations where kill-butchery or carcass-processing activities are represented. The pattern holds implications for the interpretation of the artifacts at these sites, and more generally, for the interpretation of the archaeological record of modern human dispersal in Eastern Europe.

***Kostenki-Borshchevo***. The largest group of EUP sites in Eastern Europe is concentrated around several spring-fed drainages along the west bank of the Don River near Voronezh. At least nine EUP sites—most of them containing multiple EUP occupation layers—are found around the village of Kostenki, and at least one multi-layered EUP site is known at Borshchevo (several km to the southeast). The EUP sites are found on the Second Terrace level of the Don River, although most are situated along the deep side-valley ravines incised into the high west side of the valley (which represents the eastern margin of the Central Russian Upland). The high

concentration of sites in the area probably reflects local spring activity. Most of the EUP levels are deeply buried, and many were discovered only when archaeologists probed beneath younger occupations (Rogachev 1957).

The early EUP sites at Kostenki underlie the 40,000-year-old CI tephra and include one locality in the main valley (*Kostenki 17*) and several occupations associated with a large ravine system (*Kostenki 1, 12*, and *14*) (Anikovich et al. 2007; Hoffecker et al. 2008). The dating of these levels indicates that they fall within several periods (*Greenland Interstadials 11–10* [GI 11–GI 10]) that precede the HE4 cold event (e.g., Weninger and Jöris 2008). The occupation debris is buried in slopewash with occasional inclusions of small rubble (derived from the limestone bedrock) and traces of soil formation. There is evidence of spring activity in the form of primary carbonate bands (and a spring tufa at Kostenki 14) (Holliday et al. 2007: 218).

In Layer III at ***Kostenki 12*** (on the south side of the ravine mouth), a mass of more than 500 bone fragments—primarily reindeer and horse—were excavated in 2002–2003 and are associated with a modest quantity of artifacts (small bifaces, hammer-stones, side-scrapers, end-scrapers, and others) (Anikovich et al. 2004: 27–29). The bones are somewhat weathered, although carnivore damage and probable tool damage (percussion marks) are observable on many fragments, and they exhibit evidence of transport and partial sorting on a roughly 5º slope (Hoffecker et al. 2010: 1081–1083). Differences in the taphonomy of the two taxa (significantly greater rootlet-etching and gnaw marks on reindeer bones) indicate that they probably were deposited at different times. Most portions of the skeleton are represented, although cranial parts are absent (Hoffecker et al. 2010: 1083, table 8) (Figure 4; Table 1).

Both the weathering effects and sorting complicate analysis and interpretation, but the bones may be tentatively ascribed to separate kill-butchery events that took place near or at the

site, the bones subsequently washed down the slope. Processing of the carcasses by humans is suggested by the percussion marks (as well as a high incidence of fresh breakage) and mortality in close proximity to the site is indicated by the nearly complete representation of skeletal parts. The associated artifacts are typical for Paleoindian kill-butchery sites (with short-term camps) in North America, and the assemblage is similar to that from *Blackwater Draw No. 1* (Clovis-type site) in New Mexico (Hester 1972: 97–110) (Figure 5).

On the north side of the same ravine mouth, ***Kostenki 1*** recently produced evidence of a unique EUP analog to the many examples of mammoth butchery known in North America. The lowermost level (Layer V) contains the partial skeleton of a sub-adult mammoth associated with a low-density scatter of stone artifacts. The latter include bifacial projectile points, large cutting tools, side-scrapers, small end-scrapers, and others are similar to those found in Layer III at Kostenki 12 (Anikovich et al. 2006: 91). Although Layer V is often assigned to the early EUP group at Kostenki (e.g., Sinitsyn et al. 1997: 27), its dating remains problematic—in part owing to the local absence of the CI tephra—and it may be younger (Anikovich 1977).

Only about 25% of the mammoth skeleton is present, mostly comprising rib fragments (additional skeletal parts probably lie in unexcavated areas); the remains appear unlikely to have been accumulated by water and gravity (there are no signs of sorting) or collected by carnivores (Hoffecker et al. 2010: 1083–1085). Some fresh breakage is evident, and some carnivore modification and probable tool damage was observed on the bones (see Hoffecker et al. 2010: 1085, fig. 10). It appears that the site's occupants butchered a mammoth carcass at this location; although there is no direct evidence that the mammoth was killed by human hunters, its sub-adult status renders natural mortality unlikely.

Occupations at Kostenki-Borshchevo that antedate 40,000 cal BP and probably represent long-term encampments include ***Kostenki 14***, Layer IV and ***Kostenki 17***, Layer II (Boriskovskii 1963: 83–105; Sinitsyn et al. 2004: 52–54). They yielded little evidence for large mammal carcass-processing, but produced a diverse array of large and small mammals (including a concentration of hare remains at Kostenki 14, Layer IV) (Vereshchagin and Kuz'mina 1977: 107–108) (Figure 6). The artifact assemblages are typical of extended habitation areas (e.g., burins, antler mattocks, personal ornaments) and more likely to exhibit attributes that are diagnostic of specific cultural entities (as well as evidence of important technological innovations). The topographic setting for Kostenki 17, which is situated in the main river valley, is anomalous for the EUP at Kostenki-Borshchevo (Lazukov 1982).

The Kostenki sites also yield a rich record of EUP occupation during 40,000–30,000 cal BP. During this later period (which corresponds to *GI 8–GI 5* in the Greenland ice core record [e.g., Weninger and Jöris 2008]), there is much evidence for the killing and butchering of groups of horses in the side-valley ravines. Perhaps the best example of a mass kill-butchery event in the EUP of Eastern Europe is found in Layer II at ***Kostenki 14***, where Rogachev (1957: 77–81) excavated a large concentration of horse remains and associated artifacts in 1954 (more than 2,000 bones and teeth identified as *Equus latipes*). In contrast to Kostenki 12, Layer III, there was minimal post-depositional disturbance, and multiple examples of articulated bones were recorded, including cervical, thoracic, and lumbar vertebrae, and lower limb sequences (Rogachev 1957: 78). The bones are exceptionally well-preserved for an open-air site and exhibit numerous cut-marks, many of which are in anatomically significant locations. Because of the excellent state of preservation, the low incidence of carnivore damage is significant

(Hoffecker et al. 2010: 1076–1077). A high percentage of bones were broken in fresh or green condition, and a number of bones possess percussion marks.

A similar pattern is found at ***Kostenki 15***, which is a rare example of a single-occupation EUP site at Kostenki-Borshchevo (discovered during the construction of a local reservoir in late 1951 and subject to salvage excavation by Rogachev [1957: 106–118] the following year). The site is found near the mouth of Aleksandrovka Ravine about 2 km southeast of Kostenki 14, and the occupation is roughly contemporaneous with Layer II at the latter (A. A. Sinitsyn, personal communication, 2009). Although the sample of horse bones and teeth was somewhat smaller (n = 1,501) and less well preserved than the assemblage from Layer II at Kostenki 14, the taphonomy was similar: (1) articulated sequences of vertebrae and lower extremities, (2) virtually all portions of the skeleton represented, (3) high proportion of green breakage, (4) low incidence of carnivore damage, and (5) traces of tool cut-marks in anatomically significant locations (Hoffecker et al. 2010: 1079–1081) (Figure 7).

A third occupation level containing a large quantity of horse remains from the same time period is found in Layer I at ***Kostenki 12*** (Anikovich et al. 2008: 76–77, fig. 31; Rogachev 1957: 61–65). A total of 3,262 bones and teeth (MNI = 57) were recovered (Vereshchagin and Kuz'mina 1977: 106). Although a detailed taphonomic analysis has not been undertaken, the assemblage differs from those described for Kostenki 14 and 15. Examination of a sample of several hundred bones revealed that many long-bones were intact, dry breakage appeared to be common, and there are some traces of gnawing but little evidence of tool marks (J.F. Hoffecker, unpublished notes, 2012). The significance of these observations is unclear, but the assemblage may simply represent a less heavily processed set of remains. This pattern is observed at some sites on the North American Plains (e.g., Horner II, Wyoming [Todd 1987]) characterized by a

high proportion of articulated bone sequences and intact limb bones. Although a large number of articulated bone sequences is not reported from Kostenki 12, Layer I, this could be a function of the comparatively steep slope at the site (see above) (Figure 8).

All three of these occupations yielded a combination of artifacts typical for the processing of large-mammal carcasses, and also for a habitation area (the artifact assemblages are traditionally classified as *Gorodtsovan Culture* [e.g., Rogachev and Anikovich 1984: 183–185]) (Figure 9). At each site, a group of horses appears to have been butchered (although evidence for carcass-processing at Kostenki 12 is limited) and a long-term camp also was established. The ravines on the west side of the Don Valley appear to have been used as cul-de-sacs to trap and kill groups of horses (probably mare-bands, as indicated by the demographic profiles from Kostenki 14, Layer II and 15 [Hoffecker et al. 2010]) in a manner similar to that at Solutré (central France) (Olsen 1989, 1995). The establishment of a long-term camp at the same site reflects the lack of constraints on habitation locations in a landscape where natural shelters are scarce or absent.

One of the most interesting later EUP occupations at Kostenki is found in Layer III at ***Kostenki 1***, originally excavated by Rogachev (1957: 30–35). The rather thick cultural layer is associated with (and also underlies) a cryoturbated buried soil that may correlate with GI 8 (Holliday et al. 2007: 207–210) and has yielded a new set of radiocarbon dates of ca. 36,000 cal BP. The assemblage contains several diagnostic elements of the Aurignacian techno-complex (e.g., carinated scraper, large blade with scalar retouch, Dufour bladelets) (Anikovich et al. 2007) and a diverse array of faunal remains that are consistent with a long-term habitation (Vereshchagin and Kuz'mina 1977: 100). But recent investigations of Layer III (2004–2009) revealed a more complex picture (e.g., Anikovich et al. 2006) that includes a concentration of

large mammal remains (horse and mammoth) and artifacts typical for a kill-butchery site (e.g., retouched flakes, large cutting tools, hammer-stones) (Figure 10).

Among the later EUP occupations, Layer II/III at ***Kostenki 8***, which is located on a low promontory at the confluence of two ravines (Aleksandrovka and Biryuchii), conforms most closely to the pattern of long-term habitation without evidence for large-mammal carcass-processing. A charcoal sample collected by the authors in 2008 yielded a date of 30,709±395 cal BP (CURL-15797). Excavation uncovered traces of several oval-shaped shelters with central hearths, and a mass of occupation debris comprising more than 20,000 artifacts (Rogachev 1957: 47–58; Rogachev et al. 1982: 101–109). The diverse faunal assemblage included large numbers of small and medium mammal remains, as well as some bird and fish remains (Vereshchagin and Kuz'mina 1977: 104). In contrast to Kostenki 1, Layer III, the artifacts include forms diagnostic of the Gravettian techno-complex (Anikovich et al. 2008: 128–132).

***Sungir'***. Best known for its spectacular human burials, Sungir' also represents a major EUP locality on the basis of its geographic setting and other contents (i.e., artifacts and faunal remains). The site is located on a low promontory near a ravine that empties into a small tributary (Klyaz'ma River) of the Oka River. It is near the city of Vladimir (northeast of Moscow at latitude 56º11´ North). The occupation debris is associated with a buried soil that apparently dates to one of the later phases of MIS 3; new dates on Burials 2 and 3 (and a mammoth bone) cluster at ~35,000 cal BP (Marom et al. 2012, fig. 1), which correlates with a brief mild interval (*GI 7* in the Greenland ice-core record [Weninger and Jöris 2008]). The site was discovered as a result clay quarrying (for brick production) and the artifacts and faunal remains are not as deeply buried as some EUP horizons at Kostenki or elsewhere on the East European Plain (Bader 1978: 4–19).

Sungir' contains a single EUP occupation layer (analogous to Kostenki 15), although it is conceivable that its occupants returned to the location on a seasonal basis over a period of many years (the vertical distribution of artifacts and bones, which is up to 90 cm in places, is likely to be influenced by frost action). The site presents another classic example of a long-term encampment associated with evidence for at least one major kill-butchery event. A group of reindeer appear to have been killed near the site—perhaps in the ravine—and the carcasses probably were processed at the site. Although an NISP total is not reported, reindeer dominates the faunal assemblage at Sungir' (Bader 1978: 183; Gromov 1966). All portions of the skeleton are represented and several groups of vertebrae and articulated limb elements were found in anatomical order. Photographs published by Gromov (1966: plates XVI–XVII) indicate that at least some bones were broken in fresh or green condition, and tool cut-marks are reported on many fragments (Gromov 1966: 78). The presence of frontal bones with attached antlers (and complete absence of frontal with shed antlers) indicates summer or fall mortality. Sungir' contains a significant percentage of tools commonly associated with kill-butchery sites (i.e., hammer-stones, bifaces, flake scrapers or side-scrapers, end-scrapers, and bifacial projectile points [Bader 1978: 127–137]) (Figure 11).

Sungir' also yields evidence of a long-term encampment in the form of the burials, pits, numerous former hearths, and a dense concentration of debris. The other mammalian remains are varied (including mammoth, horse, bison, saiga, hare, and several carnivores, especially arctic fox) and typical of an extended habitation. The other artifacts are more characteristic of a multiple-activity habitation area (e.g., burins, awls) and include a variety of non-stone tools such as mattocks of bone and antler, bone awls, and a needle fragment (Bader 1978: 146–164). The

assemblage also contained ornaments and art objects. Thus, the overall pattern is similar to that seen in the broadly contemporaneous occupations at Kostenki 14, Layer II and Kostenki 15.

***Mira***. This site remains the only firmly dated EUP locality in the immense Dnepr Basin, underscoring the low visibility of EUP sites on the East European Plain. Mira occupies a unique paleo-topographic setting for the EUP in Eastern Europe; it is found near the center of what was—at roughly 32,000 cal BP—the broad floodplain of the Dnepr River. The site was visited at least twice during a period of floodplain stability and weak soil formation under cool climate conditions (dating to Greenland Stadial 5/Heinrich Event 3 [GS 5/HE3] in the North Atlantic climate-stratigraphic framework). The lower occupation (Layer II/2) yielded only a small number of artifacts and bones, but contains several retouched bladelets diagnostic of the early Gravettian (Stepanchuk 2005: 27–28, fig. 3) (Figure 12).

The upper occupation (Layer I) produced another example of an extended habitation associated with a nearby kill-butchery event. Evidence of a long-term camp includes traces of an artificial structure (occupying an estimated 14.5 $m^2$) in the form of a post-hole arrangement (Stepanchuk 2005: 28), former hearths, small pits, and a dense concentration of debris. The artifacts include perforators, burins, and microliths, as well as various implements of bone and antler and ornaments. The faunal remains comprise a diverse array of large and small mammals (including mammoth, red deer, reindeer, bison, arctic fox [common], and hare).

Evidence for the killing and butchering of a group of animals near the site includes hundreds of identifiable bones and teeth of horse (*Equus latipes*), representing virtually all skeletal parts and exhibiting signs of fresh breakage and tool cut-marks. Patterns of eruption and wear on the teeth, and the scarcity of canines, indicate a mare band structure (Stepanchuk 2005: 28; Hoffecker et al., unpublished ms.). Besides the artifacts already noted, Layer I contains a

high proportion of tool types typically found in kill-butchery sites (i.e., side-scrapers, small bifaces, points) and the assemblage as a whole is similar to those of Kostenki 14, Layer II and Kostenki 15 (Figure 13; Table 2).

***Biryuch'ya Balka***. Located along a ravine system on the Severskii Donets River, near its confluence with the Don, are several localities containing EUP occupations, as well as older assemblages assigned to the Mousterian (Matyukhin 2002, 2006). At ***Biryuch'ya Balka 2***, EUP horizons 3a and 3 are associated with a weakly developed soil, and yielded radiocarbon dates on bone (wood charcoal is absent) of 31,345±364 cal BP and 35,474±439 cal BP (Dodonov et al. 2007: 74). Faunal remains from these layers were relatively scarce, chiefly representing steppe bison (*Bison priscus*), but a large quantity of artifacts was recovered from Layer 3, including those typical for kill-butchery sites such as bifacial projectile points (triangular), side-scrapers, bifaces, and large cutting tools (Matyukhin 2006: 165–167). Despite the tool types, supporting taphonomic evidence for large-mammal kill-butchery activities is lacking, and the occupation has been interpreted as a workshop location (a complete sequence of projectile point production is represented) (Figure 14).

Several underlying levels at Biryuch'ya Balka 2 (Layers 5c–4) contain tool assemblages dominated by side-scrapers, along with end-scrapers (including typical Upper Paleolithic forms), and bladelets (struck with hard-hammer technique) (Matyukhin 2006: 163–164). Larger samples of faunal remains were recovered from these layers, especially Layer 5, where a minimum of five individual bison are represented (Dodonov et al. 2007: 76, table 2). The Laschamp paleomagnetic excursion is tentatively identified in Layer 5, which indicates that these occupations may be less than 45,000 cal BP (Dodonov et al. 2007: 73; Matyukhin 2006: 162; Nowaczyk et al. 2012). Both the presence of typical Upper Paleolithic forms (e.g., bladelets),

and the potentially late age of Layers 5c–4 at Biryuch'ya Balka 2, suggest their occupants might have been modern humans, despite the fact that the assemblages are classified as Mousterian. Matyukhin (2006: 168), in fact, compares the assemblages to the Levallois blade and point industry at Shlyakh (Don River) and other assemblages in the Donbass region that are similar to the Bohunician industry of Central Europe (Nehoroshev 1999).

***East European Plain: Other EUP Sites***. The remaining EUP sites on the East European Plain lack evidence for kill-butchery events or carcass-processing activities. At least several of these probably represent long-term campsites, but there also are examples of short-term occupations (e.g., ***Mamontovaya kurya*** on the Usa River, northern Urals at latitude 66º North [Pavlov et al. 2001]).

Layer II at ***Kulychivka***—an open-air site found in the northern Volyn-Podolian Upland in western Ukraine—yielded traces of several oval shelters with stone-lined central hearths, a large lithic assemblage, some non-stone artifacts, and a diverse large-mammal fauna (Rogachev and Anikovich 1984: 175; Savich 1975). It seems to be a good example of an extended habitation area for this region, and yielded a single radiocarbon date of ~30,000 cal BP. Long-term camps also appears to be represented in EUP Layers 10–9 at ***Molodova V*** in the Middle Dnestr Valley (Chernysh 1987: 27–32), which date to roughly the same time period or slightly earlier, and are associated with a buried soil.

***Crimea and Northern Caucasus***. The mountain systems that adjoin the southern margin of the East European Plain contain several important EUP sites, all of which are found in natural shelters. Predictably, these caves and rock-shelters appear to have been used as long-term habitation areas, and they provide important information on *Homo sapiens* dispersal in Eastern

Europe because they contain artifacts diagnostic of specific cultural entities and evidence of significant technological innovation.

At ***Syuren' I*** in southwest Crimea, artifacts typical of the Aurignacian techno-complex were recovered from a layer dating to more than 30,000 cal BP (Bonch-Osmolovskii 1934; Demidenko et al. 2012; Otte et al. 1996). Further east, at ***Buran-Kaya III***, an early Gravettian assemblage (Layer 6-2) recently was dated to ~40,000–38,000 cal BP. Modern human skeletal remains in the overlying unit (Layer 6-1) were dated to ~36,000 – 35,000 cal BP (Prat et al. 2011: 7, table 1).

In the northern Caucasus, an EUP occupation has been identified in Layer 1C at ***Mezmaiskaya Cave*** (Golovanova et al. 2010a). The lithic assemblage contains a large number of bladelets and has been compared to the Ahmarian industry of the Levant. Especially important from this level is an eyed needle fragment that represents the oldest known evidence for sewn clothing in Europe (Golovanova et al. 2010b).

## MODERN HUMAN DISPERSAL AND THE EUP RECORD IN EASTERN EUROPE

Modern humans dispersed into Eastern Europe ~44,000–42,000 cal BP and may have arrived in an earlier wave roughly 50,000 years ago. Population movements into Eastern Europe may sometimes have been via the Balkans, but also probably were direct from the Levant via the Caucasus Mountains. The East European archaeological record yields important information regarding technological innovations that facilitated the dispersal of modern humans into northern Eurasia; these probably reflect the more challenging environmental conditions that confronted modern humans east of the Carpathian Mountains (i.e., low winter temperatures and reduced biological productivity).

At least two potentially important competitor species were present in Europe during the Late Pleistocene, and their spatial and temporal distribution could have influenced the timing and routes of modern human movements into Eastern Europe. Both hyenas and Neanderthals were established in the southwest plain and southern uplands (Crimea and Northern Caucasus) before the arrival of modern humans (Hoffecker 2002). Hyena remains continue to show up in a few sites occupied by modern humans in the southwest plain and in the southern uplands (e.g., Buran-Kaya III in Crimea [Yanevich et al. 2009: 189–190]), but are absent on the central plain. Neanderthals also are well documented in Crimea and the Northern Caucasus (i.e., diagnostic skeletal remains, as well as aDNA from Mezmaiskaya Cave) during the earlier phases of MIS 3 (Golovanova et al. 2010).

***Initial Upper Paleolithic***. The earliest movement of *Homo sapiens* into Europe may have taken place roughly 50,000 years ago, during a pronounced and sustained interval of warm climate in the northern hemisphere (GI 12). At this time, artifact assemblages containing Levallois points and blades and varying proportions of typical Upper Paleolithic tools (e.g., end-scrapers) appear in the Balkans and parts of Central Europe. These assemblages, which are assigned to the *Bohunician* industry (or Initial Upper Paleolithic [IUP]) are similar to and apparently derived from the IUP industry of the Levant (Bar-Yosef 2007; Kuhn 2003; Stringer 2012: 96–97; Svoboda and Bar-Yosef 2003). To date, no diagnostic human skeletal remains (or aDNA) have been recovered in these sites, and although the IUP is a credible proxy for modern humans, this remains to be confirmed.

A parallel development may have occurred in Eastern Europe, where at least one Bohunician assemblage is widely recognized in western Ukraine (Kulychivka, Layer III [Anikovich et al. 2007; Cohen and Stepanchuk 1999) and other assemblages containing

Levallois points and blades are found in many parts of Eastern Europe. As in Central Europe, no diagnostic human skeletal remains have been recovered from these sites. In Eastern Europe, the primary issue is the dating of the Levallois point and blade industry. A single—relatively young—date is available for the Kulychivka assemblage (~35,000 cal BP) (Cohen and Stepanchuk 1999: 293). Most of the East European assemblages appear to be of comparable age to the Bohunician sites (roughly 50,000 years ago or younger) but some may be significantly older. Another issue in Eastern Europe is the scarcity of typical Upper Paleolithic tools, which are common in the Bohunician. While Upper Paleolithic types are present in some of these assemblages (e.g., Biryuch'ya Balka 2, Layer 4 [Matyukhin 2006: 164]), they are rare or absent in others (e.g., Shlyakh, Layer 8 [Nehoroshev 1999]) (Figure 15). .

If the Levallois point and blade assemblages represent an early movement of modern humans into Central and Eastern Europe from the Levant at ~50,000 cal BP, they are likely to have belonged to an mtDNA haplogroup such as N and/or I, although this hypothesis can be tested only with the analysis of aDNA from human skeletal remains. It is unclear if their route(s) into Eastern Europe would have been through the Caucasus Mountains or via the Balkans or both. The apparent association with the GI 12 warm period suggests that climate might have played a major role in the earliest hypothesized *Homo sapiens* dispersal into Europe. Significantly, there is little evidence for technological innovation in the IUP (Hoffecker 2011).

***Proto-Gravettian***. If there are doubts about the authorship of the Levallois point and blade assemblages, there is little doubt that modern humans produced the bladelet-dominated assemblages that appear in Mediterranean Europe roughly 42,000 cal BP (usually termed *Proto-Aurignacian*). In addition to large number of bladelets and points, they often contain a variety of non-stone tools and personal ornaments. The Proto-Aurignacian is almost certainly derived from

the Ahmarian industry of the Levant (which, in turn, appears to be an outgrowth of the local IUP); it is associated with modern human skeletal remains in Lebanon (i.e., Ksar Akil) (Bar-Yosef 2007; Mellars 2006).

Ahmarian assemblages are found on both the southern and northern slopes of the Caucasus Mountains, and appear to represent a separate movement of modern humans from the Levant directly into Eastern Europe at roughly the same time as the Proto-Aurignacian movement into Mediterranean Europe. An Ahmarian assemblage in Layer 4d at *Ortvale Klde* in Georgia dates to ~43,000–42,000 cal BP (D.S. Adler, personal communication, 2012; Adler et al. 2006), while the Ahmarian assemblage in Layer 1C at Mezmaiskaya Cave in the northern Caucasus is dated to ~38,000–37,000 cal BP (Golovanova et al. 2010a). However, bladelets at Kostenki 14 (Layer IVb) and Kostenki 17 (Layer II) underlie the CI tephra and probably are at least ~42,000 cal BP (and the bladelets in Layer 5 at Biryuch'ya Balka 2 probably are of comparable age) indicating that this industry moved into Eastern Europe at roughly the same time that the Proto-Aurigancian industry appeared in Mediterranean Europe. Because it probably represents a separate movement of modern humans from the Near East, and is likely related to the early Gravettian bladelet industry of Eastern Europe, this industry is most appropriately termed *Proto-Gravettian* (Hoffecker 2012).

The Proto-Gravettian industry of Eastern Europe is associated with isolated human teeth at Kostenki 14 (Layer IVb) and Kostenki 17 (Layer II) that are tentatively assigned to *Homo sapiens* (Boriskovskii 1963; Sinitsyn 2002). In Western Europe, the early Gravettian has been linked to mtDNA haplogroup H at Paglicci Cave (Italy) (Caramelli et al. 2008), but it remains to be seen if the same haplogroup is represented by the people who brought the earlier bladelet industry into Eastern Europe (Figure 16).

The low visibility of this industry on the East European Plain reflects the nature of the archaeological record for old sites in an open landscape (and contrasts with the relatively high visibility of later Upper Paleolithic sites on the East European Plain and Paleoindian sites of the North American Plains). In the near absence of natural shelters, these deeply buried sites are discovered only as a consequence of unusual circumstances. The concentration of early EUP sites at Kostenki-Borshchevo reflects both the consistent attraction of active springs—also a magnet for sites on the North American Plains and Southwest—and the presence of later Upper Paleolithic sites near the surface, which encouraged archaeologists (especially Rogachev) to dig deeper and encounter the EUP occupations.

In contrast to the Levallois point and blade industry described above, the Proto-Gravettian yields evidence of major technological innovations that probably were critical to successful dispersal in Eastern Europe. Although the initial appearance of the bladelet industry may coincide with another warm period (GI 11), it is clear that it also dates to one or more cold intervals, including GS 10 (see Weninger and Jöris 2008: Fig. 3). In addition to low winter temperatures, the colonizing population would have had to adapt to reduced biological productivity—especially on the East European Plain. The eyed needle fragment recovered from Mezmaiskaya Cave suggests improved insulation of clothing (and it should be noted that sewing needles are not present in West European industries until the Solutrean) (Golovanova et al. 2010b). A concentration of hare remains in Layer IV at Kostenki 14 apparently indicates efficient harvesting of these small mammals and implies the use of snares or traps. Kostenki 14 also yielded digging implements (Sinitsyn 2002), while ornaments at Kostenki 17 indicate use of a hand-operated rotary drill (Boriskovskii 1963).

***Later EUP Industries of Eastern Europe***. A richer archaeological and human fossil record is available for the period after 40,000 cal BP (and the CI eruption and ashfall). At least two major techno-complexes are represented in Eastern Europe during 40,000–30,000 cal BP. One of these is the *early Gravettian* industry, which probably is connected to the preceding Ahmarian or Proto-Gravettian industry, at sites such as Buran-Kaya III (Layer 6-2), Mira (Layer II/2), and Kostenki 8 (Layer II/III). The other is an East European variant of the Aurignacian techno-complex (or *Eastern Aurignacian*), which is recognized at Molodova V (Layer 10), Syuren' I, and Kostenki 1 (Layer III). The Aurignacian sites presumably reflect a movement of people from Central into Eastern Europe after the CI eruption (Richards et al. 1998).

The early Gravettian assemblages are distinguished by the presence of large retouched and pointed bladelets, while the Aurignacian assemblages contain some diagnostic elements of the techno-complex in Western Europe (e.g., carinate end-scrapers, small Dufour bladelets). Many assemblages are difficult to assign to either entity (e.g., Kostenki 14, Layer II; Mira, Layer I; Sungir') and could represent other groups. Thus, for example, the assemblages assigned to the *Gorodtsovan Culture* might represent a separate cultural entity, although it should be noted that all of the sites in this category yield traces of large-mammal carcass-processing.

Reflecting the open landscape setting, much of the later EUP archaeological record of the East European Plain comprises kill-butchery locations, which significantly affects the types of artifacts and features representing these industries. Many occupations contain typical (and expedient) carcass-processing tools, such as side-scrapers, bifaces, and large cutting implements. Also common in these contexts are bifacial projectile points, which are more diagnostic of a specific cultural entity and may be associated with the Eastern Aurignacian (but could represent yet another group, as in the case of the Gorodtsovan sites). An important component of the later

EUP economy was the hunting of large mammals in groups, especially horse and reindeer; complex ravine topography probably was used to trap these groups in a manner similar to that on the North American Plains (e.g., Todd 1987).

We see no compelling evidence for any "archaic" industries in the EUP of Eastern Europe (i.e., industries that exhibit high production and use of diagnostic Mousterian tools in comparison to later industries). The occurrence of these types of artifacts in EUP assemblages (e.g., side-scrapers, large cutting implements) is logically related to the processing of large-mammal carcasses, for which there is consistent supporting evidence (i.e., taphonomic characteristics of associated large mammal remains). The comparatively high incidence of kill-butchery sites in EUP sites of the East European Plain reflects the landscape setting, and has parallels in the archaeological record of the North American Plains (Holliday and Mandel 2006). The reduced occurrence of these artifact types in later Upper Paleolithic industries of Eastern Europe is more plausibly attributed to lower visibility of carcass-processing areas than a progressive development of lithic technology and tool types.

The various hypothesized scenarios regarding population movements and sources may eventually be tested with aDNA recovered from human skeletal remains in the alter EUP sites. Analysis of aDNA from a skeleton excavated at Kostenki 14 (Layer III) indicates the presence of mtDNA haplogroup U (sub-group U2) at ~35,000 cal BP on the central plain (Krause et al. 2010). Haplogroup U represents one of the earliest movements of modern humans into Europe (Proto-Aurignacian?) and East European sub-groups may be derived from a Central European population (Malyarchuk et al. 2010). It is likely that other mtDNA haplogroups are represented in Eastern Europe during this interval, including one or more haplogroups or sub-groups related to the people who made the Proto-Gravettian industry. Analysis of the skeletal remains from

Kostenki 14, Layer III and Sungir' indicates retention of anatomical traits associated with tropical climate settings (e.g., high brachial index), despite the likelihood that these individuals probably are derived from a population that had inhabited higher latitudes for many millennia (Hoffecker 2002: 155–158).

The tropical physique of the later EUP people would have exposed them to a high risk of cold injury on the central and northern plain of Eastern Europe at this time (~35,000 cal BP), and it underscores the continuing importance of technologies for cold protection. Needles and/or needle fragments have been recovered from several of these sites, including Kostenki 15, Mira (Layer I), and Sungir' (Bader 1978; Rogachev and Sinitsyn 1982; Stepanchuk 2005). Habitation areas in these sites contain substantial evidence for artificial shelter construction, and traces of shelters are reported from Kulychivka (Layer II), Mira (Layer I), and Kostenki 8 (Layer II/III). Improvements in fishing technology may be indicated by the presence of fish remains in sites like Kostenki 8 (Layer II/III) and stable isotope values for human bone from Kostenki 1 (Layer III) that reflect high consumption of freshwater aquatic foods (Richards et al. 2001).

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FIGURE CAPTIONS

Figure 1. Both early and later EUP occupations are concentrated around spring-fed side-valley drainages on the west bank of the Don River at Kostenki. Pokrovskii Ravine is shown in this photograph. Kostenki 12 is located on the south side of the ravine mouth (photographed by JFH in August 2003).

Figure 2. The later EUP occupation layers at Mira (Lower Dnepr Valley, south-central Ukraine) are buried about 10 meters below the modern surface in alluvium of the Second Terrace (photographed by JFH in August 2012).

Figure 3. Map of major EUP sites in Eastern Europe mentioned in the text.

Figure 4. A mass of reindeer and horse bones (also mammoth bones) washed downslope at Kostenki 12 (Layer III) and apparently representing traces of several kill-butchery events. (photographed by M. V. Anikovich in August 2002).

Figure 5. Artifacts associated with the large mammal bones at Kostenki 12 (Layer III) comprise types found in kill-butchery sites and carcass-processing areas in Paleoindian sites of North America (after Anikovich et al. 2008: 91, fig. 43).

Figure 6. Bones of Don hare (*Lepus tanaiticus*) recovered from Layer IV at Kostenki 14 by Rogachev (photographed by JFH in March 2008 courtesy of G. F. Baryshnikov).

Figure 7. Horse bones and human burial at Kostenki 15, photographed during Rogachev's 1951 salvage excavation at the site (from Anikovich et al. 2008: 139, fig. 77).

Figure 8. Bone bed comprising remains of horse (*Equus latipes*) excavated by Rogachev at Kostenki 12 (Layer I) in 1961–1962. Insets (lower left): complete tibiae with damaged proximal ends; (lower right): complete radii (photographed by JFH in May 2012 courtesy of G. F. Baryshnikov).

Figure 9. Artifacts associated with evidence for carcass-processing at Kostenki 14 (photographed by JFH in March 2009, courtesy of A. A, Sinitsyn).

Figure 10. Concentration of horse and mammoth bones in Layer III at Kostenki 1, excavated in 2008 by M. V. Anikovich and A. V. Dudin. Inset: rock associated with the bones (photographed by JFH in August 2008).

Figure 11. Bifacial projectile points from Sungir' (from Bader 1978: 130, fig. 86).

Figure 12. Bladelets recovered from Mira, Layer II/2 (photographed by JFH in October 2011, courtesy of V. N. Stepanchuk).

Figure 13. Occupation floor at Mira, Layer I, which appears to represent a habitation area with artificial shelter associated with the processing of horse carcasses (from V. N. Stepanchuk).

Figure 14. Biryuch'ya Balka localities along a side-valley ravine that empties into the Severskii Donets River near its confluence with the Don River (source: Google maps).

Figure 15. Levallois blades from Layer 8 at Shlyakh (photographed by JFH in May 2012, courtesy of N. E. Nehoroshev).

Figure 16. Climato-stratigraphy based on the Greenland ice-core record and chronology of major EUP sites in eastern Europe. Sites/layers containing diagnostic elements of the Proto-Gravettian/early Gravettian are coded in red, while sites/layers containing diagnostic elements of the Aurignacian techno-complex are coded in blue. Levallois point and blade assemblages that might represent the IUP are coded in amber.


Figure 1

Figure 2

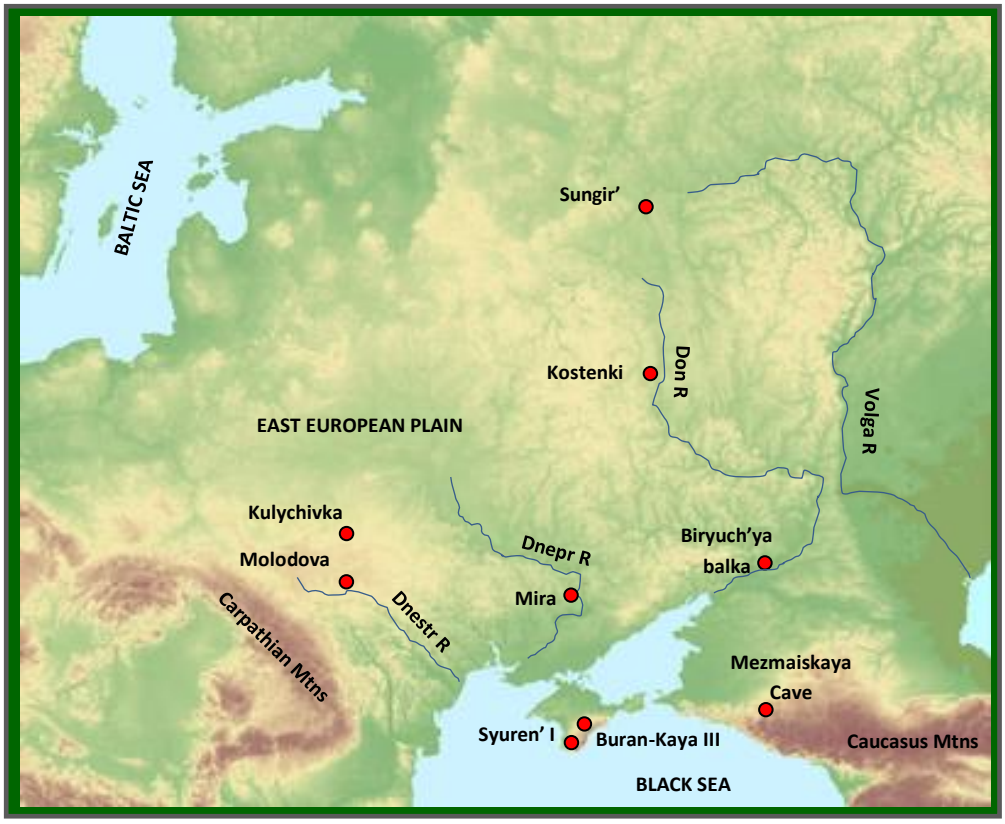
BALTIC SEA
Sungir'
Kostenki
Don R
Volga R
EAST EUROPEAN PLAIN
Kulychivka
Molodova
Dnepr R
Biryuch'ya
balka
Mira
Dnestr R
Carpathian Mtns
Mezmaiskaya
Cave
Syuren' I
Buran-Kaya III
Caucasus Mtns
BLACK SEA

Figure 3

Figure 4

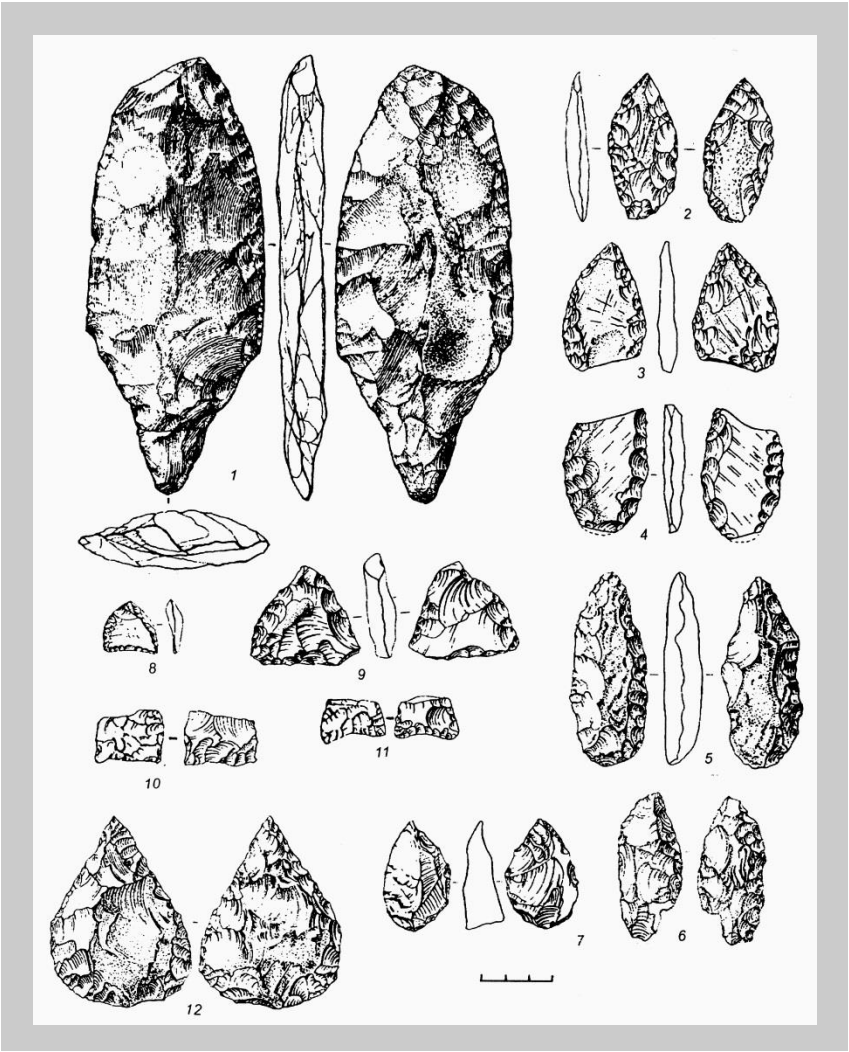


Figure 5


Figure 6

Figure 7

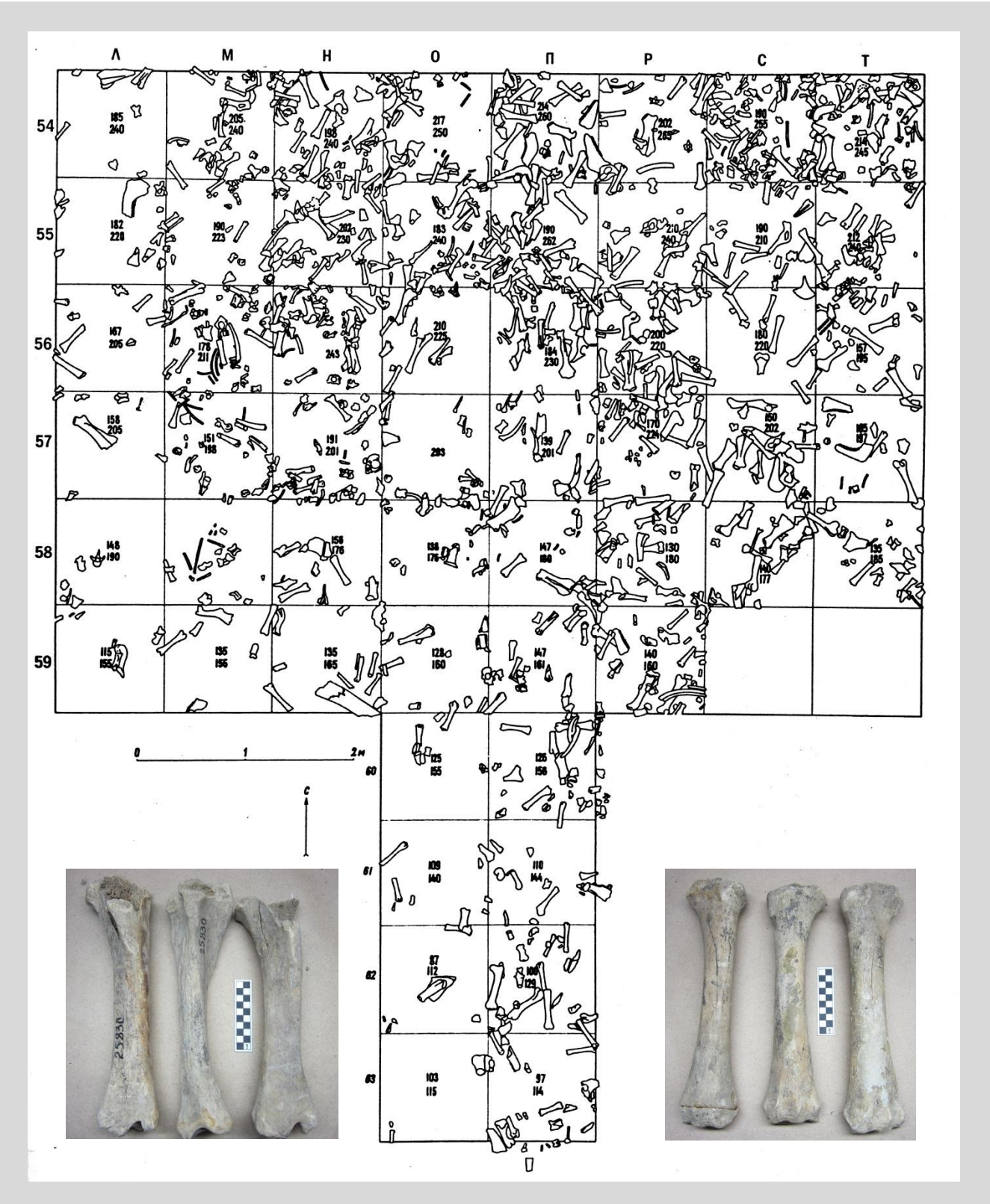


Figure 8


Figure 9

Figure 10

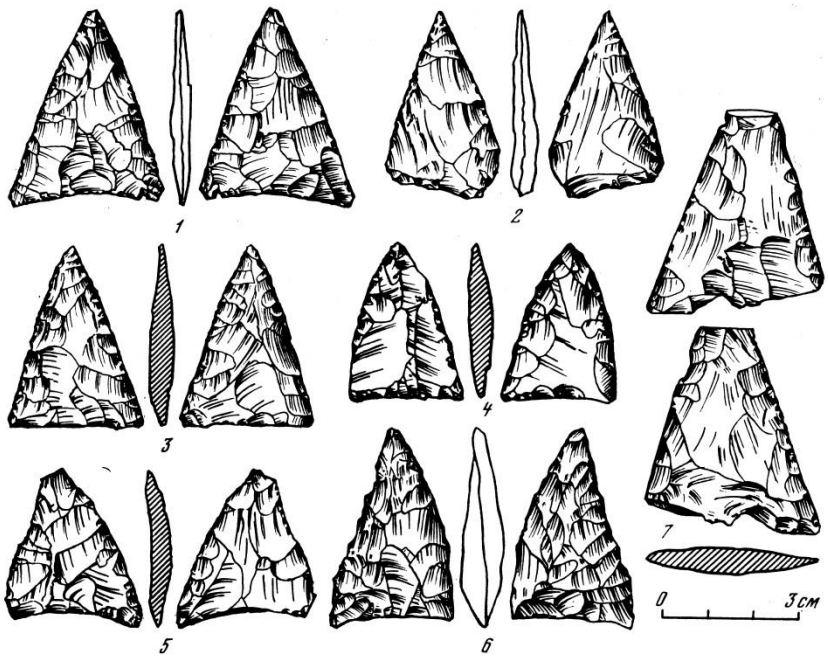


Figure 11

Figure 12

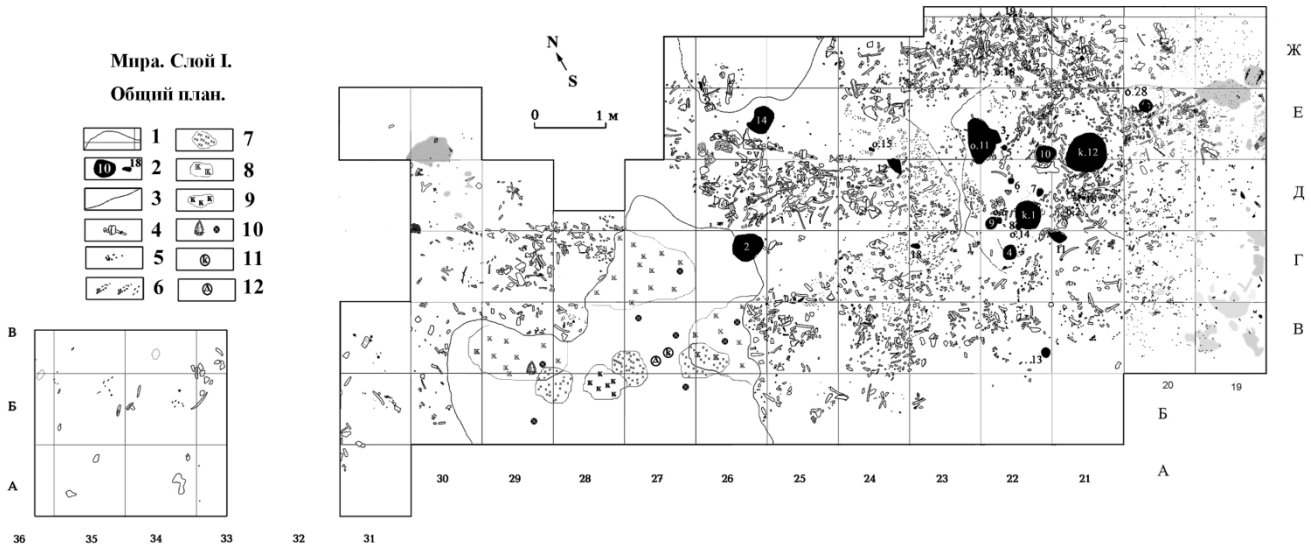
Мира. Слой I.
Общий план.
1
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Figure 13


Kremenskoy
Bazki
Severskii Donets River
Biryuch'ya Balka 1
2000 ft
500 m

Figure 14

Figure 15

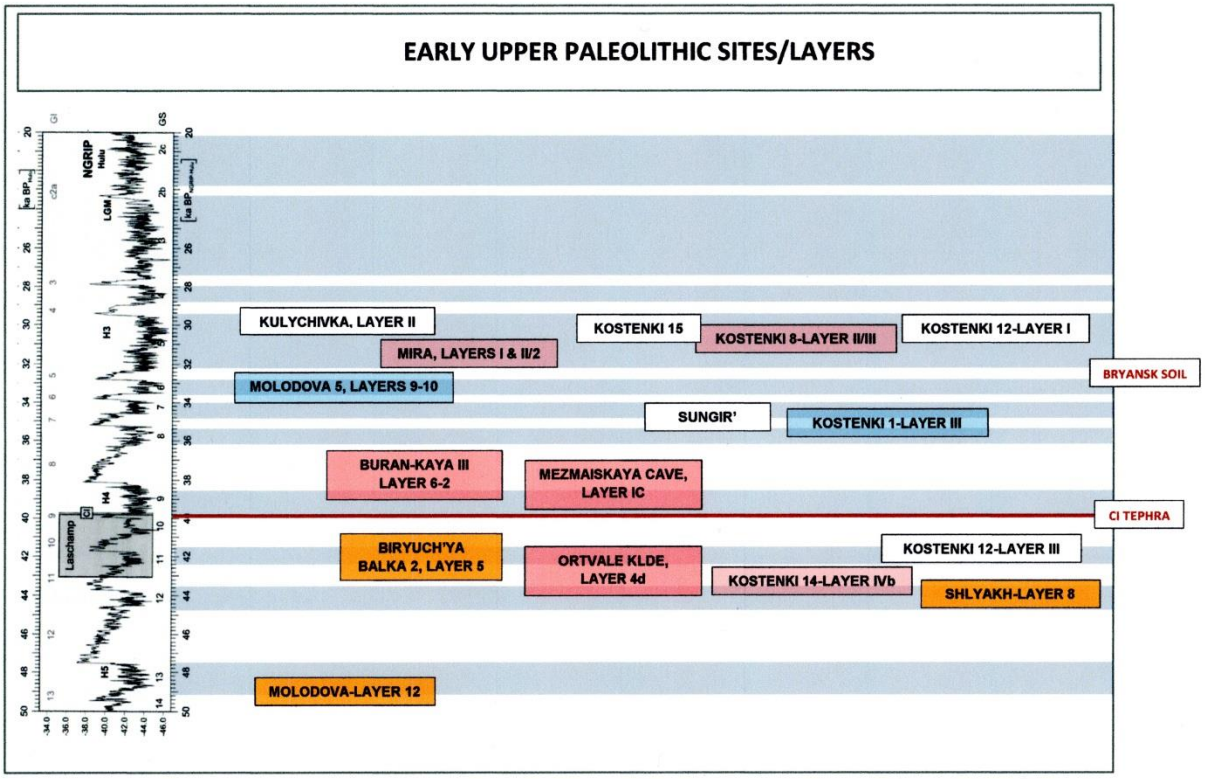
EARLY UPPER PALEOLITHIC SITES/LAYERS
KULYCHIVKA, LAYER II
MIRA, LAYERS I & II/2
MOLODOVA 5, LAYERS 9-10
KOSTENKI 15
KOSTENKI 8-LAYER II/III
KOSTENKI 12-LAYER I
BRYANSK SOIL
SUNGIR'
KOSTENKI 1-LAYER III
BURAN-KAYA III LAYER 6-2
MEZMAISKAYA CAVE, LAYER IC
CI TEPHRA
BIRYUCH'YA BALKA 2, LAYER 5
ORTVALE KLDE, LAYER 4d
KOSTENKI 12-LAYER III
KOSTENKI 14-LAYER IVb
SHLYAKH-LAYER 8
MOLODOVA-LAYER 12
NGRIP
Laschamp

Figure 16

Table 1. Representation of skeletal elements for reindeer (*Rangifer tarandus*) and horse (*Equus latipes*) 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 2. Comparative Representation of Skeletal Parts for *Equus latipes* (broad-toed horse) at Mira, Layer I and Kostenki 14, Layer II (Hoffecker et al., 2010: 1078, table 2).

| | Mira-Layer I | | | Kostenki 14-Layer II | | | |
|---|---|---|---|---|---|---|---|
| Skeletal Part | NISP | MAU | %MAU | NISP | MAU | %MAU | FUI |
| cranium | 14 | ? | ? | ? | ? | | 8.0 |
| maxilla | 12 | ? | | ? | | | --- |
| mandible | 44 | 2.0 | 36 | 44 | 6.5 | 46.4 | 3.3 |
| hyoid | 1 | 0.5 | 9 | 1 | 1.0 | 0.7 | --- |
| atlas | 2 | 2.0 | 36 | ? | | | --- |
| axis | 0 | 0.0 | 0 | ? | | | --- |
| vertebrae | 7 | ? | ? | ? | ? | | --- |
| ribs | 37 | ? | ? | ~250 | ? | | --- |
| lumbar vertebrae | 0 | 0.0 | 0 | ? | ? | | --- |
| caudal vertebrae | 2 | 1.0 | 18 | ? | ? | | --- |
| scapula | 7 | 2.5 | 45.5 | 51 | 11.5 | 82.1 | 6.7 |
| humerus-proximal | 5 | 2.5 | 45.5 | 12 | 3.0 | 21.4 | 6.7 |
| humerus-distal | 2 | 1.0 | 18 | 27 | 11.0 | 78.6 | 6.3 |
| radius-proximal | 8 | 4.0 | 72.7 | 22 | 8.5 | 60.7 | 3.9 |
| radius-distal | 2 | 1.0 | 18 | 21 | 10.0 | 71.4 | 2.7 |
| ulna | 4 | 2.0 | 36 | 16 | 7.5 | 53.6 | 3.9 |
| carpals | 14 | 1.5 | 27 | 111 | -- | -- | 1.4 |
| metacarpal-proximal | 2 | 1.0 | 18 | 18 | 8.5 | 60.7 | 0.7 |
| metacarpal-distal | 4 | 2.0 | 36 | 17 | 8.5 | 60.7 | 0.3 |
| innominate | 8 | 1.0 | 18 | 14 | 2.5 | 17.9 | 23.7 |
| femur-proximal | 11 | 5.5 | 100 | 12 | 4.5 | 32.1 | 20.3 |
| femur-distal | 6 | 3.0 | 54.5 | 11 | 5.0 | 35.7 | 20.3 |
| patella | 3 | 1.5 | 27 | 21 | 10.5 | 75.0 | --- |
| tibia-proximal | 3 | 1.5 | 27 | 5 | 2.5 | 17.9 | 11.3 |
| tibia-distal | 11 | 5.5 | 100 | 28 | 14.0 | 100.0 | 6.8 |
| calcaneus | 1 | 0.5 | 9 | 20 | 10.0 | 71.4 | 3.4 |
| astragalus | 1 | 0.5 | 9 | 20 | 10.0 | 71.4 | 3.4 |
| tarsals | 9 | 0.5 | 9 | 87 | -- | -- | 3.4 |
| metatarsal-proximal | 1 | 0.5 | 9 | 26 | 10.0 | 71.4 | 1.7 |
| metatarsal-distal | 2 | 1.0 | 18 | 17 | 8.5 | 60.7 | 0.8 |
| phalanx 1 | 6 | 1.25 | 22.7 | 39 | 9.8 | 70.0 | 0.4 |
| phalanx 2 | 7 | 1.5 | 27 | 44 | 11.0 | 78.6 | 0.4 |
| phalanx 3 | 4 | 1.0 | 18 | 37 | 9.3 | 66.4 | 0.4 |
| sesamoid | 1 | -- | -- | ? | | | -- |

NISP = Number of Identified Specimens; MAU = Minimum Animal Units
%MAU = percentage of largest MAU value in assemblage; FUI = Food Utility Index (see Outram and Rowley-Conwy 1998: 845, table 6)