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Chronology of the European Russian Gravettian: new radiocarbon dating results and interpretation

Die Chronologie des Europäisch-Russischen Gravettien: neue Radiokarbon-Ergebnisse und deren Interpretation

Natasha Reynolds[1]*, Sergey N. Lisitsyn[2], Mikhail V. Sablin[3], Nick Barton[4] & Thomas F. G. Higham[1]

[1] RLAHA, University of Oxford, Dyson Perrins Building, South Parks Rd, Oxford OX1 3QY, UK
[2] Institute for the History of Material Culture, Russian Academy of Sciences, Dvortsovaya nab. 18, Saint Petersburg 191186, Russia
[3] Zoological Institute, Russian Academy of Sciences, Universitetskaya nab. 1, Saint Petersburg 199034, Russia
[4] Institute of Archaeology, University of Oxford, 36 Beaumont St, Oxford OX1 2PG, UK

Abstract - It is now well established that many previously obtained radiocarbon dates for the earlier part of the Upper Palaeolithic are problematic, and that archaeological chronologies based on such dates may require revision. In order to help address this problem for the Gravettian of European Russia, eight new radiocarbon dates were obtained on samples of bone from Kostënki 8 Layer II, Kostënki 4 and Borshchëvo 5. The dates for Kostënki 8/II agree with the most ancient date previously obtained for the layer and confirm the dating of the assemblage to ca. 32 000-31 000 calBP, or early Greenland Stadial (GS) 5. The new dates for both Kostënki 4 and Borshchëvo 5 are markedly more ancient than those previously published. They indicate that both sites are ca. 2 000 years older than formerly believed, and that both date to ca. 29 500-28 500 calBP, i.e. the very end of GS 5 or Greenland Interstadial (GI) 4. The dates suggest that Kostënki 4 and Borshchëvo 5 are both older than the sites of the Kostënki-Avdeevo Culture, with which they previously seemed to be contemporary. The revised chronology suggests that cold stadial conditions were associated with a relatively low number of archaeological sites in Russia, but also that a notably greater geographical distribution and number of sites may have been associated with GI 3 than with the preceding GI 4. This means that a straightforward correlation between climatic conditions and site numbers should not be postulated based on present evidence.

Zusammenfassung - *Chronologie ist grundlegend für jede Studie des Paläolithikums, besonders auch um Variationen im mittleren Jungpaläolithikum (MUP) Europas, ca. 30 000 – 20 000 ^{14}C BP, zu entschlüsseln. Die wichtigste archäologische Industrie des mittleren Jungpaläolithikums in Europa ist das Gravettien, definiert durch die Präsenz von Gravette-Spitzen und anderen rückengestumpften Steinartfakten. Die Variation zwischen den einzelnen Gravettien Fundplätzen ist groß, und zahlreiche geographisch und zeitlich beschränkte Gravettien faciès wurden identifiziert. Gravettien-zeitliche Fundplätze erscheinen in ganz Europa, inklusive Russland, wobei dort die Mehrheit der Fundstellen in der kleinen Kostenki-Borshchevo Region entlang des Flusses Don liegen. Bisher haben Datierungen des russischen Gravettien eine zeitliche Lücke von mehr als 4000 Jahren zwischen dem frühen Gravettien, repräsentiert durch einen einzigen Fundplatz, Kostenki 8/II, und allen anderen Gravettien Fundplätzen gezeigt. Diese beinhalten sowohl die Fundstellen der Kostenki-Avdeevo Kultur (z.B. Kostenki 1/I, Avdeevo und Zaraisk) als auch weitere Fundplätze (z.B. Kostenki 4 und Borshchevo 5)*

Neue Radiokarbondaten wurden von acht Proben der Inventare von Kostenki 8/II, Kostenki 4 und Borshchevo 5 erzielt. Die Ergebnisse für Kostenki 8/II stimmen mit dem bisher ältesten Datum für diese Schicht überein und untermauern die Datierung dieses Fundinventars zu ca. 32 000-31 000 calBP, oder frühes Grönland Stadial (GS) 5. Die neuen Datierungen für Kostenki 4 und Borshchevo 5 sind deutlich älter als bisher veröffentlicht. Die Ergebnisse deuten an, dass beide Fundplätze etwa 2000 Jahre älter sind als bisher angenommen. Beide datieren nun ca. 29 500-28 500 calBP, das heißt am Ende von GS 5 oder Grönland Interstadial (GI) 4. Dies deutet darauf hin, dass diese Fundplätze älter als die der Kostenki-Avdeevo Kultur sind, mit welchen sie bisher zeitgleich erschienen.

Die Ergebnisse haben zahlreiche Auswirkungen auf unser Verständnis der internen Chronologie des Russischen MUP. Das Alter von Kostenki 8/II und seine Zuordnung zum frühen Gravettien wurden bestätigt. Die zeitliche Lücke, die bisher im mittleren Teil des russischen Gravettien bestand, wurde verkürzt. Die Unterschiede in den Steinartefaktinventaren von Kostenki 4 und Borshchevo 5 und späteren Fundstellen kann nun teilweise mit diachronischem Wandel erklärt werden. Jedoch kann nicht der klare Unterschied zwischen Kostenki 4 und Borshchevo 5 erklärt werden, welche momentan zeitlich nicht unterschieden werden können (obgleich dies nicht heißt, dass sie zeitgleich waren). Zuletzt deuten die Ergebnisse darauf hin, dass das Klima einen großen Einfluss auf die

*corresponding author
natasha.reynolds@rlaha.ox.ac.uk

Entwicklung des russischen Gravettien gehabt haben könnte. Die Lücke im archäologischen Rekord nach Kostenki 8/II korreliert mit dem späten GS 5, welches nach Erkenntnissen von Proxy Archiven in Europa mit schwerwiegenden Klimaveränderungen assoziiert ist. Die Anzahl der Populationen in Russland ging vielleicht zurück, oder die Menschen verschwanden gänzlich zu dieser Zeit. Jedoch erklären klimatische Faktoren allein nicht alle Entwicklungen ausreichend. Die deutliche Zunahme von Fundplätzen in Russland in GI 3 kann nicht allein *durch interstadiale Bedingungen erklärt werden. Hierfür spricht, dass das vorherige Interstadial GI 4 keine vergleichbare Zunahme von Fundplätzten verzeichnet.*

Keywords - Russia, Mid Upper Palaeolithic, palaeoclimates, ^{14}C dating, Kostënki, Borshchëvo
Russland, Mittleres Jungpaläolithikum, Paläoklima, ^{14}C Datierung, Kostenki, Borshchevo

Introduction

Chronology is a key consideration in any study of the Palaeolithic. Its particular importance for understanding the European Mid Upper Palaeolithic (MUP, ca. 30-20 000 BP or 34-24 000 calBP) lies in its necessity for untangling the relationships between various archaeological industries and facies thereof, which may be linked to population interactions and/or migrations. The most significant archaeological industry of the MUP in Europe is the Gravettian, characterised by the Gravette points and other backed lithics found, often in abundance, at sites dating to this period (Demars & Laurent 1992; Djindjian et al. 1999; Noiret 2013).

Opportunities for dating the MUP accurately and precisely have improved greatly in recent years, thanks to developments in radiocarbon dating methods (e.g. Bronk Ramsey et al. 2004; Higham et al. 2006; Brock & Higham 2009; Marom et al. 2012). It is likely that at least some Upper Palaeolithic dates obtained prior to the introduction of these methods are unreliable (see Higham 2011). These problems are particularly acute for the Early and Mid Upper Palaeolithic, which helps to explain the large and archaeologically implausible spreads of dates previously published for many Gravettian sites (e.g. Damblon et al. 1996; Djindjian et al. 1999; Abramova et al. 2001). Obtaining new dates using proven methods should be a priority in any reassessment of the chronology of the earlier parts of the Upper Palaeolithic where there is doubt over the reliability of published dates.

The Gravettian is a complex Upper Palaeolithic archaeological culture. Within the Gravettian sensu lato, numerous smaller archaeological technocomplexes or cultures can be defined, such as the Noaillian and Pavlovian. These diverse archaeological units are often geographically as well as temporally restricted (e.g. Grigor'ev 1993; Djindjian et al. 1999; Klaric 2007). Their developments and disappearances may be linked to the rather dramatic climatic changes that occurred during this period. The timing of the beginning of the Gravettian is a subject of active debate (e.g. Conard & Moreau 2004; Jacobi et al. 2010; Jöris et al. 2010; Higham et al. 2011; Moreau 2012; Noiret 2013) and thus it is not clear exactly how it relates to the Greenland interstadial/stadial cycles. The problem of possible time lags in the onsets of interstadial/stadial conditions across Europe also remains. However, in the Late Glacial at least, it appears that the lags between regions were of the order of decades or centuries, rather than millennia (Lane et al. 2013). The earliest Gravettian assemblages may date to before 30 000 BP, in which case they appeared around the same time as Greenland Interstadial (GI) 6, but this early dating remains rather controversial (Jöris et al. 2010; Noiret 2013; Rasmussen et al. 2014). In any case the earlier stages of the Gravettian certainly include the relatively substantial warm period of GI 5, which was followed by colder conditions during the long Greenland Stadial (GS) 5, to which time Heinrich Event (HE) 3 is also dated (Sanchez Goñi & Harrison 2010). Although there were two more GIs (4 and 3) during the Gravettian, these were short-lived in comparison with earlier interstadials. The final disappearance of Gravettian assemblages across Europe may be linked with the onset of the Last Glacial Maximum (LGM).

The Gravettian as a technological tradition is generally accepted to be restricted to Europe (Kozłowski 2015). The easternmost sites attributed to the Gravettian are found in European Russia, and the similarities between the sites found there and those farther west have been recognised for many decades (Garrod 1938; Roe 1971). However, for a number of reasons (language and communication barriers, differences in intellectual traditions, etc.) it has been very difficult for Western archaeologists to integrate information about the Russian record into general overviews of the European Gravettian. Such an integration is highly desirable, in order to address some of the most interesting questions concerning the European Upper Palaeolithic. These include the nature of the beginning of the Gravettian, responses to climatic and environmental changes during the MUP, the relationships between various sub-units of the Gravettian, and the possible existence of open cross-continental social networks, postulated especially on the basis of finds of female "Venus" figurines at sites across Europe (Gamble 1982, 1991).

A number of sites in Russia are commonly attributed to the Gravettian on the basis of their lithic assemblages and other elements of their material culture (e.g. figurines). The majority of these sites are

found within the small Kostënki-Borshchëvo region on the Don river ca. 30 km south of Voronezh, which has been the subject of intensive research for more than a century. Russian Gravettian sites include Kostënki 8 (Tel'manskaia) Layer II, Kostënki 4 (Aleksandrovskaia), Kostënki 9 (Biriuchii Log), Borshchëvo 5, Kostënki 11 (Anosovka 2) Layer II, Kostënki 1 (Poliakov) Layer I, Zaraisk, Gagarino, Khotylëvo 2, and Avdeevo (Fig. 1) (Praslov & Rogachëv 1982; Sinitsyn 2007; Gavrilov 2008; Amirkhanov 2009; Lisitsyn 2015). The chronological and cultural relationships between these sites and their attributions to various facies of the Gravettian, or even whether particular sites should strictly be defined as Gravettian, are in many cases unresolved questions.

At many sites in the Kostënki-Borshchëvo area, part or all of the same geological stratigraphy has been identified (Haesaerts et al. 2004; Holliday et al. 2007; Sedov et al. 2010), which can be summarised as follows (Fig. 2). A Lower Humic Bed (LHB) of paleosols interstratified with other deposits is overlain by a non-humified, calcareous layer. The latter contains an often-visible volcanic ash layer which has been identified as tephra from the Campanian Ignimbrite eruption (Pyle et al. 2006; Fedele et al. 2008; Giaccio et al. 2008; Hoffecker et al. 2008). Above this is found the Upper Humic Bed (UHB), which is of similar composition to the LHB. This is in turn overlain by loess-like loams, which contain a comparatively weakly expressed paleosol layer known as the Gmelin soil. A. N. Rogachëv divided the archaeological layers found at Kostënki-Borshchëvo into three chronological groups based on their stratigraphic positions (Rogachëv 1957; Sinitsyn 2007). These are, from earliest to latest:

1. those found in the LHB,
2. those found in the UHB, and
3. those found above the UHB, including sites found on the first (lowest) terrace, where the UHB and LHB have not been identified. This chronostratigraphic framework continues to be useful and important for the study of the Kostënki-Borshchëvo sites.

At the outset of this project, the Gravettian record of Russia appeared to be very discontinuous compared with that further west. A single site (Kostënki 8 Layer II) was usually dated to nearly 28 000 BP, and was also the only Gravettian site in the Kostënki-Borshchëvo region to be positioned within the UHB rather than above it (Sinitsyn 2007; Moreau 2010). A very long temporal gap separated that site from all other sites of the Russian Gravettian, which were dated to ca. 23 500 BP or younger (Sinitsyn 2007, 2013). The work presented here has filled in part of that gap and hence extended the chronology of the Gravettian in Russia. The assemblages and samples for dating were chosen to

Fig. 1. Locations of known Gravettian sites in European Russia.

Abb. 1. *Lage bekannter Gravettien-Fundstellen im europäischen Teil Russlands.*

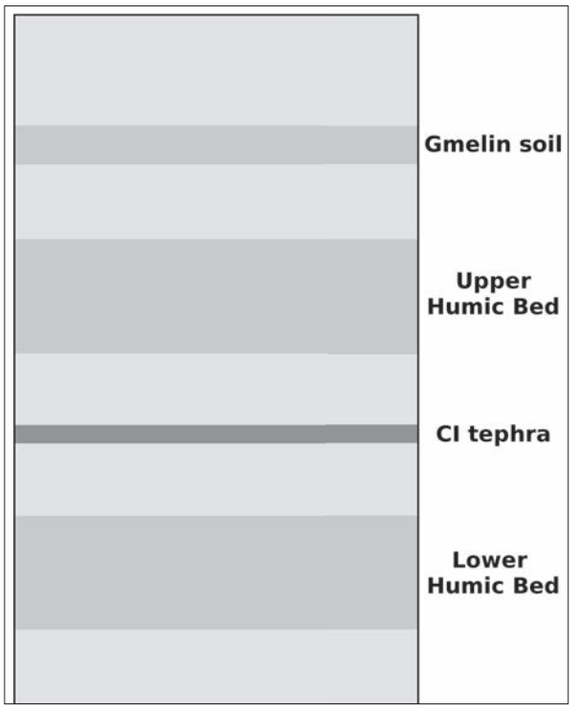

Fig. 2. Schematized stratigraphic profile for the Kostënki-Borshchëvo region.

Abb. 2. *Schematisches Profil der Stratigraphie für die Kostenki-Borshchevo region.*

complement other work on the chronology of Russian Gravettian sites, which had already been carried out within the remit of the AHOB project but which is yet to be published.

Methods

Eight new AMS radiocarbon dates on samples of bone from three sites were obtained, from collections held at the Zoological Museum, Saint Petersburg (for Kostënki 8 and Kostënki 4) and the Institute for the History of Material Culture, Saint Petersburg (for Borshchëvo 5). The samples were selected for the presence of human modifications: cutmarks or, where cutmarked bones were not available, signs of possible deliberate breakage (see Fig. 3 for details). The determinations were produced using current methods at the Oxford Radiocarbon Accelerator Unit, including ultrafiltration, and calibrated against the IntCal13 curve using OxCal version 4.2.4 (Bronk Ramsey 2009; Brock et al. 2010; Reimer et al. 2013).

Results

The new radiocarbon dates obtained during this research are given in Figure 3.

Kostënki 8 Layer II

Kostënki 8 Layer II is a key site of the Russian Gravettian. In recent years it has most frequently been described as Early Gravettian, and there is wide agreement that there are no similar contemporary sites in Eastern Europe (Anikovich et al. 2008; Noiret 2013; Sinitsyn 2013). As the only known Early Gravettian site in Russia, Kostënki 8/II has major importance for our understanding of the spread of the Gravettian across Europe. Discovered in 1936, it was excavated by A. N. Rogachëv over a total area of 530 m^2 between the 1930s and 1970s (Rogachëv et al. 1982). Excavations began again at the site in 2005 and are continuing (Bessudnov 2009; Anikovich et al. in press). The site contains five identified cultural layers, numbered from top to bottom I, Ia, II, III and IV (Rogachëv et al. 1982). The layers other than layer II are of uncertain cultural affiliation (Klein 1969; Rogachëv et al. 1982; Flas 2015).

A substantial lithic assemblage was found in layer II, including 22-23 000 pieces of worked flint; according to previously published counts about 2 100 of these were retouched (Litovchenko 1969; Rogachëv et al. 1982). The assemblage from the layer is very rich in microgravettes, of which ca. 800-900 were found, and also contains abundant burins, retouched blades, and retouched flakes and scrapers. A number of hearths and concentrations of finds have been interpreted as evidence for small dwelling structures (ibid.). Rogachëv believed that the layer was deposited within the Upper Humic Bed, and hence included it in the second of his three chronological groups for the Kostënki sites: the only Gravettian site to be included in this, rather than the third and latest, group (Rogachëv 1957). More recent work has cast some doubt on the stratigraphic position of the layer with regards to this

Lab code	OxA-30198	OxA-30197	OxA-30194	OxA-30193	OxA-30196	OxA-30195	OxA-30200	OxA-30199
Site	Kostënki 8	Kostënki 8	Kostënki 4	Kostënki 4	Kostënki 4	Kostënki 4	Borshchëvo 5	Borshchëvo 5
Layer	2	2	unknown	1	2	unknown	1a	1a
Conventional radiocarbon age (years BP)								
CRA	27 670	27 620	25 290	24 790	24 710	14 210	25 110	24 720
Error	270	270	210	190	200	70	200	190
Calibrated age range (68.2% probability)								
from	31 680	31 620	29 600	29 040	28 970	17 430	29 390	28 970
to	31 190	31 170	29 060	28 620	28 530	17 190	28 910	28 550
Calibrated age range (95.4% probability)								
from	32 250	32 150	29 960	29 320	29 260	17 530	29 630	29 250
to	31 050	31 020	28 810	28 430	28 310	17 070	28 700	28 340
%C	41.2	41.8	41.9	41.6	41.6	40.6	42.3	41.8
$\delta^{13}C$ (‰)	-19.63	-19.53	-19.48	-19.93	-19.68	-19.91	-19.62	-20.01
C:N ratio	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Species	*Equus* sp.	*Equus* sp.	*Equus* sp.	*Equus* sp.	*Coelodonta antiquitatis*	*Equus* sp.	Unknown	Unknown
Labels (on bones)	28419 TII ж-53	28419 TII в-49	20525 (3) 180 a-19	20525 (2) 172 p-16	KIV 4183 (1)	KIV 205 20525 (1)	2008 Excv. 4 Ia 220/51	2008 ?. 4 I/1 221/50; z 120,97
Possible human modification of bones	Cutmarked	Cutmarked	Smashed	Cutmarked	Cutmarked	Smashed	Cut part-way through and snapped	Cut part-way through and snapped

Fig. 3. New radiocarbon dates for Kostënki 8, Kostënki 4 and Borshchëvo 5.

Abb. 3. *Neue Radiokarbondatierungen für Kostenki 8, Kostenki 4 und Borshchevo 5.*

geological framework (Anikovich et al. in press), heightening the need for extra chronometric dating of the layer to verify its age.

The dating of the site to the early MUP was previously heavily dependent on a single radiocarbon date, obtained in the late 1970s, of 27 700 ± 750 BP (GrN-10509) (Rogachëv et al. 1982). Although other, younger radiocarbon dates have also been published for this layer (Fig. 4), the most ancient date has usually been cited as reflecting the true age of the assemblage (e.g. Sinitsyn 2007; Moreau 2010). As part of this research two new radiocarbon dates were obtained, both on horse bones: 27 670 ± 270 BP (OxA-30198) and 27 620 ± 270 BP (OxA-30197). These dates are in very close agreement with each other and with the original widely cited date, apparently confirming the age of the site (Fig. 5). They suggest that the site was occupied during early GS 5.

Layer	Material	Lab code	^{14}C BP	Ref.
II	Charcoal	GrN-10509	27 700 ± 750	1
II	Bone (*Equus* sp.)	OxA-30198	27 670 ± 270	2
II	Bone (*Equus* sp.)	OxA-30197	27 620 ± 270	2
II	Charcoal	CURL-15797	25 640 ± 210	3
II	Bone	GIN-7999	24 500 ± 450	4
II	Charcoal	CURL-15816	23 340 ± 150	3
II	Burnt human bone	OxA-7109	23 020 ± 320	4
II	Charcoal	GrA-9283	21 900 ± 450	5
I	Tooth	GIN-7997	22 900 ± 120	4
I	Bone	GIN-7988	22 000 ± 160	4

Fig. 4. Radiocarbon dates for Kostënki 8. References. 1: Rogachëv et al. 1982; 2: This paper; 3: Anikovich et al. in press; 4: Djindjian et al. 1999; 5: Sinitsyn 2004.

Abb. 4. *Radiokarbondatierungen für Kostenki 8. Referenzen. 1: Rogachëv et al. 1982; 2: dieser Artikel; 3: Anikovich et al. im Druck; 4: Djindjian et al. 1999; 5: Sinitsyn 2004.*

Kostënki 4

Kostënki 4 is an enormous and complex Gravettian site. The following summary is based on publications by Rogachëv (1955), Rogachëv & Anikovich (1982, 1984) and Zheltova (2009). The site was discovered in 1927 by S. N. Zamiatnin and the majority of it was excavated during the 1920s and 1930s by P. P. Efimenko and A. N. Rogachëv. A substantial lithic assemblage and two large linear arrangements of hearths surrounded by concentrations of archaeological material, which have been interpreted as dwelling structures, were found there. A. N. Rogachëv excavated the northern dwelling complex, and established – after some deliberation – the presence of a second, upper cultural layer in that area, including two circular dwellings, overlying the layer with the principal, linear dwelling structure. A sterile layer was described between these layers only over part of their area. However, the assemblages from each layer apparently differed strongly enough in their raw material and typology to separate the material from the rest of the site into two layers. The upper cultural layer was also argued to have been represented in the

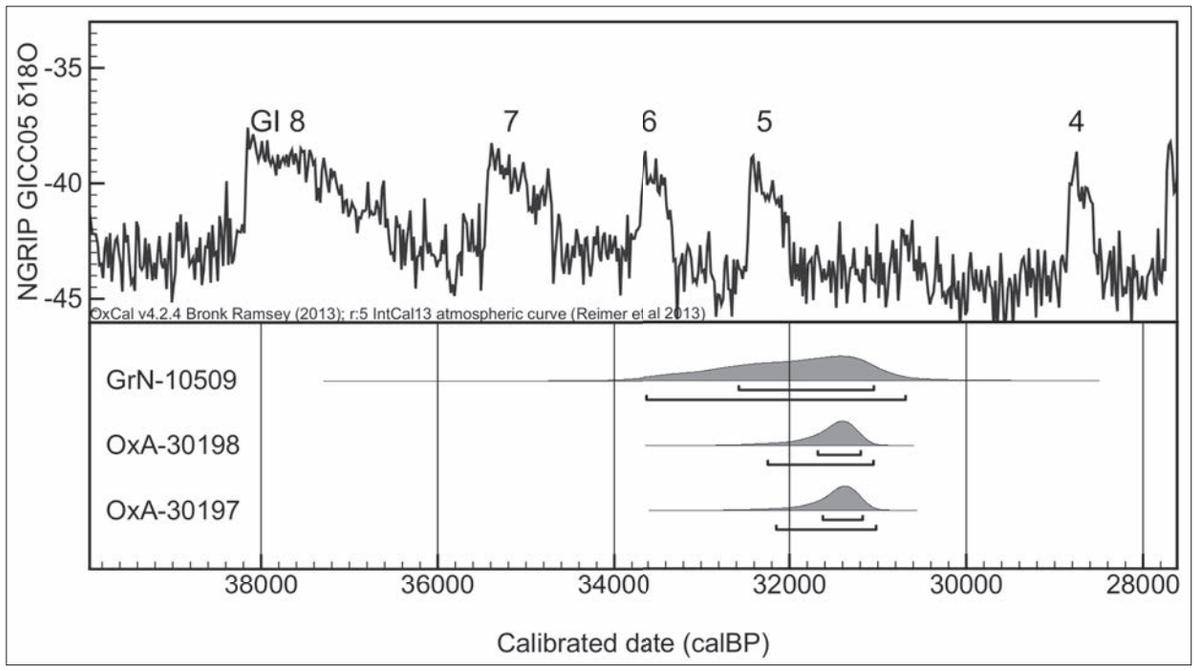

Fig. 5. Selected calibrated radiocarbon dates for Kostënki 8/II.

Abb. 5. *Ausgewählte, kalibrierte Radiokarbondatierungen für Kostenki 8/II.*

southern excavation area in the form of concentrations of finds near the linear dwelling structure. Further limited excavations were carried out at the site in the 1950s; in total, 922 m^2 were excavated during the 20th century. Excavations began again at the site in 2013, led by S. N. Lisitsyn and M. N. Zheltova (Anikovich et al. in press).

In total, around 76 000 lithic artefacts, including about 9 000 retouched lithics and 500 cores, were found during the twentieth century excavations of the areas with the dwelling structures (Rogachëv & Anikovich 1982). About 60 000 of these (including approximately 7 000 retouched pieces and 250 cores) were attributed to the lower cultural layer. The upper cultural layer is described as including backed bladelets, "Aleksandrovsky-type points" (large blades with extensive dorsal retouch forming a point on the distal end of the blank and burin removals, usually dihedral, shaping the proximal end; Zheltova 2011), burins, scrapers and a bifacially worked point; the assemblage attributed to the lower cultural layer contained Gravette points, abundant backed bladelets (often truncated at one end), splintered pieces, burins and scrapers (Klein 1969; Rogachëv & Anikovich 1982; Kozłowski 1986) The presence of an upper cultural layer has, however, been called into question by recent work by M. N. Zheltova (2009) working from original excavation records. In particular, she found that the so-called sterile layer in fact contained finds, casting doubt on the original basis for the separation of the two cultural layers.

Kostënki 4 is the first of two sites whose age must be revised in the light of the new radiocarbon dates obtained during this research. The site is located on the first (lowest) terrace and therefore is regarded as stratigraphically above the UHB (Klein 1969, Holliday et al. 2007). Figures 6 and 7 show the new dates and the previously published dates for this site. Three of the new measurements are ca. 1 500-2 500 radiocarbon years older than the oldest previously published date for the site, of 23 000 ± 300 BP (GIN-7994) (Djindjian et al. 1999).

The dating of the site is complicated by the uncertainty over the possible presence of two cultural

Layer	Material	Lab code	^{14}C BP	Ref.
N/A	Bone (*Equus* sp.)	OxA-30194	25 290 ± 210	1
I/II	Bone (*Equus* sp.)	OxA-30193	24 790 ± 190	1
I/II	Bone (*Coelodonta antiquitatis*)	OxA-30196	24 710 ± 200	1
I	Bone	GIN-7994	23 000 ± 300	2
I	Bone	GIN-7995	22 800 ± 120	2
Not stated	Bone	OxA-8310	20 290 ± 150	3
Unknown	Bone (*Equus* sp.)	OxA-30195	14 210 ± 70	1

Fig. 6. Radiocarbon dates for Kostënki 4. References. 1: This paper; 2: Djindjian et al. 1999; 3: Bronk Ramsey et al. 2002.

Abb. 6. *Radiokarbondatierungen für Kostenki 4. Referenzen: 1: Dieser Artikel; 2: Djindjian et al. 1999; 3: Bronk Ramsey et al. 2002.*

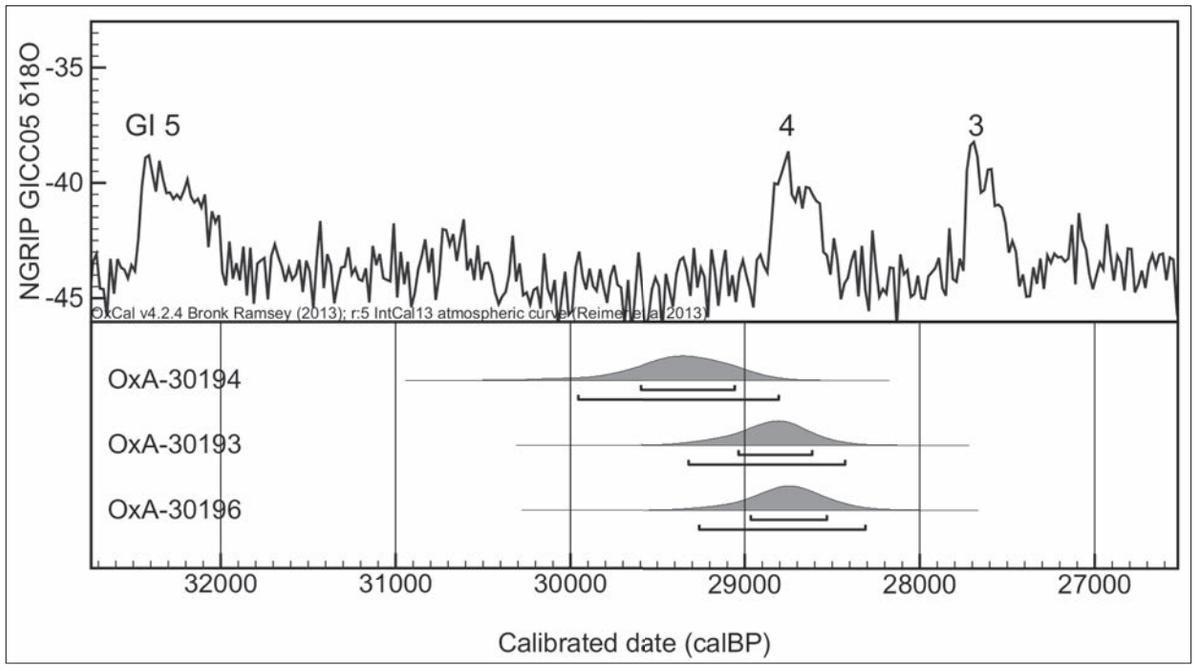

Fig. 7. Selected calibrated radiocarbon dates for Kostënki 4.

Abb. 7. *Ausgewählte, kalibrierte Radiokarbondatierungen für Kostenki 4.*

layers. The oldest new date obtained, of 25 290 ± 210 BP (OxA-30194), was from a bone which was labelled as having been found near the southern dwelling structure, but actually outside the main excavation area (square A-19), so its connection with the cultural layer(s) is questionable. Interestingly, of the two dates with good associations with the cultural layer, of 24 710 ± 200 BP (OxA-30196) and 24 790 ± 190 BP (OxA-30193), the first derived from an area where the upper layer is supposed to have been present and the second did not. The former sample was taken from a woolly rhinoceros bone found beside the hearth in the eastern "round dwelling" in the northern dwelling complex (square Ш-39). The latter was taken from a horse bone excavated in the southern dwelling complex (square Р-16). These very similar dates do not offer any support for the existence of two chronologically separated cultural layers at the site, although neither can they disprove the possibility. The very young date of 14 210 ± 70 BP (OxA-30195) was measured from a sample on a horse bone from an unknown part of the site. It is clearly from a much later event and can be ignored for the purposes of the present discussion. The two dates with the best associations with the cultural layer(s) suggest that the site was occupied during GI 4. However, the question of the existence of two cultural layers at Kostënki 4 and their temporal separation, if any, remains unresolved.

Borshchëvo 5

Borshchëvo 5 is the most recently discovered site in the Kostënki-Borshchëvo area. It was found by a local resident and the first archaeological investigations took place there in 1998, followed by test-pitting in 2002 (Lisitsyn 2011). Further, more extensive excavations took place from 2003 and are ongoing.

Five cultural layers have been identified at the site, of which the uppermost Layer 1, containing a Gravettian assemblage, is by far the richest. The finds in this layer had a vertical distribution of up to one metre, leading to doubts over the integrity of the cultural layer and how much of it was found *in situ.* The archaeological layer was originally believed to be associated with one paleosol, which was compared with the Gmelin soil identified at multiple sites in Kostënki-Borshchëvo (see Fig. 2). Subsequent work has found that there are in fact two paleosols (of which the lower has been associated with the Gmelin soil), and the cultural layer has been subdivided accordingly, into Layers 1a (upper) and 1b (lower). Both parts of the layer show signs of significant slope movement and disturbance. Layer 1a in particular may be entirely redeposited: it lacks pits and hearths and there is no obvious spatial structuring of the finds (Lisitsyn 2011, 2015).

The assemblage excavated to 2009 includes 1769 flint lithics, including 458 retouched pieces and 5 cores, and an interesting small collection of polished stone artefacts (Lisitsyn 2011). The knapped assemblage includes several Gravette points and a larger collection of backed microliths with parallel straight sides, often with ventral retouch to the ends, which can be related to the Late Gravettian rectangles described by Wilczyński et al. (2015). The dating of this site is therefore important for understanding the chronology of this recently defined lithic category. The lithic assemblage from Borshchëvo 5 Layer 1 is very similar to that from Kostënki 9 (Litouchanka 1966; Lisitsyn 2011; Sinitsyn 2007). No radiocarbon dates or material suitable for dating are available from the latter site.

Four radiocarbon dates were previously published for the site, with a large spread of results (Fig. 8). The older two dates have been suggested to be more representative of the age of the site (Lisitsyn 2015). However, the two new radiocarbon dates for the site, of 25 110 ± 200 (OxA-30200) and 24 720 ± 190 (OxA-30199), are significantly older than any of those previously obtained for Layer 1. The samples used were from inarguably humanly modified material from the 2008 excavations. Both samples derived from Layer 1a, the upper sub-section of Layer 1. The new dates likely correspond to GI 4 or the very end of GS 5 (Fig. 9).

The ages obtained may provide support for the argument that the material in Layer 1a is redeposited and is the same age as in situ deposits in Layer 1b. It can be suggested that the lower paleosol (of Layer 1b), and the Gmelin soil more generally, formed during GI 4 and/or GI 3 based on stratigraphic comparisons (Reynolds 2014a). If this is the case, then a date of GI 4 or earlier for material from *above* this paleosol, in Layer 1a, implies that the material has been reworked from lower down in the sequence (i.e. Layer 1b), likely as a result of redeposition on a slope as previously suggested. However, further work on the absolute dating of the Gmelin soil across the Kostënki-Borshchëvo region and its possible correlation with the Greenland ice core chronology is crucial to test this model.

Layer	Material	Lab code	^{14}C BP	Ref.
1a	Bone (unknown)	OxA-30200	25 110 ± 200	1
1a	Bone (unknown)	OxA-30199	24 720 ± 190	1
1	Rib (*Mammuthus primigenius*)*	GIN-10239	22 500 ± 700	2
1	Tooth (*Mammuthus primigenius*)	LE-6947	20 000 ± 300	2
1	Bone (*Mammuthus primigenius*)*	LE-5571	17 400 ± 2000	2
1	Bone (*Equus* sp.)	LE-6809	14 060 ± 110	2

Fig. 8. Radiocarbon dates for Borshchëvo 5. References. 1: This paper; 2: Lisitsyn 2011. *Samples from same bone.

Abb. 8. *Radiokarbondatierungen für Borshchevo 5. Referenzen. 1: Dieser Artikel; 2: Lisitsyn 2011. *Proben vom selben Knochen.*

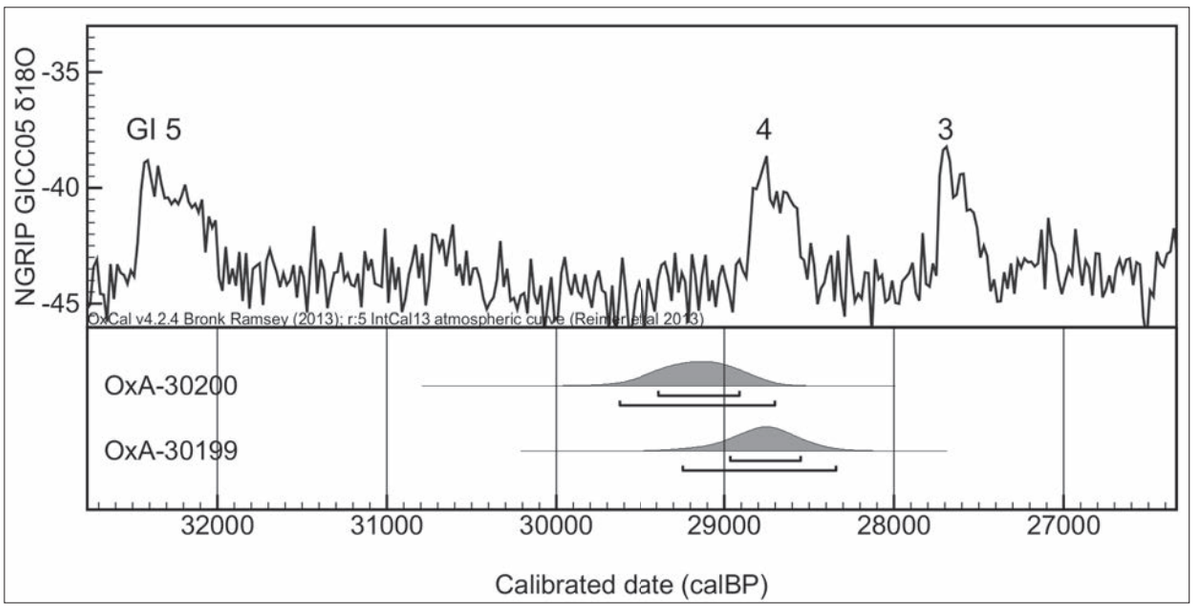

Fig. 9. Selected calibrated radiocarbon dates for Borshchëvo 5.

Abb. 9. *Ausgewählte, kalibrierte Radiokarbondatierungen für Borshchevo 5.*

Discussion

The Gravettian record of Russia is sparse compared with that elsewhere in Europe. This may in large part reflect differing intensities of research, but could also be a result of geological factors: there are significant loess deposits in much of European Russia, which may have buried pre-LGM deposits deeply (see Romanowska 2012 for a similar argument regarding the Lower Palaeolithic of Ukraine).

After Kostënki 8/II, there is a hiatus in our dated record of the Russian Gravettian of over 2 000 years. Although the small total number of sites means that caution is warranted in resting any interpretation on this gap, it is nonetheless interesting. This is especially because it coincides with the second part of the long Greenland Stadial 5. At loess-paleosol sequences in the Carpathians and Siberia, ice wedge and frost wedge formation has been noted around this time, indicating severely cold conditions (Haesaerts et al. 2005, 2010a), while multiple other proxy records also contain evidence for a downturn in climatic conditions in various areas of Europe at ca. 30 000 calBP, which has often been associated with Heinrich Event 3 (e.g. González-Sampériz et al. 2006; Soulet et al. 2011; Stevens et al. 2011). It is possible that at this time human populations disappeared from the Kostënki region, or at least became much smaller. A similar hiatus or reduction in dated occupations has been noted for approximately the same period in the Paris Basin region and the Central Apennines (Giaccio et al. 2004; Klaric 2013), and for an even longer period in the area north of the Black Sea (Demidenko 2008).

The new dates for Kostënki 4 and Borshchëvo 5 imply that the sites are markedly older than previously believed. They now appear to clearly pre-date most of the major assemblages of the Kostënki-Avdeevo Culture, discussed below, from which they differ strongly in terms of their lithic assemblages (Sinitsyn 2007; Lisitsyn 2015; Zheltova 2015). The dates for Borshchëvo 5 are indistinguishable from those for Kostënki 4. This does not, however, prove close contemporaneity between the two sites: according to the available data, one site may well pre-date the other by several hundred years or more.

The impossibility of separating Kostënki 4 and Borshchëvo 5 chronologically leaves us with a considerable interpretative conundrum, because the lithic assemblages of these two sites differ markedly. As outlined above, the collection from Kostënki 4 includes Gravette points alongside a very large assemblage of backed bladelets, frequently truncated with direct retouch (Zheltova 2015). On the other hand, the Borshchëvo 5 collection, while it does include Gravette points, also contains numerous backed, very regular bladelets with inversely retouched ends, similar to "Late Gravettian rectangles" (Lisitsyn 2015; Wilczyński et al. 2015). The latter are absent from the much larger Kostënki 4 collection. Whether the differences between the assemblages simply reflect differences in site function, or whether they are the result of past cultural diversity, is not presently clear. If the latter explanation is favoured, the dates suggest that we have evidence for two different cultural groups within a very small area over a relatively short period of time. This implies either shifting territorial boundaries or

that these groups were sharing at least some of the same territory. If, rather, difference in site function is preferred as a total or partial explanation, then detailed comparative study of the lithic assemblages is necessary to test this possibility. (It should however be noted that the fact that Kostënki 4 is many times larger than Borshchëvo 5 both spatially and in terms of assemblage size implies that some substantial difference in site function is likely). Either explanation could have significant theoretical ramifications. Unfortunately, the absence of any sites in Russia beyond the Kostënki-Borshchëvo area that are dated to the same period means that the evidence base is probably too small at present to fully resolve these issues.

The sites of the Kostënki-Avdeevo Culture, characterised by the presence of shouldered points and female "Venus" figurines, were not re-dated as part of this research. There are large ranges in the published radiocarbon dates for the three principal sites of Kostënki 1 Layer I, Avdeevo and Zaraisk. The oldest available published date for Avdeevo is 23 400 ± 700 BP (GIN-7729; mammoth tooth) but numerous other radiocarbon determinations on burnt bone also pre-date 20 000 ^{14}C BP, while other dates as young as ca. 12 000 BP have been obtained for the site (Abramova et al., 2001). For Kostënki 1/I, the oldest published date is 23 640 ± 320 BP (LE-3283; mammoth tusk) with multiple other dates also falling around the interval 23 500-23 000 BP; a few dates are also younger than 20 000 BP (Svezhentsev & Popov 1993; Damblon et al. 1996). It is unfortunately rather difficult to find published radiocarbon dates for Zaraisk, but Sinitsyn (2007) writes that there are more than twenty dates between 23 000 ± 400 BP (GIN-8397a) and 15 600 ± 300 BP (GIN-3700). If we assume that the oldest dates for each of these three sites are the most likely to be accurate, then the occupation of these sites appears to coincide approximately with the timing of GI 3. The dating of these sites to ca. 23 500-23 000 BP may find support in the fact that other Eastern European assemblages containing shouldered points (e.g. Molodova V Layer 7 and the Gravettian IV level at Mitoc-Malu Galben) have also been dated to this time (Haesaerts et al. 2010b). Following recent re-dating work, the site of Khotylëvo 2 (where female figurines have been found but which is not usually included in the Kostënki-Avdeevo culture sensu stricto) has also yielded dates which are close to contemporary with the earliest dates for the Kostënki-Avdeevo Culture sites (Gavrilov et al. 2015). The dating of Gagarino (where, like Khotylëvo 2, female figurines have been found but which is not part of the Kostënki-Avdeevo Culture as usually defined) is perhaps currently more uncertain than for the other major Russian Gravettian sites. The most ancient published date for Gagarino is 21 800 ± 300 (GIN-1872; burnt bone) but dates from only three samples are available (Svezhentsev & Popov 1993; Sinitsyn 2007).

Conclusions

The results outlined above have extended the radiocarbon chronology of the Russian Gravettian, partially filling in the long gap that previously existed between ca. 27 500 and 23 500 years BP in the dated record. Nevertheless, the record of Gravettian activity in this part of Europe remains far from continuous.

The links drawn here between climatic events and cultural changes are tentative. In particular, it is difficult to make definite attributions to an interstadial or stadial period based solely on radiocarbon dates. Correlations between archaeological levels and palaeosol horizons are helpful, but the complexities of site formation processes mean that they cannot be conclusive: micromorphological work might, however, be useful. In addition, it could be worthwhile to explore local palaeotemperature changes using intra-tooth oxygen isotope measurements of animal tooth enamel to test whether sites were occupied in warmer or colder conditions (Stevens et al. 2011). There has not to date been enough high-resolution work done on changes in faunal suites in Russia during the Late Pleistocene to use the faunal assemblages found at sites as indicators of stadial/interstadial conditions. Despite these issues, the results presented here are sufficient to start exploring the connections between palaeoclimates and human activity and to suggest some directions for future work.

The long stadial of GS 5 may have led to a reduction in human numbers or local extinction of populations. The question of how this played out elsewhere in Europe, and what impact it may have had on the general development of the Gravettian, is worthy of direct study. Consideration of the question of population reduction during GS 5 should give new context to the much longer-lived debate concerning local extinctions and contractions to refugia during the LGM (Verpoorte 2009).

However, developments over the millennia following GS 5 demonstrate, perhaps unsurprisingly, that different types of cultural responses may have been associated with different warming events. The differences seen between the only two sites in Russia directly dated to the period ca. 25 000 ^{14}C years BP, or approximately GI 4, demonstrate the complexity of human society around this time, which remains far from fully understood. The fact that a limited number of Russian sites are dated to this period is worthy of consideration in its own right. Links between these sites and contemporary sites further afield are yet to be fully explored.

Around GI 3, based on present dating, we see the development of the Kostënki-Avdeevo Culture. This group of sites shares some features – e.g. the presence of shouldered points – with sites across Eastern Europe – and others – e.g. female "Venus" figurines – with sites across the entirety of Europe. The total number of sites in Russia and, in particular, the breadth of their

geographical distribution also increases markedly around this time. A similar observation has been made for Moravia (Svoboda et al. 2000). This raises the possibility that some kind of novel cultural and/or technological adaptation transformed human societies, in terms of site distributions and perhaps also in overall population numbers. Even if the changes in the record seen here are confirmed as correlating closely with GI 3 itself, they cannot be attributed solely to the influence of interstadial conditions, because the preceding interstadial (GI 4) does not appear to have seen similar developments.

Although challenges remain, most notably the relatively low density of known sites, the possibilities for building a detailed framework of cultural change in Eastern Europe during the Gravettian and MUP are growing rapidly. Improvements in radiocarbon dating permit robust ordering of archaeological events or quantification of our uncertainties when this is not possible, and enable comparisons with palaeoclimatic frameworks. Much remains to be done to securely establish the dating of many Gravettian sites, especially in Eastern Europe. However, as this is achieved, the complexities of change in human societies during the MUP come into new focus. Future work on all aspects of the Gravettian must be informed by consideration of the diachronic variation seen within this long-lasting archaeological culture.

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Literature cited

Abramova, Z. A., Grigorieva, G. V. & Zaitseva, G. I. (2001). The age of Upper Paleolithic Sites in the Middle Dnieper River Basin of Eastern Europe. *Radiocarbon* 42: 1077–1084.

Amirkhanov, K. A. (Ed.) (2009). *Issledovaniia paleolita v Zaraiske 1999–2005.* Paleograf, Moscow.

Anikovich, M. V., Popov, V. V. & Platonova, N. I. (2008). *Paleolit Kostënkovsko-Borshchëvskogo raiona v kontekste verkhnego paleolita Evropy.* Nestor-Istoriia, Saint Petersburg.

Anikovich, M. V., Lisitsyn, S. N., Platonova, N. I., Dudin, A. E., Pustovalov, A. I., Zheltova, M. N. & Popov, V. V. (in press). Raboty Kostënkovsko-Borshchëvskoi arkheologicheskoi ekspeditsii 2010–2013 gg. *In:* N. V. Lopatin (Ed.) *Arkheologicheskie otkrytiia 2010–2013 godov.* Nauka, Moscow.

Bessudnov, A. A. (2009). Istoriia izucheniia paleolita basseina Verkhnego i Srednego Dona. *Nauchnye vedomosti BelGU (Seriia "Istoriia. Politologiia. Ekonomika. Informatika")* 9 (11): 86–96.

Brock, F. & Higham, T. F. G. (2009). AMS Radiocarbon dating of Paleolithic-aged charcoal from Europe and the Mediterranean Rim using ABOx-SC. *Radiocarbon* 51 (2): 839–846.

Brock, F., Higham, T. F. G., Ditchfield, P. & Bronk Ramsey, C. (2010). Current pretreatment methods for AMS radiocarbon dating at the Oxford Radiocarbon Accelerator Unit (ORAU). *Radiocarbon* 52 (1): 103–112.

Bronk Ramsey, C. (2009). Bayesian analysis of radiocarbon dates. *Radiocarbon* 51 (1): 337–360.

Bronk Ramsey, C., Higham, T. F. G., Owen, D., Pike, A. & Hedges, R. E. M. (2002). Radiocarbon dates from the Oxford AMS System: Archaeometry Datelist 31. *Archaeometry* 44: 1–150.

Bronk Ramsey, C., Higham, T. F. G., Bowles, A. & Hedges, R. E. M. (2004). Improvements to the pre-treatment of bone at Oxford. *Radiocarbon* 46: 155–63.

Conard, N. J. & Moreau, L. (2004). Current Research on the Gravettian of the Swabian Jura. *Mitteilungen der Gesellschaft für Urgeschichte* 13: 29–59.

Damblon, F., Haesaerts, P. & van der Plicht, J. (1996). New datings and considerations on the chronology of Upper Palaeolithic sites in the Great Eurasiatic plain. *Préhistoire Européenne* 9: 177–231.

Demars, P.-Y. & Laurent, P. (1992). *Types d'outils lithiques du Paléolithique supérieur en Europe.* Presses du CNRS, Paris.

Demidenko, Y. E. (2008). The Early and Mid-Upper Palaeolithic of the North Black Sea region: an overview. *Quartär* 55: 99–114.

Djindjian, F., Kozłowski, J. & Otte, M. (1999). *Le Paléolithique supérieur en Europe.* Armand Colin, Paris.

Fedele, F., Giaccio, B. & Hajdas, I. (2008). Timescales and cultural process at 40 000 BP in the light of the Campanian Ignimbrite eruption, Western Eurasia. *Journal of Human Evolution* 55 (5): 834–857.

Flas, D. (2015). The extension of Early Upper Palaeolithic with blade leaf-points (Lincombian-Ranisian-Jerzmanowician): the issue of Kostenki 8 level I. *In:* Ashton, N. & Harris, C. R. E. (Eds.) *No Stone Unturned: Papers in Honour of Roger Jacobi.* Lithic Studies Society, London, 49–58.

Gamble, C. (1982). Interaction and Alliance in Palaeolithic Society. *Man (New Series)* 17 (1): 92–107.

Gamble, C. (1991). The Social Context for European Palaeolithic Art. *Proceedings of the Prehistoric Society* 57: 3–15.

Garrod, D. A. E. (1938). The Upper Palaeolithic in the Light of Recent Discovery. *Proceedings of the Prehistoric Society* 4: 1–26.

Gavrilov, K. N. (2008). *Verkhnepaleoliticheskaia stoianka Khotylëvo 2.* Taus, Moscow.

Gavrilov, K. N., Voskresenskaya, E. V., Maschenko, E. N. & Douka, K. (2015). East Gravettian Khotylevo 2 site: Stratigraphy, archeozoology, and spatial organization of the cultural layer at the newly explored area of the site. *Quaternary International* 359–360: 335–346.

Giaccio, B., Rolfo, M. F., Bozzato, S., Galadini, F., Messina, P., Silvestrini, M. & Sposato, A. (2004). La risposta ambientale ed umana alle oscillazioni climatiche sub-orbitali dell'OIS3: evidenze geoarcheologiche dalla Piana di Colfiorito (Appennino centrale). *Il Quaternario* 17 (2/1): 239–256.

Giaccio, B., Isaia, R., Fedele, F., Dicanzio, E., Hoffecker, J., Ronchitelli, A., Sinitsyn, A. A., Anikovich, M. V., Lisitsyn, S. N. & Popov, V. V. (2008). The Campanian Ignimbrite and Codola tephra layers: Two temporal/stratigraphic markers for the Early Upper Palaeolithic in southern Italy and eastern Europe. *Journal of Volcanology and Geothermal Research* 177 (1): 208–226.

González-Sampériz, P., Valero-Garcés, B. L., Moreno, A., Jalut, G., García-Ruiz, J. M., Martí-Bono, C., Delgado-Huertas, A., Navas, A., Otto, T. & Dedoubat, J. J. (2006). Climate variability in the Spanish Pyrenees during the last 30,000 yr revealed by the El Portalet sequence. *Quaternary Research* 66: 38–52.

Grigor'ev, G. P. (1993). The Kostenki–Avdeevo Archaeological Culture and the Willendorf–Pavlov–Kostenki–Avdeevo Cultural Unity. *In:* O. Soffer & N. D. Praslov (Eds.) *From Kostenki to Clovis: Upper Paleolithic — Paleo-Indian Adaptations.* Plenum Press, New York, 51–65.

Haesaerts, P., Damblon, F., Sinitsyn, A. A. & van der Plicht, J. (2004). Kostienki 14 (Voronezh, Central Russia): New data on stratigraphy and radiocarbon chronology. *In:* M. Dewez, P. Noiret & E. Teheux (Eds.) *Acts of the XIVth UISPP Congress, University of Liège, Belgium, 2–8 September 2001: Section 6, The Upper Palaeolithic: General Sessions and Posters.* BAR International Series 1240. Archaeopress, Oxford, 169–180.

Haesaerts, P., Chekha, V. P., Damblon, F., Drozdov, N. I., Orlova, L. A. & van der Plicht, J. (2005). The loess-palaeosol succession of Kurtak (Yenisei basin, Siberia): a reference record for the Karga stage (MIS 3). *Quaternaire* 16 (1): 3–24.

Haesaerts, P., Borziac, I., Chekha, V. P., Chirica, V., Drozdov, N. I., Koulakovska, L., Orlova, L. A., van der Plicht, J. & Damblon, F. (2010a). Charcoal and wood remains for radiocarbon dating Upper Pleistocene loess sequences in Eastern Europe and Central Siberia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 291 (1-2): 106–127.

Haesaerts, P., Bachner, M., Borziac, I., Chirica, V., Damblon, F., Drozdov, N., Koulakovska, L. & Pirson, S. (2010b). New Insight on the Environmental Background and the Chronology of the Early Upper Palaeolithic in Central Europe. *In:* C. Neugebauer-Maresch & L. R. Owen (Eds.) *New Aspects of the Central and Eastern European Upper Palaeolithic — methods, chronology, technology and subsistence (Symposium by the Prehistoric Commission of the Austrian Academy of Sciences, Vienna, November 9–11, 2005).* Österreichischen Akademie der Wissenschaften, Vienna, 9–25.

Higham, T. F. G. (2011). European Middle and Upper Palaeolithic radiocarbon dates are often older than they look: problems with previous dates and some remedies. *Antiquity* 85: 235–249.

Higham, T. F. G., Jacobi, R. M. & Bronk Ramsey, C. (2006). AMS radiocarbon dating of ancient bone using ultrafiltration. *Radiocarbon* 48 (2): 179–95.

Higham, T. F. G., Jacobi, R. M., Basell, L., Bronk Ramsey, C., Chiotti, L. & Nespoulet, R. (2011). Precision dating of the Palaeolithic: A new radiocarbon chronology for the Abri Pataud (France), a key Aurignacian sequence. *Journal of Human Evolution* 61: 549–563.

Hoffecker, J., Holliday, V., Anikovich, M. V., Sinitsyn, A. A., Popov, V. V., Lisitsyn, S. N., Levkovskaya, G. M., Pospelova, G. A., Forman, S. & Giaccio, B. (2008). From the Bay of Naples to the River Don: the Campanian Ignimbrite eruption and the Middle to Upper Paleolithic transition in Eastern Europe. *Journal of Human Evolution* 55 (5): 858–870.

Holliday, V., Hoffecker, J., Goldberg, P., Macphail, R., Forman, S., Anikovich, M. V. & Sinitsyn, A. A. (2007). Geoarchaeology of the Kostenki–Borshchevo sites, Don River Valley, Russia. *Geoarchaeology* 22 (2): 181–228.

Jacobi, R. M., Higham, T. F. G., Haesaerts, P., Jadin, I. & Basell, L. S. (2010). Radiocarbon chronology for the Early Gravettian of northern Europe: new AMS determinations for Maisières-Canal, Belgium. *Antiquity* 84: 26–40.

Jöris, O., Neugebauer-Maresch, C., Weninger, B. & Street, M. (2010). The Radiocarbon Chronology of the Aurignacian to Mid-Upper Palaeolithic Transition along the Upper and Middle Danube. *In:* C. Neugebauer-Maresch & L. R. Owen (Eds.) *New Aspects of the Central and Eastern European Upper Palaeolithic — methods, chronology, technology and subsistence (Symposium by the Prehistoric Commission of the Austrian Academy of Sciences, Vienna, November 9–11, 2005).* Österreichische Akademie der Wissenschaften, Vienna, 101–137.

Klaric, L. (2007). Regional groups in the European Middle Gravettian: a reconsideration of the Rayssian technology. *Antiquity* 81: 176–190.

Klaric, L. (2013). Faciès lithiques et chronologie du Gravettien du sud du Bassin parisien et de sa marge sud-occidentale. *In:* P. Bodu, L. Chehmana, L. Klaric, L. Mevel, S. Soriano & N. Teyssandier (Eds.) *Le Paléolithique supérieur ancien de l'Europe du Nord-Ouest. Réflexions et synthèses à partir d'un projet collectif de recherche sur le centre et le sud du Bassin parisien. Actes du colloque de Sens (15-18 avril 2009).* Mémoire LVI de la Société préhistorique française. Société préhistorique française, Paris, 61-87.

Klein, R. G. (1969). *Man and Culture in the Late Pleistocene: A case study.* Chandler Publishing Company, San Francisco.

Kozłowski, J. K. (1986). The Gravettian in Central and Eastern Europe. *Advances in World Archaeology* 5: 131–200.

Kozłowski, J. K. (2015). The origin of the Gravettian. *Quaternary International* 359–360: 3–18.

Lane, C. S., Brauer, A., Blockley, S. P. E. & Dulski, P. (2013). Volcanic ash reveals time-transgressive abrupt climate change during the Younger Dryas. *Geology*. 41: 1251–1254.

Lisitsyn, S. N. (2011). Gravettiiskii kompleks stoianki Borshchëvo 5 v Kostënkovsko-Borshchëvskom raione na Dony. *In:* K. N. Gavrilov (Ed.) *Paleolit i Mezolit Vostochnoi Evropy.* Institut arkheologii RAN/Taus, Moscow, 204–225.

Lisitsyn, S. N. (2015). The late Gravettian of Borshevo 5 in the context of the Kostenki-Borshevo sites (Don basin, Russia). *Quaternary International* 359–360: 372–383.

Litouchanka [Litovchenko], L. M. (1966). Palealitȳchnaya stayanka Biruchȳ Log (Kastsënki IX) [in Belarusian]. *Vestsi Akadémii Navuk Belaruskaĭ SSR (Serȳya hramadskikh navuk)* 3: 110–116.

Litovchenko, L. M. (1969). Tel'manskaia paleoliticheskaia stoianka (II kul'turnyi sloi). *Sovetskaia Arkheologiia* 3: 110–123.

Marom, A., McCullagh, J. S. O., Higham, T. F. G., Sinitsyn, A. A. & Hedges, R. E. M. (2012). Single amino acid radiocarbon dating of Upper Paleolithic modern humans. *Proceedings of the National Academy of Sciences* 109 (18): 6878–6881.

Moreau, L. (2010). Geißenklösterle. The Swabian Gravettian in its European context. *Quartär* 57: 79–93.

Moreau, L. (2012). Le Gravettien ancien d'Europe centrale revisité : mise au point et perspectives. *L'anthropologie* 116 (5): 609–638.

Noiret, P. (2013). De quoi Gravettien est-il le nom ? *In:* M. Otte (Ed.) *Les Gravettiens.* Éditions Errance, Paris, 29–64.

Praslov, N. D. & Rogachëv, A. N. (Eds.) (1982). *Paleolit kostënkovsko-borshchëvskogo raiona na Donu 1879–1979: Nekotorye itogi polevykh issledovanii.* Nauka, Leningrad.

Pyle, D. M., Ricketts, G. D., Margari, V., van Andel, T. H., Sinitsyn, A. A., Praslov, N. D. & Lisitsyn, S. N. (2006). Wide dispersal and deposition of distal tephra during the Pleistocene 'Campanian Ignimbrite/Y5' eruption, Italy. *Quaternary Science Reviews 25* (21–22): 2713–2728.

Rasmussen, S. O., Bigler, M., Blockley, S. P., Blunier, T., Buchardt, S. L., Clausen, H. B., Cvijanovic, I., Dahl-Jensen, D., Johnsen, S. J., Fischer, H., Gkinis, V., Guillevic, M., Hoek, W. Z., Lowe, J. J., Pedro, J. B., Popp, T., Seierstad, I. K., Steffensen, J. P., Svensson, A. M., Vallelonga, P., Vinther, B. M., Walker, M. J. C., Wheatley, J. J. & Winstrup, M. (2014). A stratigraphic framework for abrupt climatic changes during the Last Glacial period based on three synchronized Greenland ice-core records: refining and extending the INTIMATE event stratigraphy. *Quaternary Science Reviews* 106: 14–28.

Reimer, P., Bard, E., Bayliss, A., Beck, J., Blackwell, P., Bronk Ramsey, C., Buck, C., Cheng, H., Edwards, R. L., Friedrich, M., Grootes, P., Guilderson, T., Haflidason, H., Hajdas, I., Hatté, C., Heaton, T., Hoffmann, D., Hogg, A., Hughen, K., Kaiser, K., Kromer, B., Manning, S., Niu, M., Reimer, R., Richards, D., Scott, E., Southon, J., Staff, R., Turney, C. & van der Plicht, J. (2013). IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50 000 Years cal BP. *Radiocarbon* 55: 1869–1887.

Reynolds, N. (2014a). Chronology of the Mid Upper Palaeolithic of European Russia: Problems and prospects. *In:* F. W. F. Foulds, H. C. Drinkall, A. Perri, D. T. G. Clinnick & J. W. P. Walker (Eds.) *Wild Things: Recent advances in Palaeolithic and Mesolithic Research, Proceedings of the Where The Wild Things Are conference, Durham, March 23-24, 2012.* Oxbow Books, Oxford, 1–11.

Reynolds, N. (2014b). *The Mid Upper Palaeolithic of European Russia: chronology, culture history and context. A study of five Gravettian backed lithic assemblages*. DPhil thesis, University of Oxford, Oxford.

Roe, D. (1971). *Prehistory: An introduction.* Paladin, London.

Rogachëv, A. N. (1955). Kostënki IV — Poselenie drevnekamennogo veka na Donu. *Materialy i issledovaniia po arkheologii SSSR* 45: 9–161.

Rogachëv, A. N. (1957). Mnogosloinye stoianki kostënkovsko-borshëvskogo raiona na Donu i problema razvitiia kul'tury v epokhu verkhnego paleolita na Russkoi ravnine. *Materialy i issledovaniia po arkheologii SSSR* 59: 9–134.

Rogachëv, A. N. & Anikovich, M. V. (1982). Kostënki 4 (Aleksandrovskaia stoianka). *In:* N. D. Praslov & A. N. Rogachëv (Eds.) *Paleolit kostënkovsko-borshchëvskogo raiona na Donu 1879–1979: Nekotorye itogi polevykh issledovanii.* Nauka, Leningrad, 76–85.

Rogachëv, A. N., Anikovich, M. V. & Dmitrieva, T. N. (1982). Kostënki 8 (Tel'manskaia stoianka). *In:* N. D. Praslov & A. N. Rogachëv (Eds.) *Paleolit kostënkovsko-borshchëvskogo raiona na Donu 1879–1979: Nekotorye itogi polevykh issledovanii.* Nauka, Leningrad, 92–109.

Rogachëv, A. N. & Anikovich, M. V. (1984). Pozdnii paleolit Russkoi ravniny i Kryma. *In:* P. I. Boriskovskii (Ed.) *Paleolit SSSR*. Nauka, Moscow, 162–271.

Romanowska, I. (2012). Ex Oriente Lux: a Re-Evaluation of the Lower Palaeolithic of Central and Eastern Europe. *In:* K. Ruebens, I. Romanowska & R. Bynoe (Eds.) *Unravelling the Palaeolithic: Ten years of research at the Centre for the Archaeology of Human Origins (CAHO, University of Southampton).* BAR International Series 2400. Archaeopress, Oxford, 1–13.

Sanchez Goñi, M. & Harrison, S. (2010). Millennial-scale climate variability and vegetation changes during the Last Glacial: Concepts and terminology. *Quaternary Science Reviews* 29 (21-22): 2823–2827.

Sedov, S. N., Khokhlova, O. S., Sinitsyn, A. A., Korkka, M. A., Rusakov, A. V., Ortega, B., Solleiro, E., Rozanova, M. S., Kuznetsova, A. M. & Kazdym, A. A. (2010). Late Pleistocene Paleosol Sequences as an Instrument for the Local Paleographic Reconstruction of the Kostenki 14 Key Section (Voronezh Oblast) as an Example. *Eurasian Soil Science* 43 (8): 876–892.

Sinitsyn, A. A. (2004). Les sépultures de Kostenki: chronologie, attribution culturelle, rite funéraire. *In:* M. Otte (Ed.) *La Spiritualité: Actes du colloque de la commission 8 de l'UISPP (Paléolithique supérieur), Liège, 10-12 décembre 2003.* Études et Recherches Archéologiques de l'Université de Liège 106, Liège, 237–244.

Sinitsyn, A. A. (2007). Variabilité du Gravettien de Kostienki (Bassin moyen du Don) et des territoires associés. *Paléo* 19: 181–202.

Sinitsyn, A. A. (2013). Gravett Kostënok v kontekste gravetta Vostochnoi Evropy. *In:* G. V. Sinitsyna (Ed.) *Problemy zaseleniia severo-zapada Vostochnoi Evropy v verkhnem i final'nom paleolite (kul'turno-istoricheskie protsessy).* IIMK RAN, Saint Petersburg, 4–32.

Soulet, G., Ménot, G., Garreta, V., Rostek, F., Zaragosi, S., Lericolais, G. & Bard, E. (2011). Black Sea "Lake" reservoir age evolution since the Last Glacial — Hydrologic and climatic implications. *Earth and Planetary Science Letters* 308: 245–258.

Stevens, T., Marković, S. B., Zech, M., Hambach, U. & Sümegi, P. (2011). Dust deposition and climate in the Carpathian Basin over an independently dated last glacial–interglacial cycle. *Quaternary Science Reviews* 30: 662–681.

Stevens, R.E., Balasse, M. & O'Connell, T.C. (2011). Intra-tooth oxygen isotope variation in a known population of red deer: Implications for past climate and seasonality reconstructions. *Palaeogeography, Palaeoclimatology, Palaeoecology* 301: 64–74.

Svezhentsev, Y. S. & Popov, S. G. (1993). Late Paleolithic Chronology of the East European Plain. *Radiocarbon* 35: 495–501.

Svoboda, J. A., Klíma, B., Jarošová, L. & Škrdla, P. (2000). The Gravettian in Moravia: climate, behaviour and technological complexity. *In:* W. Roebroeks, M. Mussi, J. Svoboda & K. Fennema (Eds.) *Hunters of the Golden Age.* University of Leiden Press, Leiden, 197–217.

Verpoorte, A. (2009). Limiting factors on early modern human dispersals: The human biogeography of late Pleniglacial Europe. *Quaternary International* 201 (1–2): 77–85.

Wilczyński, J., Wojtal, P., Łanczont, M., Mroczek, P., Sobieraj, D. & Fedorowicz, S. (2015). Loess, flints and bones: Multidisciplinary research at Jaksice II Gravettian site (southern Poland). *Quaternary International* 359–360: 114–130.

Zheltova, M. N. (2009). Kostenki-4: The position of artifacts in space and time (The analysis of the cultural layer). *Archaeology, Ethnology and Anthropology of Eurasia* 37 (2): 19–27.

Zheltova, M. N. (2011). Ostriia aleksandrovskogo tipa: kontekst, morfologiia, funktsiia. *In:* K. N. Gavrilov (Ed.) *Paleolit i Mezolit Vostochnoi Evropy.* Institut arkheologii RAN/Taus, Moscow, 226–234.

Zheltova, M. N. (2015). Kostenki 4: Gravettian of the east – not Eastern Gravettian. *Quaternary International* 359–360: 362–371.

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