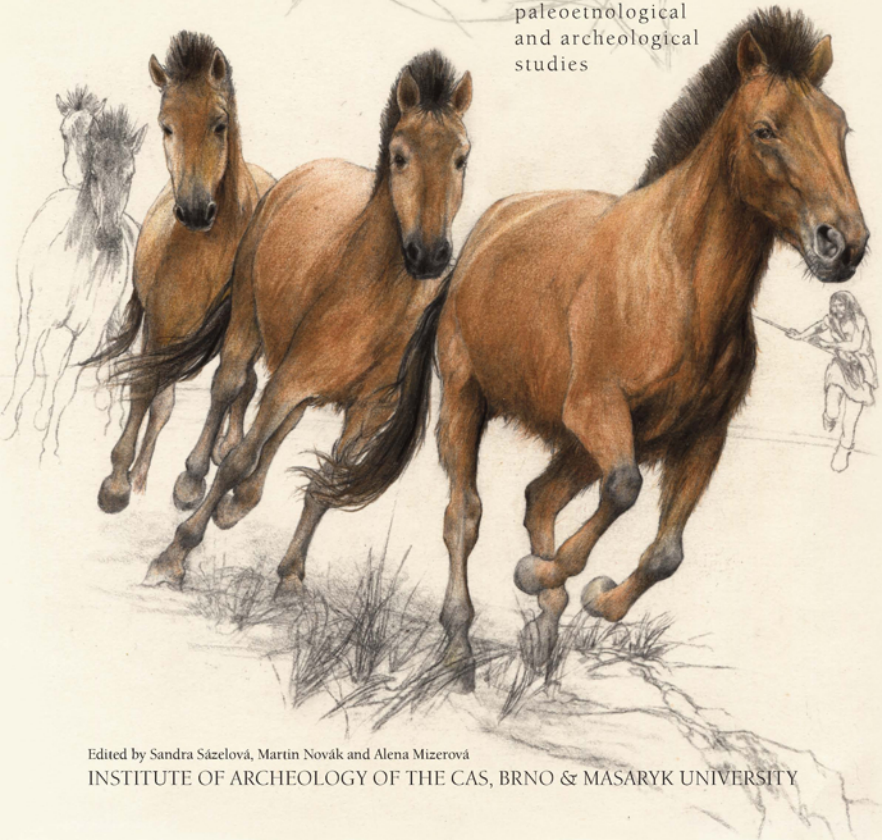
FORGOTTEN TIMES AND SPACES

New perspectives in paleoanthropological, paleoetnological and archeological studies



Edited by Sandra Sázelová, Martin Novák and Alena Mizerová

INSTITUTE OF ARCHEOLOGY OF THE CAS, BRNO & MASARYK UNIVERSITY

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and Alena Mizerová

INSTITUTE OF ARCHEOLOGY OF THE CZECH
ACADEMY OF SCIENCES, BRNO, V. V. I.
& MASARYK UNIVERSITY
BRNO 2015

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ISBN 978-80-7524-001-9 (online : pdf) (Archeologický ústav AV ČR. Brno)
ISBN 978-80-210-7782-9 (online : pdf) (Masarykova univerzita. Brno)
ISBN 978-80-7524-000-2 (hardback) (Archeologický ústav AV ČR. Brno)
ISBN 978-80-210-7781-2 (hardback) (Masarykova univerzita. Brno)

DOI: 10.5817/CZ.MUNI.M210-7781-2015

This monograph is dedicated to Jiří Svoboda

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FOREWORD

Human lives and their evolution are spanned throughout different times and various spaces. Nevertheless, their destiny might seem inexorable, for the witnesses, their memories or tangible evidences are slowly forgotten. This book displays two main efforts – on one hand in collecting and describing the shreds of previous and yet forgotten lifestyles, and on the other in reflecting the scope of Jiří Svoboda's physical and intellectual cooperation with all our contributors, even if they were looking just for inspiration in his work.

We would like to thank to the Institute of Archeology of the Academy of Sciences of the Czech Republic in Brno and Masaryk University for their financial and technical support. We are grateful to Pavel Dvorský for drawings, to Roland Nespoulet & Dominique Henry-Gambier, Luc Moreau, Laurent Klaric, Walpurga Antl, Marc Händel and Alexander Pryor for their help with French, German and English corrections and translations; to Angela Perri and Philip Nighst for their reviews, to Ivan Ruller & Valér Kováč for their unique photo documents and drawings from the Libyan expedition in 1979–1981; to Margherita for portrait of J. Svoboda, and to Petra Hájková & Lea Novotná for their brave and often ungrateful help in typing and reference-proofs. The main English work was done by company Proof-reading-Service.com.

Sandra Sázelová, Martin Novák and Alena Mizerová

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WHAT DO AUSTRIAN PUPILS KNOW ABOUT HUMAN EVOLUTION? A SURVEY IN SECONDARY SCHOOLS

Gerhard W. Weber and Cornelia Fitsch

Abstract
This article discusses the importance of education in human evolution for modern developed societies and makes an attempt to evaluate the current status-quo in Austria. In a pilot study 157 pupils at the end of their final school year (aged 18–20) of four Austrian federal states (Lower Austria, Upper Austria, Styria and Vienna) and all kinds of types of school were included. By means of a questionnaire background information about the general structure of the class and the education in biology was gathered. The second part of the questionnaire tried to assess the pupils' actual knowledge in human evolution. Moreover, structured interviews with school and university teachers as well as with didactic and paleoanthropology experts were conducted and analysed. In summary, human evolution is taught in most of the secondary schools in Austria, although the extent can be regarded as minor, particularly *vis-à-vis* the disciplines of cell and molecular biology, and often with only little or no relation to the current scientific literature. The use of demonstration material in class increased the knowledge significantly. Religious creation myths such as Intelligent Design and Creationism do not seem to have a big influence in our Austrian sample. There is a good chance for improvements since the survey highlights the distinct interest of pupils in biology and human evolution. Cross links from evolution to other topics might improve the understanding of this complex issue considerably.

Keywords
Human evolution, education, secondary school, questionnaire study, Austria

DOI: 10.5817/CZ.MUNI.M210-7781-2015-1

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Introduction

The topic "human evolution" is more or less exotic for the layman but there is hardly any educated citizen who is entirely unresponsive when it comes to the question of our own biological roots. Every now and then public media report sensational findings, for instance, when a new species or "ancestor" is discovered. These waves of attention are like tsunamis – short lasting but huge – and capture virtually all channels from high quality to tabloid press, TV and radio stations, and of course all kinds of online media. While we can be sure that the topic comes into the popular focus occasionally, the question remains what the average citizen knows about human evolution? And why should (s)he bother anyway?

Particularly the last decades have shown rapid progress in developing methods in the field and a rapid increase in the number and completeness of unearthed fossils. The picture that we can draw based on hard evidence becomes finer. In addition, molecular and genetic sciences support one or another scenario for geographical dispersal and admixture or raise doubts on traditional views such as the separateness of species. Moreover, ethologists working with extant primates or evolutionary psychologists widen our horizon on how our typical traits such as human perception and language might have evolved. Is anything of that relevant for our daily lives? Not so much if our goal is just to survive until the next day. However, to understand how groups of organisms develop over time and how humans and their societies act and interact, in the long run it seems advisable to learn from our unwritten history deep in the past. Sexual dimorphism, to mention just one obvious example, affects our daily life. Not only have sex differences in medicine (Miller 2014) became important since the 1990s but also the hurdles in overcoming gender inequalities are more likely to be understood if taking into account our biological and cultural evolution. This is not a statement out of biologism. Our genes co-determine our phenotype and are the product of a long evolution. While some traits selected in the past might have been favorably then, they could create trouble in our new lifestyle. Diabetes, impacted wisdom teeth, infarction and other problems might be better understood if we consider the conditions for which our bodies were shaped. Besides such practical considerations, knowing about our origin is mainly an intellectual endeavor, of no less and no more merit than writing opera or flying to the moon. If one appreciates those merits, one can also argue that, at least in a wealthy and educated society, people should be aware of where they come from (which might also help to understand where we might be heading in the future).

While in general the wealth of evidence for evolution, and human evolution in particular, leaves no question mark about its existence, for some people the safe harbor of religious beliefs is still stronger. Two religious creation myths, Intelligent Design and Creationism, have gained more and more influence in the USA over the last decades (http://ncse.com/creationism/general/what-is-intelligent-design-creationism) which had has an impact on biological education at US-American high schools, e.g., in Kansas (http://ncse.com/news/2005/11/antievolution-standards-adopted-kansas-

00626; http://ncse.com/news/2007/02/evolution-returns-to-kansas-001070), and led to calls for "anti-evolution bills". This situation is unfortunately not limited to the United States, there is a real danger that this movement might cross to Europe and other countries (Gross 2002; Cornish-Bowden and Cárdenas 2007; Curry 2009; Borczyk 2010). So we can find an additional motivation why we should be careful with educating our young people in evolution, in Central Europe and also in Austria, where the head of the largest religious group (Roman Catholics) supports Intelligent Design (Schönborn 2005).

According to the European statistics office Eurostat, Austria in 2013 was the second richest country in the European Union measured as the Gross Domestic Product (GDP) per capita (http://epp.eurostat.ec.europa.eu/tgm/mapToolClosed.do?tab=map&init=1&plugin=1&language=en&pcode=tec00114&toolbox=types). So there is no reason to believe that educational standards in Austria should be far behind other countries, though there are some discussions going on with regard to other educational management issues (https://www.bifie.at/node/90). In a small pilot study to which we refer here (Fitsch 2011), we tried to investigate how much graduates, who are just about to leave the Austrian secondary schools (called "Gymnasium"), know about human evolution. Their knowledge should have reached a "peak" when they were interviewed because our respondents had just passed the school leaving examination (called "Matura") a few weeks or even days before filling out our questionnaire. The last reform of the syllabus for biology lessons in those secondary schools (BGBl II Nr. 277/2004, p. 53) resulted in a strong degradation of the topic human evolution *vis-à-vis* the disciplines of cell and molecular biology. Human evolution is no longer mentioned explicitly, which practically means it can be, but is not necessarily, taught. With regard to the developments mentioned above, there should be a vital interest of developed societies to promote general education in higher schools as well as the education of the general public with regard to its own biological origins, and, of course, to consider the related training at universities.

Material and methods

We included 157 pupils at the end of their final school year (aged 18–20) of four Austrian federal states (Lower Austria, Upper Austria, Styria and Vienna) and all kinds of types of "gymnasium" which have various specialities, e.g., humanities, natural sciences, technology, economics, sport, etc.

All of them were asked to fill in the same questionnaire. One part of the questions dealt with the general structure of the class and the education in biology:

- Which school was attended?
- How many years of education in biology were passed?
- Was the topic of human evolution treated?
- How many lessons were handling human evolution?
- Was demonstration material used for teaching human evolution?

- If yes, which ones?
- Do you remember the author and title of the school book used?
- Do you think that real models (casts) could support the understanding of human evolution?
- Do you have other ideas to improve the education in human evolution?
- How would you describe the biology lessons in general?
- Are you personally interested in human evolution?

The second part of the questionnaire tried to assess the pupil's actual knowledge in human evolution (see below). Moreover, structured interviews with university teachers who are responsible for the education of future biology teachers at the University of Vienna (among them the head of the Didactic centre for biology and the chairman of the Study group in biology), ten international experts in paleoanthropology [namely Sarah Elton (Hull York Medical School), Dean Falk (Florida State U), Donald Johanson (U Chicago), Andrew Kramer (U Tennessee), Gerd Müller (U Vienna), Jeffrey Schwartz (U Pittsburgh), Horst Seidler (U Vienna), Tanya Smith (Harvard U & MPI Leipzig), Fred Smith (U Illinois State), Ian Tattersall (AMNH New York City)], eight biology teachers in Austrian secondary schools, and one prominent German expert in didactics (namely Prof. Ulrich Kattmann, Carl von Ossietzky University Oldenburg) were included. The international experts in paleoanthropology were asked to describe the situation in their countries, their experience with first-year students, and their opinion about what should be taught in human evolution.

Results and discussion

The overall results draw a fairly positive first picture. More than 75% of the Austrian pupils included in this study were generally interested in human evolution, and 87% had the opportunity to hear about the topic in school. A similar outcome was achieved from the interviews of teachers. Most of the pupils were also aware of at least two important facts: 70% knew that our closest living relative is the chimpanzee, and almost 80% answered that the relative size of the brain correlates with its performance.

However, other questions, even quite simple ones as, for instance, the approximate period when our own species emerged, could not be answered correctly by even half of the pupils, some others only by an absolute minority of one or two individuals. Particularly it seems that there is a need to catch up with present-day developments. While, as noted, most of the pupils got in touch with the topic human evolution, they were not well informed about more current findings in this field of research (where we define "current" as having emerged from the last ten or twenty years). Instead, outdated "wisdom" seems to persist for quite long. The prime example is the direct connection between bipedalism and tool production which still dominates the perception of 17% of the respondents. We have evidence for upright locomotion from *Ardipithecus ramidus* from about 4.4 million years ago (White *et al*. 2009) and very likely also for *Orrorin tugenensis* from 6 million years ago (Pickford *et al*. 2002). The first stone tools, in contrast, emerge millions of years

later (3.3 mya) in Lomekwi (Harmand *et al*. 2015; the indirect evidence for tool use based on cutmarks in Dikika 3.4 mya is rather vague and heavily disputed, see McPherron *et al*. 2010; Dominguez-Rodrigo *et al*. 2012). Of course we do not know if teachers obstinately continue to teach a view on hominid evolution dating from the 1960s or if pupils just stubbornly refuse to take notice of newer results. But at least at the teachers' front we could make some progress if we educate them further and provide newer books. There is of course always confusion about phylogenetic developments and their order in time. For instance, 7% of the pupils think that the formation of a vertebral column is one of the crucial developments of the last few million years that characterizes particularly humans. Obviously, there are not only gaps in knowledge about human evolution but with regard to evolution of vertebrates and invertebrates per se.

Things are changing fast in evolutionary sciences. Thus it is not easy to keep an up-to-date overview, even for experts and teachers. The question of who is currently the oldest known hominid in our potential ancestral line is difficult and cannot be answered with confidence. The intended choice in our questionnaire would have been *Sahelanthropus tchadensis*, published in 2002 by Brunet *et al*. Only two pupils (1.3%) checked this box, about three-quarters opted for australopithecines or *Homo erectus*. Sahelanthropus' position in the hominid line is unclear, nevertheless we would have expected that this spectacular finding dating from 7–6 mya and, not less important, originating from Central Africa instead of East Africa, would have made its way into the class room. On a closer look it turned out that the two successful subjects with regard to this question (out of 157) had both chosen human evolution as their major.

While we might consider the oldest hominid, which is in doubt anyway, as a minor gap in knowledge, the period when we anatomically modern humans appeared is certainly something central for education. More than a quarter (26.8%) of the pupils were stumped and gave no answer at all (the highest percentage for all questions), 10% opted for the correct dimension "200, 000 years", 17% for the adjacent time interval "50, 000 years" (which is true at least for Europe) and 11.5% chose "500, 000 years". Hence there is a strong tendency to under- or overestimate the time frame. In the extreme case, some pupils (1.3%) thought that modern humans did not emerge before 1,000 years ago, which would exclude Aristotle, Caesar, and Attila the Hun from our current species. Further 16% are of the mind that modern humans appeared only 10, 000 years ago which is approximately the onset of our civilization, but not of our biological rise.

The extent to which biology lessons were conducted in those schools involved in our study was quite similar. On average, biology is taught for three years in secondary schools, 54% of the pupils had no more than a meager one to four hours (in total over the years) devoted to human evolution, around 24% five to six hours, and only 7.6% heard more on the topic which was only due to the special interest of their teachers. Demonstration materials such as written und visual supplementations in the shape of TV documentaries and slide presentations are used frequently. Casts of human fossils are used more rarely (only about 34%) because they need too much

time for handling and, as some teachers claimed, are not too informative. However, the polled teachers would be interested in new teaching aids, but mostly under the condition if they are offered together with time-saving working sheets for the class. The financial aspect also seems to be an important part in the acquisition of new demonstration materials, as teachers stated.

The training of future teachers at universities can be characterized as being rudimentary with regard to human evolution. There is no obligatory specialized course regarding this topic during their education. The university professors interviewed could confirm this situation and added that freshmen in biology hardly increase their knowledge about human evolution during their studies. The education at colleges in the United States is also similarly rudimentary, as some experts reported.

The results here concern only alumni of secondary schools, thus schools which focus on general education. We left out professional schools (for instance, technical schools) because there is often no biology class at all. The polled university professors, especially the paleoanthropologists in the US, think that human evolution should be part of the school curriculum in any case. With regard to the extent of such an education, even the experts do not agree. Nevertheless, the interviewed professors stated that younger pupils, approximately from ten years of age, are able to understand human evolution if it is offered adequately (Kattmann), and that the topic should be a central theme in all biology classes with connections to other fields as well (Pass). Attention should also be drawn on geological epochs because pupils have comprehension problems with this field of science (Elton).

Our results also show that there is a significant association between the use of demonstration materials and the knowledge about human evolution. A score of correct answers for questions regarding hominid evolution was computed. Those pupils who stated that demonstration materials had been used in class reached a significantly higher score than the others ($Z = -2.185$, $p = 0.029$). This suggests that it could be favourable if the frequency for using demonstration materials would be increased. No other variable (schools with focus on natural science vs. others, more years of biology vs. less years, touching the topic of human evolution in biology vs. avoiding the topic, using fossil casts vs. not using them, interest in biology vs. disinterest, particular interest in human evolution vs. disinterest) led to any significant difference in the scoring of knowledge.

Conclusions

In summary, human evolution is taught in most of the secondary schools in Austria, although the extent can be regarded as minor, and often with only little or no relation to the current scientific literature. The religious creation myths such as Intelligent Design and Creationism do not seem to have a big influence in our Austrian sample (only 5% stated that humans do not derive from ancestral primates). There is a good chance for improvements since the survey highlights the distinct interest of pupils in biology and human evolution. This interest influences the knowledge of the pupils in a positive way and should be brought forward. Education in human evolution

could be started in lower grades because children of this age are likely able to understand this topic, especially in companion with other topics in biology. Cross links from evolution to other topics might improve the understanding of this complex issue considerably, and at the same time create comprehension in other topics such as medicine or genetics (e.g., with regard to diseases of civilization). The reflexive question about one's own nature can only be approached if evolution is considered (cf. Simpson 1966) or, as C. T. Dobzhansky (1973) phrased it: "*Nothing in biology makes sense except in the light of evolution*". Otherwise the biology class offers only a shortened view on the question "How do we function", but it does not shed light on the question "Why are we functioning this way?".

Acknowledgements
We are deeply grateful to all the pupils who volunteered to take part in our survey. We also thank our interview partners for their time and willingness to participate: Sarah Elton, Dean Falk, Walter Hödl, Leo Holemy, Donald Johanson, Ulrich Kattmann, Andrew Kramer, Gerd Müller, Günther Pass, Luitfried Salvini-Plawen, Jeffrey Schwartz, Horst Seidler, Fred Smith, Tanya Smith, Ian Tattersall, and eight anonymous biology teachers at Austrian secondary schools. We particularly thank Mag. Sonnberger for his support.

Résumé
Cet article a pour but d´évaluer l´importance de l´éducation scolaire dans l´apprentissage de l´évolution humaine dans les sociétés contemporaines modernes, à lumière du statu quo actuel caractérisant le système éducationnel autrichien. Dans le cadre d´une étude pilote, 157 élèves de terminale, âgés de 18 à 20 ans, et issus de différents types de gymnases dans quatre entités fédérées (Basse Autriche, Haute Autriche, Styrie, Vienne) ont été interrogés. Un questionnaire a permis de faire le point sur la structure générale de la classe et le niveau d´apprentissage en biologie. La seconde partie du questionnaire visait à évaluer, plus particulièrement, le niveau de connaissance des élèves en matière d´évolution humaine. Enfin, des interviews structurées avec des enseignants, des professeurs d´université, ainsi que des experts en pédagogie et en paléoanthropologie, ont été menées et analysées. Bien que l´évolution humaine soit enseignée dans la plupart des écoles secondaires en Autriche, notre étude démontre que son importance est mineure, par rapport aux domaines de la biologie cellulaire et moléculaire. Par ailleurs, l´enseignement de l´évolution humaine n´est que rarement mis en relation avec la littérature scientifique récente. Or, il est avéré que l´emploi de matériel de démonstration en classe contribue significativement à l´enrichissement de la connaissance. Les mythes créateurs de type Intelligent Design et Créationnisme ne semblent pas exercer d´influence significative dans l´échantillon autrichien pris en compte. Les possibilités de perfectionnement sont nombreuses, d´autant plus que notre étude démontre tout l´intérêt porté par les élèves à la biologie en général, et à l´évolution humaine en particulier. Les liens croisés de l´évolution humaines avec d´autres thèmes devraient à l´avenir permettre d´améliorer considérablement la compréhension de ce champ d´étude complexe.

Zusammenfassung
Der Artikel diskutiert die Bedeutung der Bildung hinsichtlich menschlicher Evolution in modernen entwickelten Gesellschaften und macht den Versuch, die aktuelle Situation in

Österreich einzuschätzen. In einer Pilotstudie wurden 157 SchülerInnen nach Beendigung ihres letzten Schuljahres (im Alter von 18–20 Jahren) in vier österreichischen Bundesländern (Niederösterreich, Oberösterreich, Steiermark, Wien) und in verschiedensten Gymnasialtypen einbezogen. Mithilfe eines Fragebogens wurden Hintergrundinformationen über die generelle Struktur der Biologiestunden erhoben. Der zweite Teil des Fragebogens versuchte, das gegenwärtige Wissen der SchülerInnen zum Thema menschliche Evolution zu beurteilen. Darüber hinaus wurden strukturierte Interviews mit Schul- und UniversitätslehrerInnen geführt, sowie mit ExpertInnen in biologischer Didaktik und Paläoanthropologie. Zusammenfassend kann gesagt werden, dass menschliche Evolution in den meisten Oberstufen der Gymnasien in Österreich unterrichtet wird, wenngleich auch in einem sehr geringen Ausmaß, vor allem im Vergleich mit Zell- und Molekularbiologie. Auch weist der Unterricht nur sehr wenig bis gar keine Verbindung mit der gegenwärtigen wissenschaftlichen Literatur auf. Die Benutzung von Anschauungsmaterialien erhöhte das Wissen signifikant. Religiöse Kreationsmythen wie Intelligent Design oder Kreationismus scheinen noch keinen großen Einfluss in Österreich zu haben. Es gibt eine gute Chance für Verbesserungen, da die Studie das deutliche Interesse der SchülerInnen an Biologie und menschlicher Evolution belegt. Querverbindungen von der Evolution zu anderen Fachbereichen könnten beträchtlich helfen, das komplexe Thema verständlicher zu machen.

BEČOV IV – EIN FUNDORT DES JUNGACHEULÉEN IN BÖHMEN

Ivana Fridrichová-Sýkorová

Zusammenfassung
Obwohl Bečov IV eine Oberflächenfundstelle ist, stellen wir sie aufgrund der Analyse der Steinabschlagindustrie sowie der geologischen und geomorphologischen Ansprache an den Beginn des Mittelpaläolithikums, und zwar an den Anfang des Saaleglazials (OIS 8; vor ca. 300.000–250.000 Jahren). Kulturell gehört das Artefaktinventar mit der geringen Menge an Faustkeilen sowie mit dem Nachweis der Levalloistechnik bei der Verarbeitung des Steinrohmaterials in das Jungacheuléen. Für einen vergleichbaren Fundplatz halten wir Markkleeberg (Sachsen) in Deutschland.

Schlüsselworte
Mittelpaläolithikum, Typologie der Steinartefakte, Siedlungsstruktur, Tschechische Republik, Bečov

DOI: 10.5817/CZ.MUNI.M210-7781-2015-2

Einleitung

Das Areal der mittelpaläolithischen Besiedlung auf der Gemarkung der Gemeinden Bečov und Břvany kann heute auf einer Fläche von ca. 22 ha (das ursprüngliche Ausmaß betrug um die 60 ha) auf dem Südhang der Anhöhe „Písečný vrch“ (260 m ü. NN) erfasst werden (Abbildung 1). Aus makrogeologischer Sicht gehört dieses Gebiet zu den westlichen Ausläufern des Komotauer Abschnitts des nordböhmischen Braunkohlebeckens. Die Ostpartie ist Teil des „Eger-Mittelgebirges“ (Ohárecko-středohorská oblast) des böhmischen Kreidebeckens. Das gesamte Gebiet mit dem deutlich ausgeprägten Flusstal der Eger (Ohře) hat ein flaches bis sanft gewelltes Relief und wird überragt von den deutlichen Erhebungen der Neovulkanite.

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Abbildung 1: Ansicht des Fundorts Bečov IV. Vorn: Versickerung der Mineralquelle; im Hintergrund: die intensive Landwirtschaft bedingt die unwiederbringliche Zerstörung des Fundorts.

Bečov IV befindet sich im flachen Tal des Hrádecký-Bachs, der schon während der Besiedlung dieser Landschaft durch die Jäger des Jungacheuléen eine wichtige Entwässerungsachse des untersuchten Gebiets bildete. Die Landschaft wurde im Mittelpleistozän im Verlaufe des Elster-Komplexes geformt und ist im Wesentlichen bis in die Gegenwart erhalten geblieben.

Forschungsgeschichte und Geologie des Fundorts Bečov IV

Bečov IV wurde schon Mitte der 60er Jahre des 20. Jhdts. entdeckt (Fridrich 1980, 1982, 2005, 2007). Allerdings fanden die letzten Geländearbeiten erst Ende der 90er Jahre statt. Damals ist die Lokalität durch die intensive landwirtschaftliche Nutzung systematisch zerstört worden. Heute ist der Fundort Bečov IV praktisch vernichtet. Bedeutend für eine Beurteilung des untersuchten Fundorts ist seine Lage am Rand des breiten und flachen Tals am Unterlauf des Hrádecký-Bachs. Der Bach selbst

befindet sich 1.5 km südlich des mittelpaläolithischen Siedlungsareals. Das Tal ist von den deutlichen Erhebungen der Neovulkanite begrenzt, welche die umliegende Landschaft um 250 m überragen. Der Hauptfluss dieses Gebiets – die Eger – war ca. 3.5 km entfernt und floss schon damals in die heutige Richtung. Geschützt durch die umgebenden Neovulkanite nahm das Tal zur Zeit der Besiedlung durch die Jäger des Jungacheuléen eine mikroklimatisch sehr begünstigte Lage ein. Die Tatsache, dass sich das Siedlungsareal zum Süden hin am Fuß der Anhöhe „Písečný vrch", die die umliegende Landschaft um ungefähr 60 m überragt, befindet, hat dieses günstige Mikroklima noch gefördert. Überdies wird das Siedlungsareal von natürlichen Wasserquellen versorgt, die von Tiefenmineralwasser gespeist werden.

Eine wichtige Rolle für die Auswahl des Orts, die von den hohen Ansprüchen zeugt, die von den Jägern und Sammlern an die Lage des Siedlungsareals gestellt wurden, spielt die Anhöhe Písečný vrch, die als „strategischer Beobachtungsposten" genutzt werden konnte. Von hier aus konnte ein beträchtlicher Ausschnitt der umliegenden Landschaft kontrolliert werden, wie die Furt, der Flusslauf des Egers und das Delta des Hrádecký-Bachs. Diese Funktion der Anhöhe schließt auch eine Nutzung als Rückzugsgebiet nicht aus, was die in dem Abri an seinem Abhang dokumentierte Industrie des Acheuléen belegt. Das Vorkommen eines Rohstoffs von hervorragender Qualität – dem Quarzstein, dessen lokale Variante als Quarz vom Typ Bečov bezeichnet wird, bot einen weiteren Grund zur Besiedlung dieses Gebiets. Dieser Silizit stellt einen hoch amorphen, perfekt spaltbaren Steinrohstoff dar, welcher zur Zeit des Jungacheuléen in Bečov IV zur Hauptquelle bei der Herstellung der Abschlagindustrie (93.72%) wurde. Weitere Silizite, die die Ansprüche der Jäger und Sammler an das lithische Rohmaterial erfüllten, wurden nur ergänzend verwendet und stammen aus der näheren Umgebung, so etwa Porzellanite aus Verpánek (aus ca. 1 km Entfernung) oder aus Dobrčice (ca. 6.5 km), Gerölle aus den Anschwemmungen der Ur-Eger („Paleoohře") (ca. 3 km) sowie Quarze des Typs Skršín (ca. 5.5 km).

Typologie der Steinartefakte

Von der Oberflächenfundstelle Bečov IV konnte ein Inventar von insgesamt 5.577 Steinartefakten geborgen werden, die Spuren von Windschliff aufweisen (Abbildung 2). Diese wurden nach der klassischen Typologie in 25 Typen geordnet (die überdies noch in weitere Untertypen und Varianten differenziert wurden). Zu den technologischen Artefakten zählen wir Kerne (Abbildung 3), Abschläge, untypische Bruchstücke sowie sogenannte Thermolithe; zu den Geräten Bifaces s. l., Keile, Schlagsteine, Unterlagen, Schaber, Messer, Spitzen, Stichel, Bohrer, gekerbte Stücke, Schlägel, Meißel, Locher und Polyhedrone s. l. Im Fall der Kerne registrieren wir eine außerordentlich hohe Variationsbreite (insgesamt 11 Untertypen), die auf einen ausgeklügelten Prozess der Steinbearbeitung, z. B. bei den Levalloiskernen hinweist. Es treten allerdings auch amorphe Kerne auf, die von einer einfachen Gewinnungsart der Abschläge zeugen. Dieser Trend hängt vermutlich mit der hohen Verfügbarkeit des Steinrohmaterials zusammen. Die Abschläge (unterschiedliche

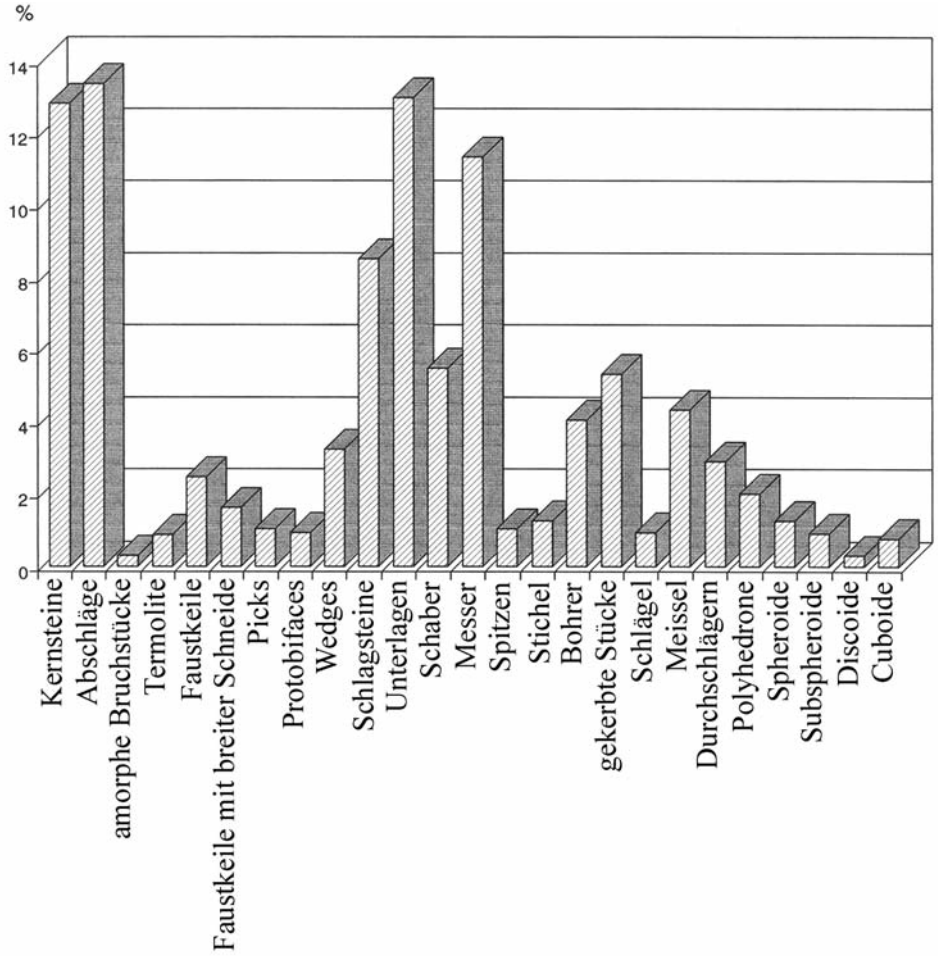

Abbildung 2: Bečov IV bei Most. Beispiele einzelner Typen der Steinabschlagindustrie.

Formen von Levalloisabschlägen), die sich durch eine hohe handwerkliche Qualität auszeichnen, stützen diese Beobachtung. Andererseits befinden sich im Inventar auch grobe massive Abschläge (gelegentlich direkt für konkrete Arbeitsaktivitäten wie Schneiden oder Hacken bestimmt) ohne Spuren einer vorangegangenen komplexen Zurichtung.

Im Zusammenhang mit technologischen Artefakten sollte das Vorkommen der sogenannten Thermolithen erwähnt werden. Diese belegen die Verwendung von Kochsteinen und damit auch die Feuernutzung in diesem Siedlungsareal. Im Fall der Geräte treten Typen auf, die mit der altpaläolithischen Tradition in Verbindung stehen. Zu diesen können nicht nur die Bifaces s. l., wie Faustkeile, Faustkeile mit breiter Schneide, Picks, Protobifaces, sondern auch die Polyhedrone, wie Spheroide, Subspheroide, Discoide und Cuboide u.a. gezählt werden. Während die Bifaces eine gewisse Formenfreiheit bei der Herstellung zeigen, müssen die Polyhedrone als sehr konservativ bewertet werden.

Die Standardausstattung im Inventar bilden die Schaber. Diese können in 22 Varianten unterteilt werden. Vor allem Schaber mit gekerbter oder gezähnter Kante

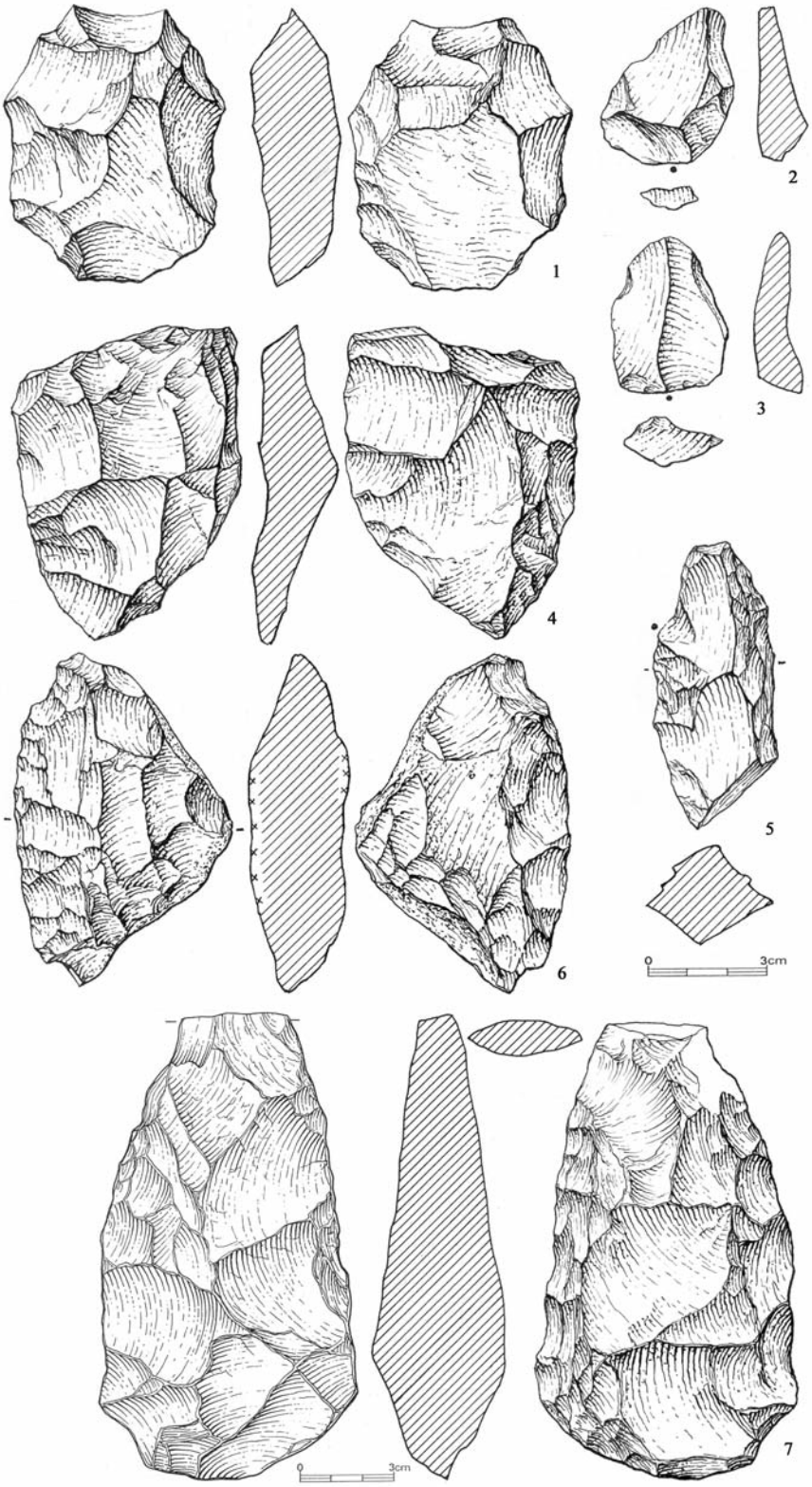

Abbildung 3: Bečov IV bei Most. Die Steinabschlagindustrie. Legende: 1 – Diskuskern; 2, 3 – Levalloisabschläge; 4 – Levalloiskern; 5 – Spitze des Typs Quinson; 6 – Keilmeser; 7 – Langgestreckter Faustkeil.

und kurz retuschierte Schaber sind typisch. Ähnlich häufig kommen Messer (in 11 Varianten unterteilt) vor. Es handelt sich um Keilmesser und Messer mit Stichelschlag, d. h. irgendeine Art „Proto-Prondnikmesser". Die Spitzen treten in zehn Varianten im Inventar auf. Es sollen hier vor allem die Blattspitzen sowie die Spitzen des Typs Quinson erwähnt werden. Das gewählte Rohmaterial bedingt offenbar den geringen Anteil der Schlägel. Das Vorkommen der Locher ist mit der Bearbeitung der organischen Materialien – vor allem von Leder – verbunden. Eine große Gruppe unter den Geräten stellen Schlagsteine und Unterlagen dar, d. h. Artefakte zur Herstellung weiterer Stein-, Holz-, Knochen- und Geweihgeräte. Die Geräte aus organischen Materialien haben sich allerdings an diesem Fundort nicht erhalten. Die Schlagsteine werden gemäß den Arbeitspuren als Artefakte zum Abschlagen und Brechen sowie zum Schleifen oder Zerkleinern (Schlagsteine-Reibsteine) bezeichnet. Im Fall der Unterlagen ist ein ähnlicher Ansatz verwendet worden. Neben Unterlagen, deren Verwendung am besten vom Terminus „Amboss" beschrieben wird, wurden sogenannte „Paletten" (zum Brechen und Anreiben pflanzlicher Produkte oder Mineralfarbstoffe) bestimmt.

Das umfangreiche Inventar der Steinabschlagindustrie aus Bečov IV ermöglichte auch die Durchführung einer morphometrischen Analyse. Dabei wurde festgestellt, dass das untersuchte Inventar einen einheitlichen mittelpaläolithischen Komplex mit einem hohen Maß an Standardisierung bei der Geräthersstellung darstellt. Einzelne Artefakttypen oder ganze Gruppen entstanden nach einem vorgegebenen Herstellungsschema, welches ein hohes Niveau an Spezialisierung belegt. Das Gewicht aller von uns aufgenommenen Artefakte bewegt sich um die 2.700 kg. Fast 13% der Artefakte weisen Brandspuren auf. Die Durchschnittslänge der Artefakte (9.87 cm) sowie der Durchschnittswert des Spherizität-Index (0.56) stellen das Inventar aus Bečov IV in die Reihe der größeren, mittelrobusten Industrien des Mittelpaläolithikums.

Diskussion

Ausgehend von der räumlichen Verteilung der Artefakte auf dem Fundplatz teilen wir diesen in zwei Grundzonen. Eine Existenz von Wohnstrukturen setzen wir für die westliche Zone voraus. Dagegen können wir in der östlichen Zone mit Herstellungs- und Verarbeitungsaktivitäten rechnen. Diese zwei Zonen befanden sich auf flachen Erhebungen in der Nähe der Wasserquellen. Aus der Tatsache, dass Artefakte eines breiten Typspektrums auf dem Fundplatz vertreten sind, folgern wir, dass die Lokalität Bečov IV als Basislager einer großen Gemeinschaft (oder mehrerer Gruppen) von Jungacheuléenjägern diente, da es auf einen organisierten Raumes innerhalb des Siedlungsareals hinweist.

Obwohl Bečov IV eine Oberflächenfundstelle ist, stellen wir sie aufgrund der Analyse der Steinabschlagindustrie sowie der geologischen und geomorphologischen Ansprache an den Beginn des Mittelpaläolithikums, und zwar an den Anfang des Saaleglazials (OIS 8; vor ca. 300.000–250.000 Jahren). Kulturell gehört das Artefaktinventar mit der geringen Menge an Faustkeilen sowie mit dem Nachweis

der Levalloistechnik bei der Verarbeitung des Steinrohmaterials in das Jungacheuléen. Für einen vergleichbaren Fundplatz halten wir Markkleeberg (Sachsen) in Deutschland (Fridrich und Sýkorová 2005; Fridrich und Fridrichová-Sýkorová 2009, 2010; Šajnerová-Dušková *et al.* 2009). Bečov IV repräsentiert einen weiteren großen Fundort, der zum Verständnis des Besiedlungsprozesses Mitteleuropas am Anfang des Mittelpaläolithikums beitragen könnte.

Résumé
L´assemblage lithique de Bečov IV représente une collection de surface, caractérisée par un faible pourcentage de bifaces, ainsi que par la présence de la technique Levallois. Le site date du début du Paléolithique moyen, au début du Saalien (OIS 80–250,000 ans avant le présent), sur base de l´étude de l´industrie lithique et du contexte géologique et géomorphologique du site.

Summary
The assemblage of the Bečov IV site represents a surface collection of artifacts, characterized by a small number of hand axes and presence of the Levallois technique in stone raw material processing. According to the stone industry analysis and geological and geomorphological evidence the site is dated to the beginning of the Middle Paleolithic, namely to the beginning of the Saale glacial (OIS 8; circa 300.0 to 250.0 ky).

A NEW PALEOLITHIC OPEN-AIR SITE AT KONOJEDY IN NORTHERN BOHEMIA?

Vladimír Peša

Abstract
The main Paleolithic open-air sites (Stvolínky, Holany) are situated on sandstone elevations above swamps in the southwestern part of the Česká Lípa district. The new artifact found by antiquarian Zdeněk Fidrhel in 2013 near Konojedy is a quartzite hand axe dated to the Middle Paleolithic.

Keywords
Middle Paleolithic, stone artifacts, Czech Republic, Konojedy

DOI: 10.5817/CZ.MUNI.M210-7781-2015-3

The territory of Northern Bohemia is one of the best-known Paleolithic regions outside the karst landscapes in the Czech Republic. The settlement patterns of the Middle and Late Paleolithic have been studied since the 1970s by Jiří Svoboda (1980, 2001), together with Mesolithic occupation in different zones of the sandstone landscape (Svoboda 2003; Svoboda *et al*. 2013). The main Paleolithic open-air sites (Stvolínky, Holany) are situated on sandstone elevations above swamps – presently ponds – in the so-called Jestřebí Basin in the southwestern part of the Česká Lípa district (Figure 1). Tertiary volcanic mountains of the Central Bohemian Uplands frame the north border of this basin, and they divide the Paleolithic area into lowlands in Lusatia and Saxony (Germany). The neighboring areas in the south consist of rocky sandstone landscapes with many rock-shelters without known Paleolithic finds or sediments.

An antiquarian, Mr. Zdeněk Fidrhel (Česká Lípa), informed the author in 2013 about an artifact from his collection found previously at Konojedy village in the adjacent district of Litoměřice, a distance of about 8 km from the closest Paleolithic site, Stvolínky I. The location near Konojedy, however, is in a different natural

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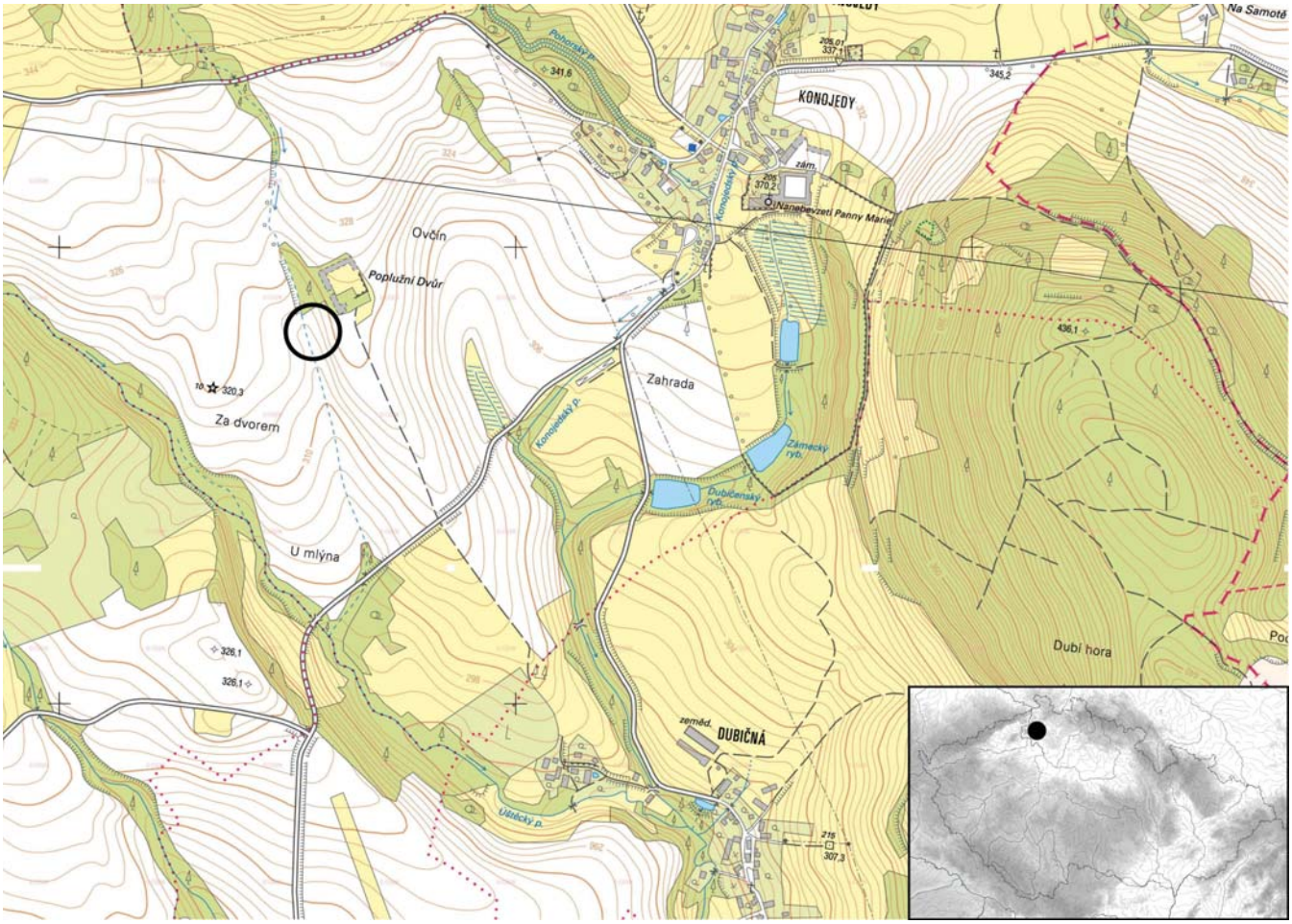

Figure 1: The site at Konojedy in Northern Bohemia. The map background was downloaded at: http://www.mapy.cz/zakladni?x=14.3520100&y=50.6276154&z=12&q=Konojedy by Seznam.cz, a.s. 2011, NAVTEQ; 10. 1. 2014.

formation than the above-mentioned sites in the Jestřebí Basin. It spreads along the sloping elevation of the southern foothills of the Central Bohemian Uplands near the disused farm of Poplužní Dvůr cca 1,200 m east of Konojedy in an area called "Za dvorem", cca 320 m a.s.l. The artifact is a quartzite hand axe approximately 14.5 cm long and approximately 9 cm wide (Figure 2). A brown patina covers the whole artifact. The site is planned to be investigated.

Résumé

La partie sud-ouest de la circonscription de Česká Lípa (nord de la Bohême) est une région qui présente des occupations allant du Paléolithique moyen jusqu'au Tardiglaciaire (cf. les différents articles publiés depuis une trentaine d'année par J. Svoboda). En 2013, la nouvelle découverte d'un biface provenant du site Konojedy, situé à 8 km du site paléolithique de Stvolínky I a été signalée.

Figure 2: A quartzite hand axe (diameters: 14.5 × 9 cm). Photo by Vladimír Štěpánský.

Zusammenfassung
Der südwestliche Teil des Bezirks Česká Lípa in Nordböhmen gehört zu den Gebieten mit einer belegten Besiedlung schon im Mittel- und Spätpaläolithikum. Im Verlauf der letzten 30 Jahren wurde diese Besiedlungsgeschichte fortlaufend von Jiří Svoboda veröffentlicht. 2013 wurde der Fund eines Faustkeils aus einer unbekannten Lage beim Ort Konojedy bekannt, in nur 8 km Entfernung vom paläolithischen Fundplatz Stvolínky I. Eine weitere Untersuchung der Fundstelle bei Konojedy wird geplant.

UPPER ACHEULEAN OCCUPATION OF WESTERN BOHEMIA

Pavel Břicháček[1] and Petr Šída[2]

Abstract
Recently, several new sites dated to Upper Acheulean were discovered during the systematic prospection of surface done by P. Brichacek in Western Bohemia region. In this paper will be discussed only three sites, namely Stříbro, Hromnice I, II and Břetislav with medium to large collections of stone artifacts, including bifaces as a significant element of this chronological period. Additionally, two dozen sites yielding smaller, insignificant collections were detected in this region.

Keywords
Lower Middle Paleolithic, Czech Republic, Stříbro, Hromnice, Břetislav, settlement, stone artifacts

DOI: 10.5817/CZ.MUNI.M210-7781-2015-4

Introduction

Settlement of the lower Middle Paleolithic in Bohemia has been systematically examined since the 1950s. The first findings of bifaces were made in the fifties by František Prošek near Srbsko village (Prošek 1947; Fridrich 1982) and Mojmír Mazálek in Putim-Ražice village (Pikarna hill) near Písek town (Mazálek 1952, 1953; Žebera 1958; Fridrich 1982). At the end of the decade Vladimír Stárka and Karel Žebera discovered one of the largest sites of this period near Mlazice village near Mělník town (Žebera 1969; Fridrich 1982). Since the 1960s Jan Fridrich has examined the largest complex of Upper Acheulean sites around the hill Písečný Vrch near Bečov by the town Most (Fridrich 1982; Fridrich and Sýkorová 2005). And also in the sixties Fridrich Hammer and Jan Fridrich discovered a small site in Mutějovice (Fridrich 1982). In the seventies Jiří Svoboda (1979) identified the first

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northern Bohemian Upper Acheulean site in Stvolínky village. This was for a long time the only one dated to this age in the North Bohemian sandstone region. New findings indicate the presence of Lower Middle Paleolithic sites in the area located eastwards, in the Bohemian Paradise (Chloumecko hill); the first occasional finds were made by Jaroslav Černohouz (1953). Eastern, Western and Southern Bohemia, however, remained until recent times without significant sites of the lower phase of the Middle Paleolithic. Eastern Bohemia still remains a blank spot on the map, and in Southern Bohemia, apart from Putim-Ražice village, some other small sites were discovered in the Budějovice Basin (namely Sedlec, Lékařova Lhota). On the border between Central and Western Bohemia explored during 1980s Pavel Břicháček one of Acheulean largest sites around Stašov village. Since then thanks to the systematic surface survey, several new sites of this period have been discovered in Western

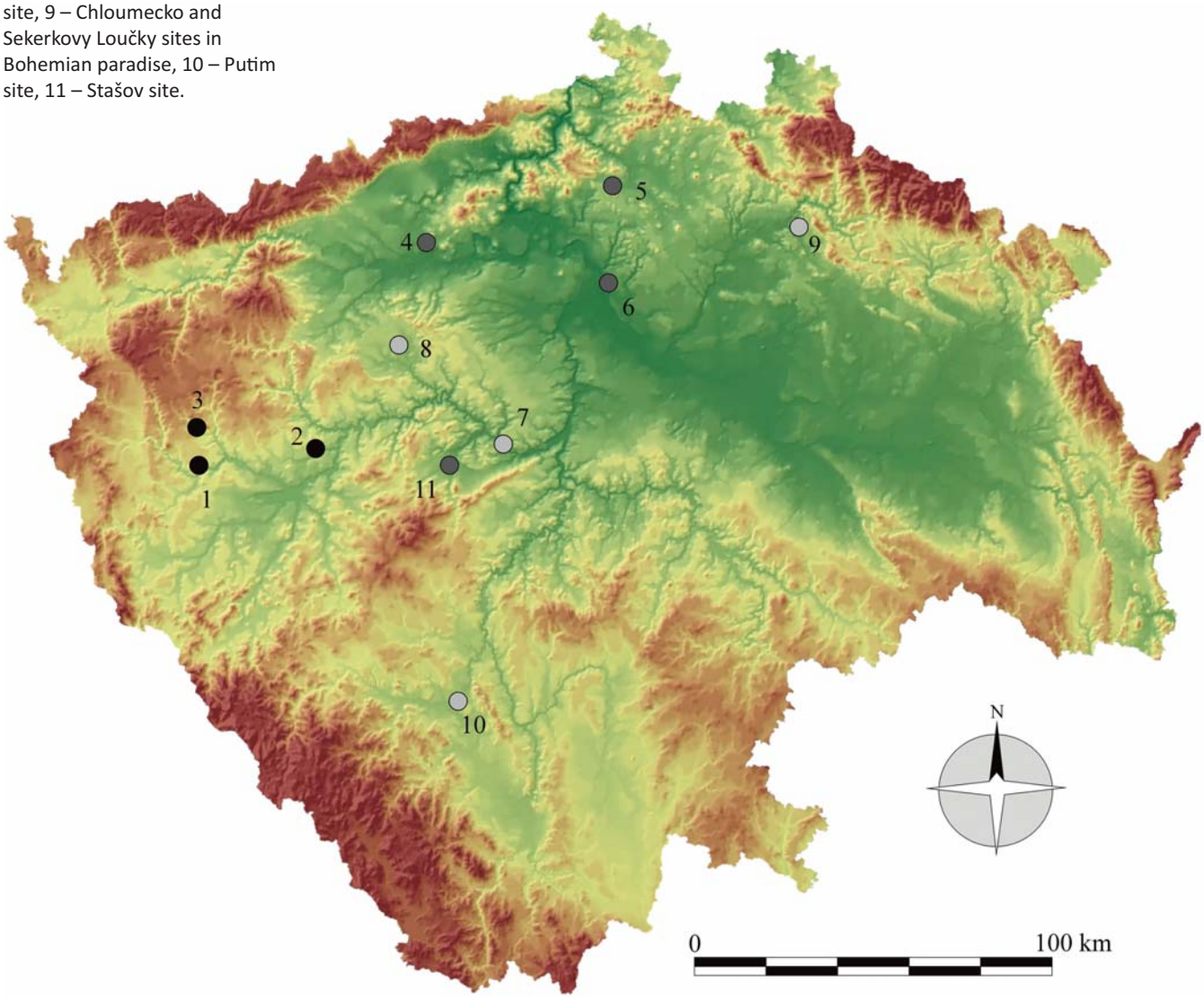


Figure 1: Bohemia. Upper Acheulean sites in Bohemia. 1 – Stříbro site, 2 – Hromnice site, 3 – Břetislav site, 4 – Bečov site, 5 – Stvolínky site, 6 – Mlazice site, 7 – Srbsko site, 8 – Mutějovice site, 9 – Chloumecko and Sekerkovy Loučky sites in Bohemian paradise, 10 – Putim site, 11 – Stašov site.

Bohemia (Břicháček 2010). Besides about two dozen sites yielding smaller, insignificant collections, which are not discussed in this text, there are three sites with medium to large collections with bifaces – a significant element of this chronological period; namely Stříbro, Hromnice (I and II) and Břetislav (Figure 1).

Western Bohemia in many ways is reminiscent of the whole of Bohemia in miniature. It is a basin enclosed on all sides, drained by a single river (the Berounka) to the northeast. From all sides it is encircled by mountain ranges and uplands (from the south, the Šumava Mountains, Český Les, Teplá, Křivoklát Highlands and Brdy Mountain). Among these ranges are passes that enable communication with the surrounding regions: Northwestern and Central Bohemia, Southern Bohemia and south to Bavaria. The distribution of river networks and the mountain ranges has not changed significantly in the last 250.0 ky, except there was a rejuvenation of the relief associated with significant sinking river beds during the last three glacial periods. In general we can use the characteristics of the relief as it appears today for the studied period.

Western Bohemia is a region which has no resources of quality silicites, but it is rich in large accumulations of Tertiary and Quaternary gravels, which contain a number of large boulders of sedimentary quartzite, quartz and quartzites. These may in some cases achieve a high quality (as in the case of Stříbro site), which is comparable to silicites. The largest accumulation can be found along the Mže river (Stříbro site), in the region of the river Třemošná (Hromnice site) and then in a belt stretching across the Rakovník region to Northwestern Bohemia. This boulder material was eroded throughout the Quaternary and was transported by the Berounka River to the north, where it appears in the river terraces and in archeological assemblages of this period around the Berounka River.

Stříbro site

Description of site

The site is located north of the town center on a large flat area of Doubrava hill at an altitude of 432–446 m. It is 48–62 m above the present level of the Mže River, which flows around the southern edge of the site at a distance of 1.2–1.5 km (Figure 3). The bedrock consists of Proterozoic phyllites over almost the entire area, but on the top of the mountain are also preserved sandy gravels and gravelly sands dated to the Neogene (Břicháček 2010). They together with phyllites were eroded and created deluvial sediments on the southern slope. Raw material for stone industry was collected from Tertiary sediments in the area of the site. In the whole area of the hill top there are no significant Quaternary sediments; so that all artifacts are today in the topsoil and certainly have high frequency of changes in their position.

The site was explored by Pavel Břicháček in 2008 during archeological supervision of construction of sewage and communications for a newly built residential area on the southern edge of the site. The density of artifacts is not high in this space; in squares of 5 × 5 m just one to three artifacts were located. In the

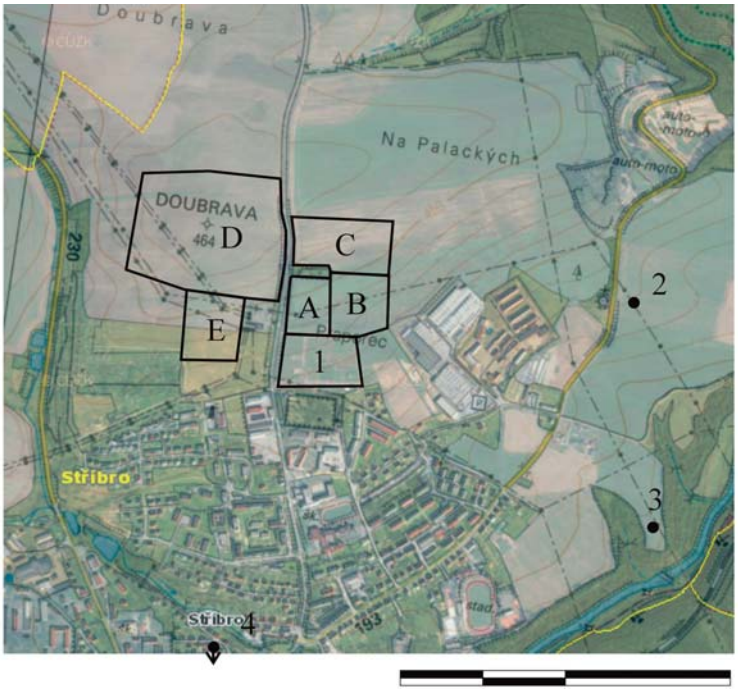


Figure 2: Stříbro site. Extent of artifact dispersion. A–E – area of surface collecting, 1 – area of rescue excavation on house construction, 2–4 – single, until now isolated, finds.

Figure 3: Stříbro site. View from area C to southeast to the Mže river valley.

central part of the position on the hill top the number of finds rapidly increased (Břicháček 2010). This area has been subjected to intensive surface survey, which so far has yielded more than 1,200 artifacts. Their evaluations are still running, thus this paper presents only one-third of achieved results. Artifacts were distributed over an area 800 × 600 m, but exploration continues, and findings outside the central concentration (Figure 2: 2–4) foreshadow a much greater range of settlement.

Raw material sources

The main source of raw material at Stříbro site consists of quartzite boulders of very good quality (Table 1). They can be found in the relics of Tertiary and Lower Pleistocene terraces around the site. According to color we recognize the varieties

of white quartzite and honey colored quartzites and a transitional form between them. The original source of these high-quality quartzites remains unknown; so far we know them only from the terraces. In the already evaluated part of the collection from Stříbro site, the 60.4% of the assemblage consists of this material. Another raw material used is quartz, again found in boulder form in the terraces. This constitutes 39.2% of the assessed assemblage. We distinguish between the white and "blue" variety. The translucent blue variety probably comes from pegmatites, the white probably comes from the quartz wall of the Bohemian forest hills. Both types of materials are the local raw material source (within a distance of 5 km). The only stone to come from a longer distance is limonite breccia, probably brought from the area of carboniferous Pilsen basin (about 20 km). The fragments of limonitic rocks are more frequent at Stříbro site, which could be most probably explained by their usage as pigments (Břicháček 2010).

Stone artifacts

Technotypological composition of the collection is significantly influenced by the methodology of collecting artifacts, based on selective surface collecting when the attention was focused on the distinctive types of findings, and state of processing of the whole collection (Table 1). Therefore, the retouched tools are strongly overestimated in comparison to the debitage (ratio of almost 1:1). Debitage is represented by standard types of artifacts, namely fragments, flakes (including Levallois forms), cores and unfinished bifaces. High variability displays the category of cores, where cores with reduced technology and also full Levallois cores with all stages of treatment can be detected.

Bifaces make up more than 7.0% of the collection (23 artifacts). They are documented as bifaces of particular types, and their reduced smaller variants. The largest part of the retouched tools is traditionally sidescrapers (20.3%), which are characterized by enormous variability in shape. Besides their combinations with notches and burins, endscrapers and points can be detected within the assemblage. In smaller number are represented knives, burins and borers, and choppers are also frequent (5.4%). Other artifacts are represented by hammerstones and manuport of raw material (probably used like a pigment) (1.6% of total collection).

The composition and morphology of tools within the Stříbro collection is fully comparable with large sites of the Upper Acheulean (such as Bečov IV, Markkleeberg). With good cleavage raw materials are typically present as variant cores with all phases of preparation developed and Levallois flake technology and Levallois points are also used. Reduction of the technological process (cores with protruding boulder surface, simple lemon-quarter cores, and chopper cores) is not used commonly. Some of the artifacts have been exposed to very weak eolization and corrosion, these are very transparent to understand of technological processes, but some other pieces are affected very strongly to the border of readability. The good quality local quartzite has not yet been published anywhere else, so we chose the name quartzite of Stříbro type for this raw material (Figures 4 and 5).

Table 1: Stříbro. Technotypological and raw material composition of evaluated assemblage.

type	white quarzite	brown quarzite	white--brown quarzite	quarzite	*quarzites total*	white quartz	blue quartz	*quartz total*	limonite brekcia	total	%
fragment	14	10	1		25	36	1	37		62	19.6
flake	26	10	1	1	38	24	1	25		63	19.9
pseudolevallois point	1				1					1	0.3
core	20	6	4		30	8	1	9		39	12.3
unfinished biface	4	1			5	1		1		6	1.9
debitage	*65*	*27*	*6*	*1*	*99*	*69*	*3*	*72*	*0*	*171*	*54.1*
biface	4	3			7	3		3		10	3.2
wedge	2				2	11		11		13	4.1
bifaces	*6*	*3*			*9*	*14*		*14*		*23*	*7.3*
sidescraper	33	11	2		46	18		18		64	20.3
sidescraper - notch	1				1					1	0.3
sidescraper - burin	1				1					1	0.3
endscraper	1	2			3					3	0.9
point	3	2		2	7	2		2		9	2.8
notch	4	3			7	7		7		14	4.4
knive	1	2			3					3	0.9
burin		2			2	1		1		3	0.9
chopper	9		1		10	7		7		17	5.4
borer	1				1	1		1		2	0.6
retouched tools	*60*	*25*	*3*	*2*	*90*	*50*	*0*	*50*	*0*	*140*	*44.3*
hammersone						2		2		2	0.6
core/hammerstone	2				2					2	0.6
manuport									1	1	0.3
other finds	*2*				*2*	*2*		*2*	*1*	*5*	*1.6*
total	**127**	**52**	**9**	**3**	**191**	**121**	**3**	**124**	**1**	**316**	**100**
%	40.2	16.5	2.8	0.9	60.4	38.3	0.9	39.2	0.3	100	

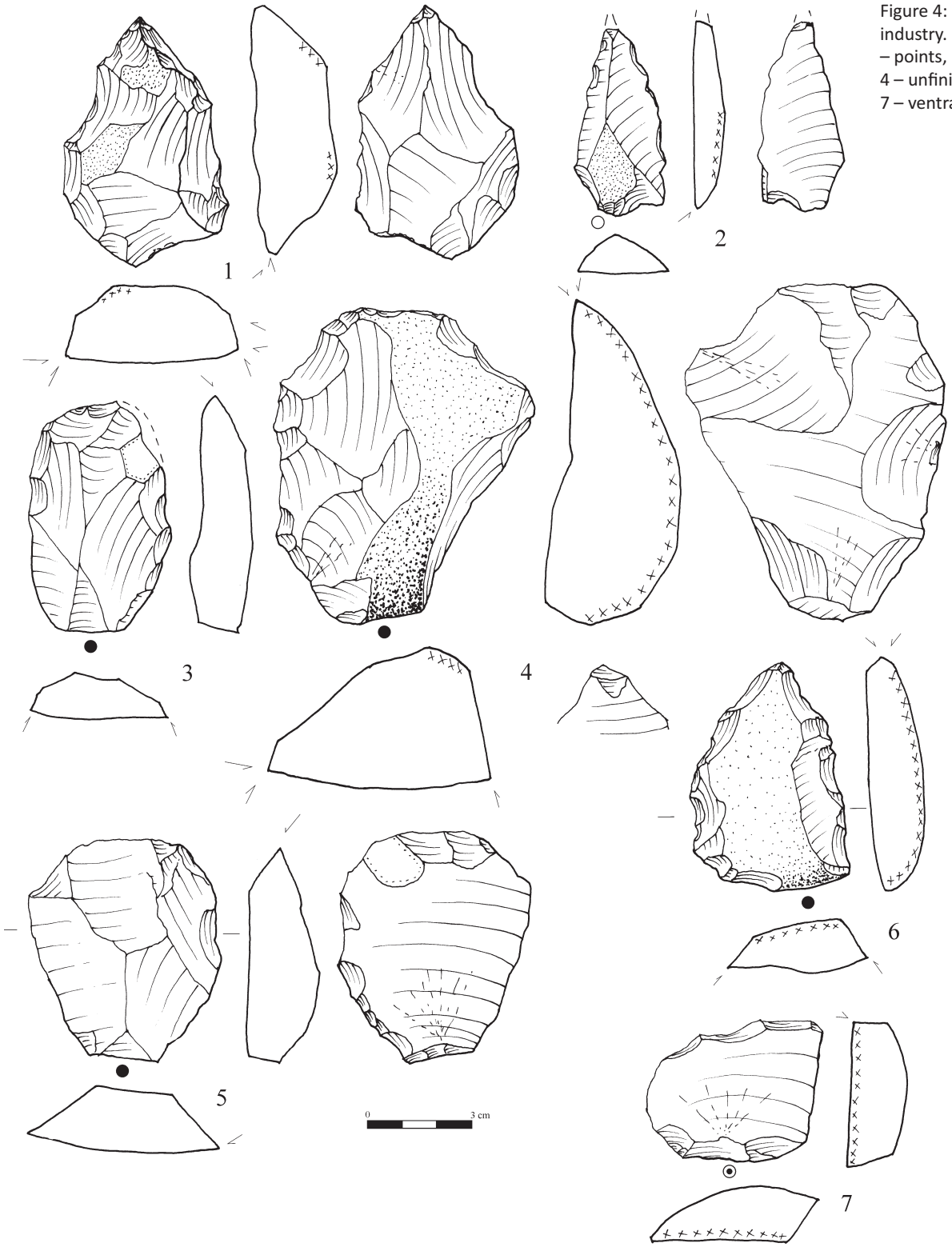


Figure 4: Stříbro, stone industry. 1 – biface, 2, 6 – points, 3 – endscraper, 4 – unfinished biface, 5, 7 – ventral sidescrapers.

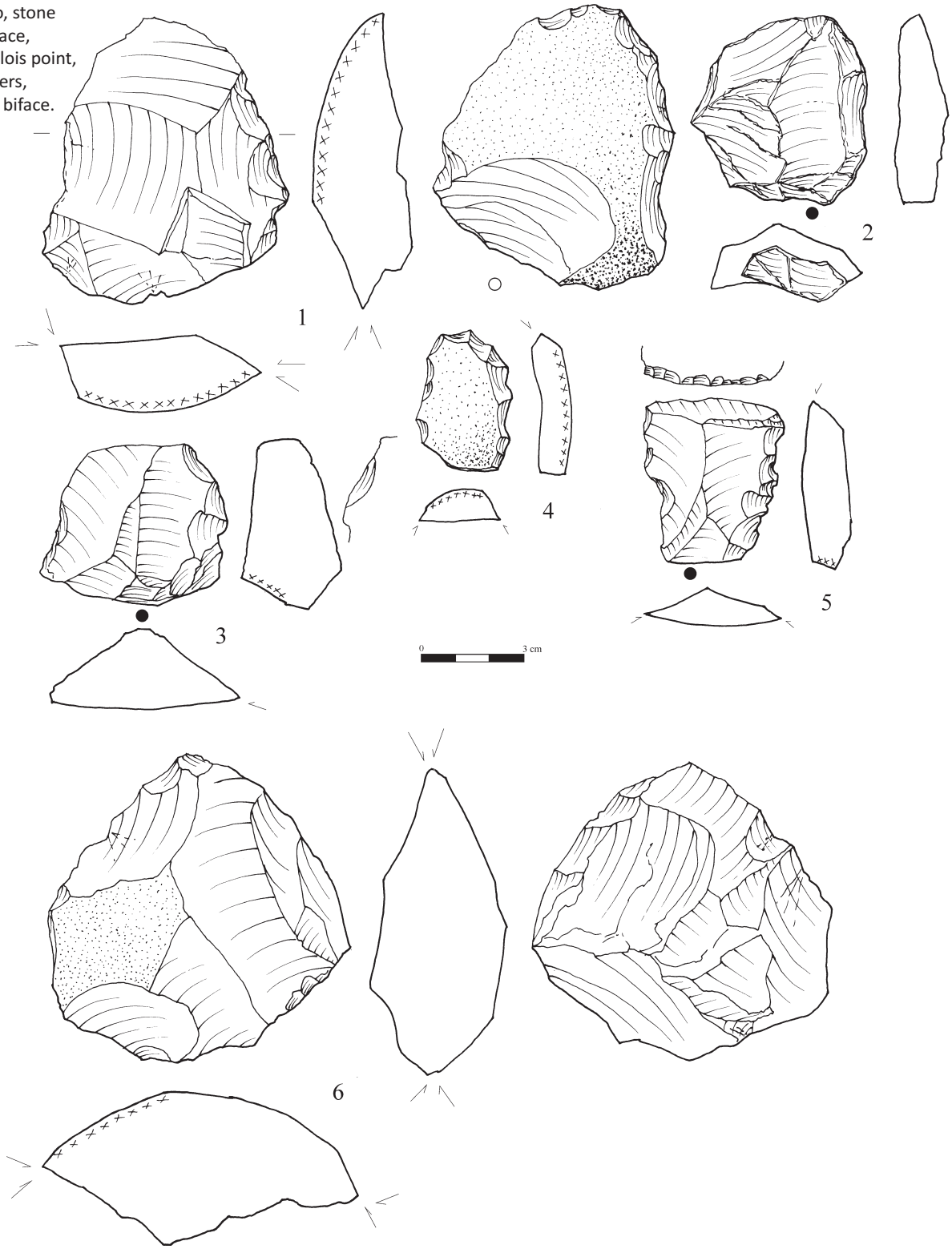


Figure 5: Stříbro, stone industry. 1 – biface, 2 – pseudolevallois point, 3–5 – sidescrapers, 6 – fragment of biface.

Hromnice I and II (distr. Plzeň-north) sites

Description of site

Hromnice I

This site is located northwards from the center of village on the tiered southern slope of Kosina hill (plots no. 2549, 2591, 2602). The bedrock here consists of undifferentiated Proterozoic sediments (see list of Geological maps of the Czech Republic Plzeň region, 12–33), but in close proximity (the lowest terrace level above the Hromnický stream and above village) Miocene fluvial gravelly sands are preserved. The sediments are covered by loess loams with a thickness of 0.2–0.8 m, which compensates for the irregular shape of a staircase hill in almost continuous southern slope, finished at the lowest level by the flat terrace, running into a sharp

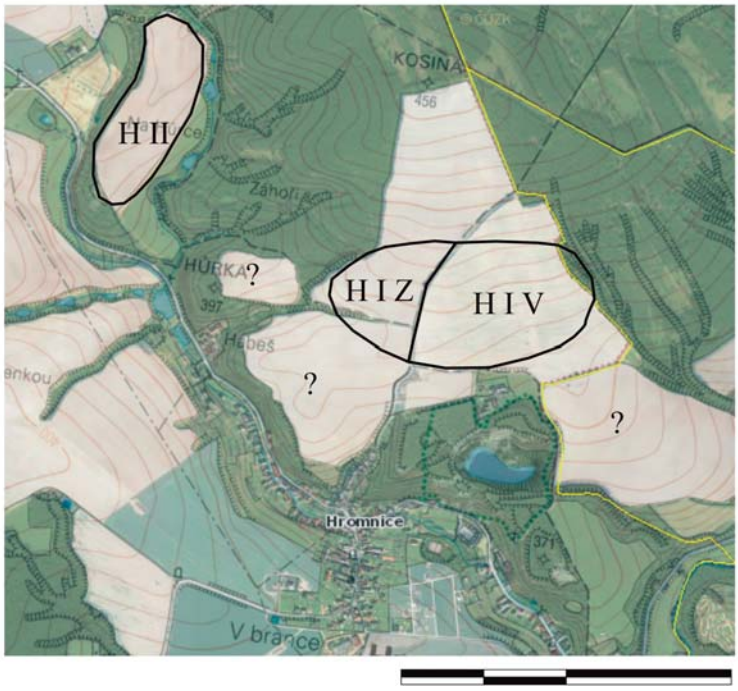


Figure 6: Hromnice site. Extent of artifact dispersion.
H I Z – Hromnice I, west part,
H I V – Hromnice I east part,
H II – Hromnice II.

Figure 7: Hromnice site. View from area H I V to southeast to the Třemošná river valley.

escarpment above the Hromnický stream. Especially on the southeast side of the hill there are significant erosion furrows in the loess loams, around which many Late Bronze Age sunken features can be found. The elevation of the central part of the site is about 46 m above the Hromnický stream and 85 m above its confluence with the river Třemošná (Figure 7).

The site was discovered in the autumn of 2013 during the archeological survey (Čechura et al. 2013) in the area of construction impacts (construction of a flood control ditch) almost in the middle of the southern slope of hill (about 401 m a.s.l.). The topsoil and loess sediments were removed, and in the gravel or in weathered rocky bedrock below a ditch was excavated to effect east-west drainage. It has a length of 720 m, a funnel shape with a width of 47–50 m and depth of 1.8–2.0 m from the raised edges, so that the recess in the surface of the ground is about 0.6 m. The excavated sediment was left in place, so it was possible to collect stone artifacts (in total of several dozen pieces) from the piles of soil and directly in the open trench. Subsequently, the uppermost layer was returned onto the surface of the trench and the rest of material was spread around the construction area.

In the western part of site one trench has purchased a large feature with pottery in the filling dated to the late Prehistory (probably late Bronze Age) with a strong stone roof. The structure has a weight of several hundred kilograms, because was composed of the biggest boulders collected from the site. Some nearby boulders were affected during construction of the structure. Additionally, many Paleolithic large cores were found during the excavation of this structure (grave?).

Artifacts were found in the 700 m length of the drainage ditch. In its western half the layer with artifacts was covered by loess, so the artifacts were hardly visible on the surface and we were not able to found them. Thus, the real range of site cannot be detected here. In its eastern half were detected a layer with artifacts, which were exposed by erosion grooves, and the material was detected lying on the surface within the range of about 500 m down the slope. The total extent of the site might be estimated to an area up to 800 × 500 m (Figure 6).

Hromnice II

Like previous site I, the Hromnice II site is located on the slope of Kosina hill. Contrary to the first site, this one is situated on the significantly steeper western slope and forms the lowest level of the flat terrace above the river (plot no. 2459–2467). It is a north-to-south sloping tongue-like promontory with a distinctive flat summit. It lies in a distance of 1 km from the western part of site I and is separated by the sharp notch of recent stream. The Hromnický stream flows around the western and southern part of the promontory.

The bedrock consists of Proterozoic phyllites and sediments of the Kladno Formation (Westphalian) dated to Carboniferous. They are covered by preserved relics of deluvial stone-loamy and loamy sediments (see Geological map of Czech Republic region Plzeň, sheet 12–33). Although the relic is determined as Quaternary, the raw material spectrum corresponds to surrounding Miocene fluvial sandy gravel.

Additionally, the site altitude is 396–397 m and the elevation above the Hromnický stream is about 22 m. The site was discovered by P. Břicháček in the autumn 2013 during the surface survey in the vicinity of site I. Artifacts can be collected within the area of 200 × 500 m.

Raw material sources

Raw materials used in the Hromnice site come mainly from local terrace accumulation of the Tertiary and Quaternary eras (Tables 2 and 3). The available materials differ significantly from the Stříbro site. Here the available sedimentary quartzites are in colors from gray up to ocher and red shade. By intense metamorphism they have changed to metamorphous quartzites. Their origin should be detected in the southwestern part of the Barrandian region, which is intensively metamorphosed. In Hromnice I these raw materials make up to the 70.1% of collection, and up to 58.1% in the case of Hromnice II site. The origin of raw materials in this area demonstrates the highly metamorphosed orthogenesis with garnet in Hromnice I. Another important raw material is quartz, coming also from river terraces. In Hromnice I this raw material forms the 20.5% of whole collection and 38.7% from Hromnice II collection. In both collections pebbles of lydite are also presented, coming also from the terrace material (lydites are bound to Barrandien Precambrian sediments). An exceptional raw material in Hromnice I is quartz-porphyry. Its nearest outcrop is in Žernoseky village (90 km), but we cannot exclude the existence of an unknown smaller outcrop situated closer to this site. Additionally, local raw materials are consistently used. Their quality is significantly worse than at the Stříbro site, due to a higher degree of metamorphism. This makes quartzites extremely hard and difficult to chip. This fact considerably influenced the technologic features observed in the collection.

Stone artifacts

The Hromnice site was discovered in the autumn 2013, and until present days only a small portion of collection was already analyzed. Nevertheless, it is possible to determine at least the cultural affiliation and to describe the main features of this assemblage.

Although the first surface collections can be connected with much more informative character, we test their representativeness (Tables 2 and 3). The ratio between debitage and retouched tools in both positions is more consistent with the original composition of assemblages (Figure 7–8: 2–3 in favor of debitage). Both assemblages are characterized by reduced technology of core preparation, which leads to their considerable simplification. Very often the preparation of the flaking platform and bottom side is eliminated. Lemon-quarter flake cores are frequently used, where preparation is reduced completely. Levallois cores are not present, although signs of reduced Levallois technology are known from Hromnice II (levalloid point, without prepared base, replaced by a boulder surface). This reduction is due to the extreme

Table 2: Hromnice I. Technotypological and raw material composition of evaluated assemblage.

technotype	core quartz	quartz	ochre quarzite	red qurzite	quarzites	quartz porfyre	orthogneiss	lydite	total	%
fragment	1	3	4	2	1				11	20
flake	1		11	4	2		1	1	20	36.4
cores	1	2	5	3	1		1		13	23.6
debitage	*3*	*5*	*20*	*9*	*4*		*2*	*1*	*44*	*80*
biface				1		1			2	3.6
sidescraper		1		3	1		1		6	10.9
borer		1							1	1.8
knife		1							1	1.8
chopper				1					1	1.8
tools		*3*		*5*	*1*	*1*	*1*		*11*	*20*
total	**3**	**8**	**20**	**14**	**5**	**1**	**3**	**1**	**55**	**100**
%	5.5	15	36	25	9.1	1.8	5.5	1.8	100	

Table 3: Hromnice II. Technotypological and raw material composition of evaluated assemblage.

technotype	quartz	red quartzite	ochre quartzite	lydite	total	%
fragment	2	2	2		6	19.4
flake	5	5	1		11	35.5
levalloid point	1				1	3.2
core	2		1		3	9.7
debitage	*10*	*7*	*4*		*21*	67.7
biface		1			1	3.2
sidescrapers	1	1	2	1	5	16.1
retouched flake		1			1	3.2
chopper		1			1	3.2
borer	1	1			2	6.5
tools	*2*	*5*	*2*	*1*	*10*	*32.3*
total	**12**	**12**	**6**	**1**	**31**	**100**
%	38.7	38.7	19.4	3.2	100	

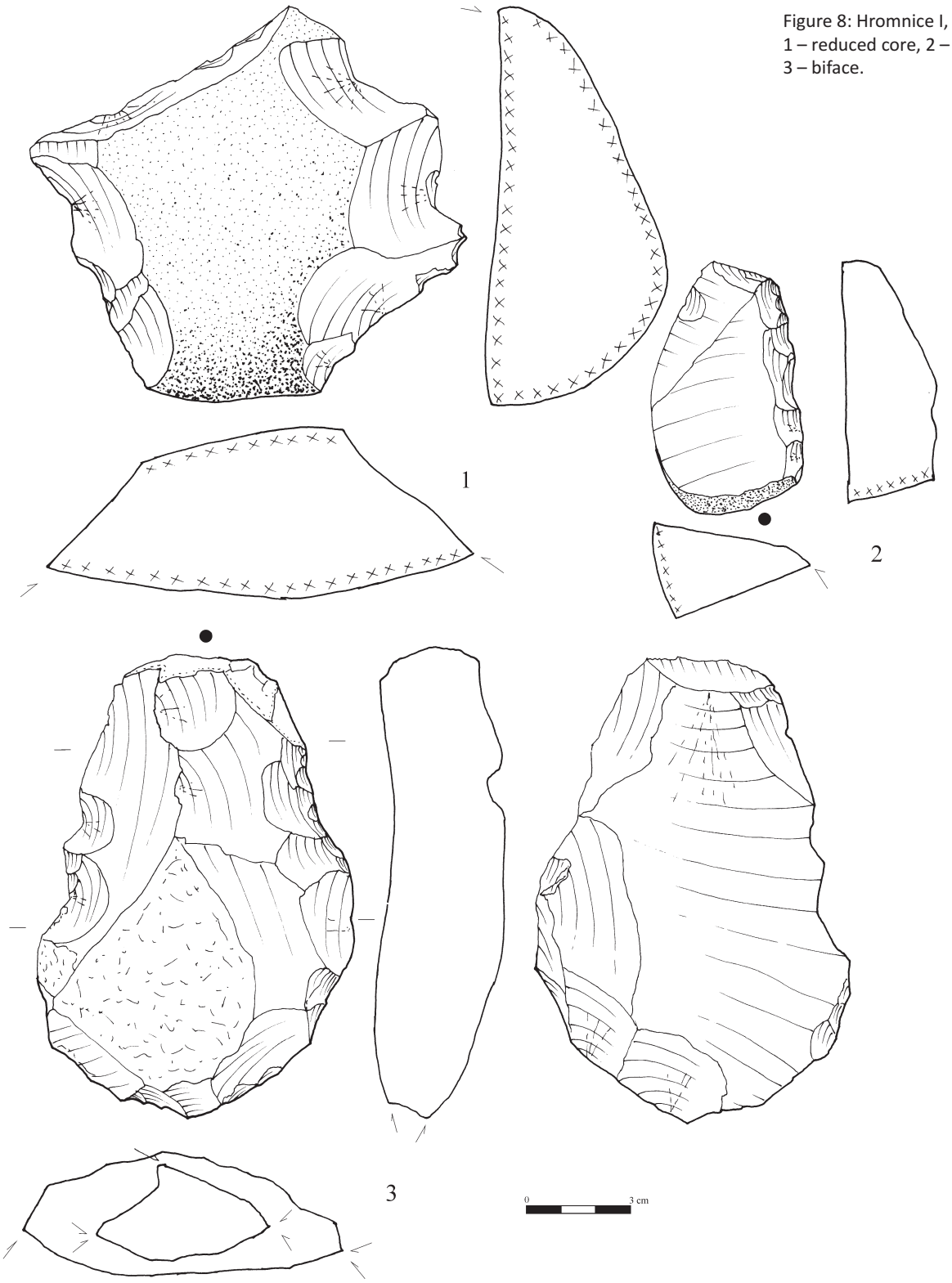
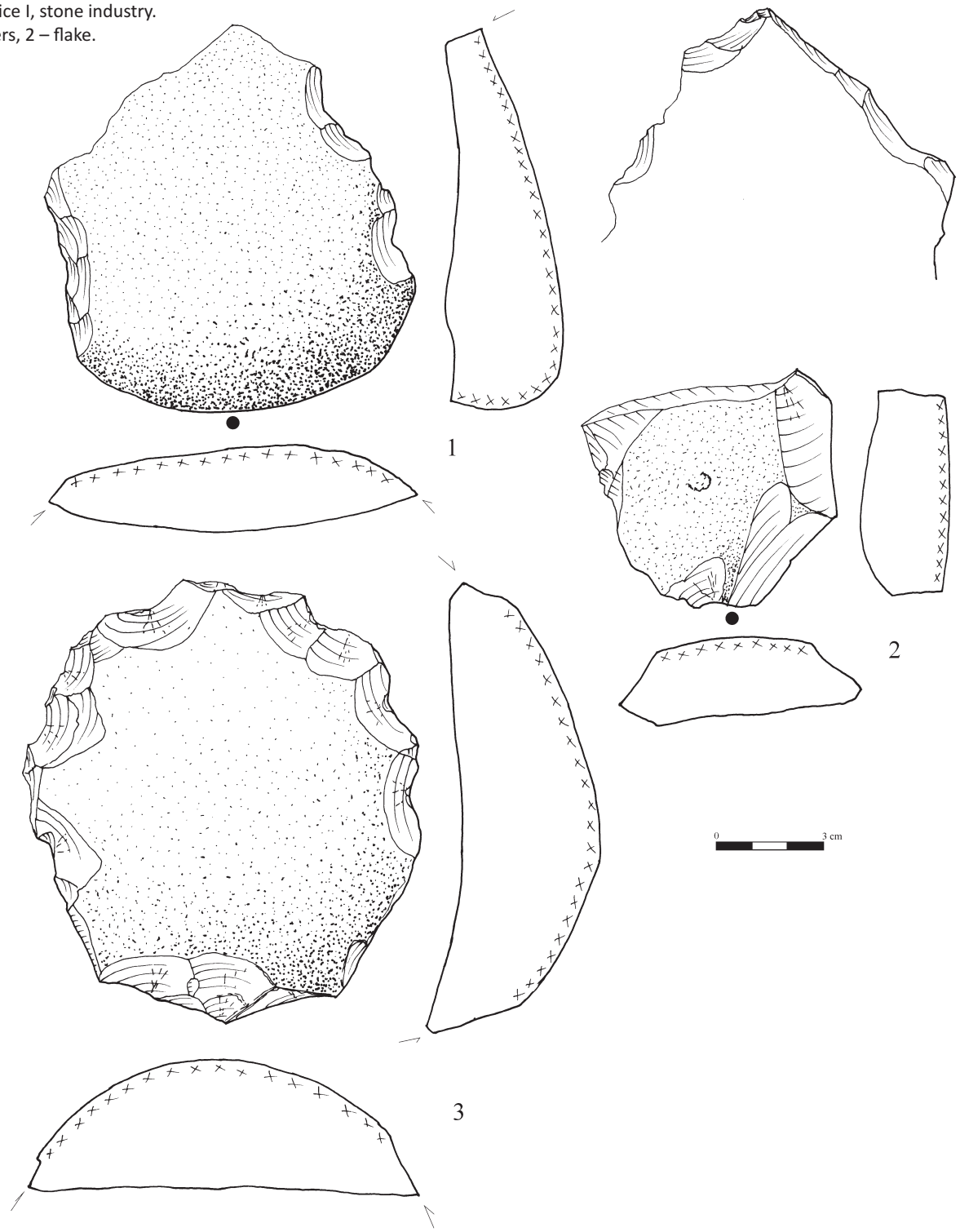


Figure 8: Hromnice I, stone industry.
1 – reduced core, 2 – sidescraper,
3 – biface.

Figure 9: Hromnice I, stone industry.
1, 3 – sidescrapers, 2 – flake.



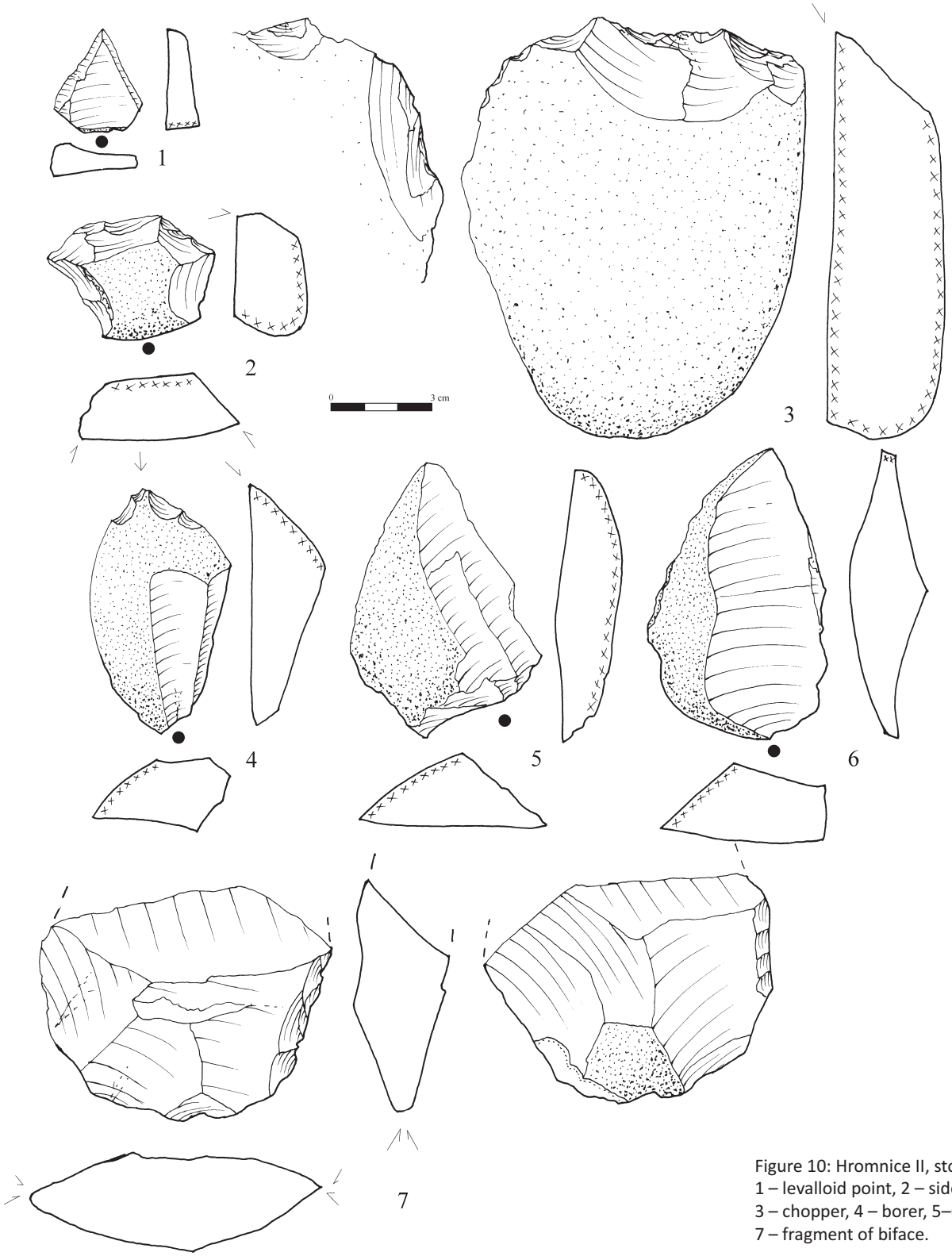


Figure 10: Hromnice II, stone industry.
1 – levalloid point, 2 – sidescraper,
3 – chopper, 4 – borer, 5–6 – flakes,
7 – fragment of biface.

character of the raw material which does not allow one to perform complex core preparation (considerable hardness limited the usable striking angle to a very small extent).

The composition of tools is comparable to the Stříbro collection, although their variation range is not as wide (again due to the poor quality of the raw material). In the collections we can find bifaces and dominant sidescrapers. To a lesser extent, there are borers, knives, choppers and retouched flakes. Eolization of stone artefacts is more frequent and stronger than in Stříbro site (Figure 8–10).

Břetislav (Konstantinovy Lázně, distr. Tachov) site

Description of site

Artifacts laid on the flat top of a hill at the western foot of the distinctive basalt hill of Okrouhlé Hradiště near Konstantinovy Lázně town (plots no. 921, 922), north of Břetislav village. The bedrock is formed by Upper Proterozoic metamorphic rocks (graphitic phyllites). This is covered with brown soils. The elevation of the highest point of the hill is 523.5 m, the artifacts were collected on a plateau with an elevation of 520 m. Carboniferous sediments of the Kladno formation with white quartz pebbles, which were used for industry production, can be found 1.0–1.5 km west on the southern outskirts of the Kokašice village. Recent watercourses enclose the hill almost all the way around (except for a small section in the northeast). The elevation above the Čelivský creek is about 32 m. The site was found by Pavel Břicháček during the surface survey in spring 2013. Artifacts can be collected over an area of 300 × 200 m (Figure 11).

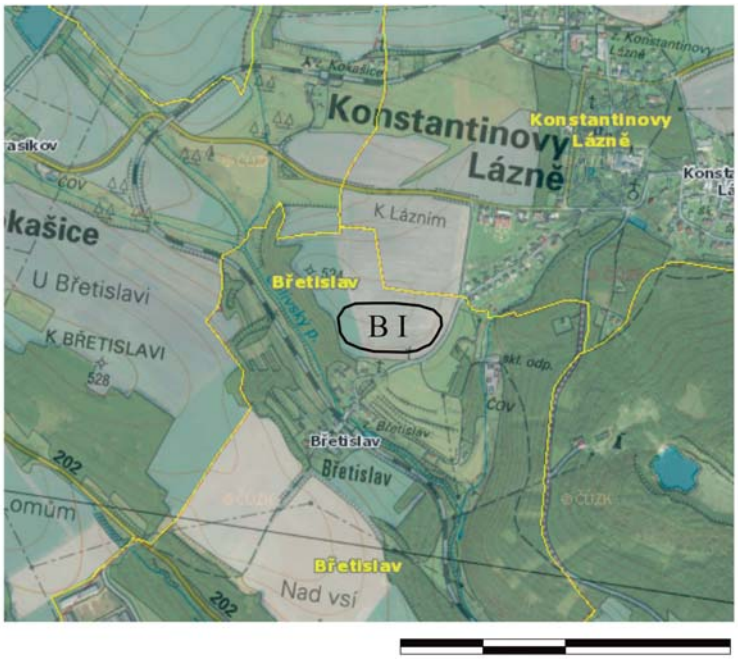


Figure 11: Břetislav site. Extent of artifact dispersion.

Raw material sources

This site is located outside the area of the Tertiary and Lower Pleistocene gravel accumulations. Thus, there were no quartzite pebbles of a good quality. There were only very difficult to work vein quartzes here, both in the form of fragments on outcrops, as well as pebbles in the Quaternary terraces. The poor quality of raw material directly affects the appearance of stone industry.

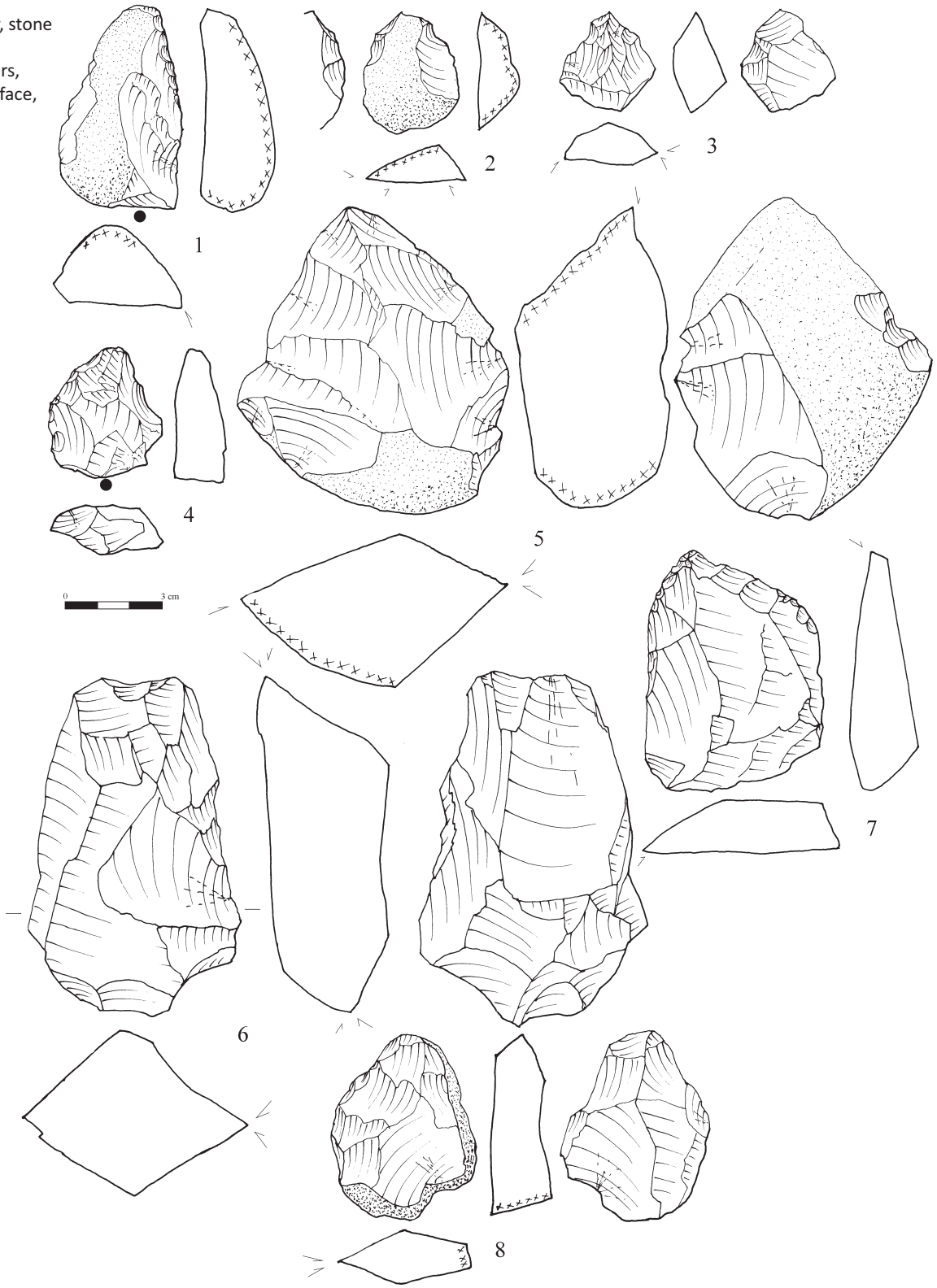
Stone artifacts

So far, in Břetislav we have collected only a small collection of 24 artifacts. The ratio of debitage and retouched tools is 1:1. Due to the poor quality of the raw material fragments are used more than flakes. Cores are represented by three pieces. Among the tools are mostly represented bifaces (documented is biface, protobiface, cleaver and wedge) and sidescrapers, both with a total of four pieces. There is one sidescraper combined with notch and chopper, and two points.

technotype	core quartz	pebble quartz	total	%
fragment	7	1	8	33.3
flake	1		1	4.2
cores	3		3	12.5
debitage	*11*	*1*	*12*	*50*
biface	1		1	4.2
protobiface	1		1	4.2
cleaver	1		1	4.2
wedge	1		1	4.2
bifaces	*4*		*4*	*16.7*
sidescrapers	4		4	16.7
notch - sidescraper	1		1	4.2
point	2		2	8.3
chopper		1	1	4.2
tools	*11*	*1*	*12*	*50*
total	**22**	**2**	**24**	**100**
%	*91.7*	*8.3*	*100*	

Table 4. Břetislav. Technotypological and raw material composition of evaluated assemblage.

Figure 12: Břetislav, stone industry.
1–2, 7 – sidescrapers,
3, 4 – points, 5 – biface,
6 – cleaver,
8 – protobiface.



The assemblage of Bretislav site at first glance looks archaic, but this is mainly due to the poor quality of raw material. In this collection we can find prepared cores and sidescrapers on flakes. The bifaces are comparable to those of the Stříbro site. The surface of the artifacts is only corroded; there is no mark of eolization. The Břetislav assemblage also belongs to the horizon of Upper Acheulean (Figure 12).

Conclusions

The largest Bohemian site of the Upper Acheulean is Bečov IV, surveyed from the 1960s by Jan Fridrich (Fridrich 1982; Fridrich and Sýkorová 2005). Artifacts of the Upper Acheulean were also found on the summit of Písečný hill (site Bečov I) and over large areas in the vicinity of both sites. Settlement at Bečov site was linked to an outcrop of high-quality quartzite of Bečov type. Findings from Bečov are analogous to the nearest large area site of the Upper Acheulean in Saxony at Markkleeberg site (Mania and Baumann 1980). The assemblage of the Stříbro site in terms of quality and complexity is fully comparable to the Bečov assemblage. On the Stříbro site a very good local raw material was used – the quartzite of Stříbro type. The extent of settlement in Bečov is very large; artifacts can be found an area of several square kilometers. The Stříbro site is approaching this area, with artifacts spread over at least one square kilometer. Hromnice and the Central Bohemian site of Mlazice and Stašov are both of the same range, but they are not connected to a source of good quality raw material. Other Bohemian sites are significantly smaller, ranging up to several tens of hectares. This includes sites in Stvolínky, and some sites in Bohemian Paradise, namely Břetislav, Mutějovice, Putim-Ražice and Srbsko. Some of them (Stvolínky, Putim-Ražice) lie on a source of good raw material, but others have no good raw material. As it seems, the presence of high-quality raw material in place is not a determining factor in the range of settlements. We know of sites of a large scale without a good quality raw material source, as well as small-scale sites on good quality raw material sources. Whether these differences reflect settlement patterns of Acheulean hunters we are not able to decide at the present state of knowledge. The differences in structure and scale are so striking, however, that it can hardly be a coincidence.

Acknowledgement
The work on this paper was supported by the grant project Operational Programm Education for Competitiveness: The Strategy of Archeological Research in Europe (CZ.1.07/2.3.00/20.0036), which is financed by the European Social Fund and the State Budget of the Czech Republic.

Résumé
En Bohème occidentale, plusieurs nouveaux sites de surface attribués à l´Acheuléen supérieur ont été découverts au cours de ces dernières années grâce aux prospections systématiques de P. Brichacek. Une bonne vigntaine de sites n´ont livré que des collections insignifiantes du point de vue numérique, si bien qu´ils n´ont pas été intégrés dans la

présente étude. Seuls trois sites se distinguent par des collections plus importantes et comprennent notamment des bifaces comme marqueur chronologique significatif pour la période en question : Stříbro, Hromnice (I et II) et Břetislav.

Zusammenfassung

In Westböhmen wurden dank der systematischen oberflächlichen Prospektionen von P. Břicháček in den letzten Jahren einige neue Fundstellen des jüngeren Acheuléen entdeckt. In diesem Artikel sind drei Hauptfundstellen mit mittelgrossen sowie grossen Kollektionen dargestellt, die Faustkeile als markante chronologische Elemente dieser Epoche beinhalten. In Stříbro wurden bisher 1.200 Artefakte dieser Kultur gefunden, die mit den grossen Fundstellen dieser Epoche (Bečov IV, Markkleeberg) vergleichbar sind. In Hromnice wurden bisher mehrere Hundert Artefakte gefunden, die ähnlich zur Kollektion von Stříbro sind. Die kleinste Kollektion stammt von Břetislav, die auch aufgrund der typologischen Zusammensetzung mit den Funden von Stříbro und Hromnice vergleichbar ist.

GROTTE DE LA VERPILLIÈRE II, GERMOLLES, FRANCE: PRELIMINARY INSIGHTS FROM A NEW MIDDLE PALEOLITHIC SITE IN SOUTHERN BURGUNDY

Jens Axel Frick and Harald Floss

Abstract
During the 2006 excavation at the *Grotte de la Verpillière* in Germolles, a team from the University of Tübingen under the direction of Prof. Harald Floss found a new archeological site. The site, now called *Grotte de la Verpillière II*, is situated around 50 m south of the well-known *Verpillière* cave (since then it has been called Verpillière I) in the same communal subdistrict of *Verpillière*. Between 2006 and 2008 mixed sediments and big limestone blocks from a roof collapse were removed to gain entrance to the cave. In 2009, intact layers with Middle Paleolithic artifacts were found and remain under excavation today. The intact find layers contain lithic artifacts, faunal elements and thousands of charcoal fragments that occur in discrete lenses. The lithic industry contains a high percentage of Levallois elements and the uppermost intact find layer (GH 3) yields a bifacial component that can be related to the Keilmessergruppen (assemblages with backed bifacial knifes), Micoquien (sensu Bosinski), Charentian with Micoquian influence (sensu Farizy), Mousterian with Micoque option (sensu Richter) of central Europe or the Mousterian with bifacial tools (sensu Ruebens) in northern France and the Benelux. Here, we provide an overview of the first insights gained from ongoing excavations (here described insights from the campaigns 2006 to 2013) and analyses at this new Middle Paleolithic site in Eastern France.

Keywords
Neanderthals, Eastern France, Saône-et-Loire, Côte Chalonnaise, bifacial elements, Levallois

DOI: 10.5817/CZ.MUNI.M210-7781-2015-5

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Introduction

The Grotte de la Verpillière II (around N 46°53'56,4", E 4°44'31,2"; 212 m a.s.l) is located on the eastern slope of the massive of Montadiot, ten kilometers west of Chalon-sur-Saône, Saône-et-Loire (71), France (Figure 1). It is situated around 50 m south of the Grotte de la Verpillière cave site, which is well known for its Middle Paleolithic assemblages of bifacially backed knives (Desbrosse *et al.* 1976; Desbrosse and Texier 1973; Frick 2010), for the easternmost known Châtelperronian points (Dutkiewicz 2011; Floss 2003, 2005) and Aurignacian implements like carinated pieces and split-base points (Breuil 1911; Dutkiewicz 2011; Floss 2005).

The excavated intact layers of *Verpillière* II contain Middle Paleolithic lithic artifacts, faunal elements and more than 3.000 charcoal fragments, which occur in distinct lenses visible in 3D plots. The lithic industries contain a high percentage of Levallois elements, and nearly the complete *chaîne opératoire* of lithic reduction is represented. The uppermost intact layer (GH 3) also contains a bifacial component (n = 10, mostly asymmetric forms) that can be correlated to a western variation of the *Keilmessergruppen* (or Mousterian with Micoquian Option, younger Micoquian, Charentian with Micoquian Influence, Mousterian with bifacial tool, etc., see Farizy 1995; Frick 2010; Jöris 2003, 2006; Kozłowski in press; Richter 1997; Ruebens 2012, 2013). Similar lithic components have been recovered from the Middle Paleolithic layers at *Verpillière* I, both from recent excavations, older excavations and recently excavated backdirt (Floss 2005; Floss *et al.* 2013a, 2013b, 2014; Frick 2010).

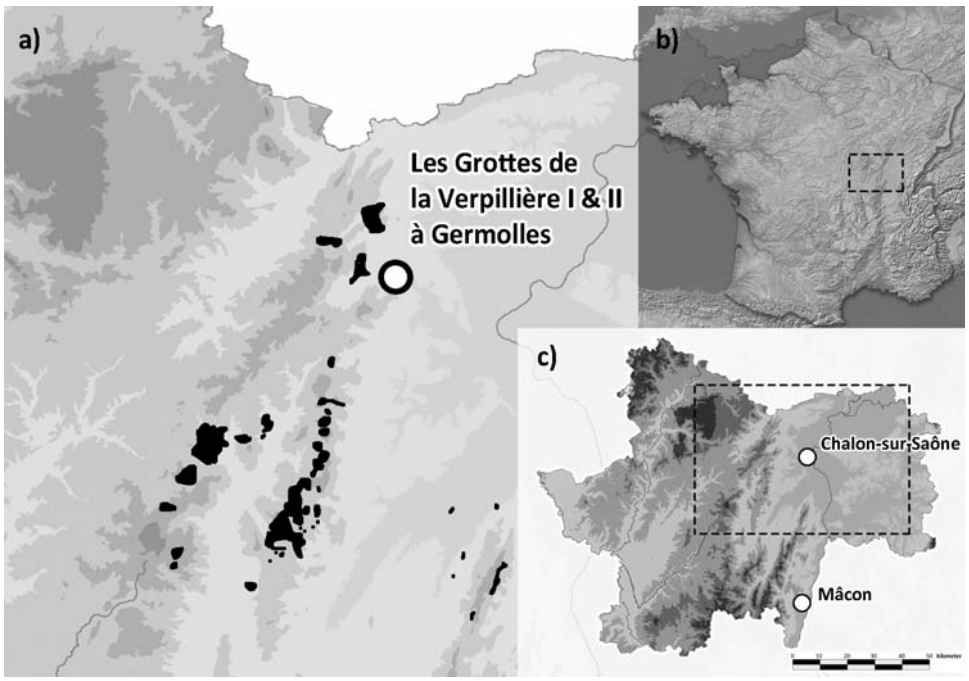


Figure 1: Location of the Grottes de la Verpillière I and II in Germolles, Saône-et-Loire, France. a) The distribution of flint from the argiles à silex in the Côte Chalonnaise (black spots, see Rué 2000) and the location of the Grottes de la Verpillière I & II in Germolles (circle), b) Topographic map of France (the dashed line indicates the Dept. Sâone-et-Loire, SRTM-NASA map from 2003), c) Location (in dashed lines) of the Côte Chalonnaise in the Dept. Saône-et-Loire (see also in Frick et al. 2012, Figure 1).

Site history

In 2006, an amateur collector (J.-N. Blanchot) indicated to Harald Floss the presence of lithic artifacts on top of a large badger den. During the 2006 excavation campaign at the *Grotte de la Verpillliè*re (I), a test pit of 2 square meters was excavated by the team, revealing the new cave on September 25th. After half a day's work, it was possible to get a glimpse under the cave roof, which showed a tunnel several meters in length. The disturbed sediments of the test pit contained lithics from the Middle and Upper Paleolithic, faunal elements like horse (*Equus*, sp.), bison (*Bison*, sp.) and hyena (*Crocuta,* sp.) and modern materials (plastic and ceramics). The upper layers (GH 1 and 2, GH = geological horizon or layer, a distinctive sedimentological unit) showed evidence of bioturbation and contained small patches of cave sediments (Floss 2006).

In 2007, additional square meters (n = 13) were opened to gain access to the cave entrance. At a depth of 1 meter, a Roman belt buckle was found, as well as patches of cave sediment, and Paleolithic and Neolithic artifacts (Floss 2007). Work continued the following year, during which large limestone blocks (up to 4 meters in greatest dimension) deriving from a substantial roof collapse were excavated, scanned and measured in order to document the collapse history (Floss 2008). GPR surveys conducted in 2009 (P. Leach, John Milner Associates and Ch. Miller, Universität Tübingen) revealed the dimensions of the cave and confirmed that there were stratified sediments underlying the mixed deposits (Leach and Miller 2009). A *sondage* (test pit) of 4 square meters directly under the recent drip line of the cave revealed several layers of these intact sediments (GH 3 to 9), which were buried under the collapse of limestone blocks (Floss 2009). Micromorphological samples taken from these layers indicated moderate bioturbation in the upper parts, but contained no modern material, and also showed that the sediments were formed in place (Bons and Wißing 2009; Floss *et al.* 2010; Wißing 2012). Currently, we have discovered three intact layers containing Middle Paleolithic finds (GH 3, 4x and 4; Floss *et al.* 2014). From 2010 to 2013 (Floss 2010, 2011; Floss *et al.* 2012, 2013, 2014; Frick *et al.* 2011), excavation of 15 square meters of intact sediments was accomplished following the Tübingen excavation system (Frick and Hoyer 2009, 2011, 2012; Frick *et al.* 2013) established by J. Hahn in the 1970s to 1990s (e.c. Hahn 1988). The system combines single-find measurements, documentation of geological and archeological settings, topographical 3D modeling (layers, surfaces, profiles, limestone blocks, cave topography, etc.) and the recording of artifacts by size classes. An experimental archeological component, as for example controlled heating of flints from the *argiles à silex* (Frick *et al.* 2012), has aided in the interpretation of finds from the site. Additionally, during the 2013 field campaign we prepared the site for radiometric dating (ESR, OSL, TL, U-Th), the analysis of which is currently in progress (pers. comm. L. Zöller and M. Richard). From a stratigraphic and typological view, we suggest a late-OIS 5 (a, b or c) date (around 75–100 ky), which would correlate with dates from open-air sites (Champlost, Villeneuve or Vinneuf) in the *Sénonais* in northern Burgundy (Deloze *et al.* 1994; Gouédo 1999; Lhomme 2000), where layers with Micoquian elements are dated to the OIS 5. Also, a datation to the

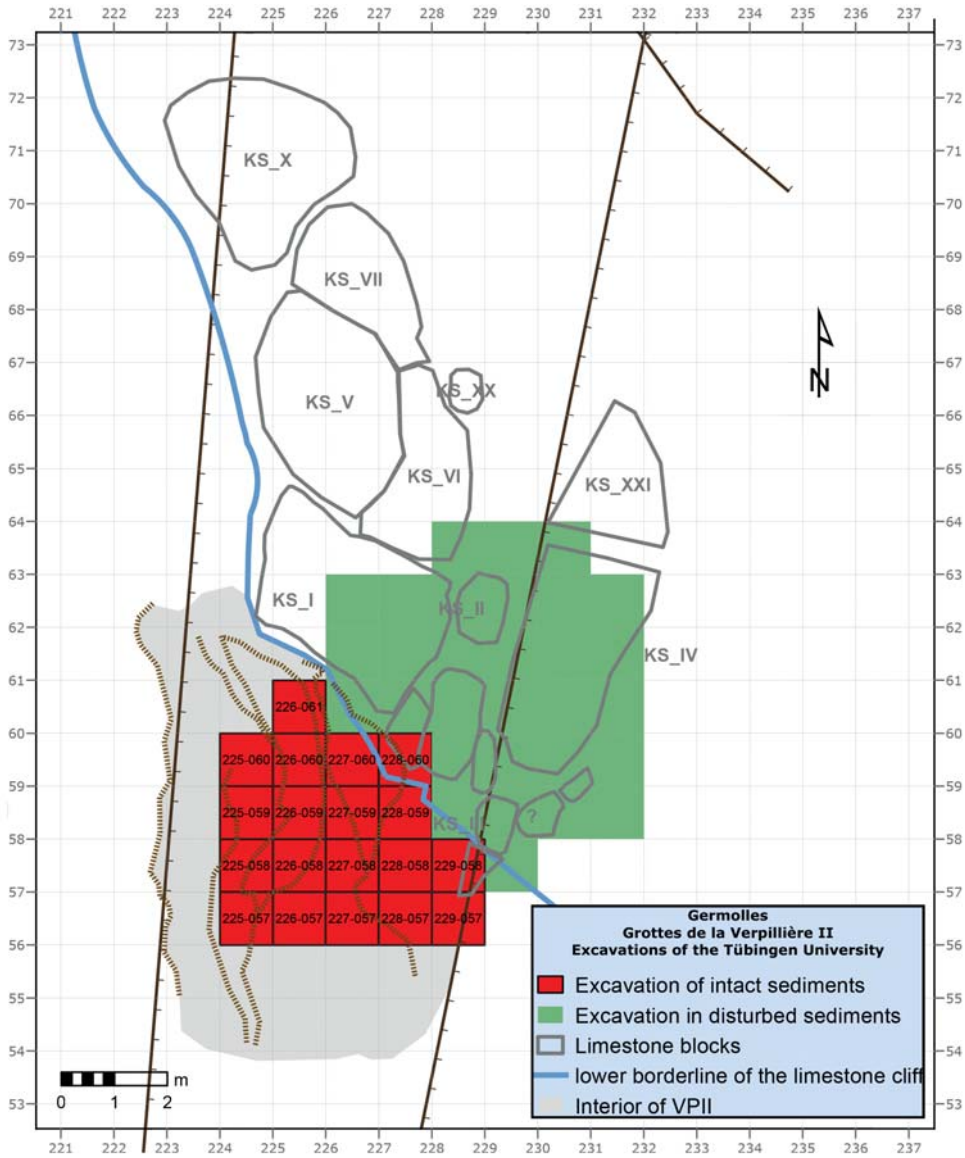


Figure 2: GIS map of Verpillière II with the outlines of the collapsed limestone blocks and the excavated square meters (map by Ch. Th. Hoyer).

OIS 4 or early OIS 3 is possible, because many assemblages from the *Keilmessergruppen* date to these stages (Jöris 2003; Richter 1997).

Analysis of finds and data from the site are continuing under the auspices of three externally funded collaborative projects headed by Harald Floss, and several final academic theses are in progress (e.c. Jens A. Frick).

Site description and site formation

The cave is situated in the Upper Jurassic (Oxfordian) limestone formation of the massive of Montadiot. It formed during the erosion of the weaker components of

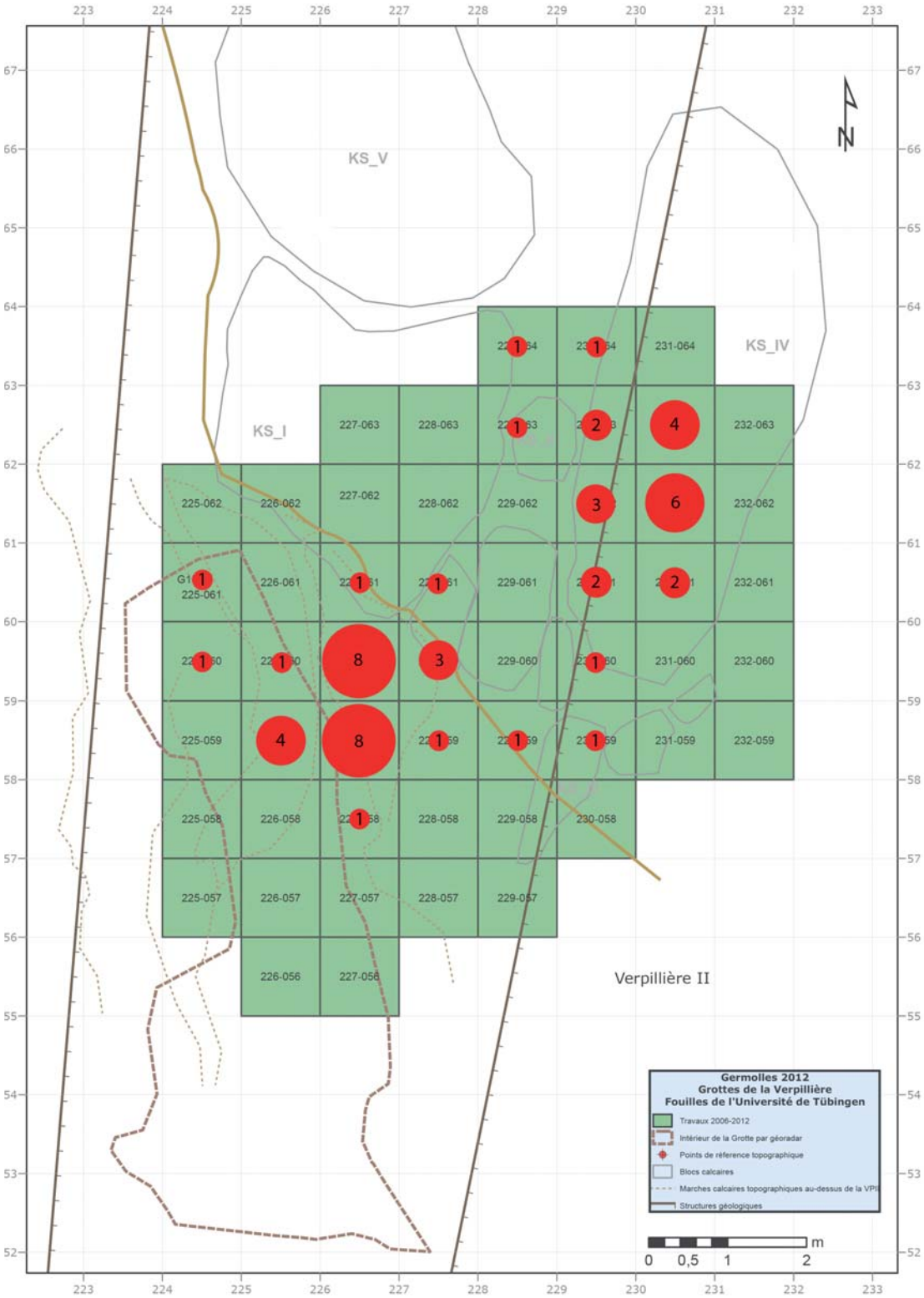


Figure 3: GIS map showing two concentrations of Upper Paleolithic lithic artifacts from GHs 1 and 2 (map by Ch. Th. Hoyer).

the formation, which likely corresponds in time with the extension of the Rhine-Saône-Rhône graben system (Bons and Wißing 2009). The intact layers are buried under a roof collapse of limestone blocks derived from an overhang of the rock face, and are situated at the foot of the cliff face and within the cave chamber (Figure 2). A first phase of roof collapse occurred before the formation of the intact find horizons, depositing large blocks beneath them. During the time of occupation, several small collapses from the cave walls occurred, breaking up the spatial distribution of the artifacts. A final, large collapse after the formation of the intact find horizons closed the cave almost completely.

The intact find layers yield sediments with a mix of fluvial and aeolian components. This suggests that the sediments were deposited in the cave with the erosion of the limestone, blown into the cave from outside, and altered and homogenized in the Upper Pleistocene (pers. comm. L. Zöller, D. Richter, Ch. Miller and P. Bons). The sediment on top of and between the limestones from the roof collapse contains artifacts from the Middle Paleolithic to the Early Upper Paleolithic in secondary context (Floss *et al.* 2013a, 2013b, 2014; Götz 2013). The Middle

Figure 4: Table of the geological layers (GHs) and their content.

geological layer (GH)	status	yield	sediment	thickness
1	mixed	modern material, items from the middle ages, upper and middle paleolithic artifacts	cover soil with many limestones and less humus and throw-off of the badger den (maybe also from the top of the plateau)	around 0.1 m
2	mixed	modern material, items from the middle ages, Upper and Middle Paleolithic artifacts	soil with a big humus content, mostly bigger limestones, limestone blocks of the roof collapse, patches of cave sediments, badger den	0.2 m to 3 m
3	intact	Middle Paleolithic artifacts	mostly aerial soil with a small fluvial component, slightly altered through bio- and kryoturbation	0.4 m to 1 m
4x	intact	Middle Paleolithic artifacts	mostly aerial soil with a small fluvial component, no alteration visible	0.5 m to 0.1 m
4	intact	Middle Paleolithic artifacts	mostly aerial soil with a small fluvial component, no alteration visible	0.1 m to 0.4 m
5	intact	sterile	soil horizon under the contemporary entrance	0.05 m to 0.1 m
6	intact	sterile	weathering horizon of limestones inside the cave	0.05 m to 0.5 m
7	intact	sterile	weathered flowstone	around 0.1 m
8	intact	sterile	concreted limestone blocks	around 0.7 m
9	intact	possibly another find horizon	crusts and blocky deposits of limestone (only in a small depth sondage)	possibly 0.1 m

Paleolithic artifacts occur throughout these disturbed deposits associated with the roof collapse and the badger den, but the Upper Paleolithic artifacts are concentrated in two spots: under the contemporary cave entrance, and 3.5 meters to the north-east (Figure 3). It is unclear at present whether these Upper Paleolithic elements are invasive (deriving from the plateau above) or the remains of otherwise eroded interior deposits.

Currently, we can suppose that the horizontal extent of the site (the area of sediment buried under the collapse and in the cave) is around 100 m^2. Up to this point, excavation has concentrated on the contemporary entrance to the cave, where 15 m^2 have been excavated down to the surface of a concreted layer (with flow stones) of limestone blocks (GH 8). Ground Penetrating Radar (GPR) and structural geological analyses from 2009 suggest that this concreted layer is not the bedrock of the cave (Bons and Wißing 2009; Leach and Miller 2009), which was confirmed by a deep *sondage* in 2009 (Floss 2009). The stratigraphy of the cave contains nine sediment layers and the bedrock in all. Archeological material occurs in GHs 1, 2, 3, 4x and 4 (see Figure 4). The layers GH 3, 4x and 4 are intact Middle Paleolithic horizons. The underlying sediments have thus far proven sterile.

Spatial find distribution

In the mixed layers (GH 1 and 2), some general tendencies can be outlined. Firstly, the Upper Paleolithic finds are concentrated in two main areas (see Figure 3) (Floss *et al.* 2013a; Götz 2013). Secondly, the artifacts of a Middle Paleolithic nature are similar to those from the intact layers below (bifacial, Levallois and discoidal elements). Of the intact find layers (GH 3, 4x and 4), only GH 3 (n = 7,375 single finds) has been excavated and analyzed extensively enough for meaningful spatial analyses to be performed. So far, GH 4 has yielded only n = 145 single finds, but contains complete bones of large Pleistocene herbivores (such as mammoth and rhinoceros). GH 4x was only found over 5 square meters, and yielded only n = 52 single finds.

GH 3 shows several concentrations of single finds, for instance an accumulation of bones and teeth in the western area of the excavated zone, close to the cave wall. Bifacial elements were found in the southern and eastern areas of the excavated zone. The termination of find-bearing sediments against the blocks from the wall collapse to the east is very clear. One of the most striking features of the 3D plots of GH3 are the horizontally stratified lenses of charcoal (n = 3,095) (Figure 5). Further analyses, including spatial distribution and density estimations, workpiece arrangements (Uthmeier 2004; Weißmüller 1995), and lithic and faunal refitting, will confirm whether the finds in this geological horizon (GH) can be divided into discrete archeological horizons (AHs) or even occupation surfaces.

Lithic assemblages

The technological, morphological, functional, typological and provenience analyses of the items from the find layers discussed above are ongoing, but some preliminary

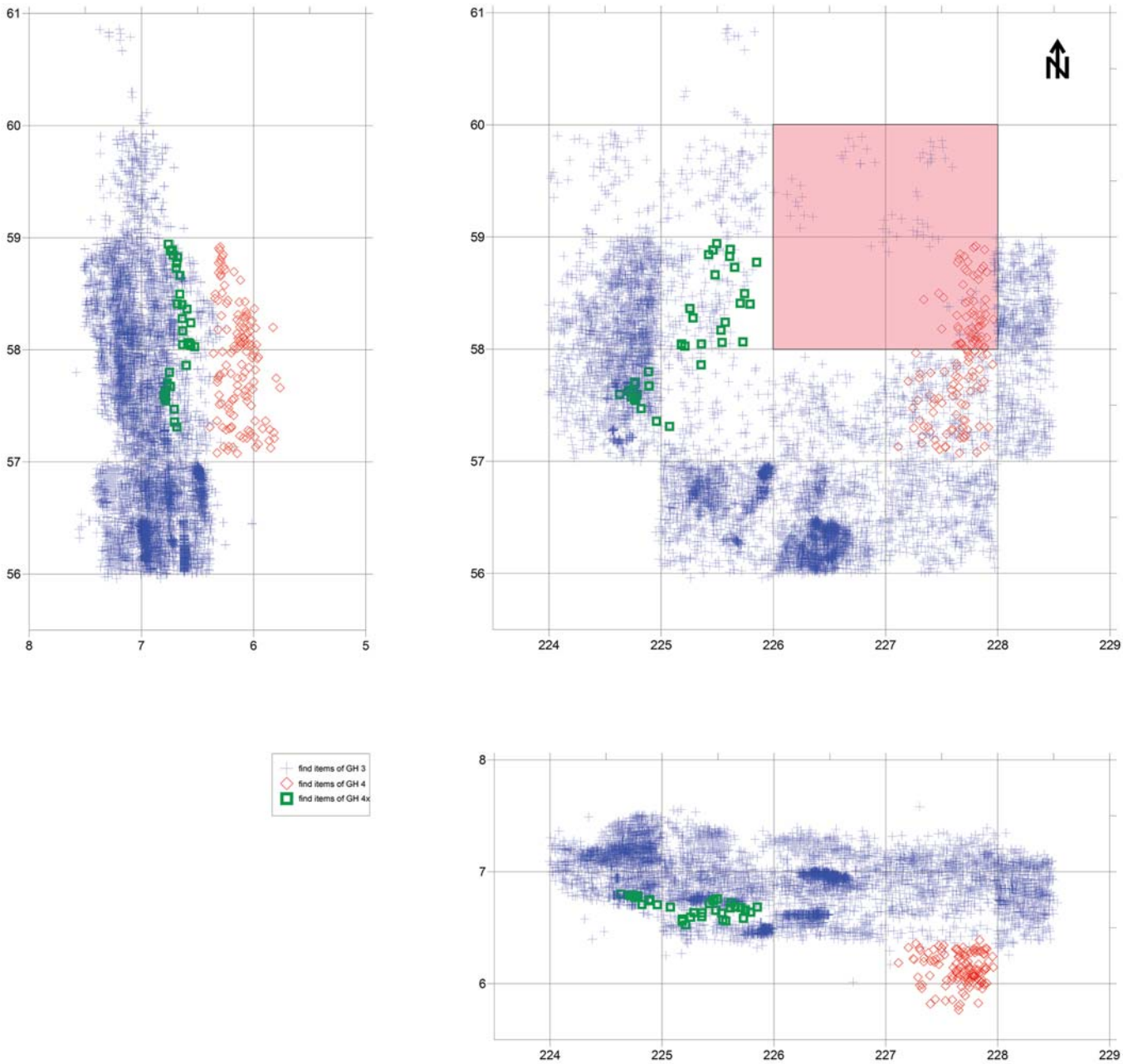
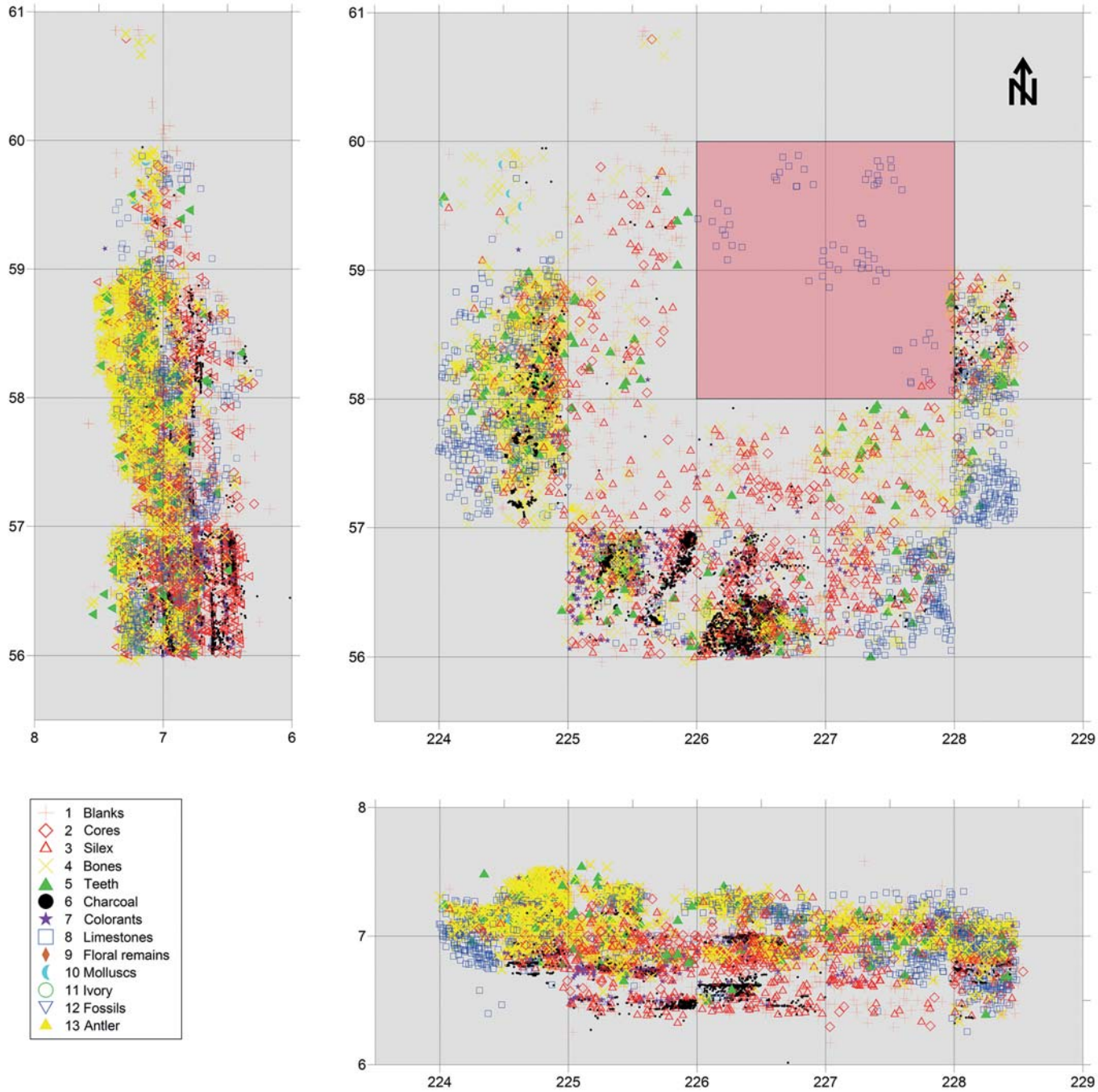


Figure 5: 3D projections of single plotted finds from the intact layers. a) projections of all finds from the layers in top view, view from west to east and from south to north; b) projections of all find items of the GH3 in top view, view from west to east and from south to north (the shaded red square indicates the sondage from 2009, 3D projections by Ch. Th. Hoyer, images by J. A. Frick).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225
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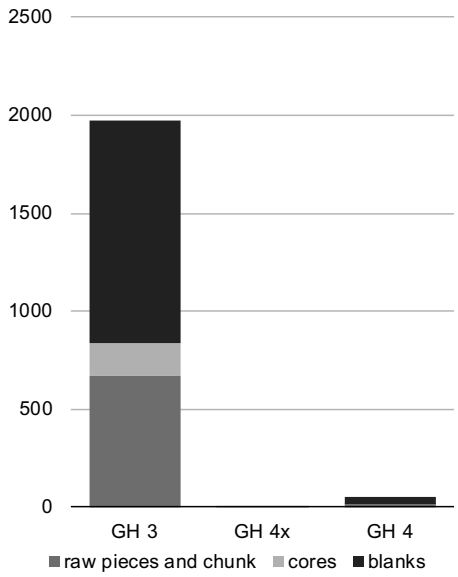
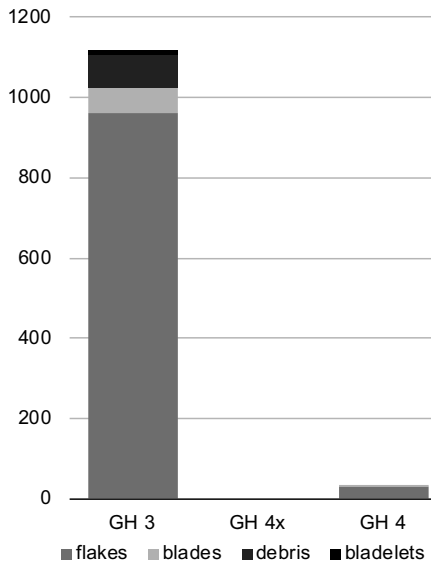
N
1 Blanks
2 Cores
3 Silex
4 Bones
5 Teeth
6 Charcoal
7 Colorants
8 Limestones
9 Floral remains
10 Molluscs
11 Ivory
12 Fossils
13 Antler





single finds	GH 3	GH 4x	GH 4
raw pieces and chunk	669	1	14
cores	166	0	4
blanks	1138	0	33
from them are flakes	962	0	32
from them are blades	64	0	1
from them are debris	79	0	0
from them are bladelets	13	0	0
total	**1973**	**1**	**51**

Figure 6: Table and diagram of all lithic items from GHs 3, 4x and 4.

observations can be presented. Here, we describe primarily the general observation made on the GH 3 assemblage. Thus far, n = 1,973 lithic single finds have been measured from this layer (see also Figure 6).

Flint from the *argiles à silex* (clay sediments with flint, see also Arcelin 1877; Collenot 1876; Dewolf 1970, 1976) is the most commonly exploited lithic raw material in this horizon (for the distribution of the flint from the *argiles à silex* in Saône-et-Loire, see Frick *et al.* 2012; Rué 2000 and Figure 1). Besides this, currently unidentified flint and *chaille* (English chert, German *Hornstein*) variations were used, as well as quartz, and various quartzite and sandstone materials. Levallois methods (Boëda 1986, 1988, 1994, 1995b) of blank production are dominant. The blanks include oval, rectangular and triangular flakes, as well as leptolithic (blade and bladelets) products. So far, the count of these leptolithic products is n = 79 blades and n = 13 bladelets (see Figure 7).

Some *éclats débordants* (core edge flakes) and many cortical flakes show on-site reduction at early stages. Six of the cores recovered to date are of Levallois character, show centripetal scar patterns on the flaking surfaces, and are mostly small and exhausted (see Figure 8). The Levallois flakes show mostly a unidirectional or bidirectional scar pattern on their dorsal face.

In addition to numerous (n = 60) Levallois elements, we have some evidence of discoidal reduction (n = 3), and of dorsal and ventral reduction on flakes (n = 11). Hammerstones have also been recovered and are made from quartzite (n = 32) and sandstone (n = 2). Flakes recovered from such hammerstones (n = 9) indicate their on-site use (Figure 9).

So far, ten bifacial pieces have been recovered (see also Figure 10). The bifacial production concept is very similar to that described by Boëda (1995a) for the

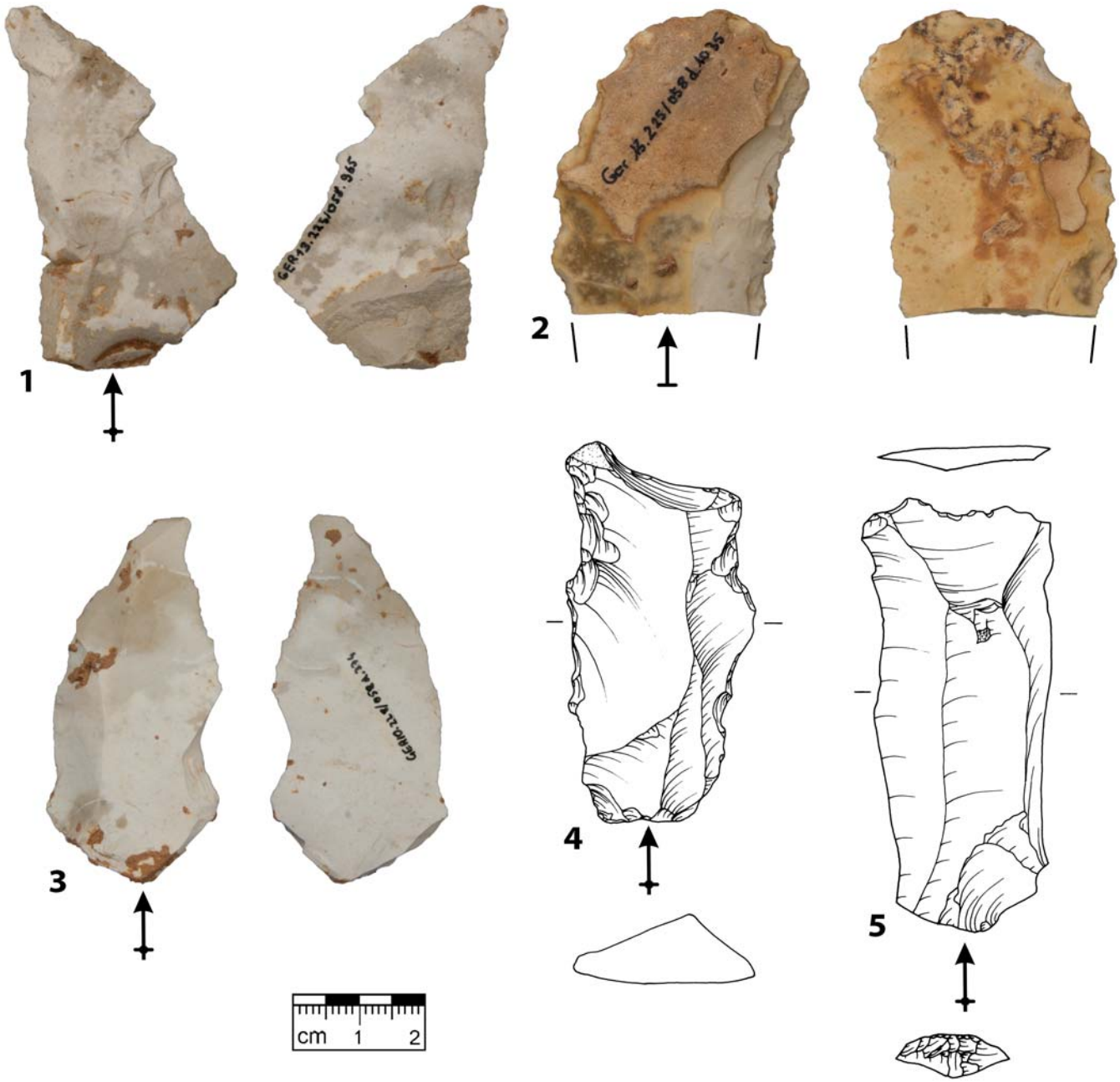


Figure 7: Illustrations and photographs of five of the Middle Paleolithic (metric) blades from the GH 3 (illustrations by Y. Hilbert, photographs and image by J. A. Frick).

Micoquian layers at Kůlna cave. The surfaces are constructed in a plano-convex manner, such that the edge of a plane always hits a convex surface (the best examples are shown in Figure 10). This concept was used for the production of both symmetrical (*bifaces*) and asymmetrical (*Keilmesser* or Bifacially backed knives) bifacial elements. In addition to complete bifacial elements, flakes from surface preparation produced with a soft-hammer technique were found (n = 27), suggesting the on-site production of bifacial pieces. The bifacial elements were

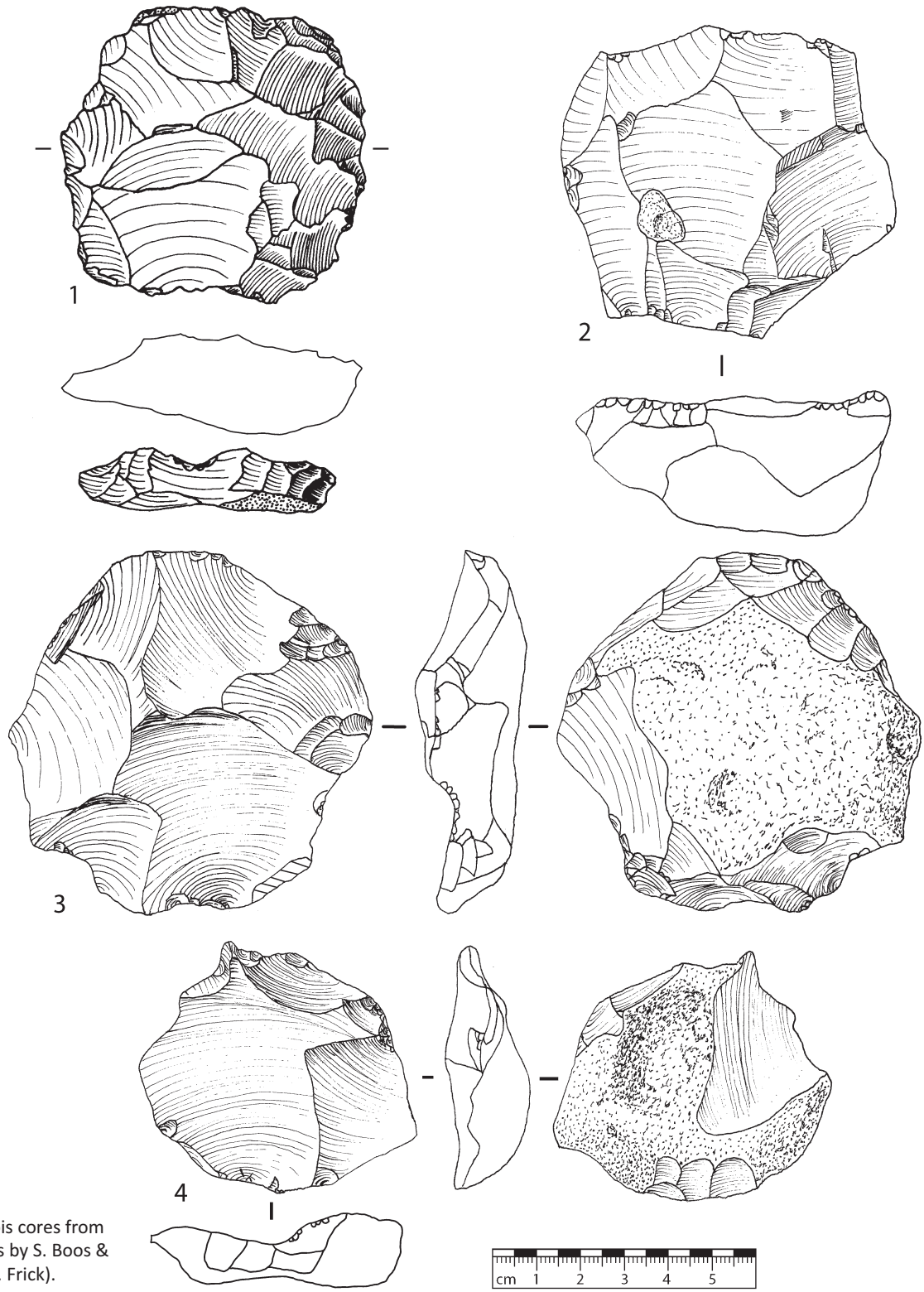
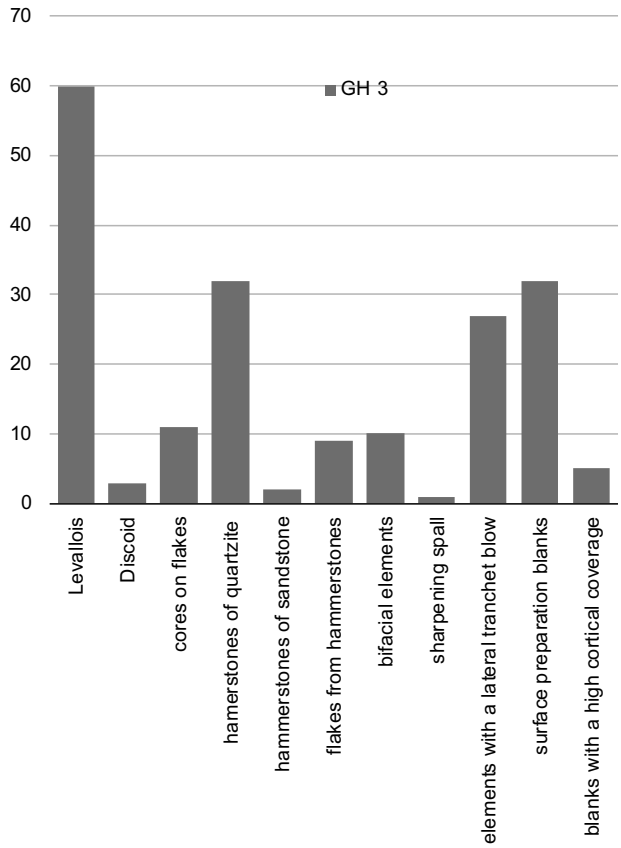


Figure 8: Four Levallois cores from the GH 3 (illustrations by S. Boos & Y. Hilbert, image: J. A. Frick).



litho-technological concepts and elements	GH 3
Levallois	60
Discoid	3
cores on flakes	11
hamerstones of quartzite	32
hammerstones of sandstone	2
flakes from hammerstones	9
bifacial elements	10
sharpening spall	1
elements with a lateral tranchet blow	5
surface preparation blanks	27
blanks with a high cortical coverage	32
total	**192**

Figure 9: Table and diagram of artifacts from GH 3 attributed to different litho-technological entities.

primarily made from local flint, but one example was made of a flint of unknown provenience (see Figure 10.2).

A total of 6.8% of all lithic artifacts from GH3 (n = 292) have been modified or transformed. Among them there are n = 5 denticulates, n = 5 notched pieces, n = 1 truncated piece, n = 8 endscrapers, n = 15 laterally retouched pieces and n = 69 side scrapers. Thus far only one sharpening spall from the retooling of a piece with a lateral tranchet blow (*coup de tranchet lateral*) has been detected, but several pieces (n = 8) with lateral tranchet blow scars were recovered. The first session of lithic refitting was done in 2010, and the results show a more or less horizontal distribution of the find items. Until now we have been able to refit n = 25 lithic pieces. Most are situated very close to each other (see Figure 11).

The lithic assemblage of GH 4 excavated so far contains only n = 74 single finds. Among them we found no evidence of bifacial reduction, but the Levallois concept seems to be dominant. The small spot of the GH 4x yielded even less material, but it also has a Levallois character.

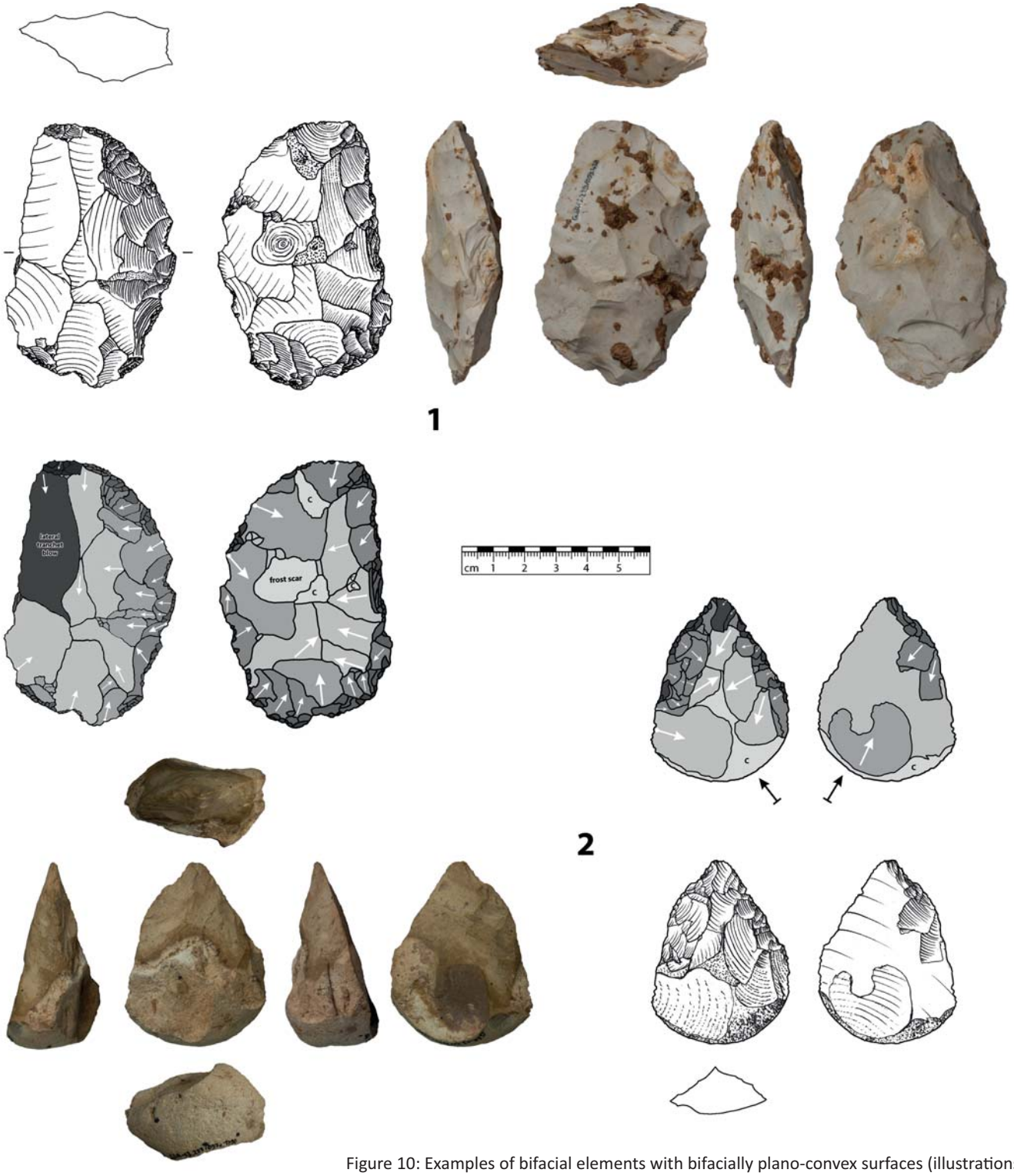


Figure 10: Examples of bifacial elements with bifacially plano-convex surfaces (illustrations by St. Wettengl, photograph, schéma diacritique & image by J. A. Frick).

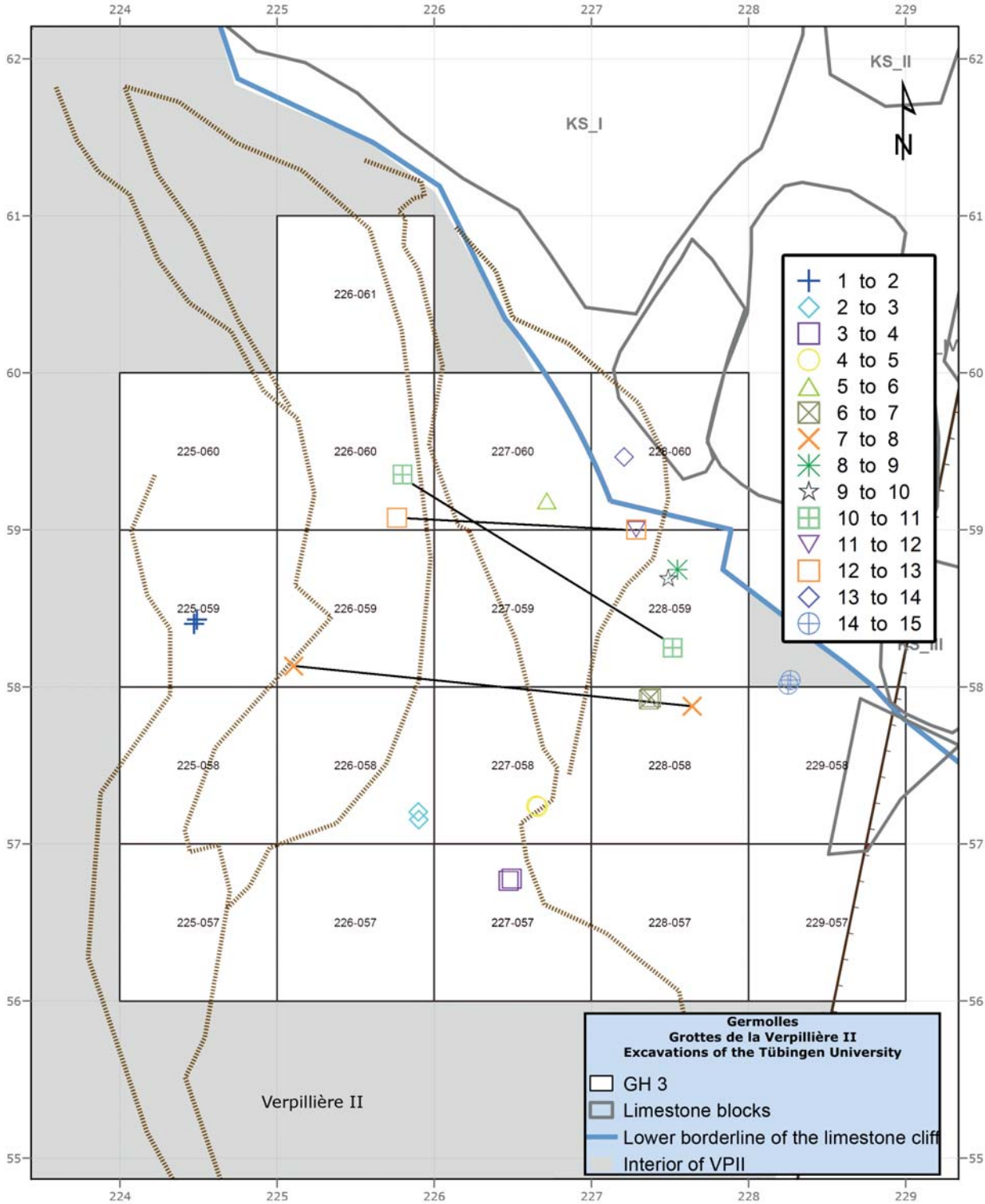


Figure 11: Refits from GH 3 in top view (GIS map: Ch. Th. Hoyer, image: J. A. Frick).

Faunal assemblages

The faunal record of the intact layers (GH 3, 4x and 4) is rich and includes a range of elements from very small fragments to large complete bones from Pleistocene herbivores like mammoth or rhinoceros (see Figure 12). GH 3 yielded n = 1,939 piece-plotted bones, n = 190 teeth, n = 2 fragments of antler and n = 7 fragments of ivory. GH 4x contains no piece-plotted faunal elements. In GH 4, n = 70 bones and n = 21 teeth were plotted. The analyzed faunal assemblage of the GH 3 (analysis made by A. Wilk) of the 2013 campaign suggests a moderate to cold climate at the time of occupation and indicates a clearly Pleistocene faunal assemblage (Floss *et al.* 2014). The faunal assemblage of GH 4 includes three complete long bones of a size appropriate to rhinoceros and one molar of a baby mammoth, which also indicate a cold climate. Beside the herbivorous hunting fauna we have only some evidence of carnivorous remains. Some bones from GHs 3 and 4 show anthropogenic modification like cut marks and knapping features. A complete atlas of an adult wooly mammoth (*Mammuthus primigenius*) was also recovered, unfortunately from the mixed layer, GH 2. GH 1 and GH 2 also contain holocene faunal elements such as a complete skull of a European badger (*Meles meles*).

Analyses of the spatial distribution of faunal artifacts indicates an accumulation of bones and teeth at the western cave wall (squares 225–058, 225–059, 225–060) in the upper parts of GH 3 (z = 7.25 to 7 m), which suggests a drop or dumping zone of scraps. In the lower parts of GH 3 the bones are more randomly distributed (Figure 5). The large bones from GH 4 were all found in 1 square meter (228–058).

Ongoing excavation, analyses and perspective

Continued excavation of the intact Middle Paleolithic layers at the *Grotte de la Verpillière II* is planned for the coming years. One aim will be to systematically remove more of the roof collapse and to excavate more of GH 3 in order to enrich the data and observations made so far and to gain further access to the GH 4 sediments. Several analyses in progress will be published in the near future (e.g. lithic technological, refitting, provenience, spatial, faunal and organic artifact analyses, site formation processes, micromorphological and geomorphological studies, 3D modeling, datations).

We hope to be able to separate the lithic finds from GH 3 into raw material units (e.c. Hahn 1988; Roebroeks 1988) and/or workpieces (Uthmeier 2004) and into archeological or occupation layers that correspond to the lenses of charcoal observed in this unit. Different archeometric analyses of organic material (ivory, antler, bone and teeth) are also in progress (Reiche *et al.* 2013), and these suggest the possibility of further refining the internal chronology of the layers at *Verpillière* II. In the ongoing excavations, we are also documenting the size (by geological size class) and distribution of limestones >5 cm, charcoal fragments and animal burrows (Frick *et al.* 2013) in order to assess their effects on the distribution of finds.

2013	species	GH 3
herbivore	*Bos primigenius or Bison bonasus*	7
	Capra ibex	1
	Equus, sp.	4
	Mammuthus primigenius	1
	Megaloceros giganteus	10
	Megaloceros giganteus or Alces alces	2
	Rangifer tarandus	2
	large Bovid or Cervid	6
	small Bovid or Cervid	12
carnivore	*Canis lupus*	1
	Crocuta spelea	1
	Ursus, sp.	1
	Martes, sp.	3
	large carnivore	1
	medium carnivore	3
rodents		3
undetermined	undetermined	135
	hare size	7
	wolf size	5
	reindeer size	61
	cervid-bovid size	68
	bigger then cervid-bovid size	1
total		**335**

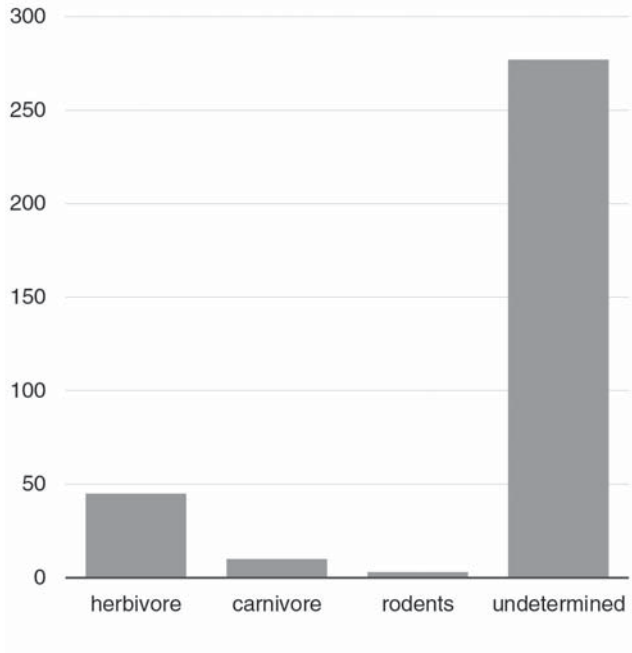


Figure 12: Two tables of the animal species from the 2013 excavation of GH 3 according to the analyses of A. Wilk.

A preliminary analysis aimed at identifying organic tools in the intact Middle Paleolithic layers found no evidence of shaped tools, but did indicate the presence of knapped bones (pers. comm. E. Tartar and C. E. Heckel). Preliminary radiometric dating results are promising and will be presented soon (pers. comm. L. Zöller and M. Richard).

Conclusion

Grotte de la Verpillière II shows a high potential for detailed analyses of the daily life of late Middle Paleolithic Neanderthals in southern Burgundy. In this region (Dept. *Saône-et-Loire*) the Grotte de la Verpillière II is (together with the Grotte de la Verpillière I) the only site that is excavated with modern high-resolution methods. Examples of mid-range-resolution excavations are Sennecé-lès-Mâcon (INRAP, unpublished), Vergisson (Chaput 2001; Combier 2001; Fabre 2010) and the Cave Denuziller in Solutré (Pautrat and Pugh 2002). From old excavations as well as old and new archeological surveys we now know more than 200 Middle Paleolithic sites in Burgundy (caves, open-air sites and surface collections).

Eastern France is an area of great interest for the study of Middle Paleolithic assemblage variation, in part because previous research has suggested that this is a region of "mixed assemblages." Many lithic assemblages in the region combine elements of the classical Bordian Moustérian facies (Ferrassie, Quina, MTA, etc.) and of the central/eastern European *Keilmessergruppen* assemblages, such that different classifications have been proposed, depending on the perspective and training of the excavators and analysts. For example, Krukowski (1939–1948) described the first known Polish assemblages with Asymmetrically backed bifacial elements as "Pradnik cycle." In the 1960s, Bosinski (1967) correlated central/western European assemblages with La Micoque, Dordogne and used the term "Micoquien" to describe them. Later, Desbrosse *et al.* (1976) associated the backed bifacial elements with a lateral tranchet blow (*Prondniks*, *Keilmesser*) from the *Grotte de la Verpillière* (I) with finds from *Ciemna*, Poland and *Buhlen*, Germany.

In the late 1990s, all of these Central European assemblages with Bifacially backed elements were integrated into the *Keilmessergruppen*, KMG (Jöris 2003), also called Moustérian with Micoquian Option, M.M.O. (Richter 1997). Around the same time, Eastern French assemblages with Micoquian elements were grouped into the "*Industries charentiennes à influence micoquiennes*" (Farizy 1995), also with a close relation to central European assemblages. Recently, these ideas were picked up by Ruebens (2012, 2013), who recognizes a transitional group between assemblages from South-western and Central France (MTA) and Central Europe (KMG), which she has named "Micoquian with bifacial tools" (MBT).

At the moment, the data from Grotte de la Verpillière II cannot help to solve this classification problem. It does, however, contribute to the increasing appreciation of the importance of time and geography to the analysis of variation in Middle Paleolithic technologies. A wealth of Middle Paleolithic sites in France remains undated, and patterns of Neanderthal exploitation of the region (e.g. distance to raw material sources, prey availability and topographical settings) remain poorly understood. The recent research at *Grotte de la Verpillière* II confirms that eastern French sites with Micoquian bifacial elements are not rare (e.c. Verpillière I & II, Vinneuf, Villeneuve, Sennecé-lès-Mâcon), and recent archeological surveys in the *Côte Chalonnaise* (*Vallée des Vaux*) have revealed open-air sites with backed bifacial elements (pers. comm. B.

Macioszczyk) that indicate the potential to establish broader territorial areas (contextual areas) to contextualize ongoing research (Richter *et al.* 2012).

Acknowledgements
First of all, we would like to thank the entire excavation team, whose commitment and hard work made the excavations and subsequent analyses possible. The analyses of all data from Verpillière II have been supported by funding from the *Deutsche Forschungsgemeinschaft* (DFG FL 244/5-1) and the *Sonderforschungsbereich "KulturenRessourcen"* (SFB 1070 B01) at the *Eberhard Karls Universität Tübingen* and the *Projet Collectif de Recherche* (PCR) "Le Paléolithique supérieur ancien en Bourgogne méridional!" at the *Université de Bourgogne*, Dijon. The excavation is financed by the Service Régional d'Archéologie, Dijon (S.R.A.). The analysis of the lithic technology is the main part of the doctoral thesis of Jens A. Frick.

We would like to say thank you to the "inner circle" of the research group Floss of the University of Tübingen, namely Christian Thomas Hoyer, Klaus Herkert, Claire E. Heckel, Nadine Huber, Sofia Paula Steigerwald, Ria Litzenberg, Heike Wuerschem, Stefan Wettengl and Simon Fröhle, for their contributions to this research. Special thanks goes to Claire E. Heckel for the English language revision. Many thanks also to Yves Pautrat of the Service Régional d'Archéologie, Dijon for his commitment to and assistance with this project over many years. Thanks to Patrick Schmidt and Nicholas Conard for scientific discussions. We would like to thank the anonymous reviewers for their helpful comments on the improvement of an earlier draft of this article. Finally, we would like to say thank you to all external researchers who have contributed to the analysis of the data presented here: S. Boos, P. Bons, J. Combier, P. Leach, Ch. Falguères, Y. Hilbert, Ch. Miller, M. Richard, D. Richter, M. Siegeris, E. Tartar, A. Wilk, Ch. Wißing, L. Zöller and many more.

Résumé
Dans le cadre des fouilles programmées à la grotte de *la Verpillière*, à Germolles (10 km à l´ouest de Chalon-sur-Saône), sous la direction d'Harald Floss, un nouveau site en grotte a pu être découvert en 2006. Cette nouvelle grotte, située à seulement 50 m de la première, a été dénommée « *la Verpillière II* », tandis que la grotte anciennement connue s'appelle désormais « *la Verpillière I* ». Les premières campagnes de fouilles, entre 2006 et 2008, ont été surtout consacrées à l'évacuation de dépôts remaniés et de blocs d'effondrement, en vue de créer un accès à la grotte. La campagne de fouilles de 2009 nous a permis de mettre au jour, pour la première fois, des niveaux intacts du Paléolithique moyen, en-dessous des niveaux remaniés. Depuis lors, des fouilles programmées annuelles sont consacrées à l'exploration de ces niveaux, qui se distinguent par des industries lithiques très riches, par une faune également abondante, ainsi que par des milliers de petits fragments de charbons de bois se présentant sous forme de niveaux bien distincts. Les industries lithiques en question se caractérisent par un pourcentage élevé de débitage Levallois. Le niveau supérieur (GH 3) dispose d'une composante bifaciale apparentée aux groupes à « Keilmesser » d'Europe centrale, au Micoquien de l'ouest de l´Allemagne (suivant G. Bosinski), au *Charentien à influences micoquiennes* de l'est de la France (suivant C. Farizy), au Moustérien à option micoquienne d´Europe centrale (suivant J. Richter), ou encore au « *Mousterian with bifacial tools* » défini par K. Ruebens pour la France septentrionale et le Benelux. L'objectif de cette contribution est de donner un premier aperçu de nos travaux sur le nouveau site du Paléolithique moyen dans l'est de la France que représente la Verpillière II, à Germolles.

Zusammenfassung
Im Zuge der Ausgrabungen an der seit alters bekannten Fundstelle Grotte *de la Verpillière* in Germolles (10 km westlich Chalon-sur-Saône) konnte ein Tübinger Team unter der Leitung von Prof. Harald Floss im Jahre 2006 eine neue archäologische Fundstelle entdecken. Da sich diese Fundstelle rund 50 m südlich der gut bekannten Grotte *de la Verpillière* (nun als Verpillière I bezeichnet) befindet und auf derselben Gemarkung liegt, wurde sie Verpillière II genannt. In den Kampagnen der Jahre 2006 bis 2008 wurden vorwiegend durchmischte Sedimente sowie große Kalksteinböcke eines Deckenversturzes entfernt, um Zugang zum Eingang der Höhle zu erhalten. In der Kampagne 2009 wurden unterhalb der Verstürze intakte Schichten mit mittelpaläolithischen Artefakten angetroffen. Seit dieser Zeit werden diese alljährlich in einer achtwöchigen Kampagne sukzessive geborgen und im Folgenden ausgewertet. Die intakten Fundschichten enthalten unter Anderem zahlreiche Steinartefakte und Faunenelemente, sowie tausende kleine Holzkohlefragmente, welche sich in voneinander abgesetzten Linsen präsentieren. Die lithischen mittelpaläolithischen Industrien beinhalten einen hohen Prozentsatz an levalloiden Elementen. Die oberste intakte Schicht (GH 3) besitzt eine bifazielle Komponente, die hohe Ähnlichkeit mit den Keilmessergruppen (mitteleuropäische Inventare mit bifaziellen Stücken mit Rücken und messerartiger Schneide), mit dem „Micoquien“ in der westlichen BRD (nach Bosinski), mit dem *Charentien à influences micoquiennes* in Ostfrankreich (nach Farizy), dem Moustérien mit Micoque-Option in Mitteleuropa (nach Richter) oder dem *Mousterian with bifacial tools* in Nordfrankreich und den BeNeLux-Staaten (nach Ruebens) besitzt. Hier wird eine erster Überblick über die laufenden Arbeiten (Ausgrabungen, Aufnahmen, Analysen und Auswertungen) an und zu dieser neuen mittelpaläolithischen Fundstelle in Ostfrankreich gegeben.

RESEARCH ON UNDERWATER MOUSTERIAN: THE SITE OF RESNIK – KAŠTEL ŠTAFILIĆ, DALMATIA, CROATIA

Ivor Karavanić

Abstract
Resnik – Kaštel Štafilić is an open air Middle Paleolithic site from a period when the sea level was much lower than today. Small scale underwater excavation and systematic collection of surface finds at the site using a grid have been ongoing since 2008. The methodology applied will be further described in this paper. Exploration of the site is important for several reasons: it adds to the overall picture of the area that was once land and connects it to the other sites, it allows for a development of methodology for underwater excavation of Paleolithic sites, and it also opens up a whole set of questions related to the processes of formation and destruction of underwater sites.

Keywords
Underwater Archeology, Middle Paleolithic, Mousterian, Resnik – Kaštel Štafilić, Dalmatia, Croatia

DOI: 10.5817/CZ.MUNI.M210-7781-2014-6

Introduction

The sites of Croatia are known worldwide in prehistoric archeology because of their important finds of Paleolithic industries and/or fossil human remains. The most famous sites are Krapina and Vindija, situated in the continental region of Hrvatsko zagorje (northwestern Croatia), which differs geographically and ecologically from the Mediterranean sites situated farther south on the Adriatic coast and its hinterland (Figure 1). Krapina yielded Neandertal remains associated with the Mousterian industry, dated ca. 130.0 ky (Rink *et al.* 1995; Simek and Smith 1997), while Neandertals associated with the Mousterian industry at the site of Vindija are dated to ca. 40.0 ky BP (Krings *et al.* 2000; Serre *et al.* 2004). Veternica cave yielded

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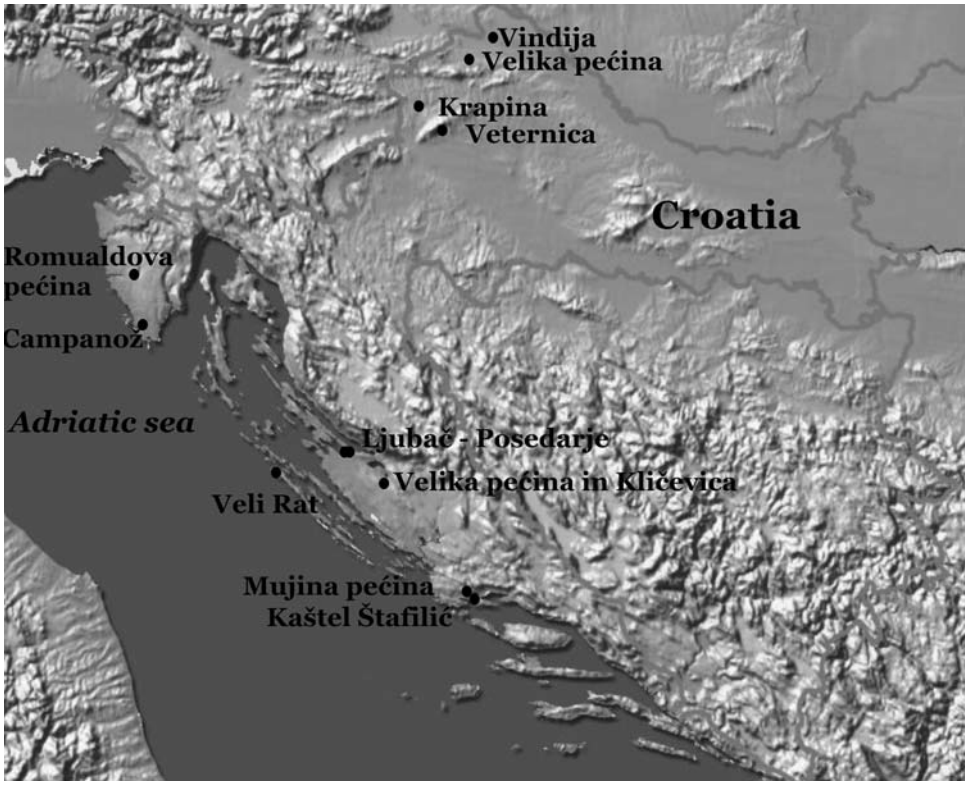

Figure 1: Map showing Croatian Mousterian sites mentioned in the text.

Mousterian artefacts. Unlike Krapina and Veternica, Vindija and Velika pećina also contain Upper Paleolithic industries that have an important role in the debate on the Middle/Upper Paleolithic transition.

In contrast to the situation in Hrvatsko zagorje, the cultural and palaeoecological situation in the Middle Paleolithic in the eastern Adriatic region is little known. Until recently, not a single Middle Paleolithic site has been known in the Croatian part of Istria. Romualdova pećina, located at the end of Limski kanal (the Lim Bay) near Rovinj had been known as an Upper Paleolithic site (Malez 1979), but D. Komšo (2008) excavated the site in 2007 and found Mousterian artefacts. Based on the dates on speleotherm by M. Malez, and the stratigraphy determined during the excavation in 2007, it is likely that at least a part of the Middle Paleolithic industry from this site represents Late Mousterian. Furthermore, Campanož, a salvage-excavated open-air site near Pula yielded more than 30,000 chert fragments (Komšo 2011). Based on the lithic finds the site belongs to the Middle Paleolithic and can be interpreted as a workshop. No human skeletal remains were associated with Mousterian deposits from Romualdova and Campanož.

Until recently, Paleolithic research in Dalmatia (south Croatia) was rare. Superficial artefact collections from the surface of open-air sites have enabled lithic analysis mainly based on typology (Batović 1965, 1988; Malez 1979; Chapman *et al.* 1996; Vujević 2009). An entire series of sites are known to exist in the area north of the town of Zadar and south of the Ražanac village, between the bay of Ljubač

and the village of Posedarje. Furthermore, a large number of stone artefacts and chunks were collected near the lighthouse at Veli Rat on the northern part of the Dugi Island. The material from all of these sites was collected on the surface where it was directly exposed to weathering. Therefore, many pseudo-artefacts, pseudo-tools and naturally fragmented pieces were found together with artefacts and tools.

The only site in Dalmatia with a clear and homogeneous Mousterian stratigraphic sequence that was excavated systematically (1995–2003) is Mujina pećina near the town of Kaštela (Karavanić *et al.* 2008). The stratigraphic sequence was dated between about 45.0 and 39.0 uncal ky BP (Rink *et al.* 2002).

A test excavation of another Dalmatian site – Velika pećina in Kličevica near Benkovac was conducted in 2006 and more extensive excavation started in 2012 and continued in 2013. A short stratigraphic sequence was established, with several layers yielding numerous Mousterian finds, one of which was dated to about 39.0 uncal ky BP (Karavanić *et al.* 2007).

Furthermore, small scale excavation at the underwater open-air Mousterian site of Resnik – Kaštel Štafilić using a grid was conducted in 2008 and continued through 2010–2013 when only surface finds were collected over a larger area (Karavanić *et al.* 2009). The methodology and preliminary research results on this site, important for several reasons, are briefly presented in this paper.

Background

The site of Resnik is a well-known locality from the Hellenistic and late Roman periods, and finds have been collected both on land and under water (Brusić 1990; 2004). Neolithic finds have also been collected from an underwater site here, but at a different location than the Hellenistic and late Roman finds (Brusić 2004). Of particular importance is the discovery of an underwater site that yielded Paleolithic artefacts. The site is at the depth of about 4 m and the discovery was reported by I. Svilan. After Z. Brusić (1977) first reported on possible Middle Paleolithic artefacts in Dalmatian underwater zone over thirty years ago, this was an entirely new case indicating a possible Middle Paleolithic site. The first archeological investigation of the underwater Paleolithic site Resnik – Kaštel Štafilić took place in September 2008, and has continued from 2010 till present.

Research method

The standard method used in investigations of Paleolithic sites on land was adapted to underwater work taking into account the specific features of this site. The first year of investigation was especially challenging because the successful application of the method was uncertain and it required the participation of experienced divers. The grid was set, as well as the benchmark for measuring depths. The corners of the grid were recorded by a total station. The finds from the surface were collected by hand, and excavations were performed with the help of a water dredge in spits 5 to 10 cm thick (Figure 2). The sondage measured 8 m^2, divided into 1 × 1 m squares, further

Figure 2: Excavation performed with the help of a water dredge (Photo with courtesy of M. Parica, University of Zadar).

subdivided into 0.5 × 0.5 m squares (which eventually proved an excessively detailed division considering the small number of finds). As it was impossible to distinguish finds from ordinary rocks underwater, the entire sediment was gathered into bags, transported to the coast and then wet and dry sieved on land in 5 mm and 2 mm sieves.

The 2008 investigations identified the stratigraphic contexts and it was established that finds only rarely appear within specific layers, being more frequent on the very surface of the seabed. This is why in the following campaigns (2010–2013), rather than excavating, we decided to collect the material from the surface, divided by squares (1 × 1 m) in the grid (Figure 3). Depths of square meters (corners and middle part) were taken before and after collecting the material (Figure 4). The corners of the grid were recorded by a total station (Figure 5). Surface material was gathered into bags, transported to the coast and then wet sieved on land in a 5 mm sieve (Figure 6).

Preliminary Results and Discussion

Research on underwater Mousterian site Resnik – Kaštel Štafilić (2008) began with the cleaning of the surface stratigraphic unit that consisted mainly of stones and some ooze. A few artefacts were found as well as some chert debris, probably broken as a result of natural processes. After the surface layer had been removed, the excavation of the sediment mixed with stones started. Several possible artefacts and large quantities of chert debris were found. The excavation layers deeper down were somewhat lighter colour, and beneath them was a marly rock. In addition to chert

Figure 3: Collecting artefacts from the surface layer (Photo with courtesy of K. Zubčić, Croatian Conservation Institute).

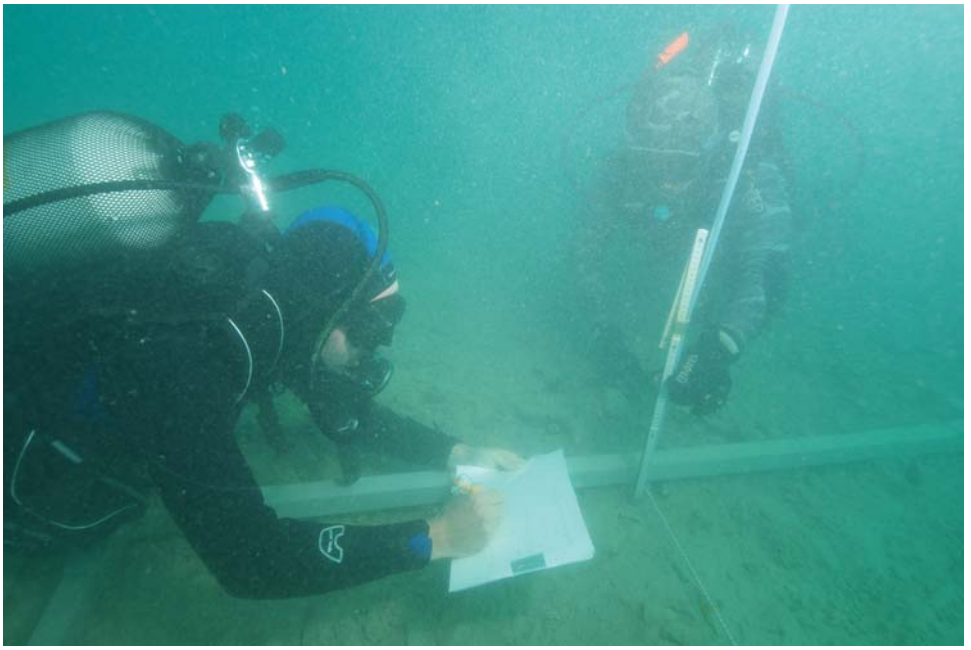

Figure 4: Taking the depths (Photo with courtesy K. Zubčić, Croatian Conservation Institute).

debris, whose frequency decreased with depth, a sidescraper and several possible tools were found (most of these are probably pseudo-tools or pseudo-artefacts, partly or entirely created by natural processes). In the following years (2010–2013) more archeological material was collected from the seabed surface.

Although the number of collected artefacts with clearly Mousterian typological features was relatively small, in addition to the artefacts collected earlier by I. Svilan, these proved beyond doubt that Resnik – Kaštel Štafilić is a Middle Paleolithic underwater site. It represents elements (lithics) from one or several open air habitation sites from the time when the sea level was considerably lower than today. The original site (or sites) was destroyed by the sea and there is a stratigraphic profile on the coast which might represent a part of the Pleistocene stratigraphy (S. Miko personal communication). However, underwater sediments which contain Pleistocene artefacts were not formed at that time, but later (Holocene). The reconstruction of site formation processes is very complex because the finds on the seabed surface can be moved by waves. According to Crmarić *et al.* (1998) the wave basis in the western part of the Kaštela Bay, near the Pantan spring, lies at a depth of 15–20 m during gale-force *jugo* (*scirocco*), and at 5 m during *bora*. In addition, the finds can be disturbed by various sea animals, as well as humans (construction works, e.g. sewer conduits, as well as seabed digging for shells). Although the finds are disturbed (due to the action of waves and other factors) it seems that their accumulation is mainly not a result of displacement from another locality that was far away from the present site as was reported earlier (Karavanić *et al.* 2009). However, only some of the finds may have arrived to their present position through erosion from another place.

Figure 5: Recording the corners of the grid by a total station (Photo by author).

Among the tools, several pseudo-tools and numerous naturally broken pieces of local chert were found. All the artefacts belong to the Mousterian industry, and there are also indications of centripetal technique. Not a single artefact from the Upper Paleolithic was found during the field work, although I. Svilan found a retouched blade that could belong to the Upper Paleolithic.

The underwater site Resnik – Kaštel Štafilić is important for several reasons. It adds to the overall picture of the area that was once land and connects it to the other sites. It also allows for a development of methodology for underwater excavation f Paleolithic sites, which is one of the important directions that Paleolithic archeology can take in the near future. It also opens up a whole set of questions related to the processes of formation of underwater sites.

However, the question whether the site is contemporaneous with, or older than, the occupation at the nearby Mousterian site Mujina pećina (that took place between 45.0 and 39.0 uncal ky BP) remains open (Karavanić *et al.* 2008). There is evidence that people used Mujina pećina during autumn and spring, while there is no evidence for hominin activity at this site during summer and winter (Miracle 2005). During winter they may have moved closer to the coast and one of the locations on their trail might have been the Resnik – Kaštel Štafilić underwater site, while other locations are most likely also below sea level at present time, or destroyed by subsequent changes in sea level (Karavanić *et al.* 2014).

Although no diagnostic fossil hominin remains have been found at Resnik – Kaštel Štafilić and other Dalmatian Middle Paleolithic sites, the archeological assemblage (Mousterian industry) and the results of chronometric dating of Mujina

Figure 6: Extracting the artefacts from the raised sediment (Photo by author).

pećina and Velika pećina in Kličevica indicate that their sequences are contemporary with the late Neandertals and earliest known anatomically modern human groups in Europe. It is important to continue research on the Middle Paleolithic of Dalmatia to reveal yet another ecological and geographical region that Middle Paleolithic Europeans inhabited, a region quite different from that of their better-known counterparts in northwestern Croatia. Furthermore, a comparison of the obtained results with the sites in Central Europe can establish and explain similarities and differences between the adaptation and behaviour of Mousterian people in two different environmental zones (Mediterranean and continental).

Acknowledgements
I am grateful to Jiří Svoboda for his friendship and professional support during the years. I would like to thank Kruno Zubčić, Slobodan Miko and Fred H. Smith for various forms of assistance related to the information presented in this paper. Research was supported by the Ministry of Culture of the Republic of Croatia and the Croatian Science Foundation.

Résumé
Resnik – Kaštel Štafilić est un site de plein air du Paléolithique moyen. Il remonte à une époque où le niveau marin était considérablement plus bas qu´à l´heure actuelle. Des fouilles subaquatiques de petite envergure, ainsi que des ramassages de surface systématiques sur le site à l´aide d´un quadrillage sont en cours depuis 2008. La méthodologie mise en œuvre fait l´objet d´une description dans le présent article. L´exploration du site en question est importante à plusieurs égards : en plus de compléter le tableau des sites présents dans la région à une époque où celle-ci était exondée, elle contribue au perfectionnement méthodologique des fouilles subaquatiques de sites paléolithiques. Qui plus est, l´exploration du site ouvre le champ à toute une série de questions liées aux processus de formation et de destruction des sites subaquatiques.

Zusammenfassung
Resnik – Kaštel Štafilić ist eine mittelpaläolithische Freilandfundstelle aus einer Zeit, als der Meeresspiegel wesentlich niedriger war als heute. Seit 2008 werden kleinräumige Unterwasserausgrabungen und systematische Oberflächenaufsammlungen mit Hilfe eines Messgitters durchgeführt. Die angewandte Methode wird in dem Beitrag näher erläutert. Die Untersuchungen an der Fundstelle sind aus mehreren Gründen wichtig: Sie leisten einen Beitrag zum Gesamtbild der Gegend, die damals Festland gewesen ist und verbinden sie mit anderen Fundstellen; sie bietet die Gelegenheit zur Entwicklung einer Methode für die Unterwasserausgrabung paläolithischer Fundstellen; und sie eröffnet einen ganzen Fragekatalog hinsichtlich der Formationsprozesse und Zerstörung von Unterwasserfundstellen.

NATIVE OCCURRENCE OF LARCH (*LARIX*) IN CENTRAL EUROPE: OVERVIEW OF CURRENTLY AVAILABLE FOSSIL RECORD

Vlasta Jankovská[1] *and Petr Pokorný*[2]

Abstract

Despite its present limited range in Europe, larch (*Larix*) was widespread over nearly whole European territory in the Last Glacial Period. Several well-determined findings of its pollen grains and macrofossils were rather recently made in both the Czech and Slovak Republics for this period. These new records extend the earlier survey published with regard to this territory. In Central Bohemia, *Larix* was present in the vicinity of Vltava River near Prague-Podbaba in between ca 40.0 uncal ky and 30.0 uncal ky BP. This record partly supports the credibility of other, so far problematic, findings of *Larix* on the territory of Bohemia. Reliable records of *Larix* pollen from organic sediments and loess of the Last Glacial age exist from southern Moravia, and quite recently, also from Moravian section of the Carpathians and from the Moravian Gate (Northern Moravia). Findings of both the pollen grains and macro-remains of *Larix* in the Slovak Carpathians witness a continual presence of this species from the Last Glacial Period to the present time; larch is commonly spread in Slovak Republic even today and there are no doubts about its native occurrence in this area. In the present Czech Republic, *Larix* is considered to be native only in the region of Jeseníky Mts. (the Moravian Sudetes – Bohemian Massif). According to latest (sub)fossil findings, however, it cannot be excluded that in Moravia and in some parts of Bohemia, larch kept continually growing within mixed forest stands throughout entire Holocene. In the Late Holocene, humans could have participated in its disappearance, yet this suggestion is only speculative and deserves further verification.

Keywords

Czech Republic, Slovak Republic, Central Europe, Holocene, Last Glacial Period, paleobotany

DOI: DOI: 10.5817/CZ.MUNI.M210-7781-7

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Introduction

Native *versus* alien/nonnative occurrence of European larch (*Larix decidua* Mill.) in Central Europe and namely in the Czech Republic is an urgent issue of current paleobotany and paleoecology. Its solution may affect the attitude toward its further use in plantations, close-to-nature silviculture and nature conservation. Particularly in protected landscape areas and national parks, the presence of larch is under the control of strict international measures; natural occurrence of this species is a topical criterion of adequate management. The goal of this article is to summarize available paleoecological information about the history of *Larix* in particular areas of eastern part of Central Europe (former Czechoslovakia; since 1993 the Czech and Slovak Republics) and within a broader frame of the whole subcontinent.

At present, European larch is native to the mountains of Central Europe, in the Alps and Carpathian Mountains, with disjunct lowland populations in the SE quadrant of Poland (according to *Atlas Florae Europaeae*; Jalas and Suominen 1972–1994). In addition, a small area in the Sudetes (a result of the Hercynian orogeny) in Northern Moravia, the Czech Republic, also appears to be within a natural range of larch; due to minor morphological characteristics and quality of wood, botanists and foresters distinguish local varieties/ecotypes called "sudetic" or "jesenický" larch (Klika *et al.* 1953; Nožička 1962).

It is necessary to clarify, right at the beginning, the meaning of the rather ambiguous term "native". Unless properly explained, many aspects may remain rather obscure. Primarily, a species should be considered as "native" if the intentional man-made plantation can be excluded. With regard to paleoecological knowledge, so far, forest ecologists have considered as "native" only the forest vegetation that grew in Central Europe until the period of gross anthropogenic landscape transformation that took place between the twelfth century and the present, when large areas were influenced even in less accessible foothills and mountain regions; before this time, the species composition of forests was presumably affected only by climatic and habitat factors. However, many scholars understood that landscapes were markedly affected already by Neolithic agriculture, animal grazing and human exploitation of fuelwood; these activities often influenced spontaneous migration and population dynamics of woody species already in the Middle Holocene (e.g. Lang 1994). The history of European larch in Central Europe provides a good example of difficulties accompanying expert decision in issues of "native occurrence".

In his review article entitled "*Larix* Mill. in the Czechoslovak Quaternary," Emanuel Opravil made a pioneering survey of data dealing with the paleoecology of *Larix* during the Quaternary period in the territory of what was then Czechoslovakia (Opravil 1980). He examined both the (sub)fossil and historical resources and covered an era from the end of the Pliocene through the entire Pleistocene and the Holocene. Although pollen findings in the Pleistocene are very rare, they indicate that larch survived during the peaks of glacial periods in periglacial areas on the margin of both the continental and Alpine glaciers, including those in the Carpathian mountain range.

At the end of the last Interglacial (Eemian), at around 115 uncal ky BP (Müller and Kukla 2004), abrupt cooling altered the species composition of interglacial vegetation. Between roughly 95.0 uncal ky and 105 uncal ky BP, the north-western part of Central Europe was covered by boreal forests with a predominance participation of larch (Behre and Lade 1986; Behre 1989). In the same period, larch occurred even in Holland, Denmark and in the Vosges Mts. (de Beaulieu and Reille 1992). The findings of pollen grains of *Larix* in Northwestern Europe thus confirm a period of continental climate in a region that is strongly marine at the present time. For the peak of the Last Glacial Period, (sub)fossil findings were summarized through the evaluation of the Eurasian macrofossil database by Binney *et al.* (2009); records of *Larix* exist in the area closely adjacent to the eastern margin of the Scandinavian ice sheet (present NW Russia) and are dated between 25.0 uncal ky and 36.0 uncal ky BP. Unfortunately, this database does not cover the area of Central and Western Europe.

Despite the above-mentioned findings, most biogeographers consider major mountain ranges of Europe – the Alps and Carpathians – as the only natural areas of larch distribution in Europe. It is generally suggested that within the rest of the Last Glacial range, *Larix* became extinct in the Holocene, as a result of severe competitive pressure from broadleaf temperate trees.

Summary of data available from the territory of the Czech and Slovak Republics

Problematic aspects of the study

With respect to the *Larix* fossil record, some serious obstacles must be taken into account as a limitation of this kind of study. Larch wood (fresh or charred) is very difficult, or sometimes even impossible, to separate from *Picea* (spruce) on the basis of internal anatomy. So, the only reliable proof of past local presence of larch remains finds of needles and/or cones. Even so, any (sub)fossil find of this kind cannot be classified below the genus level based solely on morphological characteristics. This obstacle can be surpassed only by future studies of ancient DNA (aDNA) extracted from (sub)fossil finds; although the morphological classification is still controversial, some phylogeographers distinguish several species and several varieties based on genetic characteristics of individuals and populations (Khatab *et al.* 2008).

Another obstacle is taphonomical. *Larix* presence is markedly undervalued in pollen spectra since the pollen production is negligible and pollen dispersal is extremely ineffective (Jankovská 2007a; Figure 5). While even a single *Larix* pollen grain in a pollen slide serves as evidence of presence at any particular site, the absence of this pollen cannot be considered as proof of missing *Larix* trees in the surrounding forests (Kuneš *et al.* 2008). Moreover, it is likely that some authors did not distinguish *Larix* pollen in the past, as these pollen grains (see Figure 1) can be easily overlooked in pollen slides and/or confused with some non-pollen objects, like, for example, animal (Rotifera) eggshells.

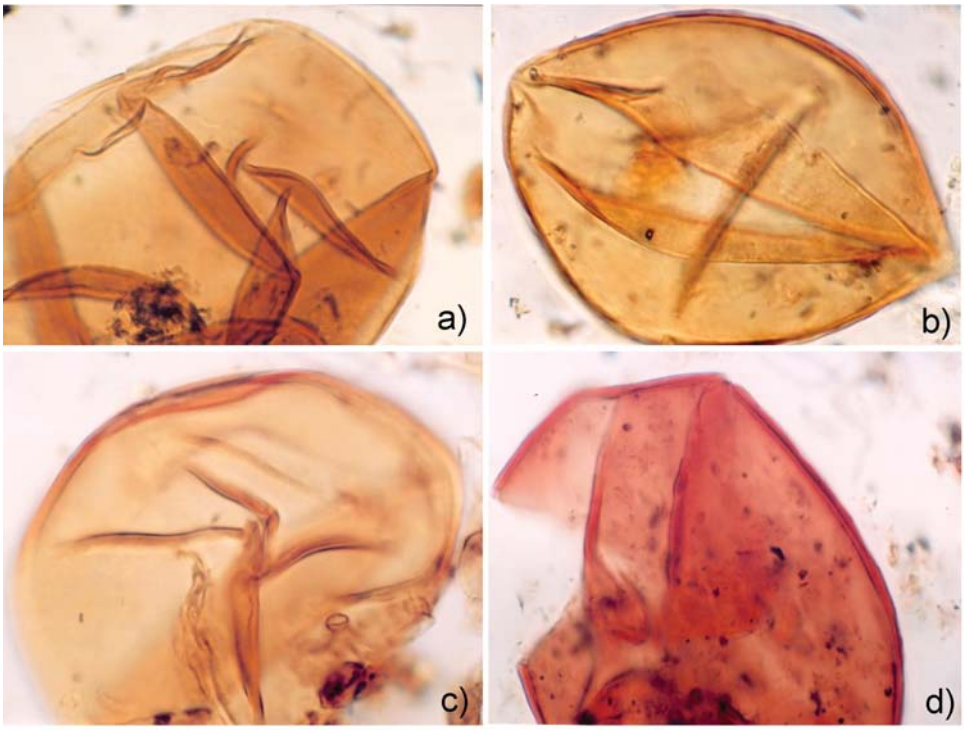

Figure 1: Microphotographs of fossil *Larix* pollen grains from different sites (magnification 600x): a) Týn nad Bečvou, b) Jablůnka, c) Šafárka, d) Praha-Podbaba (photo by V. Jankovská).

The fossil record

Unequivocal information about the larch's history in the Last Glacial Period (Würmian, Weichselian, Vistulian or Valdai) is available from the territory of Slovakia and from Moravian Carpathians. A very detailed pollen record, supplemented by botanical macro-remains, is available from the Last Full Glacial site Šafárka (N 48°52'55", E 20°34'30"; 600 m a.s.l.; for location of all sites highlighted in the text see Figure 2) near Spišská Nová Ves (Jankovská *et al.* 2002). Forests dominated by *Larix* spread here during a cool period at around 60.0 uncal ky BP and even earlier (during MIS 4 and MIS 3). The following period of slight warming brought an expansion of *Betula alba/pubescens* into the larch stands. Even in the next climatically favorable phase, larch trees jointly with *Pinus cembra* remained a constant component of forests. Radiocarbon dating of two *Larix* cones gave the ages 30, 186 ± 1,935 BP and 18, 287 ± 1,512 BP (Figure 3). The younger absolute date falls roughly in the Last Glacial Maximum (LGM, Pleniglacial) period and as such it is direct proof of local survival over the harshest period of the last glaciation – direct proof of a glacial refugium for larch in the intermontane basin of the Western Carpathians (Jankovská and Pokorný 2008). Later on, increasing temperature and humidity brought about a swift expansion of *Picea*. In this period, larch became weakened in its competitive ability, but remained an important component of forests throughout the Late Glacial, until the Pleistocene/Holocene transition period. The studied organic sediment was afterwards covered by inorganic material transported

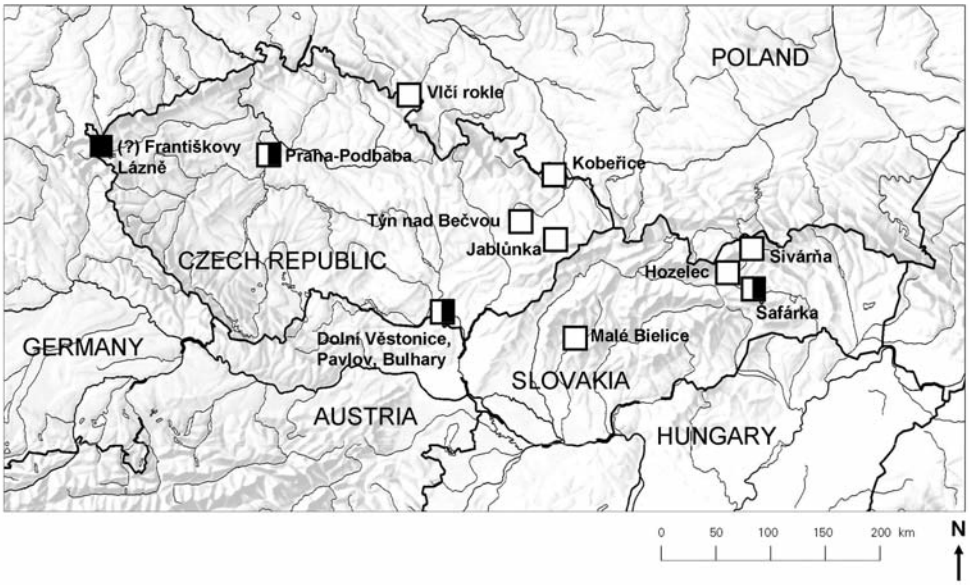

Figure 2: Sites with (sub)fossil remains of larch mentioned in the text (only within the Czech Republic and Slovakia). White squares – pollen; black square – macro-remains; black and white squares – both pollen and macro-remains.

by solifluction or landslide; thanks to this event one of the most important "archives of nature" was preserved. (This scientifically important archive was destroyed by a removal of overburden in the planned yet non-implemented surface mining of gypsum.)

At the western margin of the Carpathians, we have identical information about forest composition from the period that is radiocarbon dated between 39, 746 ± 2,132 BP and 44, 873 ± 1,230 BP. Near Jablůnka (N 49°23'; E 17°57'; 350 m a.s.l.; Jankovská 2005), situated between Vsetín and Valašské Meziříčí, a layer merely 28 cm thick

Figure 3: A find of larch cones made by V. Jankovská at the Šafárka site, Slovakia. Two other cones from this collection provided radiocarbon ages of 30, 186 ± 1,935 BP and 18, 287 ± 1,512 BP, respectively (photo by P. Pokorný).

offered a remarkable insight to the past forest vegetation. Again, larch forests with Swiss pine (*Pinus cembra*) and Scots pine (*Pinus sylvestris*) were detected (Jankovská 2006; Jankovská and Pokorný 2008). Another record of vegetation at 44, 200 ± 1,400 BP comes from a single sample of peat collected from a 15 m depth during a well drilling at site Týn nad Bečvou (N 49°30'36"; E 17°37'; 265 m a.s.l.; Jankovská 2008). This locality is situated at the foot of Mount Maleník. In the pollen spectrum, a large number of *Larix* and *Pinus cembra* pollen grains were found; despite the usual underestimation of pollen quantity of these species in pollen spectra, we could assume that in the surroundings of the locality a coniferous forest similar to present Southern Siberian taiga existed. This happened in a period when the Moravian Gate served as a northward-southward track for herds of mammoths and other large Pleistocene mammals. We should assume that the past landscape was covered by diverse vegetation types that developed according to local habitats in a pattern similar to the undamaged vegetation of present-day Siberia (Kuneš *et al.* 2008); beside the coniferous forests, other woodland types, grasslands and forest-steppe were present (Figure 4).

Since the end of the Last Glacial Period the presence of *Larix* and *Pinus cembra* in the Moravian Carpathians still remains almost unknown. The reason for lacking evidence is the absence of Late Glacial sediments in this region and little opportunity for relevant pollen analyses. Fortunately, by chance, under one landslide in Týn nad Bečvou, not far from the site with the above-described Full Glacial sample (peat from well drilling), Late Glacial and Early Holocene sediments have also been found (results remain unpublished by V. Jankovská). At the bottom of this profile several pollen grains of *Larix* were again found.

In the territory of the Slovak Carpathians, there exists the unequivocal evidence of *Larix* in the Late Glacial and in the Early Holocene profiles in basins at the foot of the Tatra Mountains. Clear evidence comes from pollen-analytical studies at the Siváňa site (N 49°19'; E 20°35'; 610 m a.s.l.) situated between Vyšné Ružbachy and Kamienka near Stará Lubovňa, and at the Hozelec site (N 49°03'; E 28°18'; 685 m

Figure 4: Species-rich continental "meadow steppe" (Russian term; a possible analogy of a "Mammoth steppe," as reconstructed by paleoecologists) with scattered individuals of Siberian larch (*Larix sibirica*). Minusinsk Basin, foothills of Western Sayan Mts., southern Siberia. In the background, the tree cover is dense because of the warming effect of a water stream. In this situation, *Larix sibirica*, *Pinus sibirica* and *Betula alba* form a narrow belt (gallery forest) along the brook. This natural situation represents a possible analogy of the Last Glacial Maximum vegetation pattern in the intermontane basins and river alluvia of central Europe (Photo by P. Pokorný).

Figure 5: *Larix sibirica* at the northern (polar) tree limit, Yamal Peninsula. Despite strong flowering of both male and female shoots (note the great amount of cones on the specimen in the foreground), *Larix pollen* is only rarely found in modern samples taken from moss pollsters. Even more surprisingly, the most common among these is *Pinus sylvestris*-type pollen; the nearest pine trees occur at a distance of several hundred kilometers (photo by V. Jankovská).

a.s.l.) near Poprad (Jankovská 1984, 1988, 1991, 1998, 2007b). At both these sites, *Larix* pollen was identified in sediments of the Late Glacial period in high quantities. In the surroundings of these localities, stands of larch covered a dominant portion of the landscape and again resembled open forests similar to Siberian taiga; *Pinus cembra* and *Pinus sylvestris* were the dominant components in these stands. It cannot be excluded that *Pinus mugo* was another element in this open vegetation. As witnessed by a high number of pollen grains of *Juniperus* and *Salix*, the light intensity was fairly high within this vegetation formation.

Large areas of inter-Carpathian basins and the northern, western and eastern Flysch margin of the Carpathian Arch possibly possessed the characteristics of a forest-tundra with larch and Swiss pine throughout the Late Glacial and the beginning of Holocene (Wacnik *et al.* 2004; Jankovská 1984, 1988, 1991, 1998). The latest Early Holocene evidence for this type of vegetation (including the pollen grains of larch) comes from Malé Bielice in the middle-Nitra Basin (Hájková *et al.* 2013). Additionally, at the very southern margin of the Carpathians, *Larix*, *Pinus cembra*, *P. sylvestris* and *Picea* grew even in the territory of present-day Hungary; these woody species were identified in sediments of the past Nagy-Mohos Lake (Magyari *et al.* 1999). The *Larix* population apparently spread southwards, reaching also the forest-steppe formations and extending towards the cool glacial steppe, periglacial steppe and steppe-tundra, or towards the Mediterranean steppe in the south.

Considering a belt from Baltic coastlands across Poland, the Slovak Carpathians and Hungary, we can speculate about large-scale vegetation zonation, analogical to present-day Siberia. In the Last Full Glacial and Late Glacial, the shrubby tundra of Northern Poland gradually changed to *Larix* forest-tundra towards the south. The

Figure 6: Locals (Khomi – Zyrtyan people) collect bilberries (*Vaccinium uliginosum*) in sparse forest-tundra near Oktyaberskoye, southern Yamal Peninsula (photo by V. Jankovská).

Carpathians, particularly its Flysch area, possessed the characteristics of various types of Siberian taiga; their composition varied along the altitudinal and exposition gradients. Further to the south, in the territory of present-day Hungary, steppe-forest and steppe prevailed.

Examination of the larch populations history in the territory situated westward from the Carpathian mountain range – in the Bohemian Massif – is a difficult task because of the scarcity of fossil records from the Last Glacial Period. Both the pollen and wood of *Larix* have been identified in a borehole drilled near Praha-Podbaba (at the northern margin of Prague, the present-day capital of the Czech Republic). The sample's age was determined directly from *Larix* wood as 31, 012 ± 1,810 BP and 40, 418 ± 4,077 BP, respectively (Jankovská and Pokorný 2008). In this riverine location, larch grew as a part of a complex vegetation pattern including patches of steppe on slopes and in gallery forest (*Larix*, *Pinus cembra*, *Pinus sylvestris*, *Picea* and even some climatically demanding trees such as *Alnus glutinosa*, *Abies* and *Corylus avellana*) along the river. A very similar vegetation record comes from the Bulhary site in southern Moravia, where Rybníčková and Rybníček (1991) quote the *Larix* pollen in association with elements of taiga-steppe vegetation; the respective sediment was deposited around 25, 675 ± 2,750 BP. In the loess section at the Dolní Věstonice II site, *Larix* pollen grains were newly discovered by Pokorný (Svoboda *et al.* 2015) in the context of the Gravettian hearth. This record is radiocarbon dated to 28, 750 ± 220 BP and again reveals a patchy vegetation character with cold steppe elements and continental taiga-like forests. Comparable pollen record was already available from the same site and from nearby locality Pavlov (Svobodová 1991; Dohnalová 2011). From the same contexts also come finds

of charcoal; however, its exact determination is almost impossible, and it is thus determined broadly as *Larix*/*Picea* (Opravil 1994; Novák in Svoboda *et al.* 2015).

At the Oporów site near Wrocław, Poland, to the north of the Sudetes, Kuszell (2003) discovered several pollen grains of larch in sediments of the "mammoth hunters" settlement (sample dated to 35, 000 BP). Unlike the situation in Praha-Podbaba and sites in Southern Moravia, the vegetation reconstruction of the author points to the open "mammoth steppe-tundra" with only some scattered larch trees.

With regard to the occurrence of larch in the territory of Bohemian Massif in the period after Last Glacial Maximum, our knowledge is unfortunately very limited. *Larix* pollen was discovered in the Late Glacial layers of profile at Vlčí rokle, located in the Adršpach-Teplice Rocks (Kuneš and Jankovská 2000) and in Late Glacial sediments near Kobeřice in the Opava region (Jankovská, unpublished results; see also Břízová 1994). The only Holocene finding of larch in the territory of the Czech Republic is reported from peat near Františkovy Lázně by Opravil (1972): a single *Larix* cone, reportedly discovered here, is biostratigraphically dated to the Atlantic Period, and as such is of utmost interest. However, this record remains rather problematic and other research is needed to either confirm or reject this peculiar finding.

Conclusion

In the Last Full Glacial Period, *Larix* occurred over nearly the entire territory of Europe. From the viewpoint of paleoecology, this tree thus represents a native component of Central European forests. For this period, although only roughly delimited, (sub)fossil evidence is available in a lowland territory of the present-day Czech Republic (at the Praha-Podbaba: 31, 012 ± 1,810 BP). Unequivocal evidence of the presence of larch also comes from southern Moravia (Bulhary: 25, 675 ± 2,750 BP; Dolní Věstonice II: 28, 750 ± 220 BP), the Moravian section of the Carpathians (Jablůnka: 39, 746 ± 2,132 BP and 44, 873 ± 1,230 BP) and the margin of Moravian Gate (Týn n. Bečvou: 44, 200 ± 1,400 BP). It cannot be excluded that larch grew in Holocene forests in numerous sites in Moravia, and its small admixture might have persisted in forests of Bohemia until the historical period. As a less competitive tree in closed-canopy stands, and as a species selectively cut for its valuable timber, larch possibly became extinct as a result of human impact. Of course, this speculation can only be confirmed or rejected by future studies.

In Slovak Republic, occurrence of *Larix* has been unequivocally ascertained by pollen and macro-remains analyses from the early part of the Last Full Glacial Period until the present time. In the Last Glacial Period *Larix* was a dominant woody species in forests of the Carpathians, and even in the outer and inner margin of the Carpathian Arch.

Acknowledgements
Prof. Jan Jeník is greatly acknowledged for stimulating suggestions and for initial English translation. This synthesis has been accomplished thanks to the projects no. P209/10/0519 and no. 13-08169S, both supported by the Czech Science Foundation. This study was also partly supported as a long-term research development project no. RVO 67985939 and no. CZ.1.07/2.300/20.0267.

Résumé
Alors que son actuelle étendue en Europe est limitée, le mélèze (*Larix*) était répandu sur presque tout le territoire européen durant la dernière période glaciaire. Pour cette période, plusieurs déterminations fiables de grains de pollen et de macrofossiles de ce taxon ont été assez récemment réalisées en Républiques tchèque et slovaque. Ces nouvelles données enrichissent la précédente étude publiée pour ce territoire. En Bohême centrale, *Larix* était présent à proximité de la rivière Vltava, près de Prague-Podbaba entre environ 40,000 et 30,000 ca BP. Cet enregistrement accrédite partiellement d'autres résultats obtenus pour Larix sur le territoire de la Bohême, et restés jusqu'ici problématiques. Des enregistrements fiables de pollens de Larix dans les sédiments organiques et les lœss de la dernière période glaciaire sont attestés en Moravie du sud, et plus récemment également, dans les Carpates et la Porte de Moravie (Moravie du nord). Des spécimens de grains de pollen et de macrorestes de *Larix* dans les Carpates slovaques témoignent d'une présence permanente de cette espèce de la dernière période glaciaire jusqu'à aujourd'hui; le mélèze est aujourd'hui encore communément répandu en Slovaquie, et sa présence indigène dans cette zone ne fait aucun doute. Dans l'actuelle République tchèque, *Larix* est considéré comme seulement originaire de la région des monts Jeseníky (Sudètes morave – Massif de la Bohême). Cependant, il ne peut être exclu, selon les dernières découvertes sub-fossiles réalisées en Moravie, que le mélèze ait continué à se développer en permanence au sein des forêts mixtes durant tout l'Holocène. et dans certaines parties de la Bohême. À l'Holocène récent, l'Hommes ont participé à sa disparition, mais cette dernière hypothèse reste spéculative et mérite des vérifications supplémentaires.

Zusammenfassung
Im Gegensatz zu ihrem heute nur eingeschränkten Vorkommen in Europa war die Lärche (*Larix*) im letzten Glazial in fast ganz Europa verbreitet. In letzter Zeit wurden sowohl in Tschechien als auch in der Slowakei einige gut bestimmte Pollen- und Makrofossil-nachweise dokumentiert. Die neuen Funde erweitern die in der Vergangenheit für dieses Gebiet publizierte Aufnahme. Im zentralen Böhmen ist die Lärche in der Umgebung des Vltava Flusses bei Prag-Podbaba für die Zeit zwischen ca. 40.000 und 30.000 BP belegt. Dies unterstützt die Glaubwürdigkeit anderer Nachweise für *Larix* in Böhmen, die bisher als problematisch galten. Zuverlässige Belege für Lärchenpollen aus organischen Sedimenten und Löss der letzten Kaltzeit liegen für Südmähren, sowie seit neuestem auch von den mährischen Karpaten sowie der Mährischen Pforte (Nordmähren) vor. Funde sowohl von Pollen als auch Makroreste aus den slowakischen Karpaten belegen eine kontinuierliche Anwesenheit von *Larix* vom letzten Glazial bis heute. In der Slowakei ist die Lärche auch heute weit verbreitet und es besteht kein Zweifel, dass sie hier natürlich vorkommt. Für das heutige Tschechien wird angenommen, dass sich die natürliche Verbreitung der *Larix* auf das Jeseníky Gebirge (in den mährischen Sudeten, die zur Böhmischen Masse gehören) beschränkt. Nach neuesten (sub-) fossilen Funden kann jedoch nicht ausgeschlossen werden, dass Lärchen während des gesamten Holozäns in

Mähren und einigen Teilen Böhmens in Mischwaldbeständen vorkamen. Im späten Holozän könnte der Mensch zu ihrem Verschwinden beigetragen haben. Allerdings ist dieser Vorschlag derzeit noch spekulativ und muss erst verifiziert werden.

PALEOLITHIC HUNTING IN THE URALS

Pavel A. Kosintsev and Natalya Plasteeva

Abstract
In the Urals there are 50 Pleistocene sites with associated human artifacts and animal remains. They include open-air sites, caves and sacred sites. Materials from only one site – Bogdanovka – can be used for characterization of the Middle Paleolithic hunting in the Urals. It was a special-purpose area near the natural death accumulations of mammoth corpses. Humans hunted here during short-term periods. In the Upper Paleolithic open-air sites can be classified into three groups: camp sites characterized by large ungulates hunting (*Equus ferus, Rangifer tarandus*), short-term camps and sites near the natural death accumulations of mammoth corpses. Cave sites include sites that were visited only once or several times. Data from just four sites allow us to summarize information about hunting activity in the Upper Paleolithic. Large mammal fauna from these sites are dominated by the ungulates. Apparently it was a seasonal hunting, although at the same time humans hunted other species, but less than the ungulate group.

Keywords
Middle and Upper Paleolithic, Russian federation, hunting strategies, settlement strategy, site hierarchy

DOI: 10.5817/CZ.MUNI.M210-7781-2015-8

Introduction

Hunting was the basic subsistence strategy used by human groups in the Paleolithic period. In the Urals there are 50 Pleistocene sites with associated human artifacts and animal remains (Table 1). These sites can be classified into three groups: open-air sites, cave sites and sacred sites. In this paper we do not discuss in detail sites with less than 50 artifacts or less than 100 animal remains.

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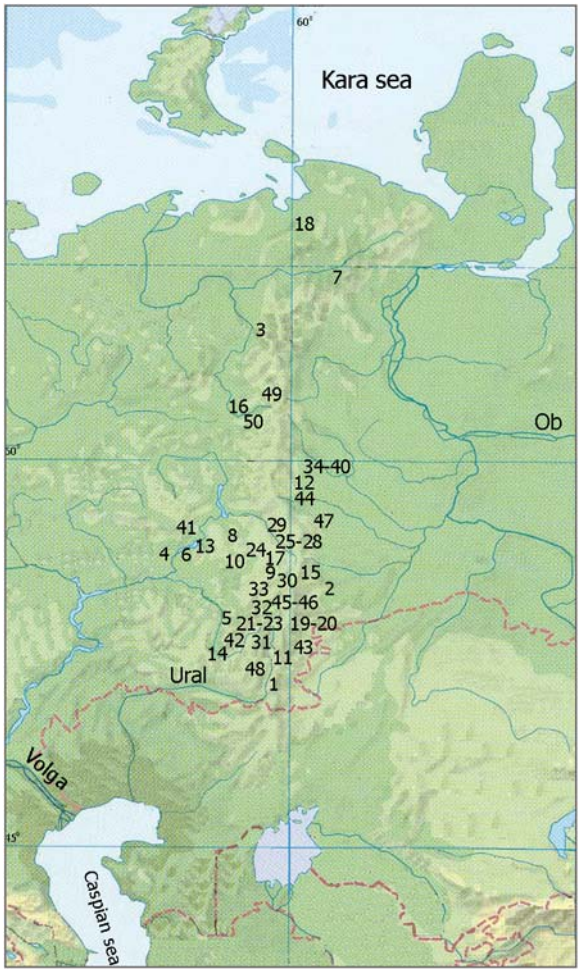
Type of localities at Polar Ural Mountains

Open-air sites

The total number of open-air sites is 19, but only 9 of them have primary deposits. On the rest of sites the cultural layer had been disturbed, thus we discuss only the in-situ finds. The earliest open-air site in the Southern Urals is Bogdanovka. Based on stratigraphic and paleontological data Bogdanovka is dated to the beginning of Late Pleistocene (MIS 5d-4), but according to the artifacts typology it is a late Mousterian site (Shirokov *et al.* 2011). The collection includes bone fragments from five individual of mammoths (*Mammuthus primigenius*) (Table 2). Also there are several bones belonging to other mammalian species, namely bones from two individuals of bison (*Bison priscus*); and one individual of small cave bear (*Ursus savini*), horse (*Equus ferus*), red deer (*Cervus elaphus*), reindeer (*Rangifer tarandus*) and saiga (*Saiga tatarica*). Some of the mammoth bones wear traces after human manipulation with animal bodies, such as cut marks. It is assumed that site was located on the river bank where human groups found mammoth bodies, transported by the river.

Figure1: Map of the Ural Mountains area shows the locations of sites.



The Zaozer'e site is situated in the Middle Urals and dated based on a series of radiocarbon dates to 30.1–35.1 ^{14}C ky BP (Svendsen *et al.* 2010). Bones are represented mostly by horse; they are fragmented and have cut marks. Byzovaya site is located in the Northern Urals and directly dated to 27.0–30.0 ^{14}C ky BP (Svendsen *et al.* 2010). Mammoth bones are prevalent (Table 2). Artifacts were discovered in an association with accumulation of complete mammoth bones. This site is situated on a natural accumulation of mammoth bones – a mammoth "cemetery". Talitskogo site is located in the Middle Urals (Gromov 1948) and has a radiocarbon date of 18, 700 ± 200 uncal BP (Shcherbakova 1994). The dominant discovered species is reindeer (Table 2). Another site in the Middle Urals is Shirovanovo II, situated 100 km from the Talitskogo site. Based on the typology of stone artifacts it is obvious that Shirovanovo II is comparable to Talitskogo (Makarov and Pavlov 2007). The number of bone assemblage recovered here is about 200 bone fragments, and the horse is prevalent species (Makarov and Pavlov 2007). The Troizkaya I site is located in the Southern Urals. The radiocarbon age of the sediments is 16, 300 ± 300 uncal BP, IERZ-165 (Shirokov *et al.* 1996). Large mammal fauna is mostly represented by remains of woolly mammoth (Table 2), belonging to a minimum of four individuals. Again stone artifacts were found near the bone accumulation. From the taphonomical point of view, the accumulation was very compact, suggesting that it is a result after human activities.

Table 1: List of Paleolithic sites located at the Ural Mountains (intervals based on ^{14}C dating).

age	sites
Late Mousterian (MIS 5d- 4)	*open-air site:* Bogdanovka (1)
Upper Paleolithic (MIS 3)	*open-air sites:* Bolshie Allaki II (2), Byzovaya (3), Garchi I (4), Gornovo (5), Zaozer'e (6), Mamontovaya Kurya (7) *cave sites:* Bliznetsova (8), Sikiyaz-Tamak 7 (9), Bolshoj Glukhoj (10), Smelovskaya II (11), Cheremukhovo 1-1 (12)
Upper Paleolithic (LGM; 1 half of MIS 2: 24.0–17.0 ky BP)	*open-air sites:* Talitskogo (13), Sergeevka 1 (14) *cave sites:* Bezymyanniy (15), Medvezhya (16), Stolbovoy (17)
Upper Paleolithic (LGT; 2 half of MIS 2: 17.0–10.2 ky BP)	*open-air sites:* Pymva Shor I (18), Troizkaya I (19) *cave sites:* Ustinovo (20), Bajslan-Tash (21), Balatukay (22), Kulyurt-Tamak I (23), Bobylek (24), Dyrovatyy Kamen (Serga river) (25), Kotel (26), Kumyshanskij (27), Ust-Koivinskaya (28), Rasik (29), Zotinskiy (30) *sacred sites:* Kapova (31), Ignatievskaya (32), Serpievskaya 2 (33)
Upper Paleolithic (MIS 2: 24.0–10.2 ky BP)	*open-air sites:* Artyushka (34), Balakina (35), Gari I (36), Gari II (37), Evalga (38), Neftebaza (39), Rychkova (40), Shirovanovo II (41) *cave sites*: Maksyutovskiy (42); Ustinovo (43), Cheremukhovo 1-2 (44)
Upper Paleolithic (MIS3 – MIS 2: 38.0–10.2 ky BP)	*cave sites:* Buranovskaya (45); Klyuchevaya (46); Medved-Kamen (47), Smelovskaya I (48), Uninskaya (49), Studeniy (50)

Nevertheless, no direct traces after human manipulation with bones (such as cut marks) were detected here. Thus, it is obvious, that Paleolithic people had most probably scavenged bones from natural death accumulations near the site. The amount of animal assemblage detected at the sites like Pymva Shor I (Svendsen *et al.* 2010), Garchi I (Svendsen *et al.* 2010) and Bolshie Allaki II (Zhilina and Petrin 1989) is very small.

Sites with postdepositionally destroyed cultural layers are located mostly on the river banks. At all these sites, the animal remains from different mammal species were accompanied by stone artifacts. Gari I site (Northern Urals) (Serikov 2007) is dated between 20.0 and 16.0 ^{14}C ky BP (Chlachula and Serikov 2011). It is also situated on a place of naturally death mammoths´ accumulation – a mammoth "cemetery" (Table 2). Most of the mammoth bones from Gari I are complete and no traces after butchering were observed. Another site, Sergeevka I, is situated in the Southern Urals and directly dates to 18, 000 ± 340 uncal BP LE-9603 (Gimranov *et al.* 2012). The bone collection consists mostly of horse remains (Table 2). Additionally, the collections of stone artifacts from the sites like Mamontovaya Kurya (Svendsen *et al.* 2010); Gari II, Neftebaza, Rychkova, Balakina, Evalga, Artyushka (Serikov 2007; 2013) and Gornovo (Yakhimovich *et al.* 1987) were not abundant.

Table 2: List of mammalian species detected at selected Paleolithic sites from Ural Mountains.

species	Bogdanovka	Zaozer'e	Byzovaya	Talitskogo	Troitskaya I	Shirovanovo II	Gari I	Sergeevka 1
Mammuthus primigenius	98	2	2628	11	102	+	2251	1
Coelodonta antiquitatis		11	7	2		+	9	1
Equus ferus	1	191	14	9	1	+++	19	96
Bison priscus	8		2				7	5
Ovibos moschatus			2					
Saiga tatarica	1						1	
Cervus elaphus	1							1
Rangifer tarandus	1	2	30	222		+	14	
Ursus arctos			4				3	
Ursus savini	5							
Canis lupus			2					
Vulpes lagopus			3	15			1	
Lepus timidus		27	–	7				

+ – present, +++ – prevalence

Cave sites

There are 28 Ural caves in which stone artifacts were accompanied by animal bones. During the excavation of Medvezhya cave in the Northern Urals 1,523 of stone artifacts and more than 100, 000 of animal bone and teeth fragments were found. The most important deposits are dated between 16.1 and 18.7 ^{14}C ky BP (Guslitser and Kanivets 1965; Kuzmina 1971; Guslitser and Pavlov 1987; Svendsen *et al.* 2010). About 300 stone artifacts and 3,000 fragments of large sized mammal bones were found in deposits of Bliznetsova cave, which is directly dated to 28.54 ^{14}C ky BP (Kuzmina 1975; Shcherbakova 2001). About 200 stone artifacts and 3,000 fragments of large sized mammal bones were recovered from Stolbovoy site deposits, dated to 22.89 ^{14}C ky BP (Kuzmina 1975; Shcherbakova 2001). Excavation of the Bobylek

site yielded about 450 stone artifacts and more than 10, 000 fragments of mammal bones and teeth. These deposits are dated from 14.2 to 16.72 ^{14}C ky BP (Volokitin and Shirokov 1997; Razhev *et al.* 2005). Finally, about 90 artifacts and more than 900 fragments of animal remains were found at the Smelovskaya II site. From these deposits two radiocarbon dates were obtained: 31.0 and 41.0 ^{14}C ky BP (Bader 1971; Kuzmina 2000).

Additionally, we didn´t observe any case at these site, where the separate layer might be directly assigned as a result after human activity. The stone artifacts were thus spread through all the sediments and they did not form separate cultural layers. We have examined the bone assemblages from all of these sites and most of bones displayed gnaw marks resulting after activities of wolf (*Canis lupus*), arctic fox (*Vulpes lagopus*), wolverine (*Gulo gulo*) and cave hyena (*Crocuta spelea*). Contrary to the bones fragments wearing traces after human activities, which are quite rare. Therefore, we can conclude, that most of the animal remains were accumulated during the predator activities. The sediments contained also plentiful micromammal remains. No fireplaces were detected at these cave sites, except the Medvezhya cave, where only several pieces of charcoals were found. From the archeological and archeozoological evidence it is obvious, that the entire mentioned cave localities were short-term campsites with repeated visits of humans.

Stone artifacts deposited at several Upper Paleolithic cave sites, namely Studeniy (Ashikhmina *et al.* 1997), Uninskaya (Ashikhmina *et al.* 1997), Cheremukhovo 1-1 (Strukova *et al.* 2006), Cheremukhovo 1-2 (Borodin *et al.* 2000), Rasik, Medved--Kamen (Serikov 2000), Bolshoj Glukhoj (Guslitser and Pavlov 1987; Kuzmina et al. 1999), Kumyshanskij (Serikov 2000), Kotel (Serikov 2000), Ust-Koivinskaya (Serikov 2000), Dyrovaty Kamen (Serga river) (Ulitko and Shirokov 2006), Zotinskiy I (Petrin and Smirnov 1977), Bezymyanniy (Petrin and Smirnov 1977), Balatukay (Kotov 2009), Ustinovo (Smirnov *et al.* 1990), Smelovskaya I (Sal'nikov 1952), Maksyutovskiy (Kotov 2009); Klyuchevaya (Bibikov 1950), Buranovskaya (Bibikov 1950) and Sikiyaz-Tamak 7 are scarce. According to dating of all these sites, which belong to different periods of the Upper Paleolithic, we can assume that human groups have been visiting these localities just sporadically. Finally, plenty of stone artifacts, but small amounts of animal remains, have been discovered at Kulyurt-Tamak (Nekhoroshev and Girya 2004) and Bajslan-Tash (Kotov 2004; Yakovlev *et al.* 2006). Both sites were visited by humans repeatedly, but no direct evidence resulting from their hunting activities were detected.

Sacred sites

There are three Upper Paleolithic sacred sites in the Ural Mountains: Kapova (Shulgan-Tash) cave, Ignatievskaya cave and Serpievskaya 2 cave (Shchelinskiy and Shirokov 1999; Shirokov and Petrin 2013). All of these caves contain wall paintings and the visiting surfaces on the upper layer have been documented nearby. The visiting surface in Kapova cave is dated from 16.71 to 13.90 ^{14}C ky BP (Shchelinskiy and Shirokov 1999). The visiting surface from Ignatievskaya cave provides younger

dates from 14.24 to 10.4 ^{14}C ky BP (Shirokov and Petrin 2013). Nevertheless, we do not have direct radiocarbon dates for the Serpievskaya 2 cave, but based on indirect evidence from paleontological data it seems, to be possible to date its visiting surface to the LGM (Kosintsev *et al.* 2011). The cave deposits from all these sites contain stone artifacts and small animal bone and teeth assemblage (Smirnov *et al.* 1990; Shchelinskiy and Shirokov 1999; Shirokov and Petrin 2013).

Discussion

Accordig to the archeological and archeozoological evidence, only the collections from site Bogdanovka can be used for the characterization of the Middle Paleolithic hunting activities in the Ural Montains. From our point of view this site should be considered as a special-purpose area, because it was established near the natural death accumulation of mammoth corpses. The other mammalian species were occasionally presented by one or two individual, as in the case of bison. It is obvious, that beside exploitation of mammoth corpses, the humans were hunting various large mammal species during several short-term periods. (Table 2). This could be an indicator, that humans in the Middle Paleolithic used different ways of natural source exploitation.

With the period of Late Paleolithic can be associated 49 sites from the Ural Mountains. The stone artifacts documented mostly at open-air sites are scarce and indicate that these sites were visited occasionally. Only three of these sites are again located on places with accumulations of mammoth bones, but only data coming out from four other sites, namely – Zaozer'e, Talitskogo, Shirovanovo II and Sergeevka I – could be used as reliable sources for documentation of human activities in the Early and Mid Late Paleolithic. Animal remains from three of the sites are dominated by horse, contrary to the last one, where the prevalence of reindeer was observed.

The majority of cave sites contain scarce stone artifacts and all of them can be described as sites with short-term visits. The representative faunal assemblage was observed on five of these cave sites, which could be dated to different periods of the Upper Paleolithic. Most of the mammal bones wear gnawing marks and only few of them were modified by humans. Also the stone artifacts were scarce, so we can assume that most of the bones were accumulated during various predator activities.

Recently, the collected data are still incomplete and allows us only to summarize the general information from these selected sites. The large sized mammal fauna assemblages dated to the Early and Middle Upper Paleolithic are time to time dominated by one of two ungulate species – horse or reindeer. This support the hypothesis, that humans were hunting animals living in large herds. Additionally, there might be difference between animal remains from two different sites located in the same region and dated to the same period (as was documented at Talitskogo and Shirovanovo II). This most probably indicates the differences between seasonal hunting, rather than the human specialization in hunting within a small micro-region scale.

Acknowledgement
The study is supported by Program of Ural Branch, Russian Academy of Sciences, project No. 12-C-4-1014.

Résumé
Dans l´Oural, une cinquantaine de sites pléistocènes, associés à des artéfacts lithiques et à des restes fauniques, sont connus à l´heure actuelle, incluant à la fois des sites de plein air et des sites en grottes, ou encore des sites sacrés. Seul un site – Bogdanovka – permet de caractériser la chasse au Paléolithique moyen dans l´Oural. Le site en question est situé au sein d´une région à but spécial, à proximité d´accumulations naturelles de cadavres de mammouths. Les Préhistoriques ont du occuper le site pendant une courte période de temps seulement. Au Paléolithique supérieur, les sites de plein air peuvent être classifiés en trois groupes: des camps de base, caractérisés par la présence de larges ongulés (cheval, renne); des camps d´occupation courte ; enfin, des sites à proximité d´accumulations naturelles de cadavres de mammouths. Les sites en grottes comprennent des sites visités de une à plusieurs fois uniquement. Les données de quatre sites en particulier nous permettent de synthétiser les activités cynégétiques du Paléolithique supérieur. La macrofaune y est dominée par les ongulés. Les occupations avaient manifestement un caractère saisonnier. S´il est vrai que les Préhistoriques ont également chassé d´autres espèces, celles-ci sont toutefois toujours sous-représentées par rapport aux ongulés.

Zusammenfassung
Im Uralgebirge sind 50 pleistozäne Fundstellen dokumentiert, in denen Artefakte mit Tierresten vergesellschaftet sind. Diese umfassen Freilandstationen, Höhlen und Kultplätze. Lediglich das Material einer Fundstelle, Bogdanovka, kann als Beleg für Jagd im Mittelpaläolithikum dienen. Es handelt sich dabei um einen zweckmäßig gewählten Standort in der Nähe einer Akkumulation natürlich verendeter Mammute. Menschen haben hier während kurzfristiger Aufenthalte gejagt. Jungpaläolithische Freilandfundstellen können in drei Gruppen unterteilt wurden: Lagerplätze, die durch die Jagd auf große Huftiere (Pferd, Rentier) gekennzeichnet sind, kurzfristige Lagerstätten und Stationen bei Akkumulationen natürlich verendeter Mammute sowie Höhlenfundstellen mit einer oder mehrerer Begehungen. Nur vier Fundstellen liefern Daten zur Jagd im Jungpaläolithikum. Huftiere dominieren die Großsäugerfauna. Die Jagd war offenbar saisonal. Andere Arten wurden in geringerem Ausmaß bejagt.

MENTUM OSSEUM: ANALYSIS OF THE EVOLUTIONARY HYPOTHESES FOR THE ONTOGENY AND PHYLOGENY OF THE HUMAN CHIN

Daniela Cunha[1], Filipe Monteiro[1] and Martin Čuta[2]

Abstract
This overview paper presents the leading theories which attempt to explain the emergence of one of the prominent features specific to our species – the protruding chin. Established theories discussing this phenomenon include the effect of masticatory stress theory, a sexual selection theory and theories relating the human chin to the emergence of spoken language. However, these explanations have proved inconclusive and the processes responsible for the emergence of *mentum osseum* in the Late Pleistocene remain unclear.

Keywords
Human chin, *mentum osseum*, masticatory stress, sexual selection, association with spoken language emergence

DOI: 10.5817/CZ.MUNI.M210-7781-2015-9

Introduction

A protruding chin, or *mentum osseum*, in the antero-inferior mandibular symphysis is one of the most distinct hallmarks in the anatomically modern *Homo sapiens* (Schwartz and Tattersall 2000; Dobson and Trinkaus 2002; Ichim *et al*. 2007; Thayer and Dobson 2010; Emes *et al*. 2011; Gröning *et al*. 2011; Daegling 2012). The anatomically modern human's mandibular symphysis *"differs from those of all other primates in being vertically oriented and possessing a chin"* (Gröning *et al*. 2011, 593). Apart from modern humans, the only extant mammal with such bone hypertrophy in the mandibular symphysis is the elephant, although it is far more protruding (Waterman 1916).

Strangely, the protruding chin is rarely mentioned as such; always overshadowed by the emergence of symbolic language or high-order theory of mind as the main

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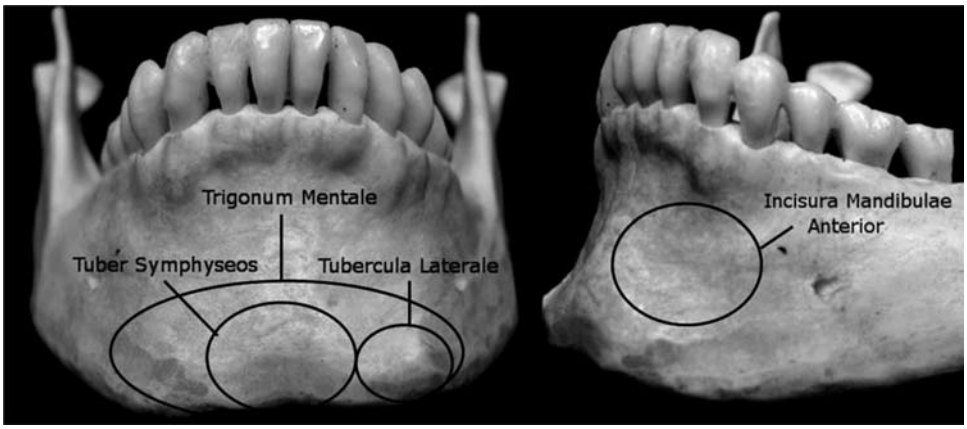

Figure 1: The human chin is a complex structure, its two main areas being the *trigonum mentale* and the depressions in the superior area of the mandibular symphysis, *incisura mandibulae anterior.* The *tubercula lateralia* have a variable degree of expression (image and description adapted from Daegling 2012).

differences of modern humans, when compared with other extant and extinct primates. Yet it is one of the few characteristics that distinctively mark the presence of anatomically modern humans in the paleoanthropological record (Dobson and Trinkaus 2002).

In this paper we will use the definition of Daegling (2012, 1) for the human chin as an *"anterior basal swelling of the mandibular symphysis (…) and it is [there that] cortical bone hypertrophy is most pronounced"* (Figure 1). The changes in the orientation and cortical hypertrophy of the mandibular symphysis emerged together during the Middle and Late Pleistocene (Gröning *et al.* 2011), a period of remarkable transformation for *Homo sapiens*, and is absent in the archaic humans and Neandertals (Schwartz and Tattersall 2000; Ichim *et al.* 2007).

Since the eighteenth century anthropologists and paleodontologists have studied the biomechanics and the phylogenetic analysis of the emergence of the human chin but no consensus has ever existed in the scientific community (Schwartz and Tattersall 2000). This paper intends to analyze the several hypotheses in modern scientific literature that attempt to explain the evolutionary emergence of the *mentum osseum* during the Late Pleistocene and the modern functional significance for the fact that "recent humans display more bone than expected [in the mandibular symphysis] given the scaling relationships of hominoids as a whole" (Daegling 2012).

The four surveyed hypotheses are both biomechanical and other. Among the biomechanical explanations, two main opinions exist: the *mentum osseum* is either an adaptation to changing masticatory demands that occurred in the Pleistocene (Daegling 1993; Dobson and Trinkaus 2002) or it is a structural response to the speech physiology that emerged around the same time, around 40.0–50.0 kya (Ichim *et al.* 2007). The other two hypotheses are that the protruding chin is an osteological artifact with no relevant biomechanical function (mentioned in Daegling 2012) and that this peculiar feature is the result of sexual selection in the search of a mate for pair-bonding (Thayer and Dobson 2010). It should be mentioned that the functional significance of the human chin in modern days may be different than the origin of the selective pressures trait involved in such bone hypertrophy (Thayer and Dobson 2010; Gröning *et al.* 2011).

Masticatory biomechanical stress

The first attempts to explain the evolution of the protruding *mentum osseum* were related to changes in masticatory stress demands during the late Pleistocene (Ichim *et al*. 2006; Gröning *et al*. 2011). Analysis of the fossil record from this period also showed changes in the orientation of mandibular symphysis (from a horizontal plane to a more vertical one), which indicates that both aspects were probably correlated (Dobson and Trinkaus 2002; Gröning *et al*. 2011).

The ontogeny of the human's unique symphyseal morphology starts in an early fetal stage and its basic characteristics appear to be maintained into adulthood (Schwartz and Tattersall 2000), which preludes some kind of functional implication. The mandibular vertical symphysis became part of the scientific debate about the functional and evolutionary significance of the human chin, originating various hypotheses connecting it with the forces applied at the symphysis in the course of the masticatory process (Gröning *et al*. 2011). There are three different types of forces exerted on the human symphysis: (1) lateral bending in the transverse plane, (2) vertical bending in the coronal plane, and (3) dorsoventral shear (see Figure 2) (Dobson and Trinkaus 2002; Gröning *et al*. 2011). Considering the nature of these forces, several hypotheses for the emergence of *mentum osseum* appeared, suggesting this feature to be the result of biomechanical stress associated with masticatory demands.

The first hypothesis was proposed by DuBrul and Sicher (1954). They claim that the human chin works as a reinforcement of the symphysis against medial transverse bending. However this hypothesis fails because wishboning is the main transverse bending regime on the anthropoid's mandibular symphysis, suggesting that medial transverse bending is an irrelevant sort of stress (Dobson and Trinkaus 2002; Gröning *et al*. 2011).

Some years later, Riesenfeld (1969) proposed that a protruding chin must result from "hypofunction", i.e. that a reduction in the size of dentition and masticatory musculature occurred (*in* Dobson and Trinkaus 2002; Gröning *et al*. 2011). Daegling (1993) refuted this approach by arguing that neither can anthropoids' mandibles be considered structurally weak nor does there exists enough evidence for the assumption that *Homo sapiens* mandibles can be considered weaker than those of other primates.

Following White's hypothesis (1977), wishboning was the reason behind evolution of the human chin, associated with the resistance to labial compression. Lateral bending in the transverse plane was proved to be the major masticatory force

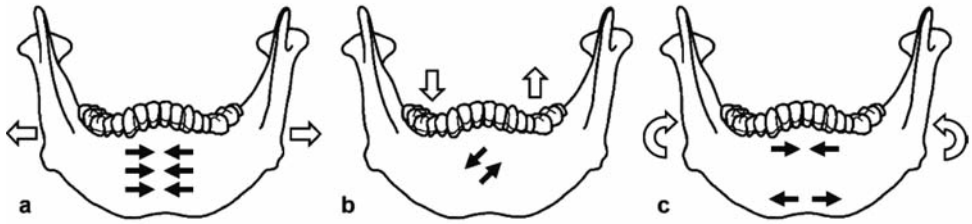

Figure 2: Forces applied at mandibular symphysis: during (a) lateral bending in the transverse plane (wishboning), the "mandibular corpus is pulled apart" leading to "labial compression and lingual tension at the symphysis"; (b) vertical bending in the coronal plane, twisting of each lateral corpus about its anteroposterior axis during incision and mastication, and (c) dorsoventral shear, "the side-balancing corpus" suffers parasagittal bending, which primarily affects the lower part of the symphysis (Dobson and Trinkaus 2002, 68–70) (image adapted from Fukase 2007; in Gröning *et al.* (2011).

exerted at the symphysis but this explanation is unsuccessful because due to the bone properties and effects of curvature, the wishboning will be more likely to cause sub-periosteal bone deposition (*in* Dobson and Trinkaus 2002).

The strongest hypothesis related to masticatory stress was proposed by Daegling (1993), who argued that the human chin results from tension at the labial symphyseal base from a structural response to resist vertical bending in the coronal plane. This phenomenon was due to the reduction of the mandibular length in *Homo sapiens* during the Late Pleistocene, causing wishboning to become a less significant force, which made vertical bending in the coronal plane a successively more important force at the symphysis in the course of human evolution. In fact, the size and robusticity of the masticatory apparatus suffered a reduction in this period and during this period there was a decrease in the human ability to endure starvation. However, the changes in morphology of the human symphysis probably tend to maintain resistance in certain levels rather than improving resistance (Gröning *et al*. 2011). Thus, dimensional reduction in the human mandible in the Late Pleistocene seems to be independent of the changes at the symphyseal morphology and from the emergence of a protruding chin.

In support of this idea, having a *mentum osseum*, biomechanically speaking, does not represent any advantage for the modern humans when compared with Neandertals' non-chinned mandibles (Dobson and Trinkaus 2002; Ichim *et al*. 2006). These findings led Daegling (2012) to revise his hypothesis. He compared the covariations in the relationship between scale, moment arm and forces applied to the area with the predictions of his hypothesis, and concluded that this relationship and, in general, the amount of stress produced by masticatory function was also highly reduced. It is not likely therefore that the masticatory stress in the mandibular symphysis is the primary cause for the rise of this unique human characteristic.

Dobson and Trinkaus (2002) proposed that in order to understand the modern human chin, it should be seen not as a consequence of a singular causes but rather as an interaction of several components, having in mind the context where it appeared, operating constrained by but not dependent from the symphysis. In accordance with these suggestions, Emes *et al*. (2011) linked the Pleistocene changes in human mandibles with the crescent changes in jaw proportion in the Early and Middle Holocene. They argue that the transition from hunter-gathering to agricultural societies led to less pressure from natural selection on the human mandible. When natural selection does not exert pressure, mutations have the most significant effect in alterations of complexity and structural size of organs. "Nonlethal mutation typically arises in the recessive state" and if this mutation produces homozygotes, an apomorphy arises in the population, completely independent of other species phylogenetically close (Schwartz and Tattersall 2000, 405).

Nowadays, biomechanical masticatory demands are not the most compelling idea for the origin of this specific human characteristic. Masticatory stress itself may not be the reason for the origin of *mentum osseum*, however the reduction in the amount of stress during masticatory function (due to alterations in feeding behavior and consequent mutations) is still an open question and needs more research.

Structural artifact

Daegling (2012) offered an alternative group of hypotheses proposing that this particular human feature does not have any functional use. The first explanation underlining the possibility that *mentum osseum* resulted from detached functional requirements was proposed by Weidenreich (1936). He argues that the human chin may result from reduction in alveolar support of the incisors because a decrease in incisor size during hominin evolution is observed. This hypothesis fails because, under this condition, the maintenance of this feature betrays functional demands (*in* Daegling 2012).

Gould and Lewontin (1979) hypothesized that the human chin is of a "non-adaptive character", resulting from the connection between growth fields. In this context, the *mentum osseum* is necessary but, in itself, a selectively insignificant artifact in human ontogeny (*in* Daegling 2012). However, this explanation seems to be unsatisfactory because all morphological features are developmentally determined so it is improbable that the human chin is just a functionless bone artifact. Furthermore, there is a heavy metabolic investment in expressing a chin, which would be a waste of energy if it did not have any function and, eventually, it would disappear over generations (Daegling 2012).

More recently, Daegling (2012) advanced another hypothesis, arguing that this recent human feature does not require biomechanical or adaptive justification, being a mere allometric artifact. He claimed that "bone volume in human mandibles is phylogenetically conserved, while the overall size of the corpus has undergone reduction". However, to accept this position we need to deny or make an exception for *mentum osseum* in the "mechanical role for modulation of bone mass" in *Homo sapiens* species (Daegling 2012, 8).

The human chin and language

The hypothesis that correlates the emergence of the *mentum osseum* with the human language is not a recent one, although the old speech theory stated that the human chin evolved to give enough space for the tongue muscles and it was never backed by experimental data. A more modern hypothesis, elaborated by Ichim and colleagues (2006, 2007) represents a strong case for the link between speech and the peculiar mandibular symphysis. Their position is "that the development of the human chin is in fact unrelated to the functional demands placed upon it by mastication" (Ichim *et al*. 2007, 21) and tries to connect the emergence of language with the formation of the chin (Daegling 2012).

They tested the hypothesis that the presence of a chin modifies the pattern of strains in the human mandible (Ichim *et al*. 2006). Comparing 3D models of chinned and non-chinned adult human mandibles, derived from CT scans, they measured the masticatory stress placed upon the mandible during incisal and molar biting. The conclusion was that the *"development of a chin does not* (…) *confer rigidity to the mandible during function*" and, thus, is in conflict with the masticatory stress

hypotheses previously mentioned, in which the chin serves as a buttress to the mandible when it is being compressed during mastication (Ichim *et al*. 2006, 641). When comparing the differences, biomechanically speaking, in strains placed upon the chinned and non-chinned human mandibles there was no proof that a chinned mandible could handle better the masticatory stress than a non-chinned mandible. This was supported by the conclusions of O'Connor (2005, *in* Ichim *et al*. 2006, 641) that "*the masticatory biomechanical adaptation does not underlie variation in the facial skeleton of later Pleistocene Homo*", they launched the hypothesis that the development of a protruding chin was the result of the activity of repetitive contractions of the tongue and perioral muscles demanded by the emergence of spoken language and that resulted in an adaptive remodeling of the chin (Ichim *et al*. 2007). Ichim *et al*. (2007) proceeded to construct a hypothetical 3D model of the adult human mandible, with and without a chin, and after analyzing the effects of non-masticatory muscles placed upon those mandibles, they found that exposing a non-chinned model of the mandible to the oblique contraction of the genioglossus muscle "*resulted in strain concentration along both the symphyseal midline and the base of the symphysis*" (Ichim *et al*. 2007, 22). This strain would cause a remodeling of the antero-inferior mandibular symphysis which is strikingly similar to the *trigonum mentale* present in the normal chin of anatomically modern humans.

This hypothesis offers a possible solution to the long and controversial debate in the scientific community over the origin of the *mentum osseum*. One of the most notorious characteristics of human evolution is the emergence of spoken language and the fact that it appeared around 50.0 kya, around the same time as the chin. This posits a strong case for the modern speech hypothesis: with the advent of spoken language came a new repertoire of movements inducing new stress patterns in the mandibular symphysis that eventually culminated in a series of adaptive changes on the osteological configuration of the mandible, resulting in the chin shape found in the modern human symphysis (Ichim 2007; Daegling 2012).

Even though the magnitude of the stress loads is rather small, it is, nevertheless, "*orders of magnitude higher than those associated with mastication*" (Daegling 2012, 9) and it produces loads of frequency over 5 Hz that may be enough to obtain a response from the bone tissue inducing bone formation (Ichim 2007; Daegling 2012). In his research article, Daegling (2012) criticizes several aspects of this hypothesis, specifically, he argues that the genioglossus muscle, albeit strongly linked to speech production, is also active during inspiration and during non-REM sleep, hence it is in relatively constant activity, meaning that the "*activity in the genioglossus muscle is producing low-level strains in the mandible whether or not speaking is taking place*". Also, the activity requirement on the genioglossus muscle during respiration is not unique to *Homo sapiens* (Daegling 2012, 9).

For this reason, Daegling argues that the orofacial stress caused by this muscle may not be enough to induce this particular mandibular symphysis and that Ichim and colleagues are ignoring the suprahyoid muscles in addition to the trigeminal and facial somitomeres and consequently their research is "*highly unrealistic and unsupported by independent data*".

Further experimental research is needed to clarify the link between bone deposition in the mandible as well developmental and theoretical research to confirm that the emergence of speech is linked to ontogenetic changes of such bone deposition. It is also necessary to answer the separate question, that is, "*whether bone hypertrophy is functionally linked to evolutionary appearance of the chin*" (Daegling 2012, 11).

Sexual selection

The last attempt to explain the *mentum osseum* does not try to understand why this feature appeared but rather why it still prevails in anatomically modern *Homo sapiens* (Thayer and Dobson 2010). This hypothesis assumes that the human chin is a display, contributing to facial attractiveness, and is susceptible to be favored by the members of the opposite sex.

Notoriously, there is a great variance in *mentum osseum* morphology and some individuals even appear to lack this feature (Schwartz and Tattersall 2000). This strong diversity and the existence of almost "chinless" individuals appear to be incompatible with a specific biomechanical function: as argued by Dobson and Trinkaus (2002), "chinless" mandibles are no weaker than chinned ones. Furthermore, intra-specific anatomical variation, in extant primates, is mainly generated by sexual dimorphism (Coquerelle *et al*. 2011).

Following Daegling (2012), it is reasonable to speculate that the human chin is sex-specific and is maintained in the population by sexual selection because this characteristic is likely to have an important role in shaping facial symmetry, and symmetry largely contributes to facial attractiveness. In forensic anthropology the chin shape is already commonly used in sex estimation (Thayer and Dobson 2010) and expresses evidence that the development of the mandible after adolescence is distinctive between both sexes (Coquerelle *et al*. 2011), so it will not be surprising if the chin was also a distinctive feature between sexes.

Thayer and Dobson (2010) suggest that if sexual selection is the reason for the maintenance of the *mentum osseum*, then chin shape must be an indication of good genes. Females might have a preference for males with a broad chin because this trait is correlated with masculinity and social dominance, characteristics favored by females for pair-bonding, while males could favor females with a narrow and small chin, since it is correlated with higher levels of estrogen which reflect higher fecundity rates (Thayer and Dobson 2010; Coquerelle *et al*. 2011).

Schwartz and Tattersall (2000) object that due to the bone properties, it is not expected that dimorphic variance in bone structure would be present between males and females. In addition, if sexual selection was the mechanism responsible for the modern human chin, dimorphism does not result in conspicuous divergence in biomechanical performance, being difficult to relate it with bone hypertrophy (Coquerelle *et al*. 2011; Daegling 1993, 2012). However, the chin shape seems to be highly dependent on steroid levels. Since steroid levels regulate a number of other secondary sex characteristics it is a strong indication that selection of chin morphology is dependent on the selection of other sexual traits (Thayer and Dobson 2010).

In 2010 Thayer and Dobson presented quantitative data showing that the shape of the *mentum osseum* is sex dimorphic, giving consistency to the sexual selection hypothesis. However, they noticed some degree of overlap in male and female chin shape, which does not indicate a "*process of selection driven by female choice*" (Thayer and Dobson 2010, 421). This degree of overlap can be explained by alternative female strategies. Some females could prefer males with a narrow chin for pair-bonding because, despite the fact that they do not display better genetic potential, they are more likely to be less violent, which could constitute a more conservative strategy for the females.

Another possible explanation for the overlap in chin shape between sexes regards regional differences in chin shape, since this study incorporates data from diversified geographical areas. It is known that females display divergent preferences in facial attractiveness depending on different phase of their menstrual cycles and on different geographical contexts (Thayer and Dobson 2010). So *"maybe regional differences in the degree and/or pattern of sexual selection* (…) *may reflect cultural influences on the assessment of facial attractiveness"* (Darwin 1871; in Thayer and Dobson 2010).

The presence of dimorphism in the human chin represents a solid argument for the sexual selection hypothesis however it does not fully prove it because the presence of dimorphism could be correlated with other factors. The fact that this feature is sex-specific constitutes a strong refutation for the biomechanical explanations, because one would not expect to observe variability between males and females in masticatory functions or production of speech (Thayer and Dobson 2010; Daegling 2012).

Further research in this topic must consider that the *mentum osseum* is a sex dimorphic character and that the dimorphism between sexes in the human species is in decline and thus the selective forces regulating sexual dimorphism when the chin started to emerge may not be linked to the maintenance of the trait nowadays (Thayer and Dobson 2010).

Conclusion

The peculiar and characteristic protruding chin present in anatomically modern humans, which can be defined as bone hypertrophy in the antero-inferior mandibular symphysis, emerged around 50.0 kya and is absent from archaic humans and in Neandertals. For more than a century it has been a subject of debate in the scientific community as to what exactly were the evolutionary forces that led to the emergence of the *mentum osseum* and its functional significance today, since they may not be linked (Schwartz and Tattersall 2000; Dobson and Trinkaus 2002; Ichim *et al*. 2007; Thayer and Dobson 2010; Emes *et al*. 2011; Gröning *et al*. 2011; Daegling 2012).

This paper surveyed the main hypotheses in the modern scientific literature. Most of them are related to biomechanical function and posit that the demands of craniofacial musculature induced bone remodeling in the mandibular symphysis (Daegling 2012). These explanations can be grouped into two main groups: the masticatory stress hypotheses, where the demands placed upon the mandibular

symphysis by the masticatory muscles prompted the bone formation (Schwartz and Tattersall 2000; Dobson and Trinkaus 2002; Ichim *et al*. 2006; Gröning *et al*. 2011; Daegling 2012). The other group suggests that the oblique contraction of the genioglossus muscle, required for speech, forced a remodeling in the mandibular symphysis (Ichim 2007; Daegling 2012).

Other scholars (*in* Daegling 2012) argue that the chin is a mere structural artifact with no functional (and sometimes adaptive) significance. However, it is very unlikely that it would not have any function, since there is no other part of the human skeleton without any functional significance; metabolic investment in the formation and maintenance of the *mentum osseum* is evident. If it really were just a structural artifact, it would disappear in a few generations.

One of the most promising contributions on this topic in recent years was brought forward by Thayer and Dobson (2010) and posits that the human chin is the result of sexual selection in the process of choosing a partner and it is maintained in modern times because a protruding chin in human males would be a display for good genes and would be favored by human females. Similarly, a narrow female chin, as a trait equivalent to the narrow and thin female waist, could indicate high fertility rate. More developmental and experimental data is required to prove that sexual dimorphism is significant, since Thayer and Dobson (2010) showed a considerable degree of overlap between male and female chin shape. This hypothesis does not explain the evolutionary pressures that caused its emergence. However, any further explanation of its appearance must account for sexual dimorphism and for the fact that selective forces that could be acting on the symphysis in Late Pleistocene are most probably divergent from the, likely non-existent, forces exerted on this area nowadays.

Résumé

Ce article de synthèse présente les théories principales qui tentent d'expliquer l'émergence de l'un des traits marquants spécifiques de notre espèce : le menton saillant. Les théories établies relatives à ce phénomène sont les suivantes : la théorie du stress de la mastication, la théorie de la sélection sexuelle et enfin les théories relatives au menton humain et à l'émergence du language articulée. Cependant, les explications qui ont été proposées par les auteurs se révèlent non conluantes et les processus responsables de l'émergence du *Mentum osseum* à la fin du Pléistocène restent flous.

Zusammenfassung

Diese Übersicht legt die führenden Theorien vor, die die Entstehung eines der bedeutenden Kennzeichen unserer Spezies – das hervorstehende Kinn – zu erklären versuchen. Unter den gegenwärtigen Theorien, die dieses Phänomen behandeln, gehören die Theorie vom Einfluss der Belastung bei Kauen (Kau-Stress-Theorie), die Theorie von der sexuellen Selektion und Theorien vom Einfluss des menschlichen Kinns auf die Entstehung der gesprochenen Sprache. Allerdings sind die Erklärungen, die von den Autoren vorgeschlagen wurden, nicht überzeugend und die Prozesse, die für die Entstehung von *Mentum osseum* im späten Pleistozän verantwortlich sind, bleiben unklar.

THE EARLY UPPER PALEOLITHIC IN SOUTHWESTERN FRANCE

Nicolas Teyssandier

This paper is a tribute to the work of Jiri Svoboda and its relevance to important discussions on the beginning of the European Upper Paleolithic.

Abstract
The Upper Paleolithic (ca. 40.0–10.0 ky BP) is traditionally envisioned in terms of a clear rupture with the Middle Paleolithic. Indeed, how can we not see, in the numerous and varied ornaments, sculpted stone blocks, ivory statuettes, or bone, antler and ivory spear points, evidence of a significant and abrupt mutation in the long history of human evolution? We try here to explore the historic depth and evolutionary significance of the main innovations that materialized with the development of modern humans during the Early Upper Paleolithic in France. This chapter, thus, provides an overview of current knowledge on the technical and socio-economic evolution of modern hunter-gatherers from the Châtelperronian to the end of the Gravettian. Our main emphasis is, thus, related to the explanation of economic and social mutations that took place during the first stage of modern human dispersion in prehistoric France.

Keywords
Châtelperronian, Aurignacian, Gravettian, Proto-Magdalenian, stratigraphy, chronology, France

DOI: 10.5817/CZ.MUNI.M210-7781-2015-10

Introduction

The Upper Paleolithic is linked with the emergence and development of the first societies of anatomically modern humans in Europe. Broadly speaking, it ranges from 40.0 to 10.0 ky BP, during the course of the last glacial cycle (OIS 3, 2 and 1),

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which was marked by rapid and intense climatic fluctuations (Dansgaard-Oeschger cycles and Heinrich events 4 to 1). This important moment of evolution in the Paleolithic was composed of six chronological entities (Châtelperronian, Aurignacian, Gravettian, Solutrean, Badegoulian and Magdalenian) that were succeeded by Epipaleolithic societies. Antler and bone points, together with particular elements of lithic tool-kits, served as type-fossils for establishing the stratigraphic succession of these different techno-complexes. This initial classification, with an emphasis on chronology, led to the recognition of separate entities whose cultural relevance remains difficult to grasp. These entities follow one another in a linear fashion, yet the evolutionary drive behind their succession is difficult to discern.

Over the last thirty years, behavioral approaches highlighting the *chaînes opératoires* of production, tool-kit curation and the existing interrelations between various components of technical systems have multiplied. They allow us to organize the cultural successions of the Upper Paleolithic in a more dynamic manner through notions of 'transition'. Improvements in the resolution of chronological and paleo-environmental data make it possible to discuss the evolutionary mechanisms of these hunter-gatherer societies.

This chapter is not intended to be an exhaustive synthesis of French Early Upper Paleolithic data. It does, however, strive to bring to light certain factors that may explain particular major transformations affecting cultural groups at the end of the Pleistocene. We have at our disposal complementary documentation for the different geographic regions of France. While Southern France and its diversity of biotopes presents a near continual record of human occupation, particularly conducive to a diachronic approach, other geographic areas, such as the Paris basin and its fringes, have produced high-resolution data-sets that favor paleo-historic considerations (Valentin 2008). Here, we mostly discuss data from Southwestern France related to the first stages of the Upper Paleolithic, from the Châtelperronian up to the end of the Gravettian.

The onset of the Upper Paleolithic: the Châtelperronian and the Aurignacian (40.0–29.0 ky BP)

Besides behavioral changes brought about by the onset of the Upper Paleolithic, this period also witnessed a major biological event which saw the replacement of European Neanderthal populations by anatomically modern humans. At the heart of this process lies the Châtelperronian (40.0–37.0 ky BP), the first Upper Paleolithic techno-complex in the French archeological sequence. Up until the end of the 1970s the authorship of the Châtelperronian had never been questioned. It was assumed that the appearance of new traits (bone and antler objects, ornaments and blade tools), which mark the uniqueness of the Upper Paleolithic, could only have been the work of modern man.

The 1979 discovery of a Neanderthal skeleton in a Châtelperronian context at the site of Saint-Césaire (Levêque and Vandermeersch 1980) overturned the classic evolutionary model and opened a new debate. Why did Neanderthals drastically

transform their behavior and invent the Upper Paleolithic? An initial hypothesis rapidly gained ground, one that evoked the acculturation of the final Neanderthals through contact with the first anatomically modern humans arriving in Europe around 40.0 ky BP (Demars and Hublin 1989; Mellars 1989, 2004). With this perspective, Neanderthals are but passive actors amongst the changes taking place within the Châtelperronian; *Homo sapiens* and the conquering culture of the Aurignacian were the innovators. This point of view has been challenged by others who underline the strict chronological precedence of the Châtelperronian over the Aurignacian (Zilhão and d'Errico 1999). According to the latter view, Châtelperronian innovations were produced by Neanderthals and resulted from the independent evolution of their groups (d'Errico *et al*. 1998; d'Errico 2003; Zilhão 2006). Accordingly, there is no correlation between the biological and cultural spheres during the Middle to Upper Paleolithic transition, rather a parallel evolution of these two human types towards forms of cultural modernity.

As the current state of research stands, it is difficult to validate either scenario. Anthropological data remains elusive and the Neanderthal/Châtelperronian association rests entirely on a couple of sites which themselves demand more thorough investigation: Saint-Cesaire and the Grotte du Renne at Arcy-sur-Cure. At Saint-Césaire, and as previously mentioned by Lévêque and de Sonneville-Bordes, two distinct lithic components are, in fact, associated in the Châtelperronian assemblage of the Ejop superior layer: a Middle Paleolithic one containing more than 2/3 of the tools and an Upper Paleolithic one. Moreover, the lithic artifacts share a distinct state of preservation, indicating that the assemblage has a complicated post-depositional history (Bar-Yosef and Bordes 2010; Bachellerie 2011; Bordes and Teyssandier 2011). An analysis of the lithics of both Ejop inferior and superior layers (Soressi 2010) has shown that, while formerly attributed to the Châtelperronian, they are in fact distinct chronoculturally. This opens the door to new questions about the mixture of Mousterian and Châtelperronian artifacts in the Ejop sup layer (work ongoing).

Moreover, the very definition of the Châtelperronian is problematic. Is it a transitional industry bearing mixed characteristics, some inherited from the Middle Paleolithic and others foreshadowing the Upper Paleolithic? Or is it a strictly Upper Paleolithic industry? In the majority of caves and rock shelters in Southwestern and West-central France where the Châtelperronian stratigraphically follows recent Mousterian industries (Bordes 2002), mixed features are frequently found. This is the case at Saint-Césaire where Mousterian flake tools and Discoïde debitage sit side by side with blade tools. The opposite is true of open-air contexts bearing a single archeological level (Canaule II, La Côte, Les Vieux Coutets, Les Tambourets) where Châtelperronian lithic production is turned almost exclusively towards the production of large, relatively short blades with a rectilinear profile (Figure 1), mainly destined for the manufacture of Châtelperron points or knives (Pelegrin 1995; Bachellerie *et al*. 2007; Pelegrin and Soressi 2007). The mixing hypothesis requires more detailed examinations since the presence of Mousterian reminders in these assemblages never surpasses 10% of the retouched tool component. Thus, the

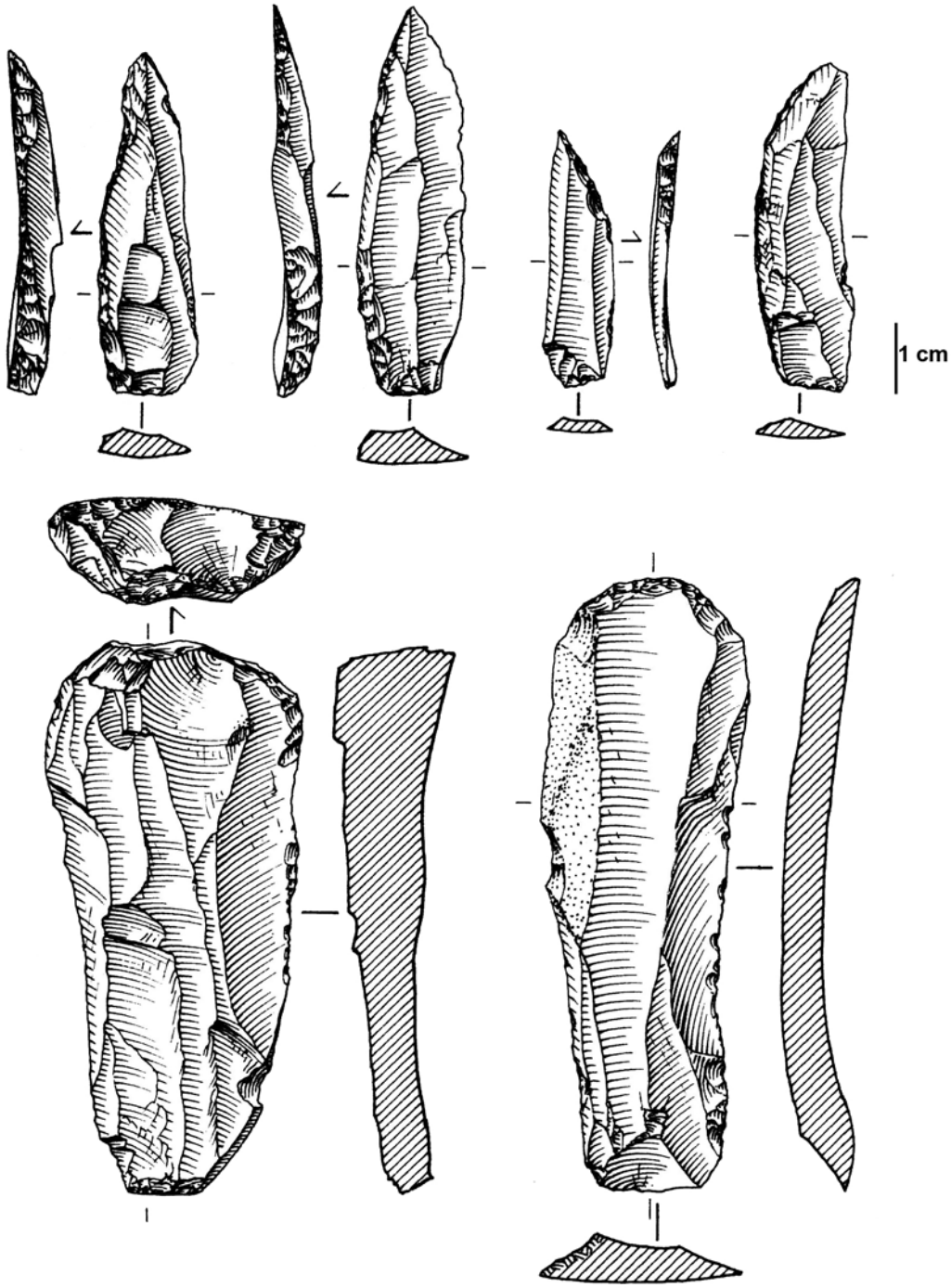

Figure 1: Blade tools of the Châtelperronian Châtelperronian points above and end-scrapers) from the open-air site of Canaule II, Dordogne (drawings by M. Jarry, after Bachellerie *et al.* 2007).

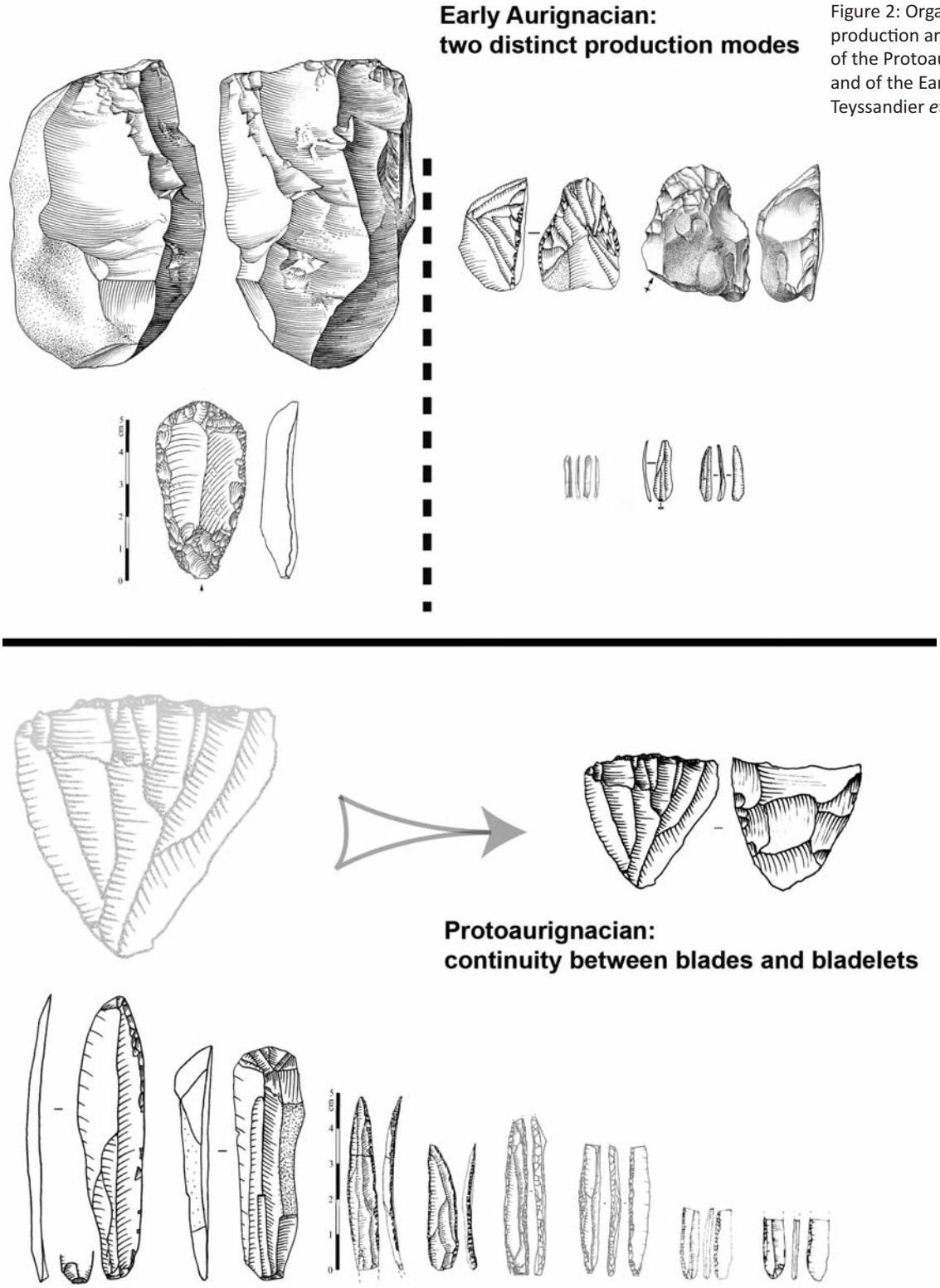

Figure 2: Organization of lithic production and characteristic tools of the Protoaurignacian (above) and of the Early Aurignacian (after Teyssandier *et al.* 2010).

Châtelperronian appears as a properly Upper Paleolithic industry and not as an Epi-Mousterian one. At the other chronological boundary of the Châtelperronian there are no links with Aurignacian production methods, which differ in both intentions and modalities (Pelegrin 1995; d'Errico *et al*. 1998). Similarly, the working of organic material remains rare and little diversified in the Châtelperronian, except at Arcy-sur-Cure or Quincay, and then only if personal ornaments are taken into account.

How then can the Châtelperronian be reconciled with the Aurignacian that follows? An important role may be assigned to projectile elements in the constitution of lithic tool-kits (Teyssandier 2008; Teyssandier *et al*. 2010). In the Châtelperronian, the most regular blades, the primary goal of the debitage, were transformed into knives and points for armatures (Plisson and Schmider 1990; Pelegrin 1995; Bachellerie 2011; Roussel 2011). The idea of hafting lightweight lithic elements represents a departure from previous technical systems and almost certainly explains the abandonment of flake-based production methods typical of the Mousterian. This idea gains significant ground during the Aurignacian, which is marked in its initial phase by the production of bladelets (Bon 2006). The Protoaurignacian (37.5–35.5 ky BP) is present in a large part of the south, spanning the western Mediterranean coastline, where it was initially identified, to the Atlantic coast, the foothills of the Pyrenees and the Aquitaine. Further north, it is also found in the Bourgogne at Arcy-sur-Cure; however, its presence in this region seems sparse. Stratigraphically, the Protoaurignacian follows the Châtelperronian and precedes the Early Aurignacian with split-based points (Bordes 2002; Zilhão 2006; Teyssandier *et al*. 2010). Another innovative characteristic is the primacy of rectilinear bladelets (Figure 2), which are transformed into pointed bladelets with bilateral direct retouch and/or bladelets with alternate retouch (Dufour bladelets). These bladelets are obtained from pyramidal and prismatic cores, which first produced blades as part of an operational *continuum* (Bon 2002). It is clear that production of lithic hunting weapons dominated the Protoaurignacian industries.

This trend continues with the Early Aurignacian (35.5–32.0 ky BP) in the form of shorter, often unretouched, bladelets. Bladelets become smaller and are the focus of a specific, independent production (Bon 2002; Teyssandier 2007, 2008). Deliberately large and thick blades are obtained by direct soft hammer percussion from unipolar prismatic cores and were destined for the manufacture of domestic tools, mainly endscrapers and retouched blades that were often subject to several cycles of re-sharpening (Teyssandier *et al*. 2010). The bladelets, which were sometimes used to arm shafts, are removed from emblematic carinated 'endscrapers', an ingenious core that permitted the production of a large number of bladelets. In other words, with the Early Aurignacian, we observe an individualization of lithic reduction sequences (Figure 2) based on the activities for which the end products would be used, such as the 'opposition' of domestic *vs*. hunting tools (Tartar *et al*. 2006; Teyssandier *et al*. 2010).

With the Early Aurignacian, the working of organic materials diversifies and becomes systematic (Figure 3). Bone is transformed into a large array of domestic tools (Tartar 2009); reindeer antler is used for soft-hammers, but primarily as the

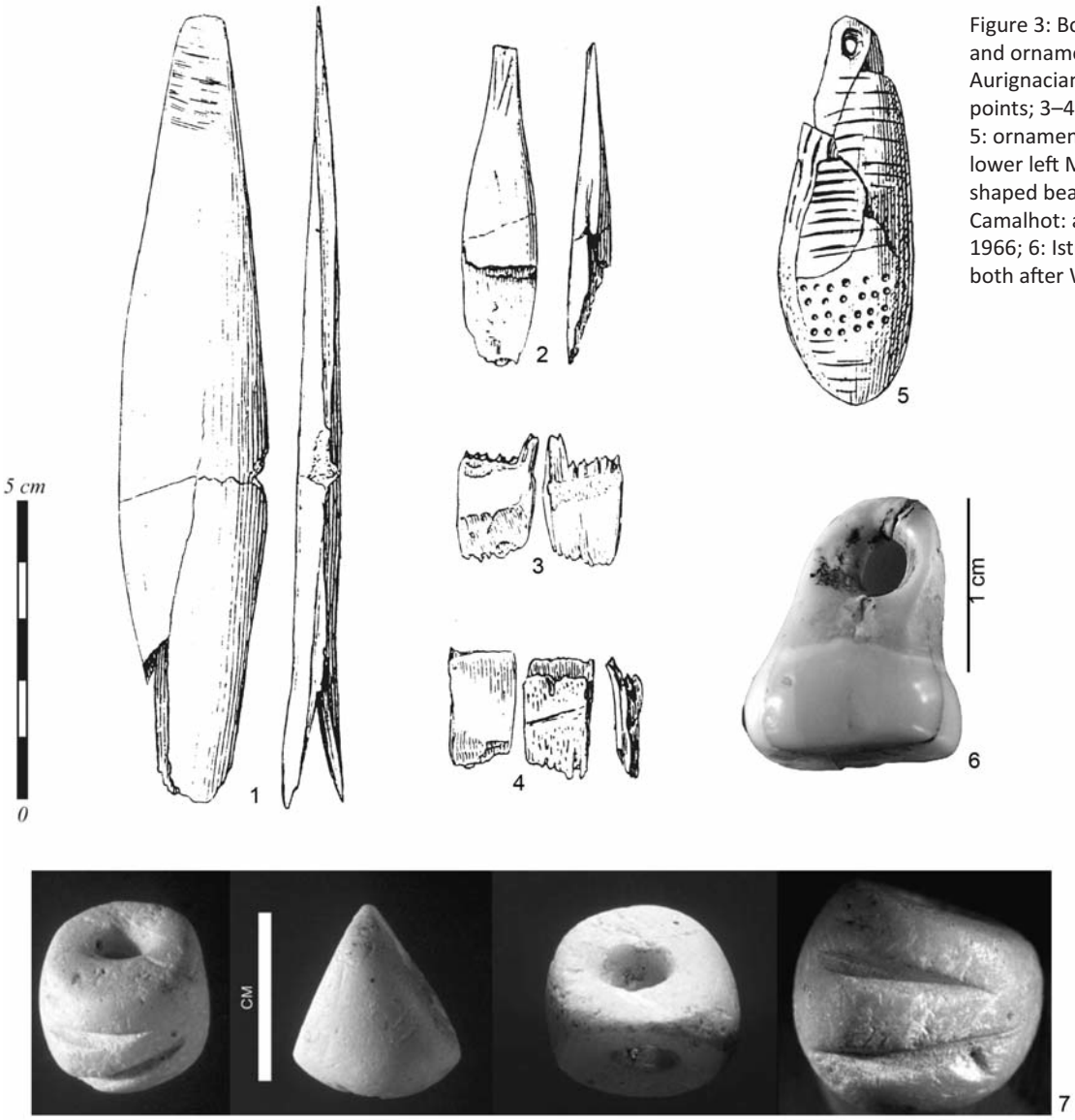

Figure 3: Bone industry and ornaments of the Early Aurignacian. 1–2: split-based points; 3–4: tongued pieces; 5: ornament; 6: perforated human lower left M2 or M3; 7: basket-shaped bead. (1–5 Tuto de Camalhot: after Vézian and Vézian 1966; 6: Isturitz; 7: Brassempouy, both after White 2007)

raw material for the famous split-based bone points whose ingenious hafting method becomes widespread (Liolios 1999). Finally, ivory is limited to the symbolic realm where it is transformed into ornaments. In this sense as well, the Early Aurignacian witnesses a very clear florescence; the use of different materials multiplies, and types become more diversified and demonstrate a regionalization, such as the well-known basket-shaped ivory beads from Southwestern France (White 2007). Personal ornaments, like some bone tools, may be decorated with geometric motifs (Tartar 2009). The Aquitaine witnesses the development of an art form on stone slabs that is principally centered on sexual representations, such as the engraved vulvas from the small valley of Castel-Merle (White *et al*. 2012).

In terms of material culture, the Late Aurignacian (31.0/29.0 ky BP) constitutes a continuation of Early Aurignacian traditions. Tool sets, both lithic and osseous, portray subtle variations; broad carinated endscrapers are replaced by narrow nosed forms, and busked burins appear whose particularity lies in their being systematically twisted in profile (Michel 2010). This puzzling technique was an immense success, spanning the Atlantic coast to the Russian plains and Zagros Mountains. Blade tools show a clear decrease of the scaled Aurignacian retouch. Split-based points disappear and are replaced by 'massive' base points of the Central European Mladeč form. Finally, and most conspicuously, figurative art develops with the spectacular examples of parietal art at Chauvet Cave (Geneste 2005) whose striking parallels with the ivory sculptures from Vogelherd or Geissenklösterle have long been recognized (Hahn 1986). This full-blown artistic expression takes place within the context of territorial expansion, notably towards the large northern plains previously ignored by Aurignacian groups. France follows this trend with the first indications of an Aurignacian in the north in the form of a late Aurignacian with twisted bladelets (Fagnart *et al.* in press).

An evolution of techniques, distinguished by the individualization of the main spheres of activity, takes place during the beginning of the Upper Paleolithic. In the case of the Aurignacian, this trend is reflected in the rise of armature production and the clear isolation of domestic realm from that of weaponry (Tartar *et al.* 2006; Teyssandier 2008; Bon 2009). This tool specialization takes form with a progressive microlithization of bladelet armatures. Aside from the obvious functional advantages of composite projectiles, bladelets present an enormous advantage in terms of hunter-gatherer mobility (Bon 2009). The travel kit of the classic Aurignacian could thus be limited to a few substantial blades, resharpened over long periods in order to satisfy domestic needs, and to small blocks or flakes functioning as a potential reserve of bladelets. This organization of lithic production during the Aurignacian can be seen as a response to a developing nomadism and to a significant increase in the size of territory covered, as evidenced by the transportation of kits over several hundred kilometers (Bordes *et al.* 2005; Féblot-Augustins 2008). This temporal and spatial organization of activities must have had important consequences on settlement patterns, although there is insufficient information to confirm this. However, this view is supported by the existence of knapping workshops, such as those of the Bergeracois, which served to distribute laminar elements, or by large, open-air occupations structured around a number of hearths and implying a codified organization of the domestic space, such as Régismont-le-Haut near Béziers (Bon and Mensan 2007).

The last years of the Aurignacian, from 30.0–29.0 ky BP, are largely unknown, either in France or on the European continent. Recent research in the Southwestern France has highlighted the diversification of bladelet production immediately preceding the Gravettian (Pesesse and Michel 2006; Pesesse 2008; Michel 2010). Elongated and rectilinear bladelets return, a phenomenon, which is clearly perceptible in the Vachons burin industries that are always in the upper-most stratigraphy of the main Southwestern Aurignacian sequences (La Ferrassie, Le

Flageolet, Pataud, Roc-de-Combe) and in the Font-Yves point industries associated with a final stage of this techno-complex and which may bridge the gap with the initial stages of the Gravettian (Pesesse 2008).

The Gravettian (29.0–22.0 ky BP): European civilization or cultural mosaic?

As with all other important chrono-cultural transitions, the origins of the Gravettian remain obscure, particularly in France where archeological sequences and radiometric dates for the oldest stages are still rare. As a general rule, the idea of an intrusive Gravettian dominates with its origin being sought in West-Central Europe or the northern plains, depending on whether one considers the precursor to be either *fléchette* or tanged-point industries (Bosselin and Djindjian 1994). Stratified sequences containing vestiges of the Early Gravettian are limited; Abri Pataud and La Ferrassie are rare examples (Bricker 1995). In the case of Abri Pataud, the sequence begins with the *fléchette* industries associated with numerous Gravette points, while, at La Ferrassie, the Gravette points are instead associated with Font-Robert points. For some, *fléchette* and Font-Robert trends are sub-contemporaneous, whereas others tend to see a diachrony and consider the *fléchette* industries (Bayacian) as representing the oldest stage (Pesesse 2008). The latter may be the oldest manifestation of the Gravettian in France, thus attenuating the strict rupture between the final Aurignacian and initial Gravettian populations. Indeed, this industry lacks backed points and, as such, does not present 'classic' Gravettian attributes, just as the Font-Yves point industries present diminished Aurignacian characteristics (Pesesse and Michel 2006; Pesesse 2008).

The archetypical Gravettian is not truly established until the Early Gravettian, as seen in the Aquitaine (La Gravette, Pataud, Puy-Jarrige) and the Loire, particularly the large open-air site of Vigne Brun, famous for the patterning of domestic space into several living units structured around hearths (Combier 1988). The production of large Gravette points constitutes the defining element of these industries together with various methods for producing blade-bladelet blanks. These production methods include long reduction sequences producing blades of different sizes and shorter sequences destined for the production of light blades (Pesesse 2008). The unity of the Early Gravettian is equally expressed in the wide range of its hunting tools: Gravette points, alternately backed points, Tursac points and *fléchettes* (Figure 4). In terms of working organic materials, the Early Gravettian is distinguished by the systematic extraction of *baguettes* by the double groove technique (Goutas 2009).

In the Middle Gravettian, regional variations develop; different trajectories of change may be observed in the northern and southern halves of France. In the north, assemblages with Raysse burins dominate and diverge from the technical norms common to the Gravettian. The Rayssian is practically devoid of abruptly backed points and consists of marginally retouched bladelets (Picardie bladelets) produced from Raysse burins (Klaric 2003, 2007). In a large area of the southern half of France, Noailles burin traditions predominate, as is the case in the Pyrenees where this tool type spans the totality of the Gravettian sequence (Simonet 2009). The Pyrenean

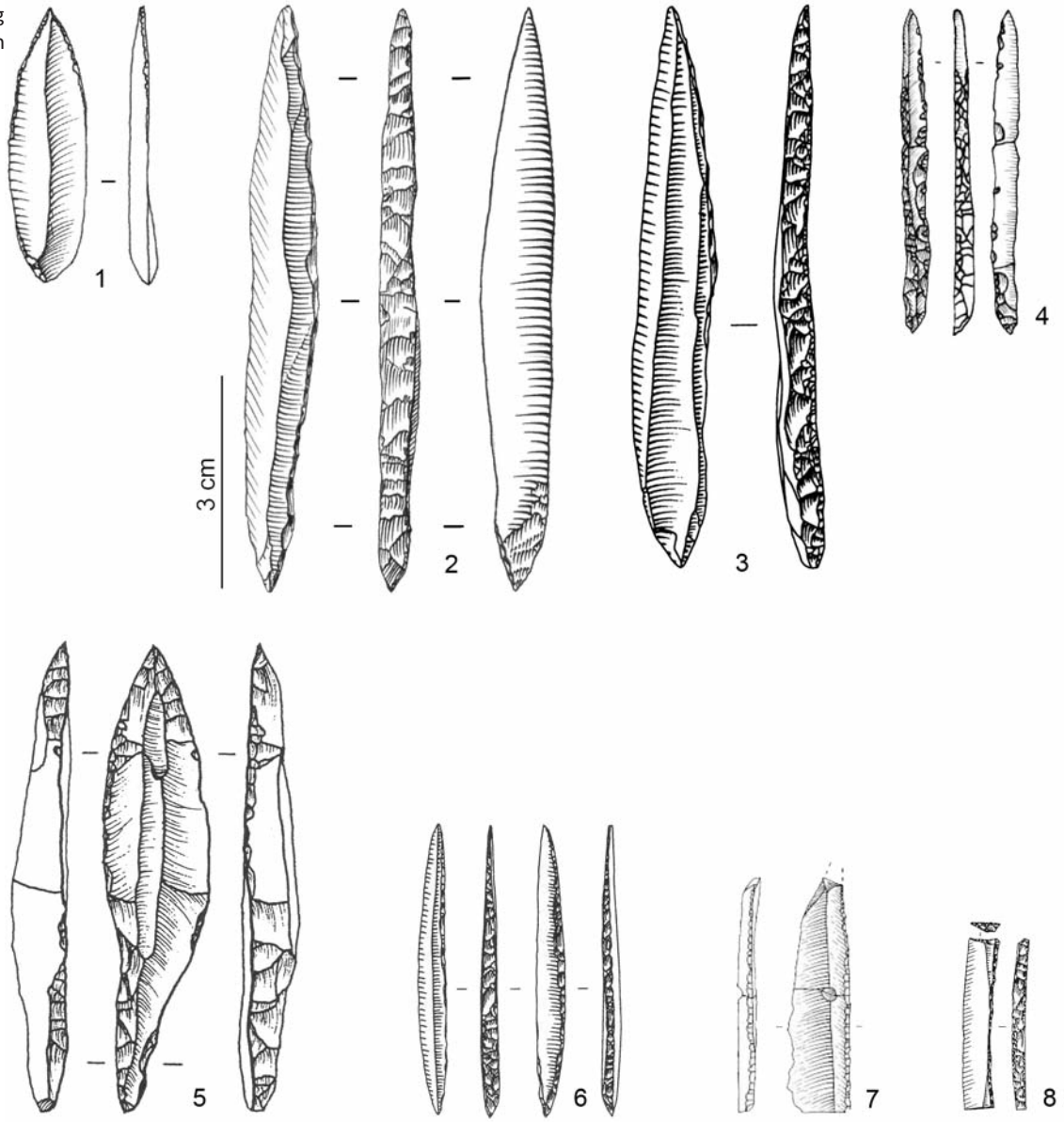

Figure 4: Lithic hunting weapons of the French Gravettian. 1: *fléchette*, La Gravette; Vachon point, Isturitz; 3: Gravette point, Vigne-Brun; 4: Micro-Gravette, Le Blot; 5: Font-Robert point, La Ferrassie; 6: Alternate backed point, Vigne-Brun; 7: Picardie Bladelet, La Picardie; 8: Bitruncated backed bladelet, Pataud (1, 3, 5–6: after Pesesse 2008; 2: after Simonet 2009; 4, 7: after Klaric *et al*. 2009; 8: after Bricker 1995).

Gravettian differs from its north-Aquitaine counterpart not only in the persistence of Noailles burins but also in the frequency of splintered pieces, as well as in a more precise blade debitage. This geographic contrast between the Rayssian and the Noaillian is not consistent; it seems that these two entities actually succeed one another in the Aquitaine, as can be seen in the Abri Pataud sequence where Raysse burins progressively replace Noailles burins.

In the Late Gravettian, several sites demonstrate marked similarities in their lithic armatures (Gravette points, Micro-Gravettes, backed bladelets) as well as in production methods, such as the development of an original method for obtaining

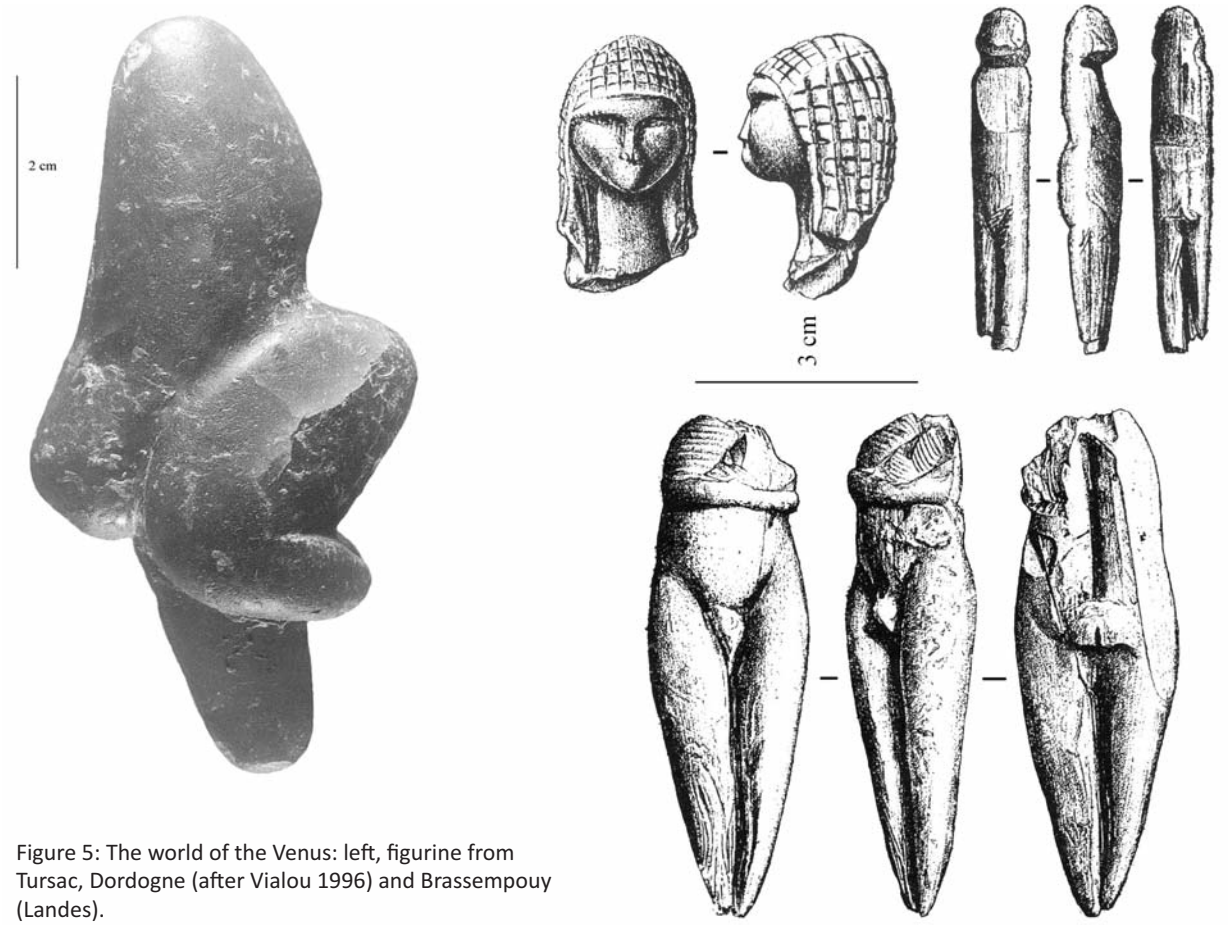

Figure 5: The world of the Venus: left, figurine from Tursac, Dordogne (after Vialou 1996) and Brassempouy (Landes).

bladelets from polyhedral core-burins (Klaric *et al.* 2009). Establishing a precise chronology for these Late Gravettian industries remains difficult in the absence of sufficient radiometric dates. The Peyrugues sequence suggests that the progressive disappearance of blade points is contemporaneous with the abandonment of the Gravette concept. This trajectory of change solidifies with the final Gravettian of the Proto-Magdalenian type, which is characterized by a decline of Gravettian lithic armatures (*ibid.*).

This example of the evolution of lithic equipment portrays the difficulty of reconstructing Gravettian chrono-cultural dynamics between roughly 29.0 and 22.0 ky BP. Certain technical traits, Gravette and Micro-Gravette points in particular, are shared over vast territories and do not constitute reliable chronological markers. Other tool types punctuate the Gravettian chronology, such as the *fléchettes*, which are characteristic of older phases (Pesesse 2008), or the recently redefined Vachon points that are typical of a middle phase, just as Picardie bladelets are associated with a very stereotypic production pattern involving Raysse burins. Recent results question the classic paradigm of a uniform and monolithic Gravettian and instead suggest a cultural mosaic punctuated by moments of uniformity (Klaric *et al.* 2009).

How can this new perception of the Gravettian be reconciled with the view of its being the great pan-European civilization of the Upper Paleolithic?

The famous 'Venus' figurines (Figure 5) made of ivory or soft stone, are the key element tying together the Gravettian cultural mosaic extending from the Atlantic to Siberia (Delporte 1979). Few well contextualized examples of these statuettes are known from France as the majority was discovered either during old excavations (Brassempouy and Lespugue in the Pyrenees, Grimaldi near Monaco) or come from contexts lacking any stratigraphy (Sireuil in the Dordogne). Despite these reservations, the figures are almost exclusively associated with a Noaillian facies of the Gravettian, as demonstrated by Delporte's excavations (1962) at Tursac in the Dordogne. The chronology of this 'Venus episode' in Western Europe is little understood; the only available dates, 25.6 and 23.0 ky BP, are from Tursac. Based on the recurring associations of Venus statuettes with particular stone and ivory armatures (shouldered and ivory points), themselves rare in the Gravettian assemblages, Simonet has suggested narrowing down the time-span of this phenomenon. He sees in this a form of Gravettian unity expressed around an ideology founded upon the duality of the feminine symbol and the realm of armatures considered to be inherently masculine (Simonet 2009).

This specific combination, albeit rare, highlights the spirituality of Gravettian society. At Brassempouy there appears to be a genuine shrine where the exceptionally crafted armatures, ornaments and animal paws, in anatomical connection, are found within a secluded location (Simonet 2009; Goutas and Simonet 2009). In the Pyrenees, this goes hand in hand with a certain hierarchy of site function (Simonet 2009), aggregation sites centered around technical (Isturitz) or spiritual (Gargas) activities and shrine-occupations (Brassempouy) and smaller sites focused on the acquisition and processing of meat-based (Tuto de Camalhot, Gatzarria, Atxurra) or mineral (Tercis) resources. Moreover, combined evidence indicates a semi-permanent character for the occupation of Brassempouy that is consistent with the indications of partial sedentism hinted at by several large Central and Eastern European sites. An additional indication of group stability may be another recurrent Gravettian phenomenon that is almost unknown throughout the Upper Paleolithic, multiple inhumations such as those known from Cro-Magnon, Cussac and Grimaldi (Henry-Gambier 2008).

Around 22.0 ky BP, we see a change in the lithic production of the late Gravettian; the classic laminar pattern typified by arched bipolar cores, Gravette points and, especially, micro-Gravettes is rejected (Klaric *et al.* 2009). Concurrently, a new type of microlithic armature appears, the truncated or bi-truncated backed bladelet, typical of the final Gravettian or Proto-Magdalenian, which has been identified at a few rare sites in the Southwestern (Laugerie-Haute, Les Peyrugues, Pataud) and Central France (Le Blot). The move from Late Gravettian apical weapons to Proto-Magdalenian non-perforating truncated armatures laterally mounted on organic points suggests a modification in the conception of hunting weapons (Klaric *et al.* 2009). The other distinctive characteristic of the Proto-Magdalenian are the lithic raw material provisioning strategies, almost entirely focused on exogenous materials of excellent

quality, as at Peyrugues or Le Blot (Klaric *et al*. 2009). The Proto-Magdalenians anticipated mineral resource requirements in order to maintain the production of large durable blades. Other characteristics, such as ornaments made of reindeer antler at Les Peyrugues (Allard *et al*. 1997) or of bone at Abri Pataud (Clay 1995), contribute to the creation of identity by these final Gravettian groups.

The final moments of the Gravettian correspond to the return of cold climatic conditions at the dawn of the Last Glacial Maximum. The explosion of technical models, already perceptible in the Final Gravettian, continues during this pivotal period leading up to the Solutrean, often considered as the 'golden age' of worked stone.

Conclusion

While there remain inevitable gaps in this synthesis, the synthesis underlines several important trends over the course of the French Early and Mid-Upper Paleolithic. The multiplication of data and the refinement of diverse analyses allowed us to identify different stages of change during these almost 20 millennia of evolution. Furthermore, the deconstruction of the traditional classifications of the Upper Paleolithic permitted us to trace some unifying links between different cultural assemblages previously considered as being hermetically sealed.

It appears that the Upper Paleolithic in general is marked by certain stability in the chosen solutions for the production of technical equipment and symbolic items. In this sense, the Upper Paleolithic breaks with the Middle Paleolithic, and it seems that the pool of choices becomes reduced. Lithic elements become almost exclusively blades and or bladelets and organic equipment is significantly oriented towards the production of cervid antler points. While ornaments and artistic manifestations vary through time and space, similar societies nevertheless display similar trends.

To sum up, the common denominators among the different techno-complexes have been recognized for some time within typological studies. We must, therefore, explore these common denominators in more detail. Hunting equipment appears to be the ideal focus as it encompasses the entirety of the Upper Paleolithic and significantly differs from Middle Paleolithic forms. Furthermore, this particular focus has the advantage of shedding light upon the interface between hunters and their prey and can be directly associated with environmental changes.

Numerous models have recently been proposed to explain the dynamics of change in relation to climatic alterations. For example, the cold Heinrich events and their ecological consequences favored the expansion of resource rich steppes that may have led to increased numbers of human groups occupying larger territories. These groups would, however, have become fragmented during more temperate periods (d'Errico *et al*. 2006).

While the adaptation of these hunter-gatherer societies to the significantly fluctuating climatic conditions of the last glacial cycle is indisputable, it demands further precision. We wish to emphasize the socio-economic changes that we believe characterize the Upper Paleolithic and which we have attempted to discuss here.

Once formulated, these changes come to represent both the internal and external motors of Upper Paleolithic evolution and must now be further deciphered and incorporated in future work.

Résumé
Le Paléolithique supérieur est traditionnellement envisagé comme étant en rupture avec le Paléolithique moyen. En effet, comment ne pas voir dans les innovations techniques qui le caractérisent, les parures nombreuses et variées, les pièces d'art mobilier et autres statuettes en ivoire ou les équipements en os et bois de cervidés, les preuves manifestes d'une mutation majeure dans l'histoire de l'évolution de l'Homme. Nous explorons ici la profondeur historique et le sens des principaux changements qui se matérialisent au cours du développement du Paléolithique supérieur en France, depuis l'emblématique Châtelperronien jusqu'à la fin du Gravettien. Sans prétendre à la synthèse, notre objectif est de proposer des explications aux changements techniques et socio-économiques qui prennent place au cours des premiers temps du développement de l'Homme moderne en France.

Zusammenfassung
In unserer Vorstellung ist der Beginn des Jungpaläolithikums (ca. 40.000–10.000 BP) üblicherweise durch einen klaren Bruch zum Mittelpaläolithikum gekennzeichnet. Wie können wir auch nicht, in den zahlreichen und vielgestaltigen Verzierungen, den geformten Steinen, Elfenbeinstatuetten, Knochen-, Geweih- oder Elfenbeingeschossspitzen, Belege sehen für eine signifikante und plötzliche Veränderung in der langen Geschichte der Evolution des Menschen? Wir wollen hier versuchen, die historische Tiefe und evolutionäre Bedeutung der wichtigsten Innovationen zu erforschen, die mit der Entwicklung des modernen Menschen während des frühen Jungpaläolithikums in Frankreich auftreten. Dieses Kapitel liefert damit einen Überblick über den aktuellen Wissensstand zur technischen und sozio-ökonomischen Evolution moderner Jäger und Sammler vom Châtelperronien bis zum Ende des Gravettien. Unser Schwerpunkt liegt demnach auf der Erklärung ökonomischer und sozialer Veränderungen im Zuge der ersten Ausbreitungsphase des modernen Menschen im prähistorischen Frankreich.

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THE PATHOLOGICAL PEOPLE OF DOLNÍ VĚSTONICE AND PLEISTOCENE HUMAN ABNORMALITIES

Erik Trinkaus

Abstract
The Pavlovian sites have yielded several individuals (Dolní Věstonice 3, 11/12, 15, 16) with severe developmental and/or degenerative abnormalities, and they served to focus attention on the high frequency of pathological specimens among Upper Paleolithic burials. A more extensive survey of Pleistocene *Homo*, remains, in the light of the ongoing paleopathology of the human fossil record, documents that serious lesions are surprisingly common among the modest number of known Pleistocene human remains. They include congenital disorders, developmental disruptions, serious trauma, and systemic degenerations. Most abnormalities have secure diagnoses, but several do not appear to have modern equivalents. Although the high frequency of such individuals in the Upper Paleolithic may be due in part to the differential burial of the unusual, their presence throughout the Pleistocene suggests small, demographically unstable and inbred populations, albeit with long-term survival of serious afflictions.

Keywords
Upper Paleolithic, paleopathology, developmental abnormalities, degenerative processes, ambiguous abnormalities

DOI: 10.5817/CZ.MUNI.M210-7781-2015-11

Introduction

Since the discovery in 1986 of the triple human burial at Dolní Věstonice II and the recognition that the middle individual, Dolní Věstonice 15 (Figure 1), was pathological (Klíma 1987), there has been considerable attention devoted to the diagnosis, interpretation and broader implications of the Dolní Věstonice 15 abnormalities (e.g. Vlček 1991; Kuklík 1992; Formicola *et al.* 2001; Trinkaus *et al.* 2001, 2006; Formicola 2007). Moreover, paleopathological analysis of the full

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Pavlovian (Dolní Věstonice and Pavlov) human sample (Trinkaus *et al*. 2006) revealed a long list of abnormalities among these humans (Figure 2). Since that time, there has been continued focus on the pathological specimens from Dolní Věstonice/Pavlov and other Mid Upper Paleolithic sites (e.g., Brno-Francouzská, Sunghir) (Formicola 2007; Trinkaus *et al*. 2014a) and from the Pleistocene in general (see lists in Wu *et al*. 2011, 2013; Martín-Francés 2015). From these considerations, it has become increasingly possible assess these abnormalities and their incidences in a more inclusive context. These considerations raise some questions regarding the social, behavioral and populational dynamics of earlier Upper Paleolithic humans, and Pleistocene members of the genus *Homo* generally.

Pleistocene Human Abnormalities

Even though pathological lesions in Pleistocene human remains were long considered an inconvenience for the "proper" morphological assessment of the remains (but see Bonnet 1919), in recent decades it has become recognized that the natures and incidences of abnormalities on the remains of Pleistocene humans

Figure 1: The triple human burial at Dolní Věstonice II.

Figure 2: Views of the pathological Dolní Věstonice human remains. Left: the Dolní Věstonice 15 skeleton *in situ*, with short femora, abnormal curvature of the femora, right humerus and left ulna, healed fracture of the left radius, pronounced dental hypoplasias and small body size (photo courtesy of J. Svoboda). Above right: Dolní Věstonice 16 with minor cleft palate. Middle right: Dolní Věstonice 3 with post-traumatic facial asymmetry and posterior cranial deformities. Below right: Dolní Věstonice 11/12 with pronounced frontal squamous trauma above the right orbit (photographs by author).

might provide insights into their systemic stress levels, risk of injury, survival, and by extension social behavior (e.g. Ogilvie *et al*. 1989; Berger and Trinkaus 1995; Guatelli-Steinberg *et al*. 2004; Underdown 2006; Formicola 2007; Villotte 2008; Wu *et al*. 2011). There have been a number of paleopathological assessments aimed specifically at the differential diagnosis of lesions and other abnormalities on the skeletal and dental remains (see below), but the majority of the analyses of samples (as opposed to individual specimens) have been concerned with the patterns and levels of the more common lesions. In particular, these abnormalities have involved non-specific systemic stress indicators, trauma, osteoarthritis, and dental caries. Yet, there has been a number of distinctly abnormal individuals described from the human fossil record, such as Dolní Věstonice 15, and it is possible that they can provide insights beyond their individual lesions.

The unusual lesions largely fall into three categories: developmental, degenerative and ambiguous. The first category includes mostly congenital deformations and early childhood major insults. The second category involves marked degenerations and serious trauma affecting function. The last groups are those that defy satisfactory diagnosis but are clearly abnormal and likely affected function.

Developmental Abnormalities

The Pleistocene humans with developmental abnormalities can be largely separated into those that appear to have been congenital (whether genetic or the result of prenatal/perinatal insults) and those that arose during development.

The former conditions include the Early Pleistocene *amelogenesis imperfecta* of Garba 4 (Zilberman *et al*. 2004). From the Middle Pleistocene there is the probable *torticollis* of Salé 1, the unilateral labyrinthine ossification and premature parietal suture synostosis of Singa 1, and the unilateral lambdoidal synostosis of Atapuerca-SH cr14 (Hublin 1991; Spoor *et al*. 1998; Gracia *et al*. 2009). Among Late Pleistocene archaic humans, there is the enlarged parietal foramen of Xujiayao 11, the pelvic asymmetry of Regourdou 1, the irregular formation of the caudal vertebral column of Kebara 2, and the craniofacial developmental delays of Pech-de-l'Azé 1 (Patte 1957; Duday and Arensburg 1991; Meyer 2013; Wu *et al*. 2013).

Among MIS 5 modern humans, Qafzeh 12 had hydrocephaly (Tillier *et al*. 2001). Earlier Upper Paleolithic (MIS 3) modern human cases include the abnormally short femora of Nazlet Khater 2, the unilateral labyrinthine ossification of Mladeč 2, the arm asymmetry of Barma Grande 2, the systemic dysplasia of Dolní Věstonice 15, the abnormally short and bowed femora of Sunghir 3, the congenital calcaneonavicular coalition in Bausu da Ture 1, the minor cleft palate of Dolní Věstonice 16, the delayed fontanelle closure and dental abnormalities of Mal'ta 1, and possibly the posterior neurocranial deformities of Dolní Věstonice 3 (Churchill and Formicola 1997; Alekseev 1998; Teschler-Nicola *et al*. 2006; Trinkaus *et al*. 2006; Crevecoeur 2008; Villotte *et al*. 2011; Trinkaus *et al*. 2014a). In the Late Upper Paleolithic there are the chondrodystrophic dwarfism of Romito 2, the macrocranium with a large cranial lacuna and dental dysmorphic lesions of Rochereil 1,

and the X-linked hypophosphatemic rickets of Arene Candide 3 (Frayer *et al*. 1988; Formicola 1995; Mafart *et al*. 2007).

Most of these abnormalities are likely to have been congenital, whether the individual died in childhood or made it adulthood. Some of the abnormalities may have been acquired later in development. To these specimens can perhaps be added the massive porotic hyperostosis of the Middle Pleistocene Eliye Springs ES-11693 and the curious lack of dental wear and masticatory muscle development in the MIS 3 Sunghir 2 (Bräuer *et al*. 2003; Trinkaus *et al*. 2014a). There are also osteolytic lesions in Sunghir 2 and the Zeeland Ridges 1 Neandertal, both of developmental origin (Buzhilova 2000a; Hublin *et al*. 2009). To these unusual aspects can possibly be added the exceptional clavicular lengths of Sunghir 1 (Trinkaus *et al*. 2014b).

Degenerative Abnormalities

Various serious degenerative conditions are evident in the mature and a few immature human remains. Most of them developed in adulthood, but some may well have occurred during development but the individual persisted into adulthood.

Systemic periostitis developed in the Early Pleistocene KNM-ER 1808 and the MIS 3 Brno-Francouzská 2 (Walker *et al*. 1982; Schultz and Nováček 2005). The Shanidar 1 and probably the Kiik-Koba 1 Neandertals developed diffuse idiopathic skeletal hyperostosis (DISH) (Crubézy and Trinkaus 1992; Trinkaus *et al*. 2008). The Middle Pleistocene Atapuerca-SH pelvis 1, the La Chapelle-aux-Saints 1 and Shanidar 3 Neandertals, and the MIS 3 Nazlet Khater 2 exhibit advanced axial degenerations (Dawson and Trinkaus 1997; Ogilvie *et al*. 1998; Bonmatí *et al*. 2010; Crevecoeur and Villotte 2006). The Feldhofer 1 and Shanidar 1 late archaic humans and the MIS 2 Oberkassel 1 sustained arm trauma sufficient to produce marked ipsilateral atrophy and/or contralateral hypertrophy (Bonnet 1919; Trinkaus 1983; Trinkaus *et al*. 1994). The La Ferrassie 1 Neandertal developed hypertrophic pulmonary osteoarthropy (HPO) (Fennell and Trinkaus 1997). The Middle Pleistocene Broken Hill (Kabwe) 1 exhibits a temporal infection and/or tumor in addition to his massive carious lesions (Montgomery *et al*. 1994; Lacy 2014). Osteolytic lesions are also present in the Guattari 2, Krapina 120.71 and Mezzena 1 late archaic humans (Colella *et al*. 2012; Condemi *et al*. 2012; Monge *et al*. 2013).

In addition, the Krapina 34.7 and Maba 1 late archaic humans and the Qafzeh 11 and Dolní Věstonice 11/12 early modern humans received depressed cranial vault fractures, the Krapina and Qafzeh ones during immature life (Tillier 1999; Mann and Monge 2006; Trinkaus *et al*. 2006; Wu *et al*. 2011). Dolní Věstonice 3 and Shanidar 1 sustained major fractures to portions of the facial skeleton, and the early Middle Pleistocene Hulu/Nanjing 1 developed a massive external frontal lesion, from burning or scalp trauma (Trinkaus 1983; Trinkaus *et al*. 2006; Shang and Trinkaus 2008). Finally, Dmanisi D3444/D3900, Aubesier 11, La Chalelle-aux-Saints 1 and Zhiren 3, from the Early, Middle and Late Pleistocene respectively, have extensive dentoalveolar lesions, associated with antemortem tooth loss, alveolar resorption

and extensive evidence of infection; the last may have been associated with *dens evaginatus* (Trinkaus 1985; Lebel and Trinkaus 2002; Lordkipanidze *et al*. 2005; Lacy *et al*. 2012).

Ambiguous Abnormalities

In addition to these conditions, most of which are readily diagnosable, the early modern Tianyuan 1 skeleton exhibits bilateral distal femoral crests of unknown etiology with associated tibial degenerations, the MIS 3 Cro-Magnon 1 remains have multiple subperiosteal lesions of uncertain etiology, and the Dmanisi D3444/D3900 cranium and mandible possess extensive external bony growths along with its pronounced antemortem tooth loss (Dastugue 1967; Lordkipanidze *et al*. 2005; Shang and Trinkaus 2010). There are also biomechanical disproportions in the Berg Aukas 1 probably Middle Pleistocene femur (Trinkaus *et al*. 1999). Moreover, several of the above mentioned remains, especially Dolní Věstonice 15, Pech-de-l'Azé 1, Mal'ta 1, Rochereil 1 and Sunghir 3 have general or largely descriptive diagnoses, but their actual conditions beg for more explicit etiologies. It may be possible to arrive at more precise or secure diagnoses for some of these specimens, but some of the lesions (especially those of Sunghir 3 and Tianyuan 1) appear to be unknown to current clinical practice.

Discussion

This inventory of Pleistocene human remains with serious and/or rare abnormalities should be largely inclusive. Yet, the lack of detailed paleopathological analyses of a number of Pleistocene human skeletal remains, especially for the more complete and numerous ones from the Late Pleistocene, means that it may not include some pathological specimens. Although many of these abnormalities are obvious on inspection, others have come to light only through careful reassessment of the remains in their Pleistocene contexts. Indeed, a number of the diagnoses come from recent paleopathological analyses of fossils known for decades. The inventory also does not include the widespread minor traumatic lesions and osteoarthritic degenerations. Nonetheless, they raise several issues.

Social, Behavioral and Demographic Concerns

Formicola (2007) suggested that the high frequency of unusual individuals in Upper Paleolithic burials, especially from some of the more elaborate internments, may reflect a prominent social status for those individuals. Similar arguments had been made previously for the Brno-Francouzská and Sunghir remains (Oliva 1996a; Buzhilova 2000b), and parallel comments have been made regarding Sunghir 1 and his manner of death (Trinkaus and Buzhilova 2012). One could therefore argue that Formicola (2007) understated his case by emphasizing only Dolní Věstonice 15, Romito 2 and Sunghir 3. Certainly, the extreme richness and unusual nature of at

least the Sunghir 2 and 3 burials (Bader 1998; Trinkaus *et al*. 2014a), as well as the multiple individuals in these three internments (Bader 1998; Bachechi and Martini 2002; Svoboda 2006a), argues for special treatment.

Yet, one may put a different perspective on the frequent encounters of abnormal individuals in Upper Paleolithic burials if they are placed in a broader Pleistocene human context. There are developmentally and degeneratively unusual individuals from Early Pleistocene *Homo*, and they appear relatively continuously through the Pleistocene as more complete specimens become known and/or the more fragmentary fossils are investigated from a paleopathological (as well as morphological) perspective. When put into this context (Wu *et al*. 2013), the presence of rare or otherwise unknown conditions in the Upper Paleolithic burials of Europe becomes less exceptional. It appears largely to follow the pattern evident in Early, Middle and earlier Late Pleistocene contexts.

The frequencies of a few of these conditions are known in modern clinical contexts (Gracia *et al*. 2009; Wu *et al*. 2013; Zilberman *et al*. 2004). Comparing those frequencies to the number of fossils, those known from the approximate time period of the abnormal specimen and preserving the altered anatomical region, makes the probability of finding such a case exceedingly small. It is not possible to place precise numbers on the incidences of these conditions (alone or collectively) among Pleistocene humans, but the impression is very much one of a substantially elevated overall frequency.

One possible reason for this occurrence of serious abnormalities would be an elevated risk (compared to recent humans) of trauma injuries and musculoskeletal degeneration from their challenging existence as foragers. This could account for the traumatic injuries, including minor ones not listed here (cf. Wu *et al*. 2011; Wu and Trinkaus 2015), as well as the frequent occurrences of axial and appendicular osteoarthritis, some of which was post-traumatic (Trinkaus 1983, 1985; Dawson and Trinkaus 1997; Trinkaus *et al*. 2006).

An additional reason would relate to the probably small and unstable populations of these Pleistocene foraging peoples, which is reflected in their mortality profiles (Trinkaus 1995, 2011; Streeter *et al*. 2001) and ephemeral cultural innovations (Hovers and Belfer-Cohen 2006). Should these populations have also been isolated and inbred, it may explain the elevated appearance of unusual congenital conditions, as well as their disappearance from the populations. It remains unclear, and probably untestable, to what extent these populations were inbred, but close genetic relationships have been suggested for one Neandertal sample (Lalueza-Fox *et al*. 2011) and for some Upper Paleolithic burial groups (Alt *et al*. 1997; Buzhilova 2000b; Villotte *et al*. 2011).

Issues of Survival

In addition to these factors, it should be apparent that almost of these mentioned individuals survived the insults to their development and/or well-being, in some cases for substantial periods of time. Consequently, from the Early Pleistocene

onwards, there is evidence of substantial survival of serious conditions. It has been suggested that it was the result of social support of the afflicted individuals (Lebel and Trinkaus 2002; Lordkipanidze *et al*. 2005), although the degree of support that would have been required for their survival remains unclear and would require knowledge of the systemic effects of the documented abnormalities. Yet, the substantial level of survival evident in these remains would serve to increase their incidence in the fossil record, although not with respect to samples of sedentary and especially urban recent humans.

Summary

These alternative scenarios are not mutually exclusive. Yet, except for the differential burial of the unusual explanation (which relates only to the Late Pleistocene), they could combine throughout the Pleistocene to produce the perceived pattern. Together they (and perhaps other processes) produced an abnormally abnormal sample of human remains from the Pleistocene (at least from a Holocene perspective).

Conclusion

The human remains from Dolní Věstonice, and especially those of Dolní Věstonice 3, 15 and 16, form part of the increasingly documented sample of developmentally and/or degeneratively afflicted human remains from the Pleistocene. The list of such specimens continues to grow, and the frequency of such specimens appears to be elevated throughout the Pleistocene. Although abnormal individuals may appear commonly in the Upper Paleolithic as a result of differential burial of the unusual (and more complete preservation), several factors (inbred unstable populations, high risk of trauma, and substantial survival) combined to produce the pathological nature of human fossil record.

Acknowledgements
Two decades ago (already!) Jiří Svoboda invited me to do “something interesting” with the human remains from Dolní Věstonice and Pavlov, which started a long term collaboration on those Pavlovian humans and their contexts, resulting in two monographs and a number of articles. It also drew me away from the Neandertals to the paleobiology of Upper Paleolithic humans and to working with such human fossils across Eurasia. In retrospect, I am immensely grateful for that initial invitation. The thoughts expressed here therefore are in part an outgrowth of that work with the Dolní Věstonice and Pavlov human remains, yet another sample of Pleistocene humans with a surfeit of unusual features.

Résumé
Les sites pavloviens de Dolní Věstonice et Pavlov ont livré plusieurs restes humains (Dolní Věstonice 3, 11/12, 15, 16) présentant des anomalies du développement et/ou des anomalies dégénératives graves, et ils ont attiré l'attention sur la fréquence élevée de

spécimens pathologiques dans les sépultures du Paléolithique supérieur. Une étude plus vaste des restes d'*Homo* au Pléistocène, à la lumière des études en cours sur la paléopathologie des fossiles humains, documente le fait que les lésions graves sont étonnamment courantes au sein du modeste échantillon de restes humains connus du Pléistocène. Ces lésions comprennent les malformations congénitales, les perturbations du développement, les traumatismes graves et les dégénérescences systémiques. La plupart de ces anomalies sont diagnostiquées avec sureté, mais plusieurs d'entre elles ne semblent pas avoir d'équivalents modernes. La fréquence élevée de ces individus présentant des pathologies au Paléolithique supérieur peut être en partie due à l'inhumation différentielle d'individus « inhabituels ». Leur existence attestée tout au long du Pléistocène suggère des populations de petites dimensions, démographiquement instables et présentant de consanguinité, qui permettaient à long terme la survie des individus aux maladies graves.

Zusammenfassung

Die Pawlowschen Ausgrabungsstätten enthielten mehrere Individuen (Dolní Věstonice 3, 11/12, 15, 16) mit schweren Entwicklungsstörungen und/oder degenerativen Erkrankungen und diese lenken die Aufmerksamkeit auf die hohe Zahl von Jungpaläolithikern mit pathologischen Veränderungen. Ein umfangreicherer Überblick der pleistozänen *Homo*-Überreste im Rahmen der paläopathologischen Erforschung menschlicher Fossilfunde zeigt, dass unter der bescheidenen Anzahl von bekannten pleistozänen menschlichen Fossilresten ernsthafte Läsionen erstaunlich häufig vorkommen. Die Liste umfasst kongenitale Anomalien, Entwicklungsstörungen, schwere Traumata und systemische Degenerationen. Viele Erkrankungen haben gesicherte Diagnosen, aber bei einigen scheinen moderne Entsprechungen zu fehlen. Es wäre möglich, dass die hohe Zahl von Personen mit krankhaften Veränderungen im Jungpaläolithikum auf einer bevorzugten Bestattug von ungewöhnlichen Individuen beruht, ihre Präsenz während des gesamten Pleistozäns lässt jedoch vermuten, dass kleine, demographisch instabile und nahe verwandte Populationen vorlagen, die aber gute Langzeitüberlebenschancen für Schwererkrankte boten.

RÉFLEXION AUTOUR DES INDUSTRIES GRAVETTIENNES « POST-PAVLOVIENNES » DE SLOVAQUIE OCCIDENTALE ET DE MORAVIE (25,500/24,500–22,000 BP NON CALIBRÉ)

Michaela Polanská[1, 2] et Bibiána Hromadová[3]

Résumé
Le Gravettien supérieur du centre d'Europe centrale se résume souvent à la reconnaissance et l'indentification des fossiles directeurs lithiques « douteux » comme les pointes à cran et les couteaux de Kostienki. Les nouveaux moyens (analyses technologiques des systèmes techniques des productions) démontrent l'hétérogénéité des collections et permettent de discuter la prétendue homogénéité des industries datés entre 25/24,500–22,000 BP non calibré.

Mots clés
Gravettien supérieur, Willendorf-Kostienkien, L'Horizon à pointes à cran, Pointes à cran, Couteaux de Kostienki

DOI: 10.5817/CZ.MUNI.M210-7781-2015-12

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Introduction

Le Gravettien du cœur de l'Europe centrale (en particulier en Moravie, République Tchèque) est essentiellement connu pour le Pavlovien dont les sites ont souvent livrés des découvertes spectaculaires (sépultures, art mobilier abondant, figurines en terre cuite, industrie riche en MDA, accumulation d'ossements de mammouth etc.). Si cette phase moyenne du Gravettien est très célèbre en Moravie et en Basse Autriche, en comparaison, la phase plus récente nommée Gravettien supérieur/récent[1] (25,500/24,500–22,000 BP non calibré), reste dans son ombre. Il faut signaler que cette phase récente semble pour l'heure posséder une extension géographique plus

[1] « *mladý gravettien* » en slovaque.

large que la phase pavlovienne puisqu'on la rencontre aussi bien en Moravie qu'en Slovaquie occidentale, et peut-être également dans quelques sites limitrophes en Autriche et en Pologne. Cependant, malgré plusieurs publications et certaines particularités non moins spectaculaires (présence des vénus, structures de combustion complexes, accumulations d'ossements de mammouth (*e. g.* Bárta 1988; Hromada 1998), ces sites demeurent moins connus. En dépit de ce fait, la présence de pointes à cran, de couteaux de Kostienki, l'importation des matières premières siliceuses de Pologne (*e. g.* Hromada 2000; Kaminská 2004; Kaminská et Kozłowski 2011; Kozłowski 1996; Sobczyk 1995; Svoboda 1996; Terberger 2013) ont souvent été présentés comme des traits caractéristiques des sites de cette phase. Toutefois, ces éléments, promus au rang de « fossiles directeurs », sont de valeur inégale et parfois insuffisamment caractérisés ou interprétés, ils peuvent freiner la caractérisation des assemblages voir conduire à des malentendus (*e. g.* Klaric *et al.* sous presse; Polanská thèse en cours; Polanská et Michalík soumis). De nouvelles approches technologiques des collections lithiques (Polanská 2009) adossées à des révisions critiques des contextes de découverte et/ou à l'étude approfondie des restes de faune (Brugère 2009; Vlačiky *et al.* 2013b) peuvent heureusement apporter de nouveaux points de vue sur cette tranche chronologique de la fin du Paléolithique supérieur ancien.

L'objectif de cet article est donc de présenter un petit état des lieux des questionnements sur cette phase post-pavlovienne essentiellement à travers une série d'observations pratiquées sur des collections slovaques et moraves ré-examinées récemment (figure 1) : Moravany-Lopata II, Moravany-Noviny, Moravany-Žakovská, Trenčianske Bohuslavice-Pod Tureckom (vallée du Váh, Slovaquie), Milovice I (secteur G et H) et Petřkovice I (Moravie, République Tchèque).

Cadre géographique et écologique des sites « post-pavloviens » de Moravie et de Slovaquie occidentale

Territoire concerné

Les réflexions sur le découpage chronologique du Paléolithique supérieur d'Europe centrale posent inévitablement le problème de la définition du territoire concerné.

La plupart des grandes tentatives de réflexions sur la chronologie du Gravettien à l'échelle de l'Europe centrale[2] se sont souvent heurtées à des obstacles liés à la géographie complexe de ces territoires et à l'hétérogénéité des informations disponibles (Kozłowski 1986; Otte 1981; Otte et Noiret 2004; Noiret 2013). En revanche, les industries peuvent être examinées du point de vue macro-régional. La plupart de ce genre de synthèses concerne plutôt les régions du cœur de l'Europe centrale comme la Moravie, la Slovaquie occidentale, le Sud de Pologne et la Basse Autriche (*e. g.* Svoboda 1996).

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[2] Soit l'est de l'Allemagne, l'Autriche, la République tchèque, la Slovaquie et la Pologne, l'ouest de l'Ukraine et Hongrie.

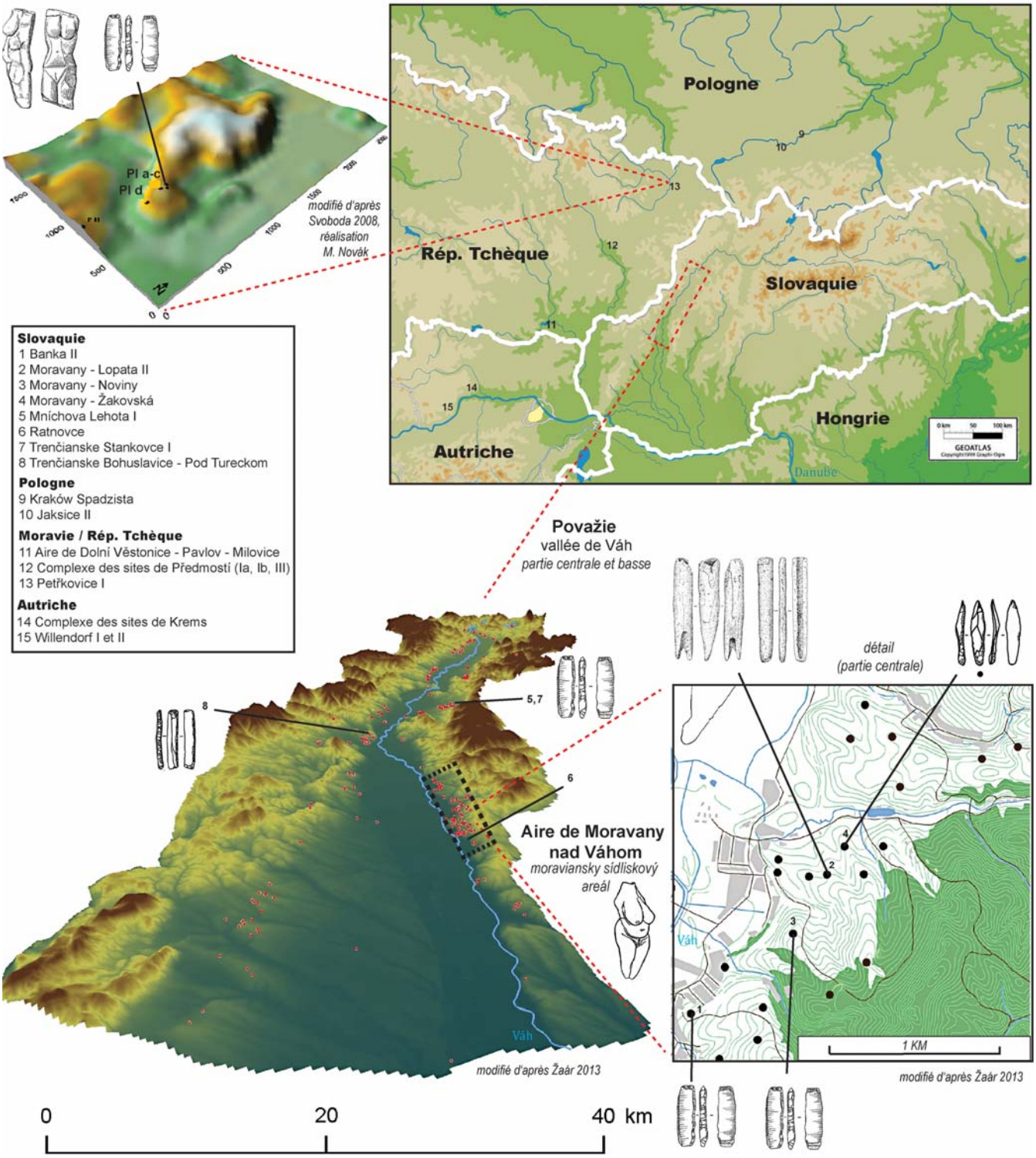

Figure 1 : Principaux sites post-pavloviens du cœur de l'Europe centrale mentionnés dans le texte (DAO M. Polanská).

Si l'on considère ces différentes zones dans leur ensemble, le territoire auquel elles correspondent est plutôt bien délimité et se situe globalement entre les Alpes et l'aile occidentale des Carpates. Il est composé par différents obstacles représentés par des chaines de montagnes et par des vallées qui constituent des axes de passages ou des zones de refuges naturelles (voir Kaminská 2004; Oliva 2007; Svoboda 2006b).

Un tel paysage peut être décrit comme une mosaïque de microrégions, qui furent occupées par divers groupes humains au fil du temps (*e. g.* Svoboda 2006b; Oliva 2007; Hromadová et Polanská étude en cours). D'après les informations disponibles, les occupations gravettiennes semblent avoir entretenu des liens étroits avec leur environnement naturel, en développant des stratégies d'installation particulières adaptées à la diversité des écosystèmes qui sont loin d'être uniformes (*e. g.* Oliva 2007).

Environnement naturel, stratégies d'installation et diversité des écosystèmes

Les questions palécologiques ainsi que les choix habituels d'installation, la stratégie d'implantation et l'adaptation à l'espace et au relief par les groupes, tiennent un rôle important dans l'étude et le questionnement sur les occupations gravettiennes (surtout pavloviennes) d'Europe centrale (Oliva 2002, 2007; Svoboda 1995). Pour certains chercheurs, l'occupation répétitive des mêmes endroits par des groupes à traditions typologiques comparables indique une forme de perduration culturelle plus forte que d'autres traits de la culture matérielle (en l'occurrence l'industrie lithique; Oliva 2007, p. 147). C'est dans cette idée que le terme de « paysage gravettien[3]» a été proposé (Svoboda *et al.* 2009, p. 176). Cette expression soutient l'idée que l'occupation des endroits stratégiques avait pour but de contrôler les vallées des rivières[4]. Des stratégies d'installation comparables ont d'ailleurs à plusieurs reprises été signalées dans les autres microrégions à occupations pavloviennes (à titre d'exemple la microrégion d'Uherské Hradište; Škrdla 2004). Cependant, les sites post-pavloviens de Považie[5] (Slovaquie occidentale) suggèrent la possibilité d'une autre stratégie et dynamique d'installation (Kaminská *et al*. 2008). En effet, dans l'Aire de Moravany nad Váhom (Slovaquie occidentale), les mêmes endroits seraient occupés par les porteurs de différentes traditions culturelles en raison de la présence des sources géothermales naturelles (Ambrož *et al*. 1952; Hromada 1998; Hromadová et Polanská étude en cours). Cette préférence d'installation n'est pour autant pas complètement originale puisqu'elle a également été constatée en Russie pour des sites de « traditions gravettoïdes » autour du LGM (Praslov et Rogachev 1982; Sinicyn 2006; Gvozdover 1998; Amirchanov 1998).

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3 Il s'agit de la traduction du terme tchèque « gravettská krajina ».

4 Il faut toutefois signaler quelques exceptions comme les sites Milovice I et IV qui semblent échapper à cette règle (Svoboda *et al*. 2011).

5 Považie est le terme slovaque pour désigner la vallée de Váh.

Position chronologique des industries post-pavloviennes de Moravie et de Slovaquie occidentale et questions de terminologie

Depuis quelques années, le modèle chronologique de la subdivision du Gravettien du cœur de l'Europe centrale (en Pavlovien et Willendorf-Kostienkien) est petit à petit remis en question avec l'avancement des recherches et les nouveaux moyens d'étude (entre autres Moreau 2012b; Polanská 2011, 2013; figure 2).

Pour résumer, il existerait un Gravettien ancien, documenté en Jura Souabe (Allemagne; *e. g.* Conard et Moreau 2004), probablement en Autriche à Willendorf II – couche 5 (Moreau 2012b) et peut-être en Moravie[6]. Ensuite, la majorité des sites moraves[7] datés de 28,000/27,500–25,500 BP non calibré correspondent à des industries à microscies ou à microlithes géométriques du Pavlovien que l'on peut classer par défaut dans « Gravettien moyen » (Polanská 2011, 2013, thèse en cours).[8] D'autres séries, souvent anciennement fouillées restent sujets à questions (Willendorf II les couches 7 à 8 etc.).

Après le Pavlovien, viennent quelques industries originales (datées approximativement entre 25,500–24,500 BP non calibré), comme celles de Milovice I secteur (G+H) ou de Dolní Věstonice III (Škrdla *et al*. 1996). Celles-ci, situées stratigraphiquement et chronologiquement à la charnière entre le Gravettien moyen (Pavlovien) et le Gravettien supérieur (classiquement appelé « Horizon à pointes à cran » ou « Willendorf-Kostienkien », cf. *infra*). Ces sites ont livré des ensembles aux caractéristiques typo-technologiques particulières qui ne permettent pas pour le moment leur rattachement à l'une ou l'autre des phases (Polanská thèse en cours).

Viennent enfin les industries du Gravettien supérieur qui présentent une assez forte hétérogénéité, qui a besoin d'être éclaircie (globalement datées entre 25,500/24,500 et 22,000 BP non calibré). A ce jour, plusieurs termes sont employés par différents chercheurs pour désigner et décrire les différentes phases du Gravettien d'Europe centrale, ce qui peut mener à quelques confusions. Les synonymes du Gravettien supérieur ou récent (appellation générique) sont « l'Horizon à pointes à cran », le « Willendorf-Kostienkien », ou encore plus rarement le « Kostienkien » (terme ancien très peu utilisé de nos jours). Enfin, plus récemment le terme de « stade 3 » a été proposé par M. Otte et P. Noiret (Otte et Noiret 2004). Toutes ces appellations sous-entendent des liens entre les industries d'Europe centrale et celles de la Plaine russe. D'après les différents auteurs, la présence de pointes à cran, de couteaux de Kostienki, de vénus en sont les indices majeurs. A ce jour, c'est sans doute le terme

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[6] Nous sommes en attente de la publication de nouvelles datations provenant des investigations de terrain à Pavlov I (en 2013) et Dolní Věstonice IIa (en 2012), menées par l'équipe de J. Svoboda. Les anciennes datations de Dolní Věstonice I et Dolní Věstonice II proviennent pour certaines des couches stériles et pour les autres nous parait impossible de les mettre en lien avec les découvertes archéologiques de manière certaine.

[7] y compris le complexe des sites de Krems en Autriche.

[8] Il est possible qu'existent parallèlement d'autres composantes industrielles (à réexaminer et à définir) comme celles d'Aggsbach, d'Alberndorf ou Grub-Kranawetberg (plusieurs niveaux gravettiens, communication personnelle W. Antl-Weiser).

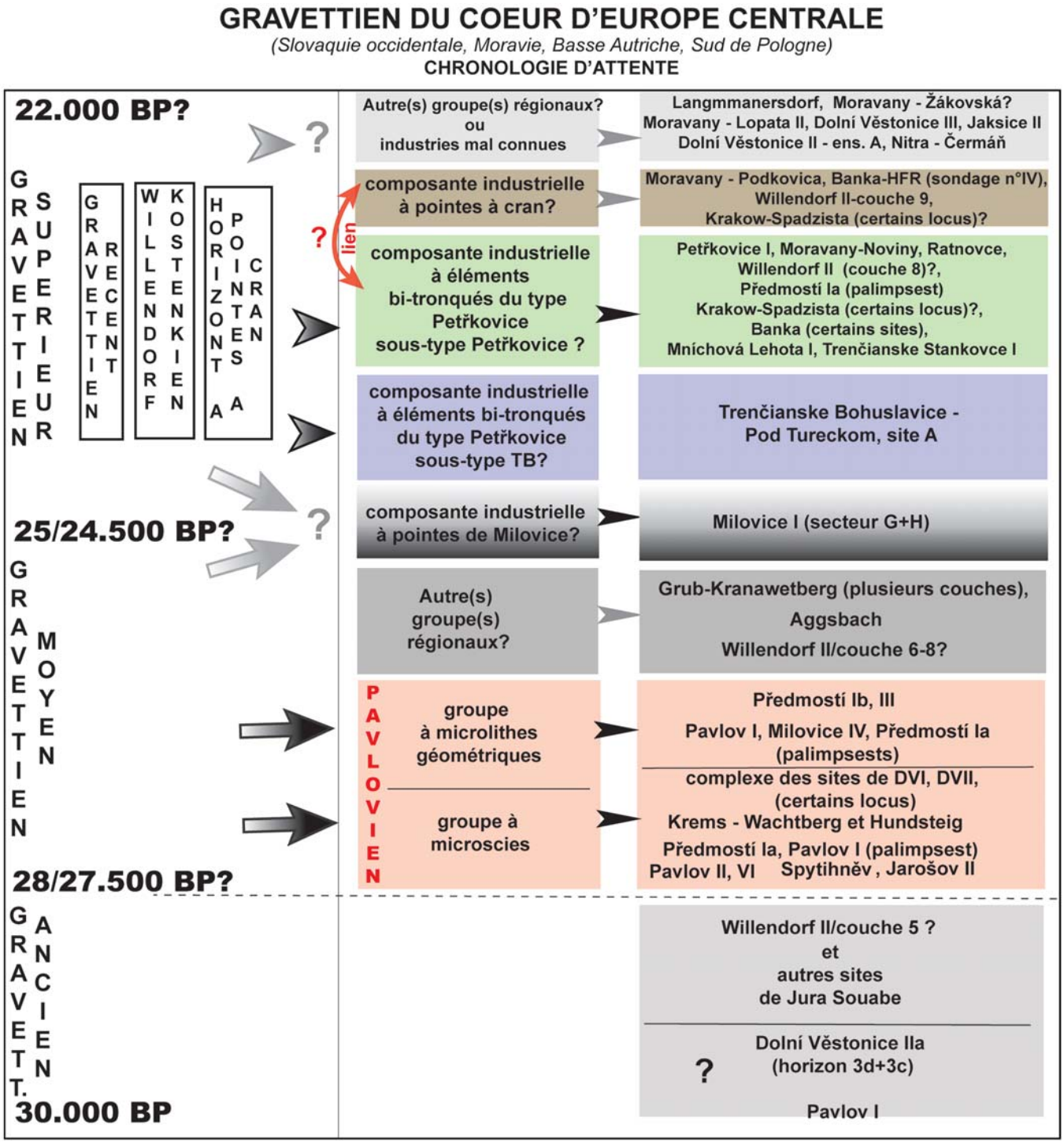

Figure 2 : Chronologie d'attente du Gravettien du cœur d'Europe centrale.

« Willendorf-Kostienkien » qui est le plus utilisé. Nous rappelons que cette notion, fait référence à la « *culture/unityWillendorf-Kostienki* », terme proposé par les chercheurs russes (Grigoriev 1966; Gvozdover 1998) et repris (pas toujours dans le même esprit cependant) par plusieurs auteurs d'Europe centrale (*e. g.* Klíma 1959; Kozłowski 1969). Le but de celui-ci avait été de souligner le nouveau cadre culturel et géographique, matérialisé par les changements observés dans la phase plus récente du Gravettien d'Europe centrale et orientale (*ibid.).* De la même manière que le terme Pavlovien, celui d'*unity Willendorf-Kostienki* a connu une évolution et est aujourd'hui compris différemment en Russie (pour un aperçu voir Anikovich 1998; Gvozdover 1998; Gavrilov 2008) et en Europe centrale (*e. g.* Svoboda 2003).

Notre but n'est ni d'entrer dans la justification ou le refus de ces analogies entre Europe orientale et centrale, ni dans la justification d'emploi d'un de ces termes pour désigner le Gravettien supérieur d'Europe centrale, mais d'attirer l'attention sur la diversité des industries englobées sous ce terme.

Toutefois, au vu des éléments que nous allons présenter, le fondement de telles analogies doit se baser sur des éléments plus approfondis.

Etat des recherches: entre révision des principaux « fossiles directeurs » et hétérogénéité des industries

Les connaissances ainsi que les études sur les industries[9] du Gravettien supérieur d'Europe centrale restent largement basées sur la reconnaissance des « fossiles directeurs » et de certains traits techniques des assemblages: les pointes à cran et les couteaux de Kostienki, la prédominance des burins, présence des pièces à bord abattu etc. (*e. g.* Kozłowski 1996, 2008; Svoboda 2006b). Dans la majorité des cas, l'essentiel des arguments reposent sur la présence de deux fossiles directeurs et l'importation des matières premières siliceuses provenant de Pologne, l'industrie en MDA n'est souvent même pas mentionnée.

Les pointes à cran et les couteaux de Kostienki sont-ils de bons fossiles directeurs du Gravettien supérieur d'Europe centrale?

Les pointes à cran

Comme nous l'avons déjà souligné, les fossiles directeurs classiquement avancés comme typique du Gravettien supérieur d'Europe centrale sont les couteaux de Kostienki et les pointes à cran (Hromada 1998; Kozłowski 1969, 1996, 2008; Svoboda 1996). Or, ces artefacts sont-ils vraiment des fossiles directeurs fiables et sont-ils identifiés de manière pertinente dans les collections? Pour J. K. Kozłowski, qui est l'un des chercheurs qui a le plus travaillé sur l'identification « des éléments kostienkiens » dans les industries d'Europe centrale, les pointes à cran sont des

[9] Nous rappelons que l'industrie en MDA et très rarement conservée sur ces sites.

éléments emblématiques et innovateurs qui combinent les caractéristiques fonctionnelles et stylistiques qui justifie l'expression « d'Horizon à pointes à cran » (Kozłowski 1969, 1986, 1996, 2008): « *Shouldered points were certainly innovative with their combination of stylistic and functional characteristics and they became a stable component of the Gravettian tools kit repertoire, defining the late horizon of this complex* » (Kozłowski 2008, p. 181–182). Il faut toutefois noter que ces artefacts sont généralement qualifiés de versions atypiques des pièces de la culture Kostienki-Avdeevo (entre autres Kozłowski 2008). Au contraire de nos prédécesseurs, nous pensons que, dans le cas du Gravettien récent d'Europe centrale, leur identification reste problématique. D'une part parce que la majorité de ces artefacts provient de contextes dont l'intégrité est discutable ou impossible à évaluer (fouilles anciennes, ramassage de surface), et d'autre part car leur identification reste purement « morphologique » (présence ou absence d'un cran). Le problème d'une identification simpliste de ce genre est qu'elle ne prend pas en compte le stade de façonnage et d'abandon des artefacts. Toute pièce entière ou fragmentée est alors considérée comme un « objet fini et intentionnel » qui acquiert alors un poids considérable dans l'attribution chrono-culturelle. Or dans de nombreuses industries à pointes à dos du Gravettien occidental, il a pu être montré que des déchets/ratages éventuels accompagnent souvent le façonnage des artefacts à dos ou bord abattus [10] (déchets de fabrication, pièces cassées ou abandonnés au cours de retouche du fait d'un défaut rédhibitoire dans l'abattage du dos, etc.). Si de tels cas de figure laissent planer une ambiguïté, cela n'implique pas forcément que les pointes à cran identifiées dans les industries post-pavloviennes n'en soient forcément pas[11]. Cependant, en réexaminant les séries plus fiables et homogènes avec un nombre élevé d'armes ou armatures de chasse, comme celles de Milovice I (secteur G et H), il nous semble que, sur ce site au moins, il s'agisse de pièces abandonnées en cours de fabrication[12] (figure 3). En élargissant l'examen à d'autres collections, il nous semble que quelques pièces inachevées et rares, sont effectivement présentes dans toutes les industries à pointes à dos de la région (qu'il s'agisse des industries post-pavloviennes ou pavloviennes d'ailleurs). A titre d'exemple, le site de Dolní Věstonice II (rattaché aux industries à microscies du Pavlovien) a livré quelques exemplaires de ce genre mais, selon nous, il s'agit bien d'ébauches défectueuses de microgravettes du sous-type Dolní Věstonice (Polanská thèse en cours; figure 3 : 2, 5–6). L'abattage peu s'arrêter pour différentes raisons et notamment à cause d'imperfection dans la matière première qui ne permettent plus le façonnage. Il est fréquent que le bord

[10] On évoquera ici les pièces à dos gibbeux très irrégulières, les fragments proximaux ou distaux à cran correspondant à une facture simple en cours de façonnage, etc.

[11] Pour s'en convaincre on peut s'appuyer sur les observations minutieuses d'A. Simonet à Brassempouy et Isturitz ou certaines pièces à cran sont finalement interprétées comme des déchets tandis que d'autres semblent bien être des objets intentionnels et finis (*cf*. Simonet 2010, 2012).

[12] Ces pièces avaient été auparavant interprétées comme des pointes à cran du type méditerranéennes (Oliva 2007).

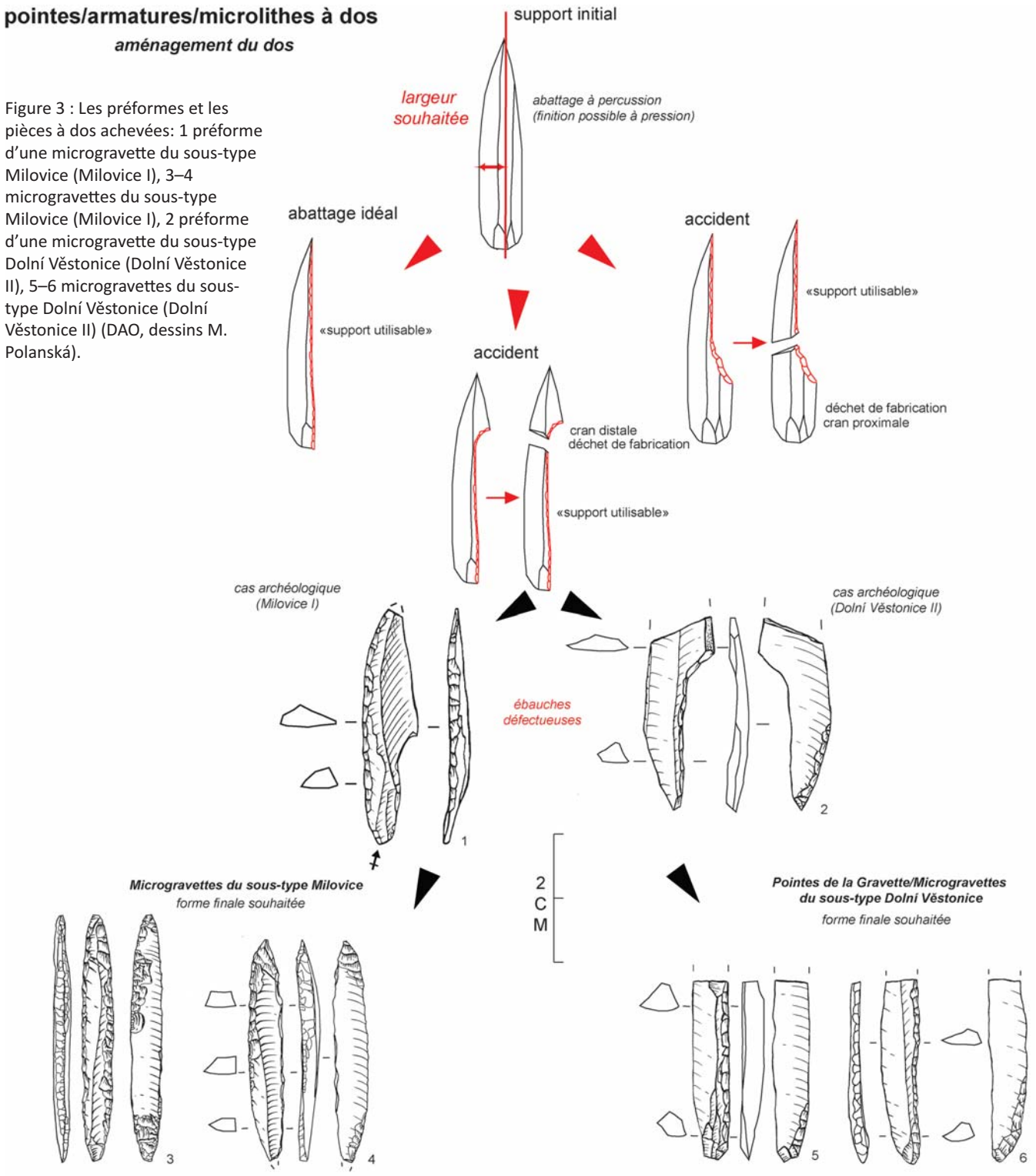

Figure 3 : Les préformes et les pièces à dos achevées: 1 préforme d'une microgravette du sous-type Milovice (Milovice I), 3–4 microgravettes du sous-type Milovice (Milovice I), 2 préforme d'une microgravette du sous-type Dolní Věstonice (Dolní Věstonice II), 5–6 microgravettes du sous-type Dolní Věstonice (Dolní Věstonice II) (DAO, dessins M. Polanská).

opposé au dos soit aménagé en premier pour rectifier la courbure du profil[13] (Polanská thèse en cours). Pour cette raison, les études restent encore à approfondir et les prétendues pointes à cran d'Europe centrale et leurs systèmes techniques de production ont besoin d'une révision critique.

Les couteaux de Kostienki

Une étude récente sur les couteaux de Kostienki de sites russes (Kostienki I et Zaraysk) a bien rappelé et démontré technologiquement que ces artefacts s'inscrivent dans un procédé de raffutage des bords de lames utilisées comme couteaux (*e. g.* Lev *et al.* 2009 et 2012; Klaric *et al.* sous presse). Ce point de vue et cette nouvelle caractérisation technologique nous porte à penser qu'un réexamen des artefacts anciennement publiés comme tels en Europe centrale est vraiment nécessaire. Il faut se souvenir que les travaux anciens sur ces artefacts se sont appuyés sur les études de J. K. Kozłowski, qui portaient principalement sur les morphologies des extrémités de ces objets (entre autres Kozłowski 1969). Or, nos propres observations nous portent à penser que de véritables couteaux de Kostienki sont aujourd'hui bien attestés en Moravie mais uniquement dans le groupe à microlithes géométriques du Pavlovien dans le complexe des sites de Předmostí et à Pavlov I (Polanská 2013 thèse en cours). Ces premières réévaluations et l'examen des dessins des artefacts publiés comme « couteaux de Kostienki » dans les séries post-pavloviennes d'Europe centrale (*e. g.* Kozłowski 1969, Kozłowski 1998) nous incitent à penser que leur présence reste véritablement à démontrer dans cette phase récente du Gravettien (Klaric *et al.* sous presse). Par conséquent, il nous semble que les deux éléments typologiques les plus fréquemment avancés pour la définition des industries du Post-pavlovien doivent pour l'instant être reconsidéré sous un angle critique. En outre, il paraît également pertinent de revoir le poids des arguments de caractérisation culturelle secondaire comme la fréquence de la silicite de Pologne ainsi que la prédominance des burins et le grand nombre de microlithes dans les collections. Ces deux derniers traits apparaissent en effet hautement discutable du fait du problème de fouilles ou de collecte des artefacts évoqués (fouilles anciennes, palimpseste, ramassage de surface, etc.). Ce constat difficile mais lucide nous paraît important tant il justifie la reprise et l'intensification des travaux sur cette période manifestement mal connue du Post-pavlovien.

[13] Dans le cas des pointes de la Gravette et microgravettes du sous-type Dolní Věstonice, il s'agit d'une retouche inverse courte, qui est l'une parmi des caractéristiques de ces artefacts et les différencient de ceux du secteur G de Milovice I ou encore de ceux de Kraków Spadzista (Polanská, thèse en cours; figure 3).

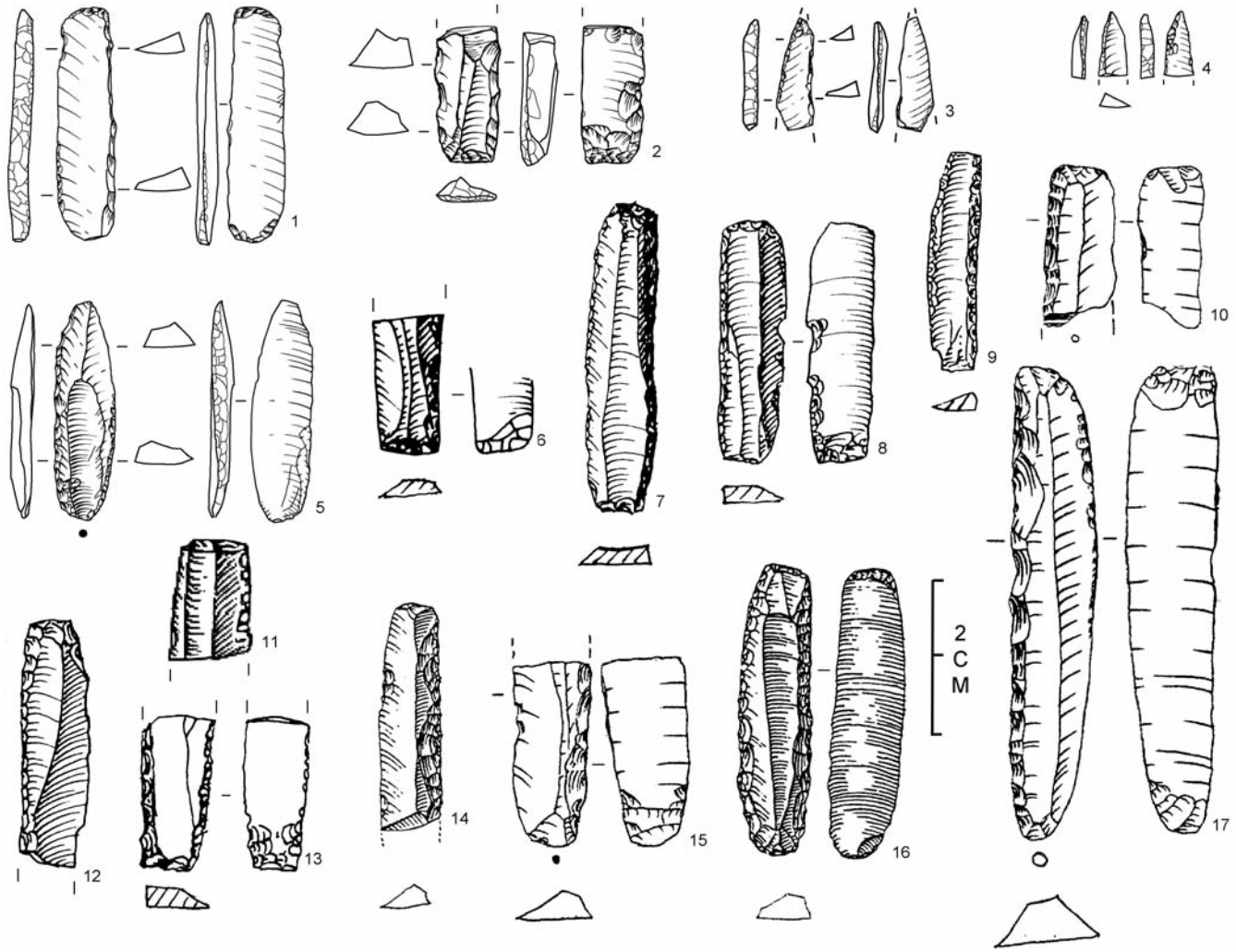

Figure 4 : 1–18 Petřkovice I (fouilles anciennes et récentes; dessins: 1–6 M. Polanská, 7–10, 12–14 in M. Novák 2008, 11, 15–18 in Oliva 2007).

Quelques observations sur les principaux sites post-pavloviens

Pour les raisons précédemment exposées, nous proposons ici un premier aperçu de résultats et d'observations issus de nos travaux sur certains des ensembles « typiques » de cette période. Il ne s'agit pas de résumer les données bibliographiques existantes mais bien d'avancer de nouvelles observations préliminaires, principalement sur le lithique mais aussi parfois sur l'industrie en MDA et les restes fauniques, en nous focalisant sur les éléments qui semblent essentiels à pister dans d'autres collections.

Petřkovice I (Moravie, République tchèque)

Le site de Petřkovice I est pour certains auteurs (Svoboda 2006b) l'un des plus importants représentant du « Willendorf-Kostienkien » d'Europe centrale. Outre

l'importation de matériaux siliceux provenant des moraines et la présence des pointes à cran[14] (Oliva et Neruda 1999; Neruda sous presse), les systèmes techniques de production et les divers types restent encore relativement mal connus. Par ailleurs, les quelques pièces provenant des nouvelles fouilles et décrites comme « couteaux de Kostienki », ne nous semblent pas pour l'instant correspondre au procédé de raffutage récemment décrit et recaractérisé (Lev *et al*. 2009; Klaric *et al*. sous presse). Leur présence sur le site est donc à confirmer par un nouvel examen. Pour autant, les anciennes fouilles de B. Klíma et les nouvelles interventions à Petřkovice I de J. Svoboda ont livré des artefacts particuliers jusqu'ici passés inaperçus (figure 4 : 1–2, 6–17). Il s'agit d'une sorte d'éléments bi-tronqués, aménagés sur lame, à deux extrémités tronquées par une retouche bifaciale associant une troncature directe et une retouche inverse rasante plus ou moins envahissante. Cette retouche de par son envahissement a pu à la fois rectifier partiellement la délinéation du bord et l'extrémité ou les extrémités concernées. Les aménagements de ces dernières présentent différents aspects et sont étendus de manière à aplatir la face inférieure du support, ce qui explique leur variabilité. En général, le bord gauche est abattu par une retouche directe abrupte de manière à créer un dos à délinéation rectiligne, tandis que le bord opposé légèrement convexe est en général laissé brut (ou comporte une retouche directe marginale). Il est peu probable qu'il s'agisse de pièces à dos reprises puisqu'au moins 6 pièces entières présentent les deux extrémités tronquées[15]. Le site Petřkovice I a livré plus de 20 pièces de ce type (différents secteurs), à dimensions variables (jusqu'au 6 cm de longueur figure 4:17, et 12–13 mm de largeur). Des artefacts très semblables sont aussi présents dans d'autres sites post-pavloviens et en particulier dans l'Aire de Moravany (figure 5:1-13, 15) et peutêtre dans la couche 8 de Willendorf II ou à Kraków Spadzista. Du fait de leur mise au jour anciennement à Petřkovice I, nous proposons donc de nommer ces artefacts « élément bi-tronqués du type Petřkovice sous-type Petřkovice ». Un fragment de ces artefacts, présent dans le sondage B (fouille 1994–95), a relevé des traces de boucherie (Novák 2008, figure 24:38, détermination d' A. Šajnerová-Ďušková; figure 4:2).Un artefact identique identifié à Předmostí Ia, que nous avons fait examiner tracéologiquement (détermination C. Guéret) a aussi révélé des traces d'utilisation comme « couteau ». Même si d'autres études doivent confirmer la fonction de ces artefacts, les examens préliminaires ainsi que leur conception suggèrent un possible emmanchement latéral au niveau du dos et où le bord opposé aurait donc eu la fonction du tranchant. Nous proposons le terme « élément », puisque ces aménagements peuvent être appliqués à la fois aux supports de petites et de plus grandes dimensions. Ces pièces ressemblent énormément au

[14] D'après nos propres observations il semblerait que les « pointes à cran » provenant des nouvelles fouilles de J. Svoboda (fouille de 1994) sont plutôt des pièces abandonnées en cours de fabrication. La question subsiste pour une pièce en radiolarite, qui, si elle est bien une pointe à cran ne présente pas de base aménagée par retouches inverses, puisque les enlèvements décrits comme tels sont en fait accidentels.

[15] Nos décomptes sont provisoires se basant sur le matériel stocké à l'Institut d'archéologie de Dolní Věstonice.

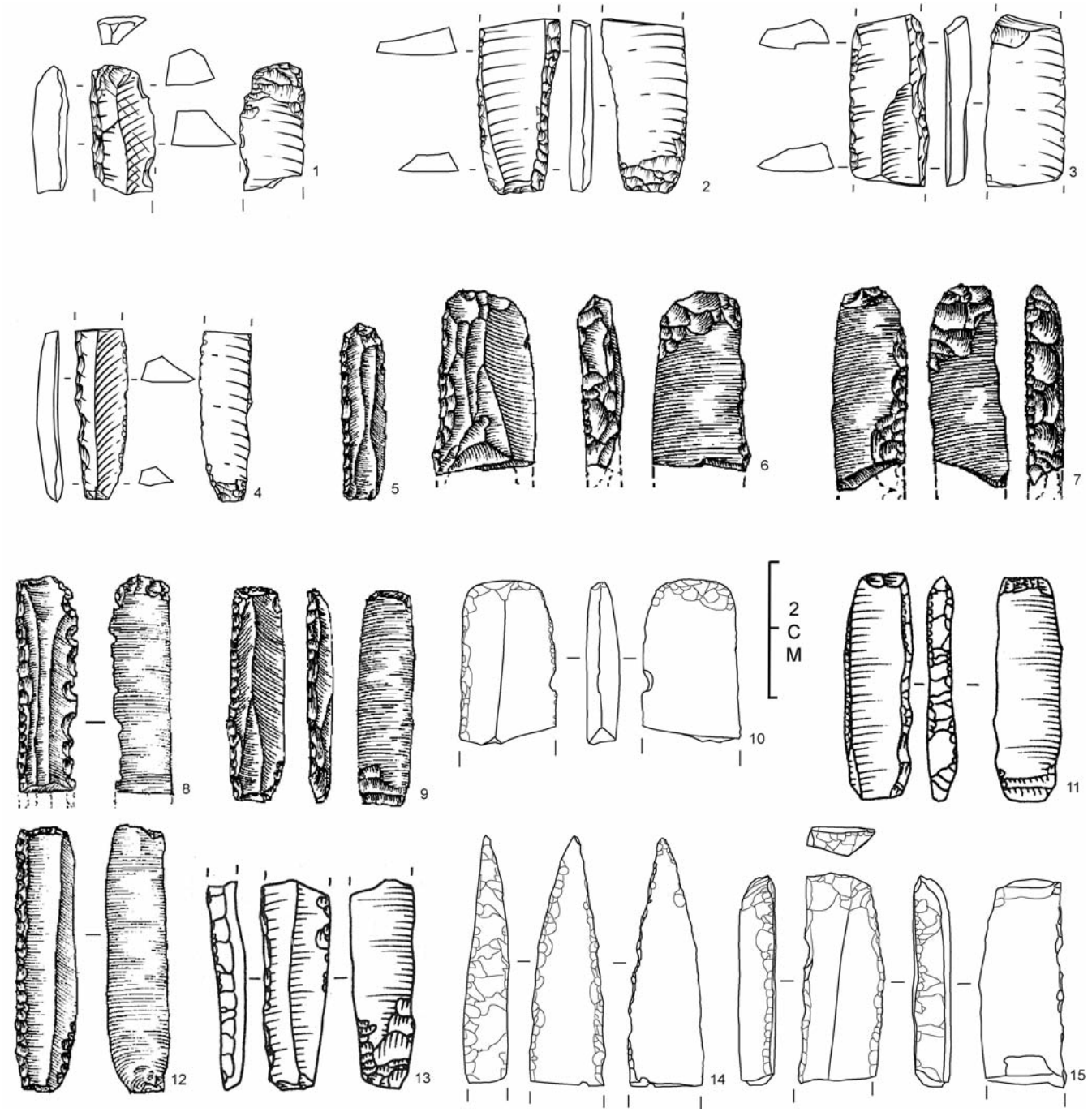

Figure 5 : 1, Mníchova Lehota I, 2–4 Trenčianske Stankovce I, 5–7 Moravany (sans plus de précision; in Nerudová et Valoch 2009), 8–9 Banka (sans plus de précision; in Nerudová et Valoch 2009 figure 49b), 11–13, 15 Moravany-Noviny (11–13 in Bárta et Kazior 2000), 10, 14 Banka II (dessins 1–4, 10, 14–15 M. Polanská).

type récemment signalé à Trenčianske Bohuslavice (Vlačiky *et al.* 2013b), mais qui présente toutefois des particularités (*cf. supra*), d'où la subdivision en sous-types.

En attente de la caractérisation approfondie de l'industrie de Petřkovice I, le contexte archéologique permet de mettre en lien ces éléments bi-tronqués de Petřkovice sous-type Petřkovice et quelques armatures perçantes, dont nous connaissons pour le moment seulement des fragments.

Les sites de l'Aire de Moravany nad Váhom (Slovaquie occidentale)

Le complexe de sites situé entre les villages de Modrovka et Sokolovce, et dont le centre correspond à peu près à Moravany nad Váhom (à proximité de la ville thermale de Piešťany), est désigné comme « *moraviansky sídliskový areál* » (figure 1), ce que l'on peut traduire par « l'aire » de Moravany (Hromada 1998). Le très petit territoire de cette région concentre plus de 50 sites indépendants (localisés sur 12 km de long sur la rive gauche du Váh, autour d'une altitude constante (d'environ 250–350 mètres). Seulement certains d'entre eux sont bien datés du Paléolithique supérieur ancien jusqu'au LGM (Hromada 1998). Pour l'essentiel ces sites correspondent à des ramassages de surface ou plus rarement à des travaux de terrain plus ou moins anciens dont les plus récents remontent au milieu des années 90 (Hromada 1998; Hromadová et Polanská étude en cours). Les rares gisements connus par des fouilles ou des sondages sont: Moravany-Noviny (Bárta 1965, 1980), Banka-Horné farské role (Alexandrowicz *et al.* 2000; Polanská 2009), Moravany-Lopata II (Kozłowski 1998) et enfin Moravany-Žakovská (Hromada et Kozłowski 1995). Ces sites semblent correspondre à un horizon chronologique assez court durant lequel s'exerçaient des conditions climatiques locales favorables (Hromada 1998; Hromada et Kozłowski 1995). Selon J. Hromada la majorité de ces occupations appartiennent au Gravettien *lato sensu*.

Moravany-Noviny

Le site Moravany-Noviny, qui a fait l'objet de sondages en 1963 (sondage A–A1, B–B1; 211 artefacts lithiques), a livré à côté de quelques exemplaires de possibles pointes à cran (à vérifier) quelques pièces s'apparentant aux éléments bi-tronqués du type Petřkovice sous-type Petřkovice (figure 5 : 11–13, 15; Bárta et Kazior 2000). Ces pièces sont d'autant plus intéressantes qu'elles apparaissent dans d'autres ensembles de cette région ou des régions voisines (malheureusement souvent issus de contextes moins favorables). À titre d'exemple, nous avons pu en détecter certains dans d'anciennes fouilles ou ramassages de surface à Moravany (figure 5 : 5–7), à Ratnovce, à Banka (figure 5 : 8–10, 14; Nemergut 2011) ou encore à Mníchova Lehota I (figure 5 : 1), ou Trenčianske Stankovce I (figure 5 : 2–4); Michalík 2011; Polanská et Michalík soumis). La faune de Moravany-Noviny n'a jamais fait l'objet d'une étude détaillée mais contient du renne, du mammouth et du renard polaire (Bárta et Kazior 2000).

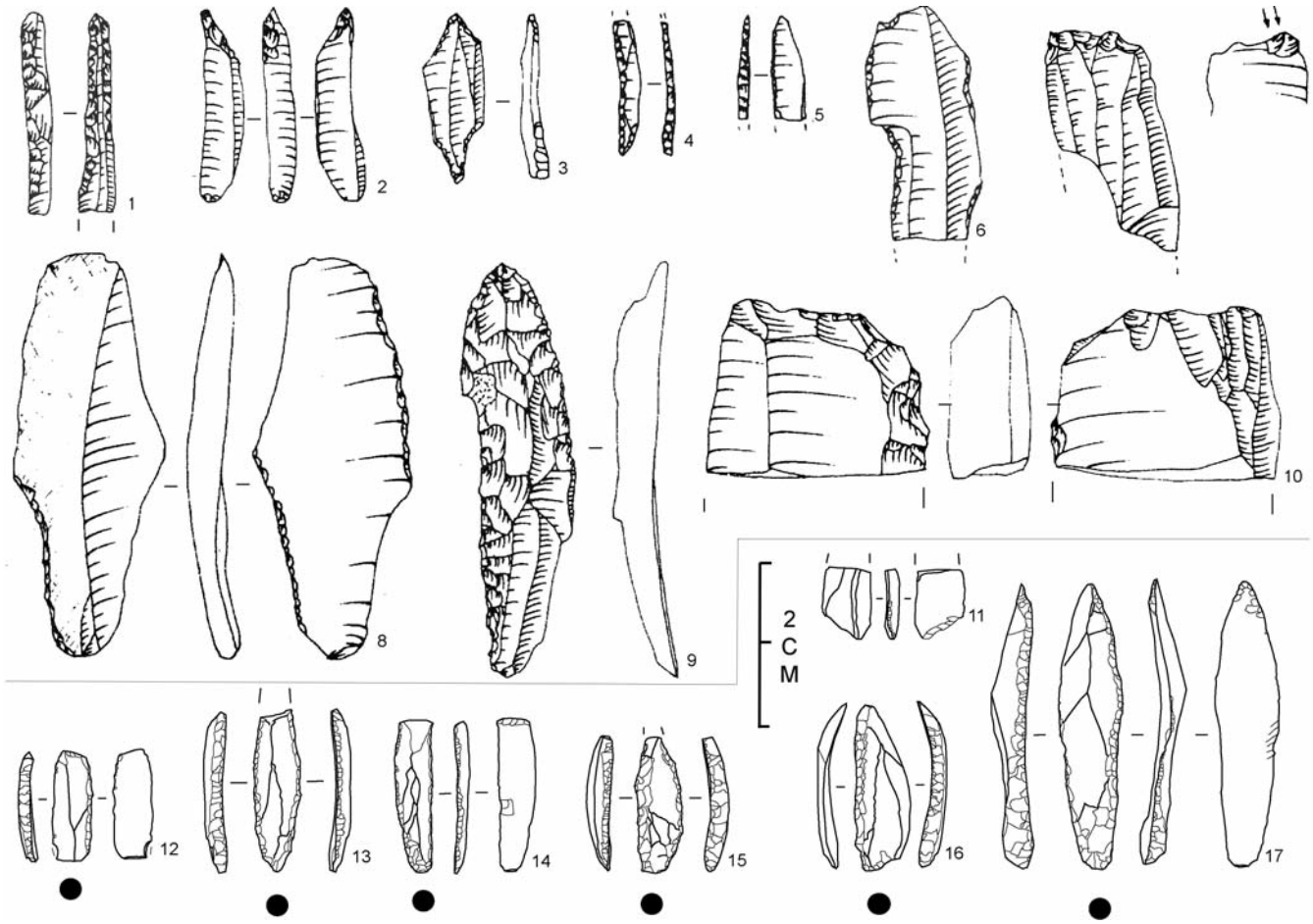

Figure 6 : Divers outils lithiques : 1–10 Moravany-Lopata II (in Kazior *et al.* 1998), 11–17 Moravany-Žakovská (dessins M. Polanská).

Moravany-Lopata II

Le site Moravany-Lopata II est sans doute l'un des sites qui présente un fort potentiel pour l'étude du Post-pavlovien en Slovaquie occidentale (fouille récente, l'échantillon significatif de l'industrie lithique, présence de l'industrie en MDA et de la faune). Bien qu'il ait été présenté comme un bon représentant de « l'Horizon à pointes à cran » (Hromada 1998; Kozłowski 1998) le réexamen du matériel archéologique révèle pourtant de nombreux traits originaux, aussi bien pour le lithique que l'industrie en MDA, ou encore la faune (Hromadová et Polanská étude en cours; Vlačiky 2012). Pour commencer, le comportement vis-à-vis de l'utilisation de matériaux siliceux de bonne qualité importés de Pologne ainsi que la présence assez fréquente de matériaux à grain plus grossier (quartz ou quartzite) suggère une économie de la matériaux locaux première qui reste à caractériser (Hromada 1998). Ensuite, l'industrie lithique comprend de nombreux petits nucléus à lamelles (souvent polyédriques) faits sur éclats ou lames et qui sont probablement destinés à la production de supports de lamelles à bord abattu (figure 6 : 10).Une fois le potentiel lamellaire de ces nucléus épuisé, ils ont parfois été transformés en nucléus à petits

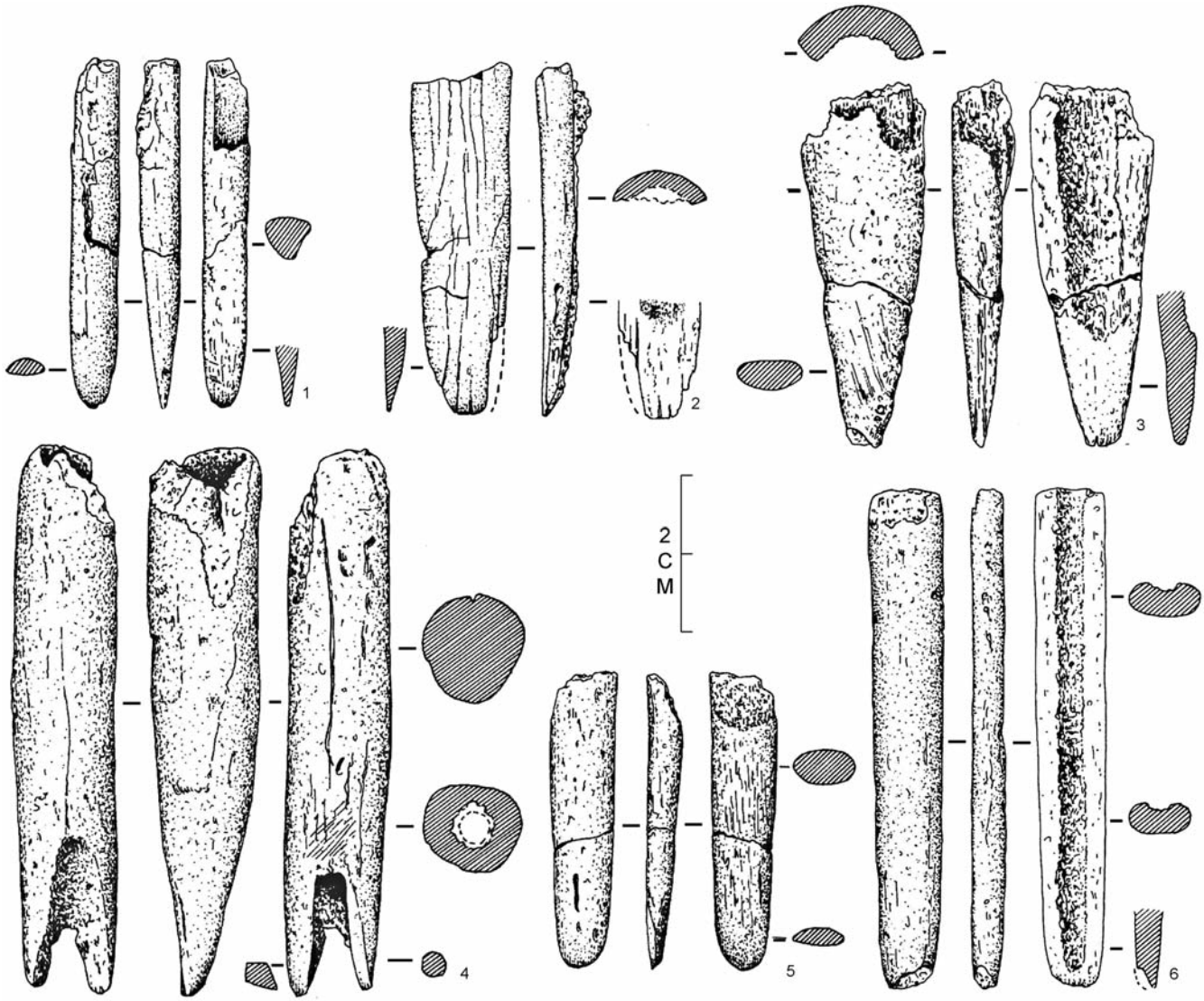

Figure 7 : Divers outils en MDA de Moravany-Lopata II (fouille 1993–1996; modifié d'après Kozłowski 1998, figures 38, 46).

éclats/esquilles et débités par percussion bipolaire sur enclume (Polanská étude en cours). Autre fait remarquable la série ne compte ni couteaux de Kostienki ni pointes à cran alors que leur présence a pourtant été signalée par le passé (Hromada 1998; Alexandrowicz *et al.* 2000). Toutefois, le réexamen que nous avons pu conduire nous a permis d'infirmer cette déclaration (Polanská étude en cours). En effet, les « pointes à cran » sont en réalité des pièces à bord abattu (ou à retouche marginale) inachevées (figure 6 : 6, 8–9). Quant aux « couteaux de Kostienki », il s'agit en réalité de burins sur troncature et de pièces esquillées aux morphologies approchantes (Polanská étude en cours; figure 6 : 7, 10). En revanche, il faut signaler la forte présence des perçoirs (figure 6 : 1–3), qui constitue sans doute un indice d'une activité particulière qui reste cependant à déterminer. La révision des restes fauniques a confirmé la prédominance des restes de rennes, vestiges probables d'une utilisation alimentaires. M. Vlačiky

signale également la prédominance des jeunes individus vraisemblablement apportés sur le site entier ou déjà en partie découpés (Vlačiky 2012). Ces observations viennent s'ajouter à celles menées sur l'industrie en MDA (figure 7) qui ont permis démontrer que tous les artefacts produits sur place (outils biseautés, lissoirs, etc.) ont été réalisés en bois (ou plus rarement en os) de rennes ou provenant d'individus de taille moyenne (Vlačiky 2012; Hromadová étude en cours). L'ensemble de ces observations témoigne d'une chasse orientée vers l'exploitation d'animaux évoluant en troupeau ce qui est quelque peu inhabituel puisque la plupart des groupes gravettiens de cette partie de l'Europe centrale ont souvent été décrits comme des chasseurs de mammouths[16] (*e. g.* Hromada 1998; Oliva 2007).

Ainsi, les caractéristiques originales de l'industrie lithique (présence des perçoirs, absence des pointes à cran et couteaux de Kostienki, etc.), ainsi que les données de l'industrie en MDA et la faune suggère une fonction de site particulière, peut-être en lien avec le traitement et la distribution des rennes (Vlačiky 2012; Hromadová et Polanská étude en cours). Cette première relecture du matériel archéologique offre un nouveau point de vue non seulement sur le site mais aussi sur le Gravettien supérieur d'Europe centrale, puisque Moravany-Lopata II a toujours été présenté comme un des sites majeurs de « l'Horizon à pointes à cran » ou du « Willendorf-Kostienkien » (Hromada 1998; Kozłowski1998). Il conviendra donc de poursuivre le travail entrepris afin d'offrir un panorama réactualisé et plus complet des informations disponibles pour ce site majeur pour la connaissance du Gravettien récent de cette région.

Moravany-Žakovská

Le site de Moravany-Žakovská reste toujours sujet à questions. Initialement, ce site qui a fait l'objet d'une petite fouille (1991–92) a été attribué à l'Epigravettien (Hromada et Kozłowski 1995) sur la base d'un faisceau d'arguments de valeur inégale. Ce sont d'abord la datation puis certains aspects typologiques par défaut (essentiellement l'absence d'artefacts à dos) ainsi que l'utilisation de la radiolarite (matière première locale) qui ont guidé ce premier diagnostique. Toutefois, le site a été redaté par la suite puis reclassé dans le Gravettien supérieur/récent (Verpoorte 2000). D'après, quelques observations préliminaires nous avons pu déterminer que les supports lamellaires des armatures ont été produits à partir de surface de débitage de morphologie carénée. Un tel cas de figure pourrait sembler original pour le Gravettien[17] mais il s'avère finalement assez banal dans ce contexte particulier. La radiolarite se présentant fréquemment sous la forme de petits blocs diaclasés ou de rognons de faibles dimensions, cette matière première est donc particulièrement propice à l'installation de surface de débitage caréné (Polanská thèse en cours). Ces supports sont destinés à être aménagés en lamelles à deux bords retouchés

[16] Peut-être un peu hâtivement?

[17] Les débitages sur morphologies carénées étant davantage communs dans d'autres ensembles culturels du Paléolithique supérieur d'Europe comme l'Aurignacien ou le Magdalénien ancien en Europe occidentale par exemple.

légèrement convexes (en général réalisés par un abattage direct marginal ou envahissant, figure 6 : 12–17). Quelques unes de ces pièces présentent des troncatures directes ou inverses, mais leur taux reste encore à évaluer figure 6 : 11–12, 14). Malheureusement, les conditions pédologiques n'ont pas été très favorables à la conservation d'artefacts en MDA. L'échantillon restreint des restes fauniques ainsi que les outils mal conservés ne permettent pour l'instant pas d'aller plus loin dans l'interprétation du cadre chronoculturel du site.

Trenčianske Bohuslavice-Pod Tureckom (Slovaquie occidentale)

Que ce soit les fouilles anciennes ou plus récentes qui ont eu lieu, le site de Trenčianske Bohuslavice a livré une industrie lithique inédite sans pointes à cran et sans couteaux de Kostienki (Bárta1988; Žaár 2007). Toutefois, parmi quelques 8000 artefacts lithiques taillés que comptent les différentes séries (fouilles anciennes et récentes), nous pouvons remarquer quelques outils particuliers auparavant passés inaperçus (figure 8 : 1–3, 6–8; Vlačiky *et al*. 2013b; Polanská et Žaár étude en cours), mais très ressemblant à ceux de Petřkovice. Il s'agit essentiellement de petites lames à dos (ou à bords abattu), en général à deux extrémités tronquées ou aménagées par une retouche bifaciale, complétée par des retouches inverses. Toutefois, ces outils montrent un soin particulier dans la régularité des deux bords ainsi que des deux extrémités. La silhouette, généralement en forme de rectangle et la nature de l'aménagement du bord « tranchant » différencie ces artefacts de ceux de Petřkovice. En effet, le bord opposé à dos possède une délinéation parfaitement rectiligne et est souvent aménagé par une retouche inverse (dans peu de cas directe) rasante plus ou moins étendue, qui affecte souvent la totalité du bord. En fin de compte, ces pièces d'une standardisation remarquable (plusieurs dizaines pour l'ensemble des fouilles, dont au moins 16 complètes), sont toutefois moins robustes que celles mentionnées précédemment. L'analyse est actuellement en cours mais il semblerait que les plus grands de ces artefacts ne dépassent pas 4 cm de longueur et 8 mm de largeur (avec une moyenne autour de 5 mm). Mais, il faudrait prendre en compte que les anciennes fouilles n'ont pas fait l'objet de tamisage et qu'il nous manque la petite fraction du matériel et en l'occurrence les microlithes[18]. Effectivement, en vue de ces données préalables il semble qu'il existe une diversité à la fois dans les dimensions et dans l'aménagement du bord opposé au dos entre les pièces de Petřkovice et Trenčianske Bohuslavice. Néanmoins, les artefacts analogues à ceux de Trenčianske Bohuslavice sont pour le moment inconnus dans d'autres séries par rapport à ceux de Petřkovice (présents dans plusieurs séries). La question à poser est: Est ce qu'il s'agit de deux types différents ou bien plutôt d'une variante d'un seul type? Nous avons pour le moment fourni les premières descriptions qui doivent être

[18] En dépit de tamisage du matériel provenant des fouilles plus récentes de Petřkovice I, le site n'a pas livré de si petits éléments bitronqués que celui Trenčianske Bohuslavice (fouille récente), ce qui encore renforce l'idée de l'existence de deux dimensions différentes.

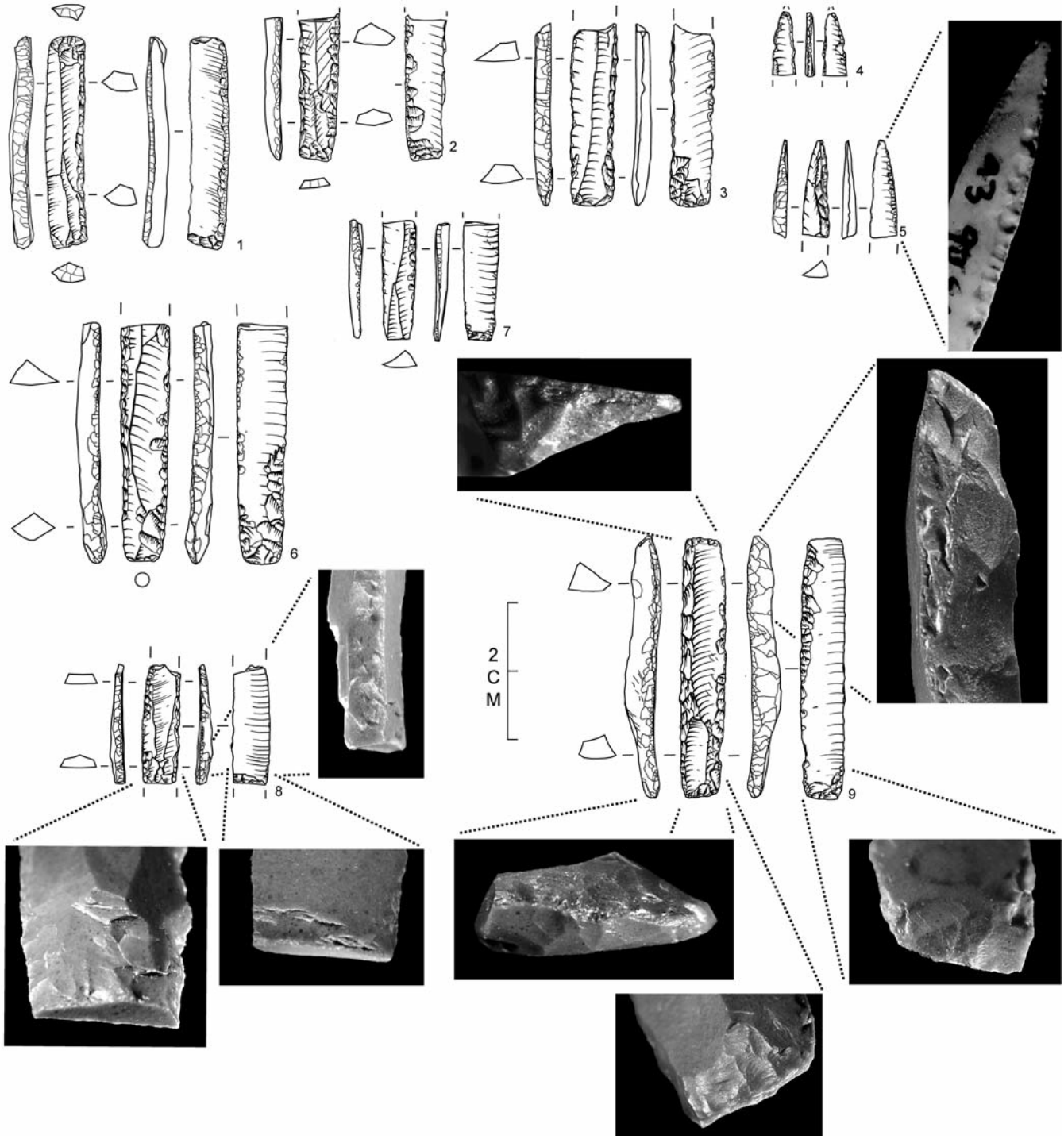

Figure 8 : 1–2 Les éléments bi-tronquées du type Petřkovice sous-type Trenčianske Bohuslavice (fouille J. Bárta), 3, 6–9 les éléments bi-tronquées du type Trenčianske Bohuslavice, 5 pointe indéterminée (couche 3, fouille 2008), 4 pointe indéterminée (couche 2, fouille 2008; dessins, clichés M. Polanská).

approfondies et complétés par les systèmes techniques de production. Dans ce cas, nous proposons premièrement de créer un type d'outil nommé élément bi-tronqué du type Petřkovice qui inclura les pièces à dos à deux extrémités tronqués (complétées par les retouches inverses) et de créer deux sous-types : celui de Petřkovice et celui de Trenčianske Bohuslavice. Ces deux sous-types qui correspondront aux descriptions que nous avons fournis précédemment seront considérés avant d'aboutir à la définition finale comme des catégories de travail. En effet, la série de Trenčianske Bohuslavice a fournit assez de matériel pour remarquer la grande standardisation dimensionnelle et le façonnage plus soigné par rapport aux pièces de sous-type de Petřkovice (qui semblent existés sur plusieurs sites et présentant une plus grande variabilité). Néanmoins, la caractérisation définitive reste à définir et il se peut qu'il existe d'autres types de pièces bi-tronqués, notamment des lamelles bi-tronqués (sans retouche inverses) qu'il ne faudrait pas assimiler aux pièces décrites auparavant[19].

Avant de connaitre des pièces de Petřkovice nous avons proposé l'appellation « microlithes bi-tronqués du type Trenčianske Bohuslavice » (Vlačiky *et al.* 2013b) pour les pièces de Trenčianske Bohuslavice. Or récemment, nous nous sommes rendu compte à la fois des ressemblances décrites et du fait que malgré la grande standardisation de ces artefacts, certaines pièces se rapprochent de 4 cm de longueur et semblent trop grand pour être appelés microlithes. Nous signalons que ces artefacts, qui pourront devenir de bons fossiles directeurs et que nous appelleront désormais les éléments bi-tronqués du type Petřkovice sous-type Trenčianske Bohuslavice, sont stratigraphiquement callés dans les nouvelles fouilles à la couche 3 qui a été datée à 24, 540 ± 130 BP (GrA-2312 29, 403 ± 135 BC calibré, Vlačiky *et al.* 2013a)[20].

Comme à Moravany-Lopata II, les restes fauniques du site de Trenčianske Bohuslavice-Pod Tureckom sont largement dominés par le renne, mais on peut signaler que des restes de cheval ou de mammouth ont également été identifiés (Vlačiky 2012). La composition de la faune est en accord avec les observations préliminaires effectuées sur l'industrie en MDA (Hromadová étude en cours). Un seul objet en MDA (un « manche en bois de renne ») avait été anciennement signalé sur le site (Bárta 1988) mais la révision en cours a révélée la présence d'autres outils et de déchets de transformation de bois de renne. Cet examen préliminaire a aussi permis de reconnaitre la technique du « fendage longitudinale de côtes » (espèces non identifiables). Enfin, la collection compte également des percuteurs en bois de

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[19] Des pièces à première vue comparables ont été signalées sur le site polonais Jaksice II (Wilczyński et Wojtal 2011), mais sans un examen direct des artefacts, il est difficile de se prononcer sur la pertinence d'un rapprochement. D'autant plus que toutes les pièces dessinées sont fragmentées.

[20] Nous avons récemment fait part des doutes quant à la situation stratigraphique avancée plus anciennement. Il est forte probable que les pointes foliacées ne proviennent pas ni des mêmes couches, ni des mêmes secteurs que les éléments bi-tronquées du type Trenčianske Bohuslavice (Vlačiky *et al.* 2013b) pertinence d'un rapprochement. D'autant plus que toutes les pièces dessinées.

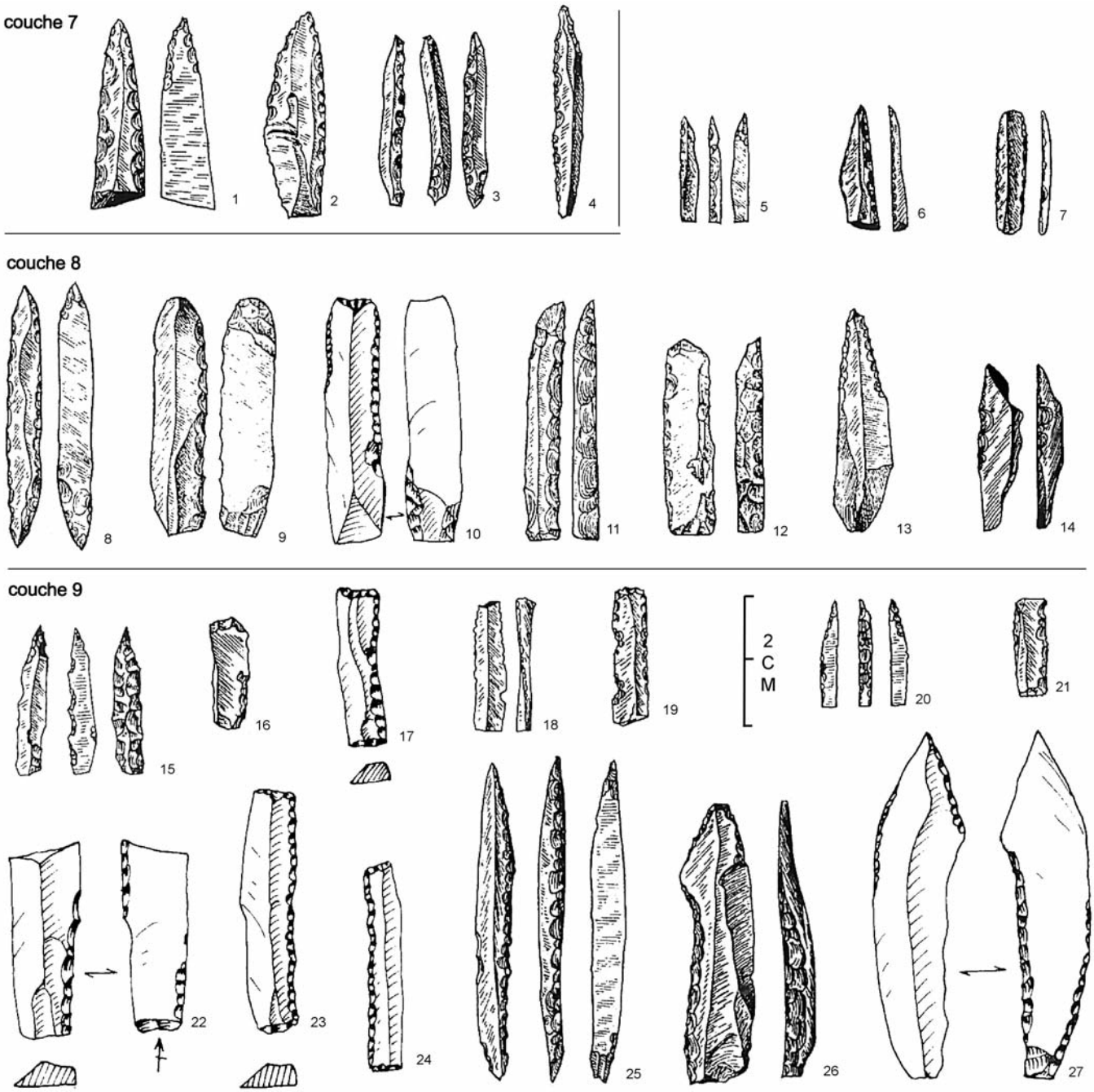

Figure 9 : Quelques exemples du matériel lithique de Willendorf II.

renne, ce qui concorde avec la détermination de la technique de débitage des supports lamino-lamellaires identifiés sur le site (Hromadová et Polanská étude en cours). De par ces premiers indices et la qualité des fouilles conduites (nouvelles fouilles), ce site constituera donc, au même titre que Moravany-Lopata II, un élément clef pour la connaissance des industries post-pavloviennes de la région.

Conclusion

La compréhension et l'établissement du cadre chronologique du Gravettien d'Europe centrale nécessite non seulement une caractérisation des industries mais également une révision critique des contextes de découverte et des stratigraphies. Les premières observations que nous venons d'exposer attirent l'attention, non seulement sur l'apparente hétérogénéité des assemblages mais aussi sur les nouveaux éléments qui pourraient servir à mieux caractériser d'éventuels traits technologiques communs à ces différents sites (à titre d'exemple éléments bi-tronqués du type Petřkovice).

Si l'on écarte les pointes à cran et les couteaux de Kostienki, qui apparaissent dans ce contexte comme des fossiles directeurs peu pertinents (puisque la plupart des artefacts identifiés comme tels sont selon nous sujets à caution), nous nous heurtons à la caractérisation insuffisante des industries du Gravettien supérieur du cœur de l'Europe centrale. Un autre point faible réside dans le fait que les sites fouillés anciennement présentent souvent des contextes problématiques qui sont devenus des « mythes » cités de manière indirecte à travers la littérature. A part les travaux sur Lopata II et Žakovská, les sites de Moravany sont pratiquement inconnus (à l'exception de quelques poignées de dessins sommaires). Les premières révisions livrent des industries inédites qui ne connaissent pas d'équivalent. Le fait que ces industries aient été décrites comme possédant des caractères « kostienkiens » (couteaux de Kostienki et pointes à cran) a en quelque sorte occulté le fait qu'elles puissent présenter des particularités propres à caractériser un groupe régional distinct. La reprise des collections ainsi que la réévaluation du matériel nous a déjà apporté quelques pistes intéressantes. Bien entendu, les premiers éléments sont fragiles et soulèvent plus d'interrogations qu'ils n'apportent de réponse. En outre, il reste la question cruciale des rapports que ces sites moraves et slovaques entretiennent éventuellement avec la séquence stratigraphique de référence de Willendorf II (Basse Autriche), en particulier avec la couche 8 qui est censée se rattacher au « Pavlovien » (*e. g.* Svoboda 2003; figure 9). Le contexte de découverte ancien et l'état de la documentation de ce site laissent penser que des mélanges intercouches sont possibles. En outre, la récente remise en question de la datation de la couche 5 (Noiret 2013) peut indiquer des problèmes stratigraphiques et de fait interprétatifs. En l'état actuel, il nous paraît possible que le matériel lithique de la couche 8 de Willendorf II puisse peut-être présenter quelques analogies avec celui des sites du Gravettien récent comme Petřkovice I. Il est cependant trop tôt pour se prononcer de manière définitive. Pour conclure, il nous semble qu'il faudrait d'abord avancer sur la caractérisation de ces sites rattachés à la phase post-pavlovienne afin de pouvoir élaborer une synthèse plus globale au niveau local avant

de passer à l'échelle plus large de l'Europe centrale. Une fois ces caractérisations bien avancées, les rapports et analogies avec les sites de la Plaine russe pourront être enfin réexaminés sous un angle neuf, mieux à même de montrer la pertinence ou le caractère inopportun des rapprochements effectués anciennement.

Remerciement
Les auteurs souhaitent remercier Monsieur L. Klaric pour les conseils, ainsi que les relectures, Messieurs J. Svoboda, M. Ruttkay, O. Žáar, A. Nemergut, M. Vlačiky et T. Michalík pour nous autoriser à consulter le matériel et Mesdames S. Scheffer-Farray et A. Delaplace pour la correction linguistique. Le travail de B. Hromadová a été soutenu par le projet VEGA 2/0181/14.

Summary
The late Gravettian of Central Europe still remains in the shadow of the spectacular discoveries of the Pavlovian (around 28/27.5–25.5 ky BP). In particular, the understanding of more recent inventories (from 25.5/24.5–22.0 ky BP) is based on recognition and identification of lithic fossiles directeurs such as shouldered points and Kostienki knives. The inventory of hard organic material is described partially but it remains almost unknown. New methods for studying lithic assemblages are built on the technological analysis of the whole lithic production process and demonstrate the heterogeneity of collections. Accordingly, this calls into question the current perception of chronology of the Gravettian in Central Europe, represented by the Pavlovian and Willendorf-Kostienkien. The objective of this paper is to present a state of the art of the post-Pavlovian phase through some observations of recently reviewed Slovak and Moravian collections: Moravany-Lopata II, Moravany-Noviny, Moravany-Žakovská, Trenčianske Bohuslavice-Pod Tureckom (river Váh valley, Slovakia), Milovice I (sectors G and H) and Petřkovice I (Moravia, Czech Republic).

Zusammenfassung
Die späte Gravettien in Mitteleuropa bleibt noch im Schatten der spektakulären Entdeckungen des Pavlovien (um 28/27.500–25.500 BP). Insbesondere das Verständnis der jüngeren Bestände (von 25.500/24.500–22.000 BP) basiert auf dem Erkennen und Identifizieren der fossiles directeurs aus Stein, als Kerbspitze und Kostienki-Messer. Das Artefaktinventar des organischen Materials wird teilweise beschrieben, aber es bleibt fast unbekannt. Die neuen Wege zum Studium der Steinertefakte basieren auf der technologischen Analyse der gesamten Steinartefaktproduktion und sie zeigen die Heterogenität der Sammlungen auf. In der Folge stellen sie auch die aktuelle Auffassung über die Chronologie des Gravettien in Mitteleuropa, vertreten durch das Pavlovien und das Willendorf-Kostienkien, in Frage. Diese Arbeit zeigt den aktuellen Forschungsstand der Post-Pavlovien Phase anhand einer Untersuchung der slowakischen und mährischen Sammlungen, die vor kurzem überprüft wurden: Moravany-Lopata II, Moravany-Noviny, Moravany-Žakovská, Trenčianske Bohuslavice-Pod Tureckom (Waag Tal, Slowakei), Milovice I (Abschnitte G et H) und Petřkovice I (Mähren, Tschechische Republik).

NEW GRAVETTIAN SITE FROM RATNOVCE (SLOVAK REPUBLIC)

Ľubomíra Kaminská[1], Adrián Nemergut[2] and Ondrej Žaár[2]

Abstract
The chipped stone industry from Ratnovce-Úvozová Cesta was gained at cleaning of the loess profile during the investigation in 2008. The collection of 131 artifacts contains 92.36% artifacts made of erratic silicite and 6.78% are made of radiolarite. The collection includes five cores, 18 blades, four bladelets, seven retouched tools, 81 flakes and 16 burin spalls. There are three burins, a retouched blade, a shouldered point and a retouched flake in the group of tools. The industry is classified as Late Gravettian, which appears in the Váh river basin in 24.0–20.0 ky BP, before the LGM. The new site extends the network of known sites of the Late Gravettian, the horizon of shouldered points, in the area of Moravany-Banka-Ratnovce.

Keywords
Slovakia, Váh river basin, Gravettian, Chipped stone industry

DOI: 10.5817/CZ.MUNI.M210-7781-2015-13

Introduction

One of the best known sites in Slovakia with evidence of Gravettian settlement is the area around Piešťany, in the Váh river region. Investigations by Zotz in the first half of the 1940s focused mostly on the cadaster of Moravany nad Váhom (Zotz and Vlk 1939; Zotz 1951), like the investigations of Absolon in 1946 (Nerudová and Valoch 2009). Finds from Moravany nad Váhom, as well as Banka and Ratnovce (Ambrož *et al.* 1951), come from the times of Prošek (1950). Their number was significantly increased by Bárta (1965, 1970), during his numerous surveys and investigations. Some of the results, as in the case of Prošek' s surveys, are preserved only in the form of short reports in the documentation of the Institute of Archeology

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of Slovak Academy of Sciences in Nitra (Nemergut 2011). Later, collections of lithic industry were gathered by Čepan (1985), who numbered the individual sites by means of his own system, as well as by Thurzo (2004, 2005). Most of the 14 known sites with Upper Paleolithic industry from the cadaster of Ratnovce revealed only a few finds and were often dated to the Gravettian only by the occurrence of blades. None of the Paleolithic sites in Ratnovce have yet been archeologically investigated. According to the dating of horse (*Equus ferus*) bones from the surface of one of the sites, its age is about 19, 080 ± 390 BP and it belongs to the final phase of the Late Gravettian in the Váh river basin (Kozłowski 2000, 10). Investigating the sites in the area of Moravany nad Váhom, Banka and Ratnovce in 2008, we obtained Gravettian chipped stone industry from several known sites. Additionally, the existence of a new site with the Late Gravettian was indicated in the loess wall of a holow way in Ratnovce (Kaminská *et al.* 2011).

The site location

The holow way leads southeastwards from the southern edge of the village (Figure 1). It is a groove in the loess about 3 m deep. Along the sides of the ravine, there is arable soil without finds, at an altitude of about 220 m above sea level. While searching for paleontological finds, Vlačiky and Moravcová noticed the occurrence of lithic artifacts in the lower part of the loess profile with tree roots. A layer of an indistinct color, with small carbons and lithic industry, was indicated 30–40 cm above the bottom of the profile. The bottom of the profile comprises of pale ocher limy loess with small lumps.

Chipped stone industry

During profile cleaning, we obtained 131 artifacts: 121 of them were made of patinated erratic silicite (92.36%), nine pieces of radiolarite (6.78%) and one piece (0.77%) was made of unidentified raw material (Table 1). Mostly, the artifacts (81 pieces) were flakes, fragments of flakes and splitters. Ten flakes were damaged by fire. Five cores were found: four of them were single-platform cores (Figure 2: 6) and one change-of-orientation core. Almost all blades were made of erratic silicite and, with the exception of one piece, only fragments were preserved. Four bladelets were also broken. Sixteen burin spalls were found. Seven retouched tools included an angle dihedral burin (Figure 2: 5), two concave truncation burins (Figure 2: 3, 7), the base part of a retouched blade (Figure 2: 2), a backed bladelet (Figure 2: 1), a fragment of a shouldered point (Figure 2: 4) and a retouched flake (Table 2).

Discussion

The collection of artifacts obtained from Ratnovce-Úvozová cesta is rather weak, mostly if we take its typology into consideration. However, it provides some possibilities for evaluation. Raw materials of the lithic industry comprising more than

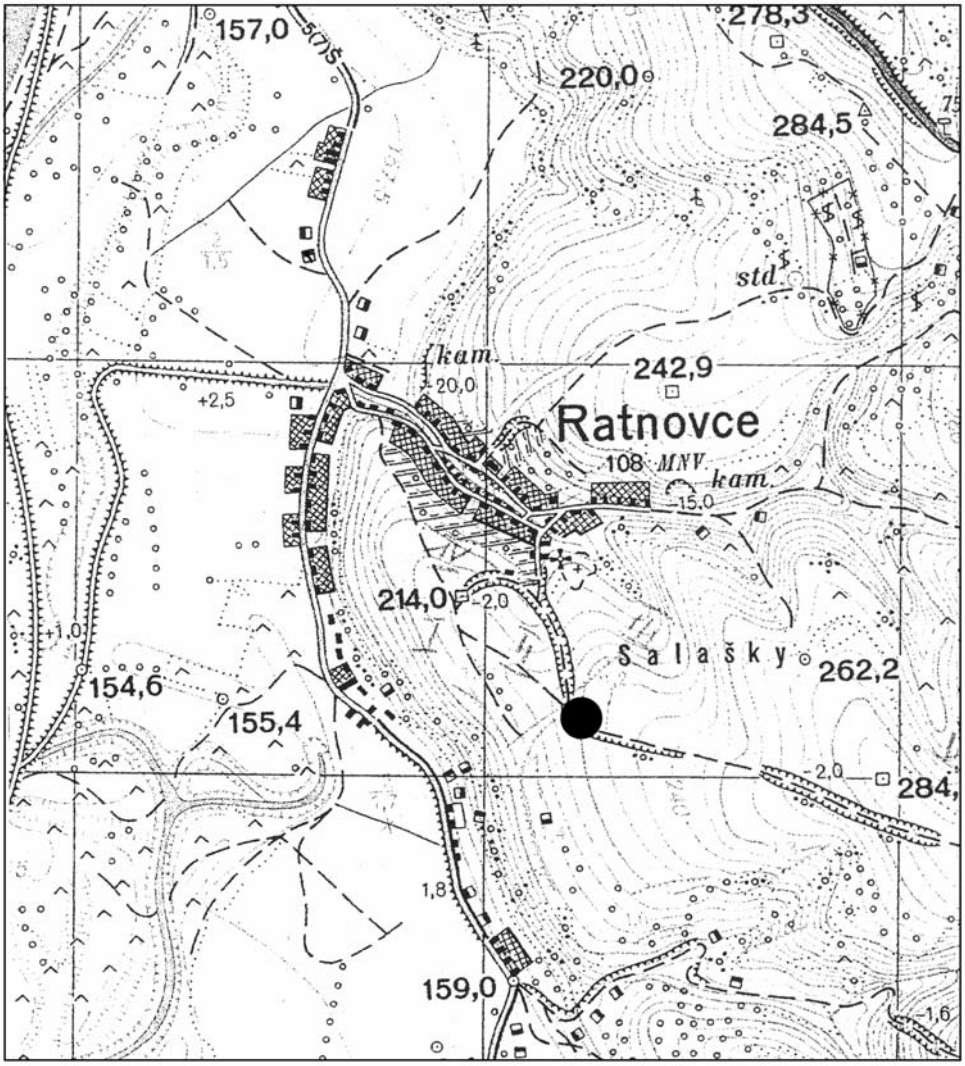

Figure 1: Ratnovce-Úvozová cesta. Localization of the site.

object	raw materials			total	%
	erratic silicite	radiolarite	other		
cores	4	1		5	3-8
flakes	35	4		39	29-8
splinters	40	2		42	32
blades	17	1		18	13-8
bladelets	4			4	3-1
burin spalls	15	1		16	12-2
retouched artifacts	6		1	7	5-3
total	**121**	**9**	**1**	**131**	**100**

Table 1: Ratnovce-Úvozová cesta. Overview of finds and utilised raw materials.

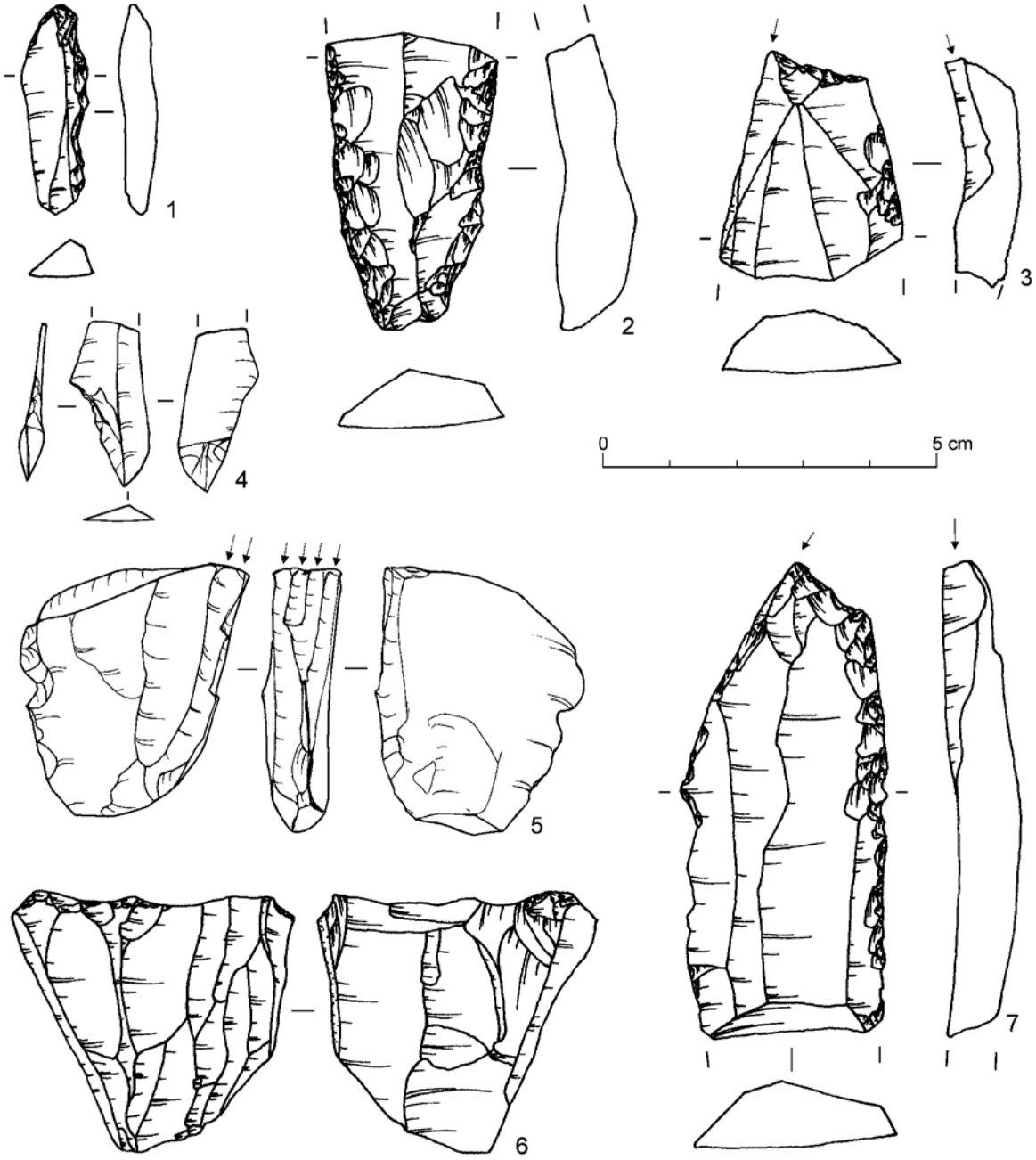

Figure 2: Ratnovce-Úvozová cesta. Chipped stone industry: 1 – backed bladelet; 2 – retouched blade; 3, 7 – concave truncation burin; 4 – shouldered point; 5 – dihedral burin; 6 – single-platform core. 1–7 – erratic silicite.

Table 2: Ratnovce-Úvozová cesta. Overview of types and utilised raw materials.

retouched artifacts	raw materials		total	%
	erratic silicite	other		
angle dihedral burin	1		1	14-3
concave truncatin burin	2		2	28-5
retouched blade	1		1	14-3
backed bladelet	1		1	14-3
shouldered point	1		1	14-3
retouched flake		1	1	14-3
total	**6**	**1**	**7**	**100**

92% of erratic silicite are analogous with several industries of the Late Gravettian in the Váh river basin. They include finds from the collections from Modrovka (Kaminská and Kazior 2000, Plate 7) in Moravany-Baraniny (Hromada 1998, 149), from the investigation of Bárta (Bárta and Kazior 2000) on the site of Moravany-Noviny I, and from concentration C in Moravany-Lopata II (Kazior *et al.* 1998, Plate 3). The situation is similar in Banka-Horné Farské Role, trenches IV and V (Alexandrowicz *et al.* 2000), Banka-Kopanica and Banka-Kňazovica (Sobczyk 2000, Plate 2, 5), and in Banka-Chrašť (Kozłowski 2008, 184). In the area of Trenčín, industries with prevailing erratic silicite were found in Trenčianske Stankovce V, Trenčianska Turná IV (Kaminská *et al.* 2008) and Mníchova Lehota I (Michalík 2007).

The technological-typological composition of the industry from Ratnovce-Úvozová cesta includes cores of Upper Paleolithic types which are common in Late Gravettian sites. Types of single-platform and change-of-orientation cores are known, e.g., from Moravany-Lopata II (Kazior *et al.* 1998, Pl. 2: 1, 3: 2, 5: 7). Concave truncation and dihedral burins are also common types known from the near localities of the Late Gravettian, e.g., from Banka-Kóta 288 (Kaminská and Kazior 2000, 36, Pl. 13: 3). Several collections of industries from the area of Moravany-Banka are characterized by prevailing burins and scrapers and, in relation to their production, by burin spalls – Moravany-Podkovica in collections of Čepan (Kaminská and Kazior 2000, Table 5), but also in Moravany-Lopata II (Kazior *et al.* 1998, Table 1). The situation was similar in Nitra I-Čermáň, mostly in concentration V (Kaminská and Kozłowski 2011). Within the typological range of the Late Gravettian, backed bladelets are important. The finds from Ratnovce-Úvozová cesta only include one such artifact and also only one retouched blade.

Typological classification of a tool which we call a shouldered point is rather problematic. A shouldered point is an important tool of the Late Gravettian industries in the Váh river basin in the period between 24.0 and 20.0 ky BP, before the last LGM. Shouldered points of various shapes and sizes occur in industries from various sites. Artifacts similar to the one from Ratnovce-Úvozová Cesta, either whole or in fragments, with inversely retouched base, are classified as shouldered

points. However they are usually smaller. The whole pieces come from Moravany-Podkovica (Nerudová and Valoch 2009, Fig. 10b: 206) and Banka-Chrašť (Kozłowski 2008, Fig. 3: 1, 4: 1, 5: 1). They are also rather frequent in Nitra-Čermáň – complete tool (Kaminská and Kozłowski 2011, Fig. 50: 2), almost complete tools (Kaminská and Kozłowski 2011, Fig. 32: 1, 4; 35: 2) or just basal parts (Kaminská and Kozłowski 2011, Fig. 30: 2, 38: 8, 43: 17, 18).

With regard to the raw materials used for making the chipped stone industry and its technological-typological content, we suppose that it does not exceed the framework of industries typical of the Late Gravettian in the Váh river basin. The new site extends the network of known sites of the Late Gravettian, the horizon of shouldered points, in the area of Moravany-Banka-Ratnovce.

Acknowledgement
This study was undertaken as part of project Scientific Grant Agency of the Ministery of Education, science, research and sport of the Slovak Republic and the Slovak Academy of Sciences – VEGA, No. 2/0006/14.

Résumé
L'industrie lithique de Ratnovce-Úvozová cesta a été récoltée à l'occasion du réaménagement d'un profil lœssique réalisé en 2008. La collection comprend 131 artefacts lithiques. Du point de vue de la matière première, 92,36 % des pièces sont en silicite erratique et seulement 6,78 % en radiolarite. L'ensemble se compose de 5 nucléus, 16 lames, 4 lamelles, 7 outils stricto-sensu, 81 éclats et 16 chutes de burin. Les outils stricto-sensu comprennent 3 burins, une lame retouchée, une lamelle à bord abattu, une pointe à cran et un éclat retouché. L'industrie lithique gravettienne est datée dans la région de la vallée de Váh entre 24–20 kans BP. Ce nouveau site fait partie du complexe de sites des alentours de Moravany-Banka-Ratnovce attribués au Gravettien supérieur et plus particulièrement à l'Horizon à pointe à cran.

Zusammenfassung
Die gespaltete Steinindustrie aus Ratnovce-Úvozová cesta wurde durch Säubern des Lössprofils bei der Untersuchung im Jahr 2008 gewonnen. Der Komplex von 131 Artefakten besteht zu 92,36 % aus Feuerstein und zu 6,78 % aus Radiolarit. Er beinhaltet fünf Kerne, 18 Klingen, vier Klingenlamellen, sieben retuschierte Werkzeuge, 81 Abschläge und 16 Stichelabsplisse. In der Werkzeuggruppe befinden sich drei Stichel, eine retuschierte Klinge, ein Rückenmesser, eine Kerbspitze und ein retuschierter Abschlag. Die Industrie ist in die junge Phase der Gravettien, die im Waagtalgebiet im Zeitalter 24.000–20.000 BP vor dem maximalen Gletschervorstoß (LGM) vorkommt, eingegliedert. Die neue Lokalität erweitert das Netz von bekannten Fundorten der jungen Phasen des Gravettiens, des Kerbspitzen-Horizonts im Bereich Moravany-Banka-Ratnovce.

KREMS-WACHTBERG EAST – – A NEW FIND SPOT IN THE GRAVETTIAN SITE CLUSTER OF KREMS (AUSTRIA)

Thomas Einwögerer, Marc Händel and Ulrich Simon

Abstract
For more than a century the Wachtberg of Krems has been well known for its Quaternary geological outcrops and Paleolithic sites. Since the 1990s research has increasingly intensified. In the meantime a considerable quantity of archeologically relevant information exists for this area of roughly 16.0 ha. Besides archival research, surveys, test trenches and core samples, new excavations in particular have provided important insights into the Wachtberg's use in the Gravettian. The find spot Krems-Wachtberg East represents yet another piece in the jigsaw puzzle of the Upper Paleolithic settlement pattern of this area.

Keywords
Upper Paleolithic, settlement pattern, Krems-Wachtberg, Austria

DOI: 10.5817/CZ.MUNI.M210-7781-2015-14

Introduction

The Wachtberg is oriented north-west to south-east forming a spur-shaped terrace above the city centre of Krems upon Danube (Figure 1). To the south the gently descending slope is limited by the Danube's valley, to the east by the valley of the Krems River. Today's valley floors are separated from the Wachtberg by rocky escarpments. The Wachtberg' s topography is shaped by a thick loess cover that resulted in an intense agricultural use. Even today, grapes are cultivated on the Wachtberg's upper slopes, while its lower parts are obstructed by modern development. Hence only a limited number of plots are available for future fieldwork.

Along its ridge the Wachtberg is separated into a north-east and a south-west half by a hollow-way, the Schießstattgasse. Adjacent to the Schießstattgasse are the classic site of Krems-Hundssteig (Strobl and Obermaier 1909; Neugebauer-Maresch

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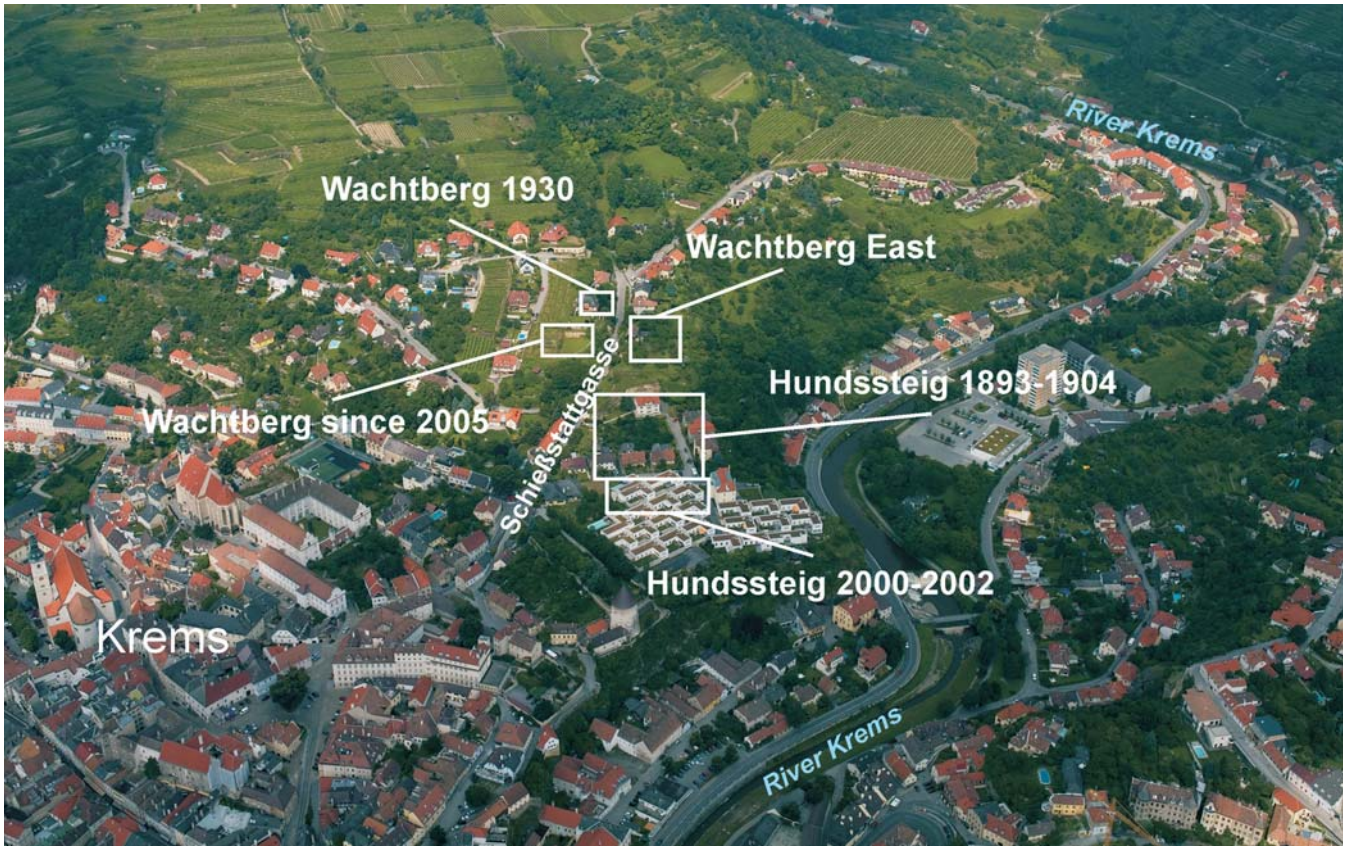

Figure 1: Aerial view of the Wachtberg and its Paleolithic sites (photo taken from the south-east, Institute of Prehistoric and Historical Archeology, University Vienna. Graph with courtesy of OREA, Austrian Academy of Sciences).

2008), the area of the old 1930 Krems-Wachtberg excavation (Einwögerer 2000; Fladerer 2001), and of the new excavations since 2005 (Einwögerer *et al.* 2006; Händel *et al.* 2009a; Händel *et al.* 2009b; Simon *et al.* 2014). Since 2000, extensive core sampling has provided evidence of the occurrence of Upper Paleolithic find horizons east of the Schießstattgasse (Neugebauer-Maresch 2008; Einwögerer *et al.* 2014). We named this find zone Krems-Wachtberg East.

Krems-Wachtberg East

In the summer of 2012, a large-scale construction project in the Krems-Wachtberg East area required archeological measures. The building contractor commissioned the Quaternary Archeology research group of the Institute of Oriental and European Archeology (OREA) of the Austrian Academy of Sciences to conduct the necessary investigations. Fieldwork was coordinated with the Austrian Bundesdenkmalamt and was carried out from September to October 2012 (Einwögerer and Schmitsberger 2012) and in May 2013. The research area comprised 550 m^2.

The first step was to complement the data provided by previous investigations. Six further core samples were drawn focusing on the area immediately affected by the construction proposal (Figure 2). Core sample RKS-B44 produced evidence for

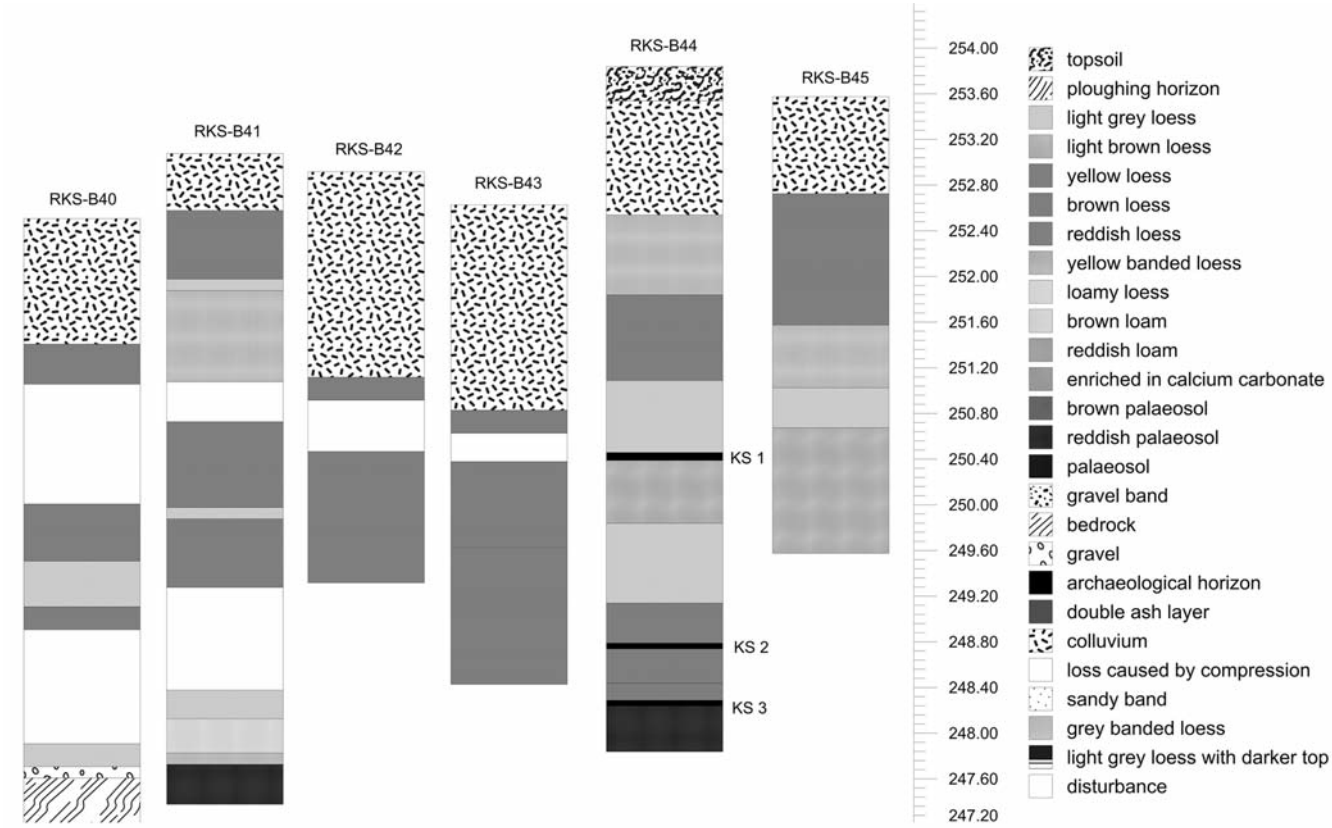

Figure 2: Krems-Wachtberg East. Core samples (RKS) extracted in June 2012 (graph with courtesy of OREA, Austrian Academy of Sciences).

three separate archeological layers (KS 1 – KS 3), of which the uppermost horizon was clearly placed within the specified depth of intervention.

The goal of the subsequent archeological excavations was to assess the extent of the Upper Paleolithic find layers evidenced in core sample RKS-B44. Furthermore, the loess stratigraphy into which the find layers are embedded was to be investigated and sampled.

Commencing fieldwork, however, soon showed that a great number of younger prehistoric settlement remains were preserved in the area under investigation. It is likely that the area's topography had already been modified in the course of the Urnfield Culture by the construction of three terraces. The majority of the settlement structures date to the Latène period and are the first proof of an extended representative hilltop settlement in Krems. Evidenced are also late medieval and early modern period terracing, presumably connected to viniculture.

Access to the Paleolithic layers and their assessment was facilitated by the removal of an old deep wine cellar. The resulting trench was extended south by 0.8 m. This enabled both the controlled excavation of a manageable area and the creation of a profile for comprehensive and widescale sampling.

Sixteen geological (GH 201 – GH 216) and four archeological horizons (AH 101 – AH 104) were distinguished in the resulting 3 m high loess profile. AH 101

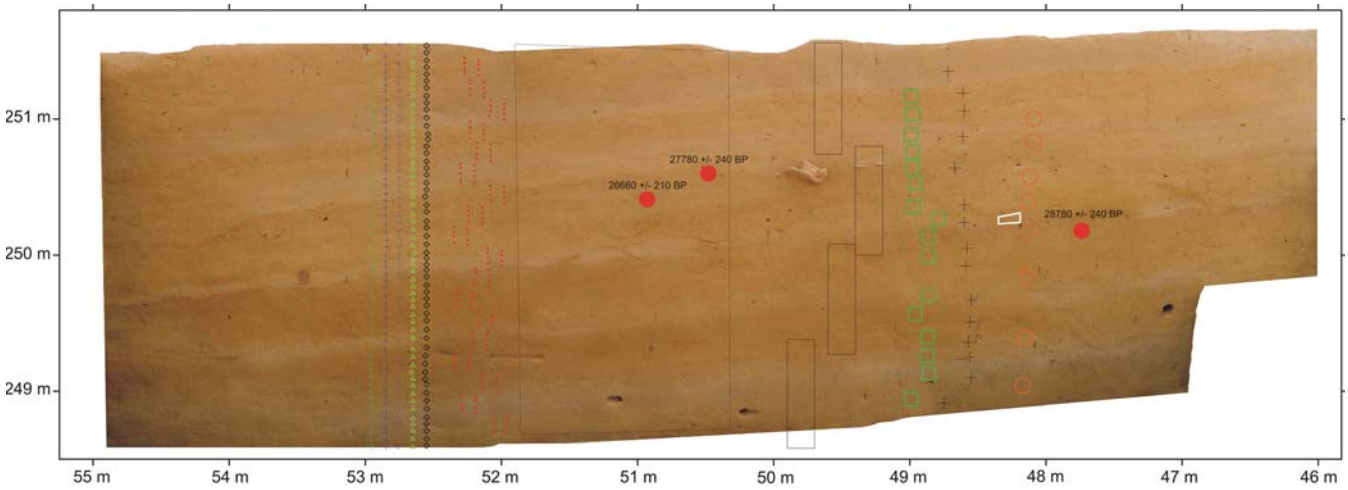

Figure 3: Krems-Wachtberg East. Photogrammetric representation of the south profile with positions of samples (photo/graph with courtesy of OREA, Austrian Academy of Sciences).

and AH 102, and respectively AH 103 and AH 104, are closely spaced. All documented horizons were characterized by periglacial slope processes. While the stratigraphically consecutive archeological horizons AH 101 and AH 102 feature high find densities of lithic artifacts, burnt and unburnt faunal remains, color pigments and charcoal, the archeological horizons beneath, AH 103 and AH 104, show considerably lower find densities. Because study of the find material is still in progress, detailed specifications cannot yet be presented.

Documentation of the profile comprised sampling for sedimentological, malacological and palynological investigations, as well as retrieving samples for geomagnetic measurements, as well as radiocarbon and OSL dating (Figure 3). The strategy was supplemented by the extraction of micromorphological samples and by recovering a series of sediment blocks capturing the entire stratigraphic sequence for future in-depth investigations. Furthermore, a varnish profile was produced.

The areal exposure of the concerned Paleolithic find layers was conducted according to the respective maximal depths of intervention proposed by the construction plans. A highly variable find density was documented in the individual archeological horizons. A further profile with an average height of 1.2 m and a length of about 20.0 m was created along the slope.

In spring 2013, rescheduling on the part of the building contractor required the investigation of 63.0 m^2 to the proposed increased depth of intervention (Figure 4). In the course of fieldwork the remains of a dislocated hearth were documented in archeological horizon AH 104 (Figure 5). The disturbed fireplace was characterized by redeposited burnt sediment, ash concentrations and a small amount of charcoal. The boundaries to the circumjacent sediment were blurred. Ashy spots in AH 104 have been observed and documented in the entire investigated area. Color materials and poorly preserved animal bones occurred equally frequently. Due to their state of preservation the faunal remains could not be recovered, let alone attributed to a particular species. Whereas AH 104 provided no lithic artifacts, a bilaterally retouched blade fragment was recovered from the considerably deeper geological

Figure 4: Krems-Wachtberg East. Overview of the excavation area in 2013 (photo with courtesy of OREA, Austrian Academy of Sciences).

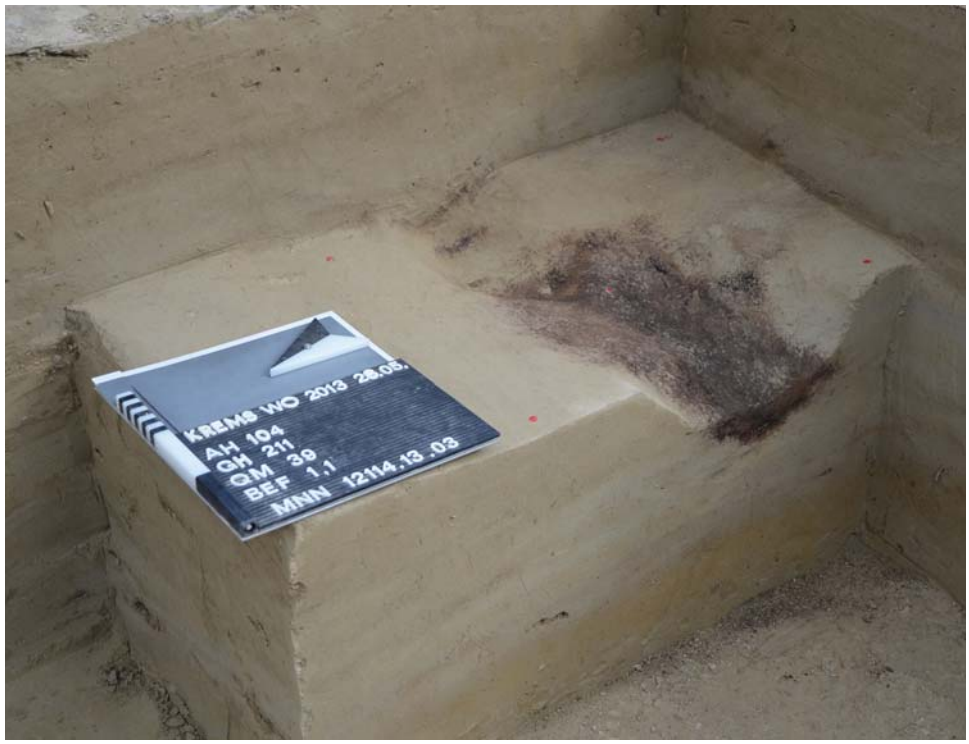

Figure 5: Krems-Wachtberg East. Redeposited hearth remnants in AH 104 (photo with courtesy of OREA, Austrian Academy of Sciences).

site	sample name	laboratory number	geological horizon	archeological horizon	^{14}C-age [BP]	plus	minus
Wachtberg East	ID 1073	POZ-51490	GH 208	AH 101	27, 780	240	240
Wachtberg East	ID 1315	POZ-51491	GH 208	AH 102	26, 660	210	210
Wachtberg East	ID 1687	POZ-51492	GH 211	AH 104	28, 780	260	260
Wachtberg	ID 100362	VERA-4538	GH 25	-	26, 050	200	200
Wachtberg	ID 8886	VERA-3932	GH 26	AH 4.11	28, 300	270	270
Wachtberg	ID 17176	VERA-3933	GH 26	AH 4.11	27, 420	240	230
Wachtberg	ID 17775	VERA-3934	GH 26	AH 4.11	27, 190	230	220
Wachtberg	ID 39440	VERA-4533	GH 26	AH 4.11	27, 230	230	220
Wachtberg	ID 40983	VERA-4534	GH 26	AH 4.11	28, 000	250	240
Wachtberg	ID 10913	VERA-5196	GH 26	AH 4.11	26, 800	220	220
Wachtberg	ID 18075	VERA-3819	GH 26	AH 4.3	26, 520	210	200
Wachtberg	ID 19771	VERA-3935	GH 26	AH 4.4	27, 220	230	220
Wachtberg	ID 21423	VERA-3937	GH 26	AH 4.4	28, 240	270	260
Wachtberg	ID 22056	VERA-3938	GH 26	AH 4.4	27, 000	220	220
Wachtberg	ID 71968	VERA-4536	GH 26	AH 4.4	26, 980	210	210
Wachtberg	ID 23775	VERA-3941	GH 26	AH 4.4	26, 870	220	220
Wachtberg	ID 33435	VERA-4532	GH 26	AH 4.4	26, 840	220	220
Wachtberg	ID 9105	POZ-12920	GH 28	AH 4.4	26, 580	160	160
Wachtberg	ID 22156	VERA-3939	GH 28	AH 5	28, 750	270	270
Wachtberg	ID 22191	VERA-3940	GH 28	AH 5	28, 470	280	270
Wachtberg	ID 64186	VERA-4535	GH 28	AH 5	28, 700	290	280
Wachtberg 1930		GrN-3011	-	-	27, 400	300	300
Wachtberg 1930		Groningen	-	-	27, 910	510	0
Wachtberg 1930		VERA-669	-	-	27, 700	200	200
Wachtberg 1930		VERA-671	-	-	27, 100	170	170
Hundssteig	ID 46008	VERA-2291	-	AH 3.21	27, 200	240	230
Hundssteig	ID 27005	VERA-3280	-	AH 3.21	27, 640	260	260
Hundssteig	ID 225018	VERA-3281	-	AH 3.21	27, 970	270	260
Hundssteig	ID 446001	VERA-3279	-	AH 3.22	27, 800	250	250
Hundssteig	ID 14017	VERA-1615	-	AH 3.24	27, 940	210	210
Hundssteig	ID 413005	VERA-3513	-	AH 3.43	27, 860	270	270
Hundssteig	ID 235002	VERA-3514	-	AH 3.44	28, 070	240	240
Hundssteig	ID 261001	VERA-3515	-	AH 3.44	27, 630	230	230
Hundssteig	ID 239003	VERA-3910	-	AH 3.44	27, 820	270	260
Hundssteig	ID 63012	VERA-2293	-	AH 3.51	28, 550	250	240
Hundssteig	ID 60001	VERA-2292	-	AH 3.51	28, 780	270	260
Hundssteig	ID 121027	VERA-3282	-	AH 3.54	28, 250	280	270
Hundssteig	ID 188007	VERA-3283	-	AH 3.64	28, 360	280	270
Hundssteig	ID 188007	VERA-3912	-	AH 3.64	28, 110	270	260
Hundssteig	ID 436001	VERA-3944	-	AH 3.73	27, 900	230	230
Hundssteig	ID 369003	VERA-3943	-	AH 3.74	27, 790	250	240
Hundssteig	ID 9003	VERA-1616	-	AH 4.14	30, 750	290	280
Hundssteig	ID 232001	VERA-2289	-	AH 4.21	32, 810	450	420
Hundssteig	ID 301001	VERA-3516	-	AH 5.11	41, 000	1300	1100
Hundssteig 1893-1904		KN-654	-	-	35, 500	2000	2000
		VERA-670	-	-	27, 000	150	150

horizon GH 214, which had not yet been conspicuous for the presence of anthropogenic find material.

So far radiocarbon dates have been produced for the archeological horizons AH 101, AH 102 and AH 104 (Figure 3; Table 1). The uppermost Paleolithic find layer AH 101 provided a date of 27, 780 ± 240 BP, AH 102 of 26, 660 ± 210 BP and find horizon AH 104 of 28, 780 ± 240 BP. These results are comparable to the radiocarbon dates assessed for the Gravettian horizons AH 4.11, AH 4.4 and AH 5 of the Krems-Wachtberg site located about 60.0 m to the west of where the Austrian Academy of Sciences has been conducting research since 2005 (Einwögerer *et al.* 2009; Wild and Steier 2010). Also the main horizon of Josef Bayer's Krems-Wachtberg 1930 excavations dates to this time range (Einwögerer 2000). Taking into account the radiocarbon dates of the new excavations at Krems-Hundssteig 2000–2002 (Neugebauer-Maresch and Stadler 2008; Wild *et al.* 2008), the Gravettian settlement of the Wachtberg at Krems falls within the time frame of ca. 28.7–26.5 ky BP. It can therefore be assigned to the older Gravettian in the sense of Jiří Svoboda (Svoboda 1996; 2007a), whereas, to date, evidence of the younger Gravettian is missing.

← ← Table 1: Radiocarbon data from archeological sites in the Krems-Wachtberg area: All dates were determined on charcoal except for Wachtberg ID 10913 (animal bone). Data are listed with 1δ-uncertainty. Designation of geological and archeological horizons is site-specific.

Conclusion

In general, the loess sequence of Krems-Wachtberg East compares well to the stratigraphy of the nearby Krems-Wachtberg sites. This is particularly true for the archeological horizons. In contrast to the rich *in situ* features documented in the course of the excavations conducted since 2005 (Simon *et al.* 2014), however, Krems-Wachtberg East substantiated evidence for find layers with apparently redeposited material. Due to the varying and partly fragmentary data it is hardly possible to determine whether the find layers evidenced by excavations and core sampling represent consecutive depositions, or whether solifluction may have disintegrated and split up one and the same layer (Einwögerer *et al.* 2014). At present a comprehensive site-formation model as shown in detail for Krems-Wachtberg since 2005 (Händel *et al.* 2014) cannot be constructed, although it is highly probable that parameters and processes are comparable. Further insights can only be provided by the results of the pending geomorphological and archeological-paleontological analysis.

Acknowledgements
We express our special thanks to Sandra Sázelová and Martin Novák for the opportunity to contribute to the anniversary monograph dedicated to Jiří Svoboda. Furthermore, we are grateful to Luc Moreau for translating the summary into French. The rescue excavations at Krems-Wachtberg East were financed by the building contractor and the Austrian Academy of Sciences with the support of the Austrian Bundesdenkmalamt.

Résumé
Les séquences loessiques quaternaire, de même que les sites du Paléolithique supérieur sur le promontoire du Wachtberg sur la commune de Krems, sont connus de longue date.

La reprise des opérations de terrain dans le courant des années 1990 a contribué à les replacer au centre de la recherche. Un nouveau site du Paléolithique supérieur a ainsi été découvert en l'an 2000 au cours d'opérations de carottage entre les sites anciennement connus de Krems-Hundssteig et Krems-Wachtberg. La nouvelle concentration a été désignée « Krems-Wachtberg Ost ». En raison d'un projet de construction de grande envergure, des fouilles ont été entreprises à cet endroit en 2012 et 2013. La séquence loessique se compose de seize horizons géologiques (GH 201 – GH 216) et de quatre niveaux archéologiques (AH 101 – AH 104). L'ensemble des horizons et des niveaux documentés ont été affectés par des phénomènes périglaciaires de solifluction en relation avec la situation en pente du site, avec pour résultat une répartition relativement éparse des vestiges. La documentation d'un foyer fortement remanié en AH 104, en association avec quelques taches cendreuses, mérite une mention particulière. Les dates radiocarbone disponibles à ce jour indiquent un âge de 27,780 ± 240 BP pour le niveau AH 101, de 26,660 ± 210 BP pour AH 102, enfin de 28,780 ± 240 BP pour AH 104. De par leur position chronostratigraphique, il est permis de rapprocher les niveaux archéologiques de Krems-Wachtberg Ost avec les niveaux gravettiens des sites voisins de Krems-Wachtberg et de Krems-Hundssteig. Il en ressort une occupation gravettienne de l'ensemble du promontoire du Wachtberg dans la fourchette 28,7–26,5 kyr BP. Les occupations attestées sont donc toutes attribuables au Gravettien ancien d´Europe Centrale, tandis que les vestiges du Gravettien moyen et récent font défaut jusqu'ici.

Zusammenfassung

Seit den 1990er Jahren steht der durch seine quartärgeologischen Aufschlüsse und jungpaläolithischen Fundplätze seit langem bekannte Kremser Wachtberg wieder verstärkt im Fokus der Forschung. Im Zuge ausgedehnter Rammkernsondierungen wurde im Jahr 2000 eine weitere jungpaläolithische Fundzone zwischen den Altfundstellen Krems-Hundssteig und Krems-Wachtberg nachgewiesen. Diese Fundzone wird als Krems-Wachtberg Ost bezeichnet. Aufgrund eines größeren Bauvorhabens fanden hier in den Jahren 2012 und 2013 Ausgrabungen statt. Innerhalb der untersuchten Lössabfolge konnten 16 geologische (GH 201 – GH 216) und vier archäologische Horizonte (AH 101 – AH 104) unterschieden werden. Alle dokumentierten Horizonte waren durch periglaziale Hangprozesse überprägt und weisen vergleichsweise lockere Fundstreuungen auf. Ergänzend konnten in AH 104 eine stark verlagerte Feuerstelle sowie einige Ascheflecken dokumentiert werden. Die bisher vorliegenden Radiokarbondatierungen erbrachten für die hangende Fundschicht AH 101 ein Datum von 27.780 ± 240 BP, für AH 102 ein Datum von 26.660 ± 210 BP und für die Fundschicht AH 104 ein Datum von 28.780 ± 240 BP. Damit lassen sich die Fundhorizonte chronostratigraphisch gut mit den Gravettienschichten der benachbarten Fundstellen Krems-Wachtberg und Krems-Hundssteig vergleichen und ergeben für den Kremser Wachtberg eine gravettienzeitliche Belegung im Zeitraum von ca. 28,7–26,5 kyr BP. Die Begehungen sind damit dem Älteren Gravettien Zentraleuropas zuzurechnen, während Funde des jüngeren Gravettien aus dem Gebiet bisher fehlen.

A NEW LOOK AT AN OLD SITE: STUDIES OF THE KRAKÓW SPADZISTA SITE 1968–2013

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Abstract
The excavations at site Kraków Spadzista (Poland) were conducted in eleven trenches from 1968 until present with several interruptions. During this period approximately 370.0 m^2 of the site were explored. The series of radiocarbon dates cluster from 25.0 to 20.0 ky uncal BP, placing the site into the Gravettian cultural complex. Up to 2013 more than 50, 000 bone remains of different mammals of the Pleistocene steppe-tundra environment were discovered. At Kraków Spadzista site most of the faunal remains belong to woolly mammoth, of which a minimum of 93 individuals were estimated. Other large mammal taxa are represented only by isolated bones and teeth of single individuals. On the basis of the analyses of lithic materials, faunal remains, and radiometric data we can suggest that the Kraków Spadzista site was frequently re-occupied area by groups of Gravettian hunters within periods of few weeks or months. This short-term camp site was related to mammoth hunting. Most of the animals were probably killed by hunters directly at the site or in close vicinity, and then dismembered. The analysis allows the identification of three possible activity zones: a camp area, a lithic workshop, and an animal-processing area, besides the well-known accumulation of mammoth bones.

Keywords
Gravettian, settlement strategies, faunal remains, Kraków Spadzista, Poland

DOI: 10.5817/CZ.MUNI.M210-7781-2015-15

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Introduction

In the late autumn of 1967, very close to the center of old Kraków and about 2.0 km from Wawel castle and the Main Market Square, a huge accumulation of mammoth bones was accidentally discovered (Figure 1). This new archeological site was called Kraków Spadzista Street (B), and regular fieldwork at this site was started in 1968

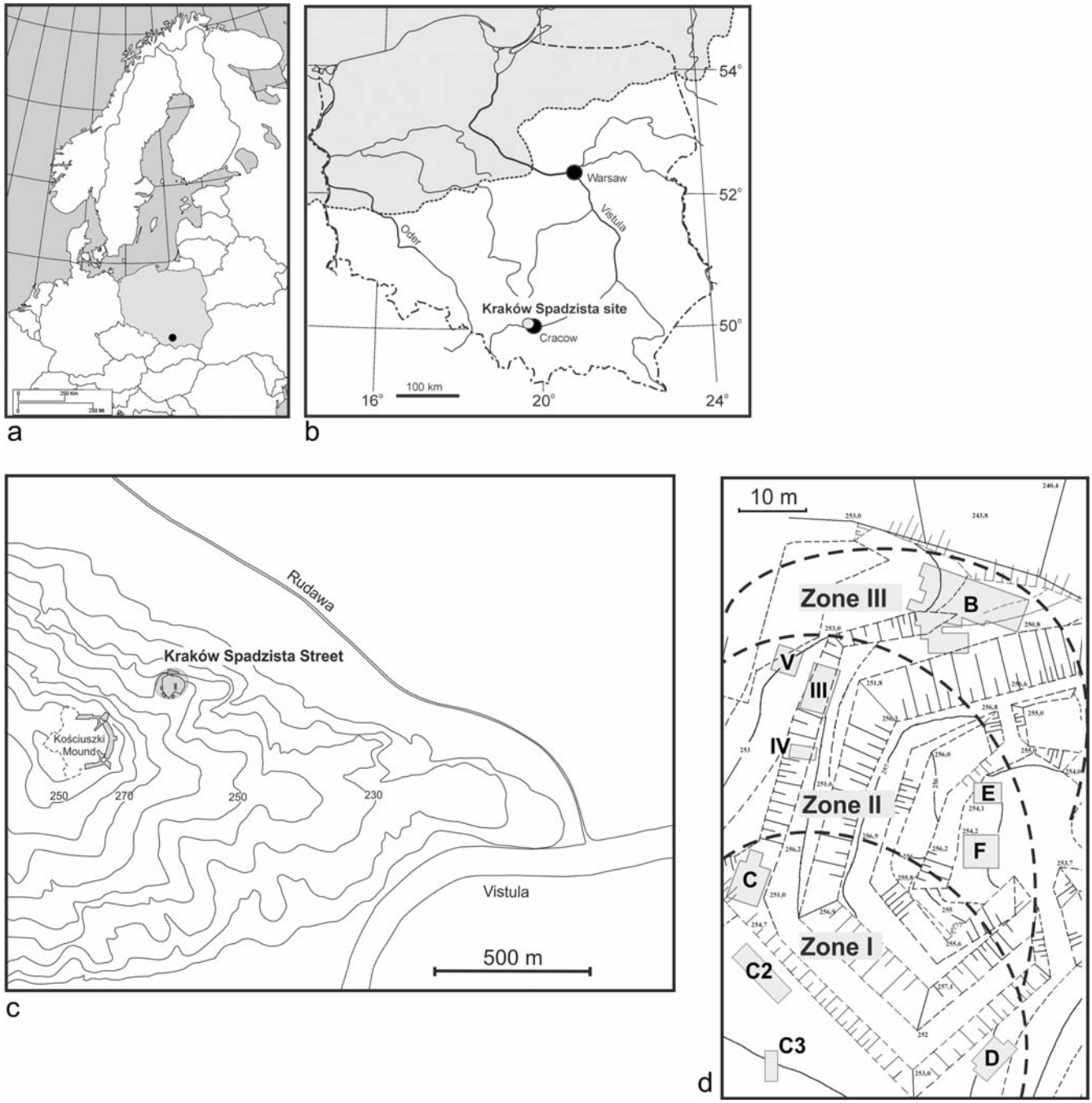

Figure 1: Location of the Kraków Spadzista site. (b) the approximate southernmost ice sheet limit during the Last Glacial Maximum (LGM); (c) location of the Kraków Spadzista site on Blessed Bronisława Hill and (d) plan of the trenches at the site with suggested zones of different spatial sets of human activity.

→ → Table 1: Radiocarbon dates for the Kraków Spadzista site. All samples are AMS dates unless otherwise stated. Calibrated using OxCal (Reimer *et al.* 2013).

trench	radiocarbon date	calibrated date (BP)		labolatory	sample source		literature
		from	to				
Spadzista C2	17, 400 ± 310 BP	21, 860	20, 265	Ly–2541	unidentified bone fragment	Conventional	Kozłowski and Sobczyk 1980
Spadzista B	19, 450 ± 120 BP	23, 770	23, 044	Poz-31039	carbonised bone	AMS	Wilczyński *et al.* 2012
Spadzista C2	20, 200 ± 350 BP	25, 280	23, 522	OxA–635	mammoth bone	Conventional	Kozłowski and Sobczyk 1980
Spadzista B	20, 600 ± 1050 BP	27, 262	22, 646	Ly-631	mammoth bone	Conventional	Kozłowski *et al.* 1974
Spadzista C2	21, 000 ± 900 BP	27, 342	23, 410	Ly-2542	unidentified bone fragment	Conventional	Kozłowski and Sobczyk 1980
Spadzista C trench II	21, 920 ± 200 BP	26, 638	25, 796	Poz-28809	reindeer bone	AMS	Wilczyński *et al.* 2012
Spadzista D	22, 330 ± 160 BP	27, 087	26, 166	Poz-26226	carbonised bone	AMS	Wilczyński *et al.* 2012
Spadzista C3	22, 770 ± 160 BP	27, 445	26, 641	Poz-31040	carbonised bone	AMS	Wilczyński *et al.* 2012
Spadzista F	22, 900 ± 600 BP	28, 257	25, 990	KI–3712	unidentified bone fragment	Conventional	Montet-White 1996
Spadzista B	23, 020 ± 180 BP	27, 665	26, 994	Poz-242	mammoth bone	AMS	Wojtal and Sobczyk 2005
Spadzista B	23, 040 ± 170 BP	27, 655	27, 040	GrN-6636	carbonised bone	Conventional	Kozłowski *et al.* 1974
Spadzista E	23, 150 ± 190 BP	27, 730	27, 114	Poz-28733	polar fox bone	AMS	Wilczyński *et al.* 2012
Spadzista F	23, 600 +1400/ -1200 BP	–	–	KI–3713	unidentified bone fragment	Conventional	Montet-White 1996
Spadzista B	23, 750 ± 140 BP	28, 121	27, 583	Poz-1248	mammoth bone	AMS	Wojtal and Sobczyk 2005
Spadzista B	23, 750 ± 150 BP	28, 151	27, 572	LuS 7417	mammoth bone	AMS	Arppe and Karhu 2010
Spadzista C2	23, 750 ± 150 BP	28151	27, 572	LuS 7418	mammoth bone	AMS	Arppe and Karhu 2010
Spadzista B	23, 770 ± 160 BP	28, 205	27, 576	Poz-1251	mammoth bone	AMS	Wojtal and Sobczyk 2005
Spadzista B	23, 980 ± 280 BP	28, 629	27, 625	Poz-225	mammoth bone	AMS	Wojtal and Sobczyk 2005
Spadzista B	24, 000 ± 300 BP	28, 675	27, 616	Poz-268	mammoth bone	AMS	Wojtal and Sobczyk 2005
Spadzista E	24, 200 ± 140 BP	28, 596	27, 886	Poz-27292	carbonised bone	AMS	Wilczyński *et al.* 2012
Spadzista trench III	24, 240 ± 160 BP	28, 652	27, 899	Poz-28735	mammoth bone	AMS	Wilczyński *et al.* 2012
Spadzista C2	24, 380 ± 180 BP	28, 789	27, 979	GrN-1006	charcoal	Conventional	Kozłowski and Sobczyk 1980
Spadzista C2	24, 460 ± 160 BP	28, 840	28, 095	Poz-23644	mammoth bone	AMS	Wilczyński *et al.* 2012
Spadzista C2	24, 470 ± 150 BP	28, 834	28, 130	Poz-23645	mammoth bone	AMS	Wilczyński *et al.* 2012
Spadzista F	24, 625 ± 180 BP	29, 083	28, 235	LuS 7420	mammoth bone	AMS	Arppe and Karhu 2010
Spadzista F	24, 640 ± 160 BP	29, 047	28, 303	Poz-28734	polar fox bone	AMS	Wilczyński *et al.* 2012
Spadzista C2	24, 690 ± 230 BP	29, 307	28, 221	Poz-27375	carbonised bone	AMS	Wilczyński *et al.* 2012
Spadzista E	24, 700 ± 180 BP	29, 189	28, 334	LuS 7419	mammoth bone	AMS	Arppe and Karhu 2010

(Kozłowski and Kubiak 1972; Kozłowski *et al.* 1974). In 1973, excavations at the area of the mammoth bone assemblage were stopped, but, then, other trenches located close to it were explored. Regular fieldwork at different trenches was continued with few stops until 2013. During these 45 years, excavations were conducted in 11 trenches; all of them are situated within the area of a 19th century Austrian fortification (Figure 1).

The Kraków Spadzista site is situated at a height connected with the main summit of Blessed Bronisława Hill and is limited from the north by a rock cliff and from the west and east by a large Pleistocene depression. It is located about 50.0 meters above the Rudawa River valley (Kozłowski *et al.* 1974). Archeological and paleontological materials were discovered in all trenches. Most of them were found in the layer of tundra gley, which had developed in a soliflucted clay loam deposited under a moist and harsh climate (layer 6). In trench B + B1, the layer measured from 30.0 to 100.0 cm in thickness (Kozłowski *et al.* 1974; van Vliet 1974; Kalicki *et al.* 2007). However, some of the archeological artifacts were found in older sediments – a colluvial or soliflucted calcareous sandy loam (layer 7) – and also in a younger layer 5.

Radiocarbon dating

A series of radiocarbon dates (Table 1) allow determining the time of the site's occupation at the end of the Interpleniglacial – from 25.0 to 20.0 ky uncal BP. It should be noted that most of the dates from trench B (mammoth bone accumulation) focused between 23.0 and 24.0 ky uncal BP (Table 1). Unfortunately, until now, we have no direct, unquestionable radiocarbon dates corresponding to the Aurignacian and Epigravettian occupation discovered at the site.

Archeological finds – stone artifacts

The Kraków Spadzista site is best known as a Gravettian site. The main cultural level (layer 6) is represented in all trenches and contains characteristic tools, such as shouldered points and Kostienki knives, which define the shouldered point horizon of the Gravettian (Kozłowski 1996) (Table 2). Below the main cultural Gravettian level, in layer 7, Aurignacian stone artifacts were discovered. They are presented in almost the whole surface of the site, whereas Epigravettian artifacts, discovered in layer 5, are observed mainly in the NW part of the site at trench B + B1 and the B "workshops" (Drobniewicz *et al.* 1976; Wilczyński 2007).

The Gravettian stone inventory composition of trench B+B1 is meaningful. This area contained the highest proportion of retouched tools among all sectors of the site (Wilczyński *et al.* 2012). Shouldered points and backed blades are the most numerous; some of them have visible signs of impact damage, which indicates they were use as projectile points – probably during mammoth hunting. The high proportion of burins and the use of part of them as knives are also notable (Stefański 2007). The presence of a large number of flint artifacts useable as projectile points (such as shouldered points, Gravette points) and knives (namely burins, Kostienki

Table 2: Number of inventory and tool groups from all trenches of Kraków Spadzista site.

inventory(without chips and chunks)	zone I – camp area			zone II – stone tools workshop		zone III – bone assemblage		total
	Spadzista C and trench II	Spadzista C2	Spadzista D	Spadzista E	Spadzista F	Spadzista B	Spadzista B „workshop" trench III and V	
	N	N	N	N	N	N	N	N
cores	29	48	40	11	9	63	7	**207**
flakes	408	2,214	1,502	214	311	773	229	**5,651**
blades	141	3,504	2,045	234	221	883	133	**7,161**
tools	75	431	351	36	51	488	21	**1,453**
total	**653**	**6,197**	**3,938**	**495**	**592**	**2,207**	**390**	**14, 472**
end scrapers	6	9	12	1	1	13	2	**44**
burins	27	127	139	11	16	88	6	**414**
backed pieces	17	177	56	6	14	95	5	**370**
shouldered points	2	10	5		3	125	1	**146**
truncations		4	2			7		**13**
Kostienki knives	2	10	18	5	2	51	3	**91**
retouched blades	11	51	74	6	15	69	1	**227**
retouched flakes	6	24	15	3		26	2	**76**
others	4	19	30	4		14	1	**72**
total	**75**	**431**	**351**	**36**	**51**	**488**	**21**	**1,453**

knives, retouched blades) supports the proposition that the killing of mammoth and the processing of their carcasses took place at the site.

Archeological finds – ornaments and bone artifacts

Bone artifacts, both bone tools and ornaments made from animal teeth or bones, are rare at the Kraków Spadzista site. They were found in trenches B + B1, C, C2 and F. In other trenches, no bone artifacts were noted. In earlier papers, "lamps" made from mammoth *cuboideum* bone and *patella*, similar to those discovered in Mezhirich (Ukraine), were mentioned from trench E and F (West 1996a). However, our studies show that no human modification is visible on these remains.

Among the very large numbers of stone tools from trench B + B1, only a few bone artifacts were found:

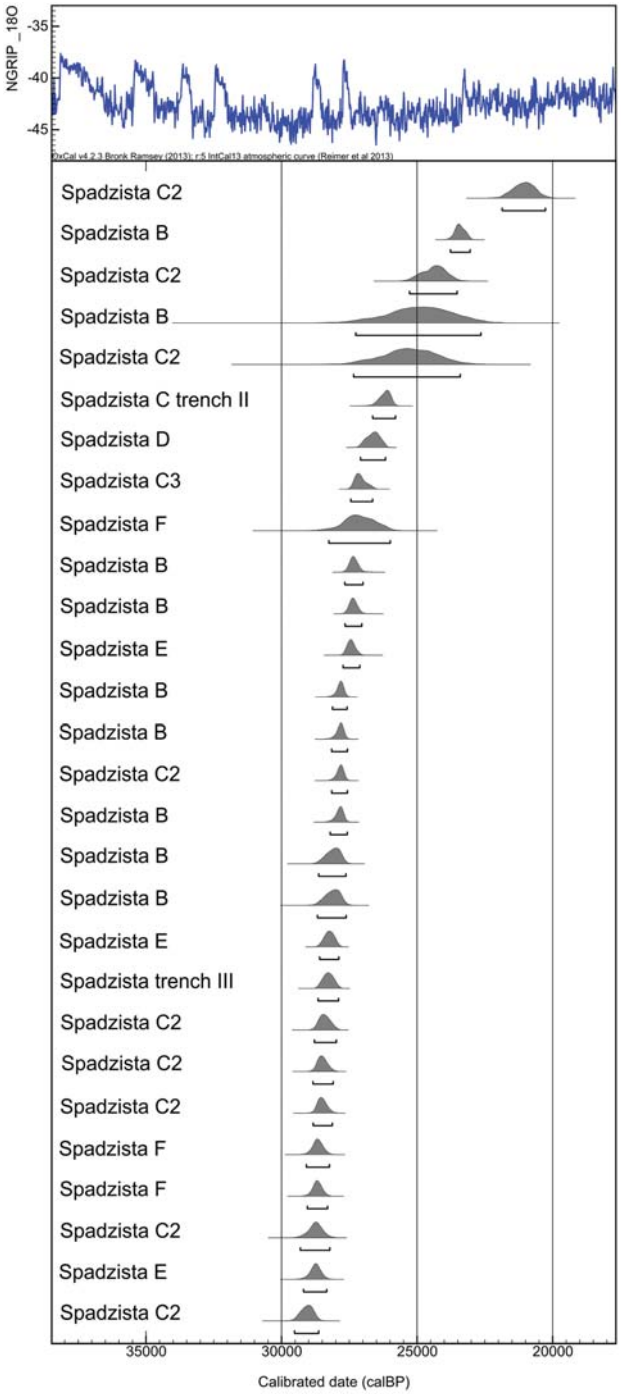

Figure 2: Plot of radiocarbon dates alongside the NGRIP ice core $\delta^{18}O$ record, generated using the radiocarbon calibration program OxCal v.4.2.3; r:5. Atmospheric data after Reimer *et al.* (2013).

- a retouched scraper made on a fragment of a bone, probably mammoth (Figure 3).
- a small fragment of bone or an ivory point (length about 2.5 cm) (Figure 4).

In this trench, were only two finds that can be described as art objects:

- part of a mammoth rib with intentional notches at both edges (Figure 5). The bone was broken, and two fragments were found in different square meters. They were moved by solifluction.
- a fragment of a mammoth rib covered by a large number of lines (Figure 6). They are irregular and cross each other. It is not possible to unequivocally describe this artifact as an art object. We cannot exclude the possibility that this bone fragment was used as protection during manipulating or cutting animal hides.
- a fragment of a carefully polished bone artifact (probably a mammoth rib). The preserved fragment is damaged and broken. On the bone edge, three notches are preserved (Figure 7)
- a fragment of a reindeer femur (10.0 cm long) with unusually deep cut marks was discovered in trench B + B1 (Figure 8). These marks were probably created during trying to split the bone for preparing a tool or art object.

It is not surprising that the largest number of bone artifacts and ornaments was found in trenches C and C2 located on the campsite area. They were discovered during fieldwork in the 1980s and 2000s. They are presented by:

- three pendants made from carnivore teeth, which were found during excavations in 1980 and 2011. There are two upper bear incisors and one wolf upper third incisor. All of them are ornamented in a similar way by series gentle cuts on the tooth roots (Figures 9–11). The first tooth has six preserved notches, and the second one has eight. The ornaments are located on the labial part of the roots. Despite similar decorations, they differ in the method of suspensions. The first bear incisor has a preserved damaged hole. The second has a notch around the tip of root, which was used for suspension of a pendant. The pendant is made from a wolf's tooth and is decorated by 10 notches on the labial part of the root and two series of notches (eight and seven) on the lingual part of the root. The wolf incisor has an unfinished hole.
- a small pendant (2.2 cm length; 1.4 cm width) made from a mammoth tusk was found in 1980. It is polished into a

Figure 3: Kraków Spadzista B + B1. Retouched scraper made on a fragment of a mammoth (*Mammuthus primigenius*) bone. Scale is 10.0 cm.

Figure 4: Kraków Spadzista B + B1. Fragment of bone or ivory point. Scale is 2.0 cm.

Figure 5: Kraków Spadzista B + B1. Mammoth (*Mammuthus primigenius*) rib fragment with intentional notches on edges. (a) details of two fragments of the rib were found in different square meters and both have the same notches (b and c). Scale is 10.0 cm

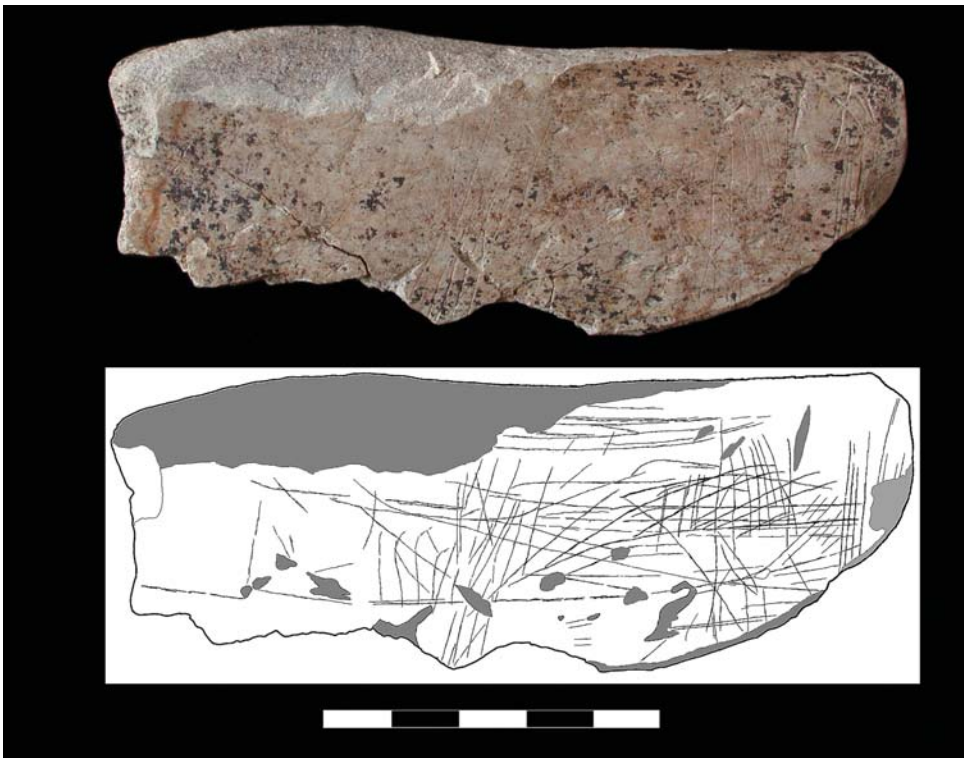

Figure 6: Kraków Spadzista B + B1. (a) mammoth *(Mammuthus primigenius*) rib fragment with engravings; (b) illustration of a mammoth rib fragment with engravings. Scale is 5.0 cm.

pear shape. The other side is polished and flattened. It should be noticed that the artifact is burned and its color is brown (Figure 12).

- an artifact made from part of a long limb bone (probably femur) of a wolf/reindeer-sized animal was discovered in 2011. The bone (length 3.5 cm) was cut from both sides and carefully polished. The surface of the artifact is also polished and ornamented by seven engraved lines (Figure 13a). A drilled hole (Figure 13b) and eight oblique notches (Figure 13c) are also present. We cannot exclude that this is a final product artifact, which was found during excavations in trench B + B1 (Figure 8).
- a fragment of bone, probably a scapula of a hare/fox-sized animal, is polished and ornamented by a series of small notches. A different number of notches are located on all bone edges (Figure 14).
- a fragment of polished bone (4.7 cm length and 1.5 wide), which is certainly part of a larger artifact. It has 30 small notches (about 0.5 mm width) on one edge. On the opposite edge, are three wide (from 5.0 mm to 1.0 mm), large (about 5.0 mm) indentations (Figure 15).
- a fragment of polished bone (3.4 cm length; 1.7 cm width) with eight narrow (about 0.5 mm width) notches on its edge (Figure 16). It is probably a fragment of a mammoth bone.
- a very carefully polished fragment of bone (probably mammoth) in a point shape. The length of the artifact is 7.5 cm and its width at its widest point is 1.9 cm. On the edge, are five small notches (Figure 17).

↑ Figure 7: Kraków Spadzista B+B1. Fragment of a carefully polished bone artifact, probably made from a mammoth rib with three preserved notches. Scale is 2.0 cm.

↑→ Figure 8: Kraków Spadzista B+B1. A reindeer (*Rangifer tarandus*) femur with unusually deep cut marks suggesting preparation of a tool or art object and a detailed view of the cut marks. Scale is 5.0 cm.

Figure 9: Kraków Spadzista C2. A pendant made from a bear *(Ursus* sp.) upper incisor with notches. Scale is 2.0 cm.

Figure 10: Kraków Spadzista C2. A pendant made from a bear (*Ursus* sp.) upper incisor with notches. Scale is 2.0 cm.

Figure 11: Kraków Spadzista C2. A pendant made from a wolf (*Canis lupus*) third upper incisor with notches. Scale is 2.0 cm.

Figure 12: Kraków Spadzista C2. A pendant made from a mammoth (*Mammuthus primigenius*) tusk. The pendant is burned. Scale is 2.0 cm.

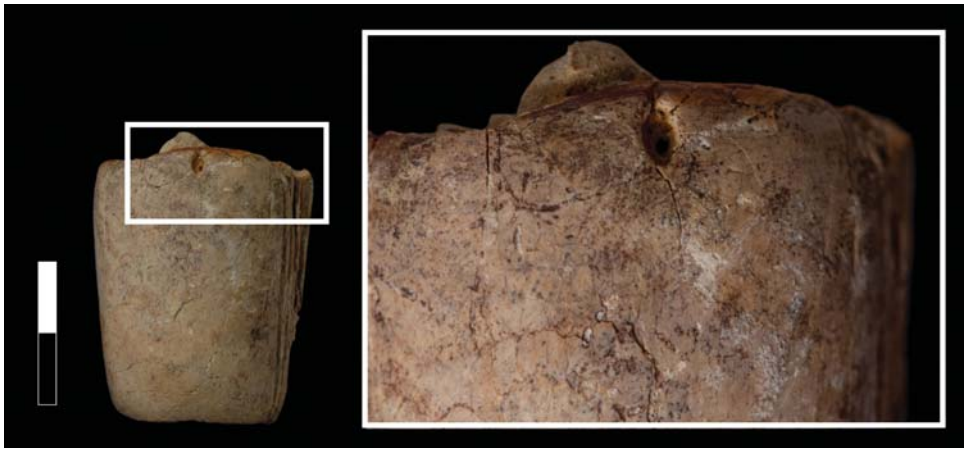

Figure 13: Kraków Spadzista C2. (a) an artifact made from part of a long limb bone (probably a femur) of a wolf/reindeer-sized animal; (b) a detailed view of a drilled hole; (c) a detail view of an ornament. Scale 2.0 cm.

- an artifact made probably from a mammoth rib (length 13.2 cm, width 2.3 cm) that is partly damaged. It is polished, and its shape resembles a point. (Figure 18).
- an artifact made probably from a mammoth rib (length 9.5 cm, width about 1.5 cm). It is carefully polished and its shape resembles a point. It is broken along the long edge (Figure 19).
- a small bone fragment (length 2.5 cm), probably from a larger artifact, has five parallel wide (about 1.0–2.0 mm) notches (Figure 20).
- a small fragment (about 5 cm long) is a root fragment of a mammoth tooth found in 2011. There are two oblique, large and wide (about 5.0 mm) notches (Figure 21). The purpose of making them is unknown. Their location and size exclude their being made accidentally during dismembering a mammoth body or during tooth extraction.

In trench F, only one fragment of bone artifact was discovered. It is probably part of a shovel like tool (Figure 22).

It should be noted also that a fragment of stone, carefully polished into an oval shape (in cross-section) with notches on both edges, was discovered during the 1980s (Kozlowski and Sobczyk 1987) (Figure 23).

Figure 14: Kraków Spadzista C2. A fragment of a bone of a hare/fox sized animal, polished and ornamented by a series of small notches. Scale is 5.0 cm.

Paleontological finds

In total, all seasons of excavations at the Kraków Spadzista site yielded more than 26, 000 mammal remains (Wilczyński *et al.* 2012). The most spectacular paleontological finds were discovered in trench B + B1. There, in a very small area, about 150.0 m^2, remains of a minimum of 86 woolly mammoth individuals were discovered (Wojtal and Sobczyk 2005; Kalicki *et al.* 2007; Wilczyński *et al.* 2012). The osteological material is dominated by woolly mammoth (*Mammuthus primigenius*) bones and teeth. There were more than 6,000 remains (NISP = 6,375) identified from all parts of the mammoth skeletons (cranial and post cranial). Except those mentioned above, the identifiable mammoth remains amount to more than 16, 000 bone fragments that were collected in trench B + B1 (Table 3). Their dimensions and the thickness of the cortical part of the bones suggest that it is very possible that they came

↑ Figure 15: Kraków Spadzista C2. A fragment of a polished bone with a series of small notches and three large indentations. Scale is 5.0 cm.

→ Figure 16: Kraków Spadzista C2. A fragment, probably of a polished mammoth bone, with series of notches. Scale is 2.0 cm.

Figure 17: Kraków Spadzista C2. A fragment of bone (probably mammoth) very carefully polished into a point shape. Scale is 5.0 cm.

Figure 18: Kraków Spadzista C2. An artifact probably made from a mammoth (*Mammuthus primigenius*) rib. Scale is 5.0 cm.

Figure 19: Kraków Spadzista C2. An artifact probably made from a mammoth (*Mammuthus primigenius*) rib. Scale is 5.0 cm.

Figure 20: Kraków Spadzista C2. A small fragment, probably of a larger artifact, with five wide notches. Scale is 2.0 cm.

Figure 21: Kraków Spadzista C2. A small root fragment of a mammoth (*Mammuthus primigenius*) tooth with two wide parallel notches. Scale is 2.0 cm.

Figure 22: Kraków Spadzista C2. A fragment of a bone artifact made from a mammoth (*Mammuthus primigenius*) bone. Probably a shovel like tool. Scale is 5.0 cm.

from mammoth bones. In other zones (represented by other trenches) of the site, mammoth remains were also discovered. Bones of this animal dominate in the paleontological material also at other parts of the site (Table 3). Similar to the case in trench B + B1, the morphological features and dimensions of indeterminate bone fragments suggest that they come from mammoth bones. We can assume that, in the whole area of the Kraków Spadzista site, nearly 27, 000 woolly mammoth remains belonging to a minimum of 93 individuals were discovered during the excavation seasons (Table 3).

Other than the huge number of mammoth remains, single bones or teeth of seven representatives Late Pleistocene steppe-tundra species were discovered. However, they are represented in much smaller proportions (Table 3). In all trenches until 2011, only 164 teeth or bones of other mammals, e.g., Arctic fox (*Vulpes lagopus*), wolf (*Canis lupus*), reindeer (*Rangifer tarandus*) and horse (*Equus ferus*), were found (Wojtal and Sobczyk 2005; Kalicki *et al.* 2007; Wilczyński *et al.* 2012). These species are represented by only a few individuals. One exception is Arctic fox remains, which were found especially in trenches E, E1 and F. During old excavations conducted in the 1970s and 1980s, a few dozen bones and teeth of this species, belonging to a minimum of 11 individuals, were collected (Wilczyński *et al.* 2012). It should be mentioned that, in 2012 at trench E1, located between trenches E and F, a few hundred bones and teeth of this species were collected (Wilczyński and Wojtal unpublished data; the remains are still under analysis). Such a large disproportion in the amount of Arctic fox remains is caused by the water sieving of the sediments of the Gravettian cultural layer during recent fieldwork. This allowed collection of a large number of small remains of polar foxes (e.g., metapodials, phalanges, isolated teeth).

Carnivores are also represented by the remains of large predators (bear and wolf). There are not only the mentioned above pendants but also other parts of the skeleton, e.g., skull fragments (maxilla and mandibles), metapodials and phalanxes (Wilczyński *et al.* 2012). Their remains are spread through the whole site and were found in trenches B + B1, C2, E, E1 and F. Remains of three herbivore species (woolly rhino, horse and reindeer) were found in different parts of the site. There are only two bones of woolly rhino and seven remains of horse. Reindeer are represented by a larger number of specimens – 36 bones and teeth. It should be mentioned that, during wet sieving of sediments from the Gravettian cultural layer, rodent remains (namely *Dicrostonyx gulielmi, Microtus gregalis, Microtus arvalis/agrestis, Arvicola terrestris, Lemmus lemmus,* and *Microtus* sp.) were discovered. They were noted in trenches B + B1 and C2.

Figure 23: Kraków Spadzista C2. A fragment of stone, carefully polished into an oval shape (in cross-section) with notches on both edges. Scale is 5.0 cm

Table 3: Summary NISP (Number of Identified Specimens) and MNI (Minimum Number of Individuals) for mammals distributed in different zones at Kraków Spadzista.

Taxon	zone I camp site		zone II stone tools workshop and processing of animals		zone IIImammoth bones assemblage		total for all zones	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Rodentia	8						**8**	
Lepus sp. hare					6	1	**6**	**1**
Canis lupus wolf	10	1	1	1	9	1	**20**	**3**
Vulpes lagopus/vulpes foxes	211	4	69	6	5	2	**285**	**12**
Ursus sp. bear	4	1	3	1	2	1	**9**	**3**
Mammuthus primigenius woolly mammoth	750	3	172	3	6,400	87	**7,322**	**93**
Coelodonta antiquitatis woolly rhinoceros			1	1	1	1	**2**	**2**
Equus ferus horse	11	1	1	1	1	1	**13**	**3**
Rangifer tarandus reindeer	38	2	1	1	15	1	**54**	**4**
Cervidae	3						**3**	
determinate	**1,035**		**248**	**14**	**6,437**	**95**	**7,720**	**109**
fox/hare sized animals	82		9				**91**	
reindeer/wolf sized	66		8				**74**	
horse sized animals	19		1				**20**	
mammoth sized animals	2,427		255		16, 978		**19, 660**	
indeterminate	**26, 608**		**273**		**16, 978**		**43, 859**	
total NISP/MNI	**27, 643**	**12**	**521**	**14**	**23, 415**	**95**	**51, 579**	**121**

Interpretation

The Kraków Spadzista site is one of the most famous and important Gravettian sites in Poland and the rest of Europe. Fieldwork there started in 1968 and continued with few stops until 2013. For 45 years, 10 trenches localized in an area of about few hundred square meters were excavated. The fieldwork covered different zones of the site (Wilczyński *et al.* 2012). Based on the field research, we can assume that the Gravettian activity primarily occurred on almost the entire area of the promontory (about 2.0 ha). The hunter-gatherers occupation during that period of time covers no more than 5,000 years, between 25.0 ky and 20.0 ky uncal BP (Table 3, Figure 2). However, it should be pointed out that most of the dates made from mammoth bones from the B + B1 trench (mammoth bone accumulation) cluster in a shorter time, from 24.0 ky to 23.0 ky uncal BP. One younger date comes from a burned bone, and it is not possible to identify the kind of species. This could suggest that the huge mammoth bone assemblage was created during only a certain period of the site's occupation.

The excavations at the site started in the 1970s in terms of the most impressive area – the mammoth bone accumulation (trench B + B1). At this area, excavations were undertaken in two stages. The first part of the fieldwork was conducted from 1968 to 1973. In 1989, new fieldwork began a few meters southwest of trench B, and a new trench was designated as B1. The following studies between 1989 and 2002 allowed the joining of trenches – the old (studied in the 1970s) and the new (studied in the 2000s). The uncovered mammoth bone assemblage is probably even bigger than that studied until today. Primarily, after finishing the excavations in 1973 at trench B, the presence of the remains of two or three dwellings made from mammoth bones was suggested (Kozłowski and Kubiak 1972; Kozłowski *et al.* 1974). In this hypothesis, the area of trench B, and later also of B1, was interpreted as a base camp of Gravettian hunters. The bones used to construct the dwellings came from mammoths killed in the nearby Rudawa valley and were transported by people to the site (Kozłowski and Kubiak 1972; Kozłowski *et al.* 1974). Later archeological, taphonomical and zooarcheological studies have created another interpretation of this mammoth bone accumulation (Sobczyk 1995; Wojtal 2001; Wojtal and Sobczyk 2003; Wojtal 2004; Wojtal and Sobczyk 2005). They show that, at this area, complete mammoth skeletons are represented. The presence of all bones from the mammoth skeletons, including abundant non-meaty bones such as hyoids, caudal vertebras, sesamoids and phalanges, supports this suggestion. Indeed, an unexpectedly high number (NISP = 451) of these small, easily destroyed and low utility woolly mammoth bones were recovered. It is unlikely that people carried these elements as baggage along with other bones more suitable for use as dwelling walls. A comparison with bone proportions at the Mezhirich (Ukraine) site is instructive; people there used mammoth bones to erect dwellings (Soffer 1985; Lister and Bahn 1994), and the remains needed for the construction were probably transported from a nearby non-cultural mammoth "cemetery." There are significant differences in the proportion of bones found in Kraków Spadzista and Mezhirich. At Mezhirich, bones useful for the building of huts dominate especially flat bones (scapula, innominate)

and mandibles. Other bones that would not have been as useful are represented in much smaller numbers. But at Kraków Spadzista (+ B1), small bones not useful for the construction of huts are represented in large numbers. At Mezhirich, the quantity of phalanges (NISP = 17) and sesamoids (NISP = 2) is extremely low in the remains of dwellings, unlike the situation at the Kraków site where far more phalanges (NISP = 172) and sesamoids (NISP = 85) were found. The same is true for vertebral bones; at Mezhirich, there are 201, and, at Kraków Spadzista, there are 859 specimens. In contrast, the bone composition from the Milovice site in the Czech Republic, a mammoth kill site, is similar to the bone composition at the Kraków Spadzista site (Svoboda *et al.* 2005; Brugère and Fontana 2009; Brugère *et al.* 2009). We can assume that mammoths died at or in the vicinity of the trench B + B1 area. It is very possible that most of them were killed by people, but we cannot exclude the possibility that some of the animals died naturally. The suggestion of mammoth killing by Gravettian hunters is supported by the large number of shouldered points and backed blades in trench B + B1, which could have been used as a spear points. It should be noted that many of the shouldered points have characteristic impact traces, which could be the result of hitting mammoth bone (Kufel-Diakowska et al. in preparation).

From 1973 until 2012, other trenches of the Kraków Spadzista site, called next using alphabet letters, were excavated (Figure 1). At first, all studied trenches were regarded as isolated sites (e.g., site C2; Kozłowski and Sobczyk 1987). However, new data (archeological, paleontological, zooarcheological, radiocarbon dates) collected during the last few years allow us to state that all these trenches were located in the different zones of one large site (Wilczyński *et al.* 2012). Now we can interpret the Kraków Spadzista site as one large Gravettian hunter-gatherer site where a few zones of activity can be described. In zone I, which covers the camp area, trenches C, C2, C3 and D were excavated. In zone II, where the workshop and animal-processing areas were, trenches E, E1 and F were studied. Trenches B + B1, B (workshop), III and V lie in zone III. The zone of the accumulation of mammoth bones lies at the north part of the site and is limited by a rocky cliff. Gravettian hunters probably killed mammoth at the site or close to it. The mammoth bodies were skinned and dismembered at the site and the remains left in zone III (bone assemblage).

Huge numbers of mammoth remains with a large number of carnivore gnawing marks visible on them suggest that hunters stayed at the site only during some periods. They were killing mammoths and other mammals, but the small number of bone and ivory artifacts shows that the site was occupied temporarily not permanently. After the hunters abandoned the site, large carnivores (wolves or cave hyenas) had access to the mammoth bones, as indicated by the presence of a large number of gnawed bones. However, hunters returned to the site after a few months. Also, the presence of few bone and ivory artifacts shows that the site was occupied temporarily rather than permanently. It also confirms that it was regularly abandoned by the inhabitants.

The bone artifacts from the Kraków Spadzista site are decorated in a characteristic way by a series of regular notches. This is obvious especially on the

pendants (Figures 9, 10, 11) where the notches are made on the roots. It is also clear that the bone artifacts are mostly made from mammoth ribs and reach from few to a dozen centimeters in length. They are also ornamented by a series notches on the bone edges (Figures 5, 7, 13, 14, 15 and 18).

The excavations at the Kraków Spadzista site were undertaken jointly by the Institute of Archeology at the Jagiellonian University and the Institute of Systematics and Evolution of Animals of the Polish Academy of Sciences. During the 45 years of study of this site, many scientists from several countries analyzed the archeology, paleontology, zooarcheology and geology of the site. Janusz K. Kozłowski, Krzysztof Sobczyk, Elżbieta Sachse-Kozłowska, Barbara Drobniewicz, Anta Montet-White (USA), William Banks (USA), Catherine Escutenaire (Belgium), Valery Sitlivy (Belgium), Damian Stefański, and Jarosław Wilczyński described the archeological material (Kozłowski *et al.* 1970, 1975; Drobniewicz *et al.* 1976; Kozłowski and Sobczyk 1987; Sobczyk 1995, 1996; Banks 1996; Escutenaire et al. 1999; Stefański 2007; Wilczyński 2007, Wilczyński *et al.* 2012, Wilczyński *et al.* 2015). Henryk Kubiak and Grażyna Zakrzewska studied the mammalian remains in the 1970s. Gary Haynes (USA), Dixie West (USA), Piotr Wojtal, Jarosław Wilczyński, Alina Krzemińska and Grzegorz Lipecki are studying the mammalian remains from the new excavations and re-analyzing material from the old excavations (Kozłowski *et al.* 1970, 1974; Kubiak 1987; West 1996a, 1996b; Lipecki and Wojtal 1999; Niven and Wojtal 2002; Wojtal and Sobczyk 2003, 2005; Wojtal 2007; Krzemińska 2008; Wilczyński *et al.* 2012, Wilczyński *et al.* 2015). Geological studies of the site were conducted by, among others, Brigide van Vliet (Belgium), Tomasz Kalicki, Kazimierz Kramarz, Maria Łanczont and Przemysław Mroczek (Kozłowski *et al.* 1974; Kozłowski *et al.* 1975; Kalicki *et al.* 2007; Łanczont *et al.* in press).

Acknowledgements

The studies were partly supported by National Science Center (Poland) (grant decision No. N N109 188039 awarded to J. Wilczyński and No. DEC-2011/01/B/ST10/06889 awarded to P. Wojtal), by Ministry of Science and Higher Education of Poland (grant No. 2 P04C 081 30 awarded to P. Wojtal).

Résumé

Depuis 1968, avec quelques interruptions, des fouilles dans onze tranchées ont été effectué au site de Cracovie Spadzista (Pologne). Au total, 370.0 m² du site ont été explorés. La série de datations radiocarbones, concentrés entre 25,000 et 20,000 BP non calibré, permet d'attribuer le site au complexe culturel du Gravettien. Jusqu'en 2013, plus que 50,000 restes osseuses de différents animaux pléistocènes, vivant dans la steppe-toundra, ont été trouvés. A Cracovie Spadzista, la plupart des restes fauniques appartient à au moins 93 individus de mammouth. D'autres taxons de grandes mammifères sont représentés par quelques os et dents isolés de peu d'individus. Sur la base des analyses du matériel lithique, des restes fauniques et des datations radiocarbones on peut conclure que le site était réoccupé fréquemment pendant quelques semaines ou quelques mois par des groupes de chasseurs gravettiens. Ce camp de base de courte durée est lié à la chasse au

mammouth. La plupart des animaux étaient probablement tués par des chasseurs sur le site même ou très proche du site, et étaient ensuite désarticulés. L'analyse permet d'identifier à coté de l'accumulation d'ossements de mammouth trois zones d'activités possibles : une zone d'habitation, un atelier de taille et une zone de traitement des carcasses.

Zusammenfassung

Die Ausgrabungen im Fundplatz Kraków Spadzista (Polen) wurden von 1968 an, mit wenigen Unterbrechungen bis heute, in elf Schnitten durchgeführt. Während dieser Zeit wurden ungefähr 370 Quadratmeter des Fundplatzes untersucht. Die Serie der Radiocarbon Datierungen konzentriert sich auf einen Zeitraum von 25.000 bis 20.000 uncal BP, die den Fundplatz in das Gravettien stellen. Bis 2013 wurden mehr als 50.000 Knochenfunde verschiedener Säugetiere der Pleistozänen Tundrasteppe gemacht. Am Fundplatz Kraków Spadzista gehören die meisten Faunenreste zum Wollhaarigen Mammut, das durch mindestens 93 Individuen belegt ist, während andere Großsäugetier-Taxa nur durch isolierte Knochen und Zähne einzelner Individuen belegt sind. Auf der Basis der Analyse des lithischen Materials, der Faunenreste und der radiometrischen Datierungen kann geschlossen werden, dass Kraków Spadzista durch gravettien-zeitliche Jägergruppen häufiger freuquentiert wurde im Zeitraum von einigen Wochen oder Monaten. Dieses Kurzzeitcamp wurde für die Mammutjagd genutzt. Die meisten Tiere wurden wahrscheinlich durch die Jäger direkt am Fundplatz oder in der Nähe gejagt und dann zerlegt. Die Auswertung erlaubt uns drei mögliche Aktivitätszonen zu identifizieren: eine Camp-Areal, eine Steinschlagzone und eine Zone zum Zerlegen von Tieren neben der wohlbekannten Akkumulation von Mammutknochen.

THE GRAVETTIAN AND EPIGRAVETTIAN SETTLEMENT OF POLAND

Jarosław Wilczyński

Abstract
This article provides information about the Gravettian and Epigravettian occupation of Poland, based on recent archeological fieldwork and analysis of collections from past studies. Also provided is a provisional overview of the current status of research into Poland's Upper Paleolithic settlement between 30.0 ky and 14.0 ky uncal BP. Early Gravettian settlement in Lesser Poland is known only from cave discoveries. Two cave sites attributed to the MUP (Obłazowa and Borsuka respectively) have yielded extraordinary assemblages in association with the remains of anatomically modern *Homo sapiens*. The unclear chronology of sites in Upper Silesia also does not strongly support the presence of Pavlovian groups in this area (except for Henryków 15); however, given the remarkably high proportion of exotic northern (Polish-derived) flint in Moravian inventories, the presence of Pavlovian groups in Upper Silesia seems clear. During the Late Gravettian only the western reaches of Southern Poland appear to have been occupied by humans. Now, on the basis of inventories from Kraków Spadzista and Jaksice II sites, we propose that in the LGM period 24.0–20.0 ky uncal BP the territory of Southern Poland was penetrated by separate and distinct human groups. This is indicated by differences in (1) the choice of landscape setting of habitation sites, (2) tool production technologies and tool forms, and (3) choice of game animals hunted. A similar degree of diversity is also observed in inventories from Southern Poland dated later than the LGM. What is most notable is that during the post-LGM period only workshops or short-term camps are recorded.

Keywords
Settlement strategy, Upper Paleolithic, Southern Poland, animal hunting

DOI: 10.5817/CZ.MUNI.M210-7781-2015-16

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Introduction

Gravettian culture appears in Central Europe around 29.0 ky uncal BP and is characterized by the presence of numerous open settlements, some of them multi-seasonal, often accompanied by accumulations of mammoth bone. Stone inventories feature double-platform blade cores and various types of backed tools which become the most characteristic elements of the lithic assemblages. The process which led to the emergence of this cultural unit has not been fully elucidated and still raises much controversy (Conard 2000; Svoboda 2007; Kozłowski 2013). Although the Gravettian entity is characterized by a marked uniformity, which is noticeable especially in the case of figural art, its lithic inventories sometimes display a considerable diversity, observed both in Western and Central Europe (Klaric 2007; Klaric *et al.* 2009; Oliva 1999; Polanská 2013; Wilczyński *et al.* 2015a).

The study of Gravettian and Epigravettian occupation in Poland is made extremely difficult by the geomorphological situation, namely, the existence over much of the territory of a thick layer of loess, sometimes several meters deep. That is why Paleolithic open-air sites are known either from accidental finding (Jaksice) or discoveries made during loess digging in brickyards (Kraków Zwierzyniec, Przemyśl) or during construction work (Kraków Spadzista). Only in Upper Silesia, where the youngest loess deposits are insubstantial, have a number of open-air sites been identified during fieldwalking (Wójcice, Henryków 15). Thus, our present knowledge of Upper Paleolithic settlement in Poland is more the result of accidental discovery than planned research. Also, the exploration of cave sites, started during the nineteenth century, did not yield a longer series of Gravettian artifacts, except for the Mamutowa Cave with its abundant lithic assemblage. The present text aims to provide information on Gravettian and Epigravettian occupation of Poland – using input from recent archeological research and interpretation of collections from past studies. Also provided is a provisional overview of the status of research in the Gravettian and the Epigravettian settlement in Poland between 30.0 ky and 14.0 ky uncal BP.

Early Gravettian (31.0–25.0 ky uncal BP) – Existing problem(s)

Among the Early Gravettian/Pavlovian sites in Poland published in the reference literature there are several that were recorded in Upper Silesia and in western Lesser Poland, such as the Obłazowa Cave, Henryków 15, Wójcice, Cyprzanów, and level IV at Kraków Spadzista, trench C2 (Figure 1).

As a result of more recent research, some of these sites can no longer be interpreted as Early Gravettian/Pavlovian while others are being subjected to a serious reassessment. This is because some of these inventories were never analysed or published comprehensively – especially those from Upper Silesia – and reliable radiocarbon dates are often lacking. This situation makes it difficult to give a reliable presentation of the Mid Upper Paleolithic (MUP) of Southern Poland and its changes during this period.

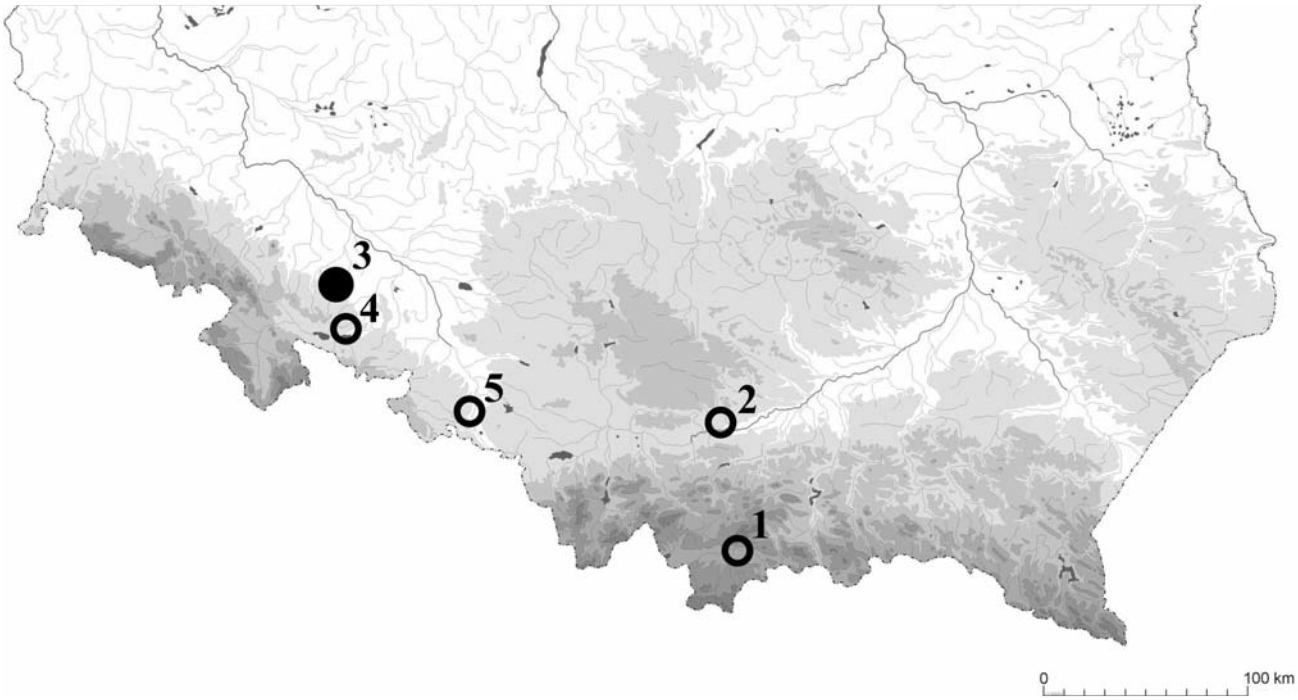


Figure 1: Location of the Early Gravettian/Mid Upper Paleolithic sites: 1 – Obłazowa Cave, 2 – Borsuka Cave, 3 – Henryków 15, 4 – Wójcice, 5 – Cyprzanów. Black dots – Early Gravettian sites. Black circles – Mid Upper Paleolithic sites (Early Gravettian cultural affiliation uncertain).

Obłazowa Cave

One of the most spectacular assemblages connected to MUP settlement in Central Europe comes from the Obłazowa Cave and includes an arched curved object made from a mammoth tusk – the so-called "boomerang", pendants made from fossil *Conus* sp. shells, ornaments made of fox teeth and other bone artifacts (Valde-Nowak 2003). They were discovered together with a small lithic inventory and the oldest *Homo sapiens* remains recorded in Poland, dated to around 31.0 ky uncal BP (Housley 2003, 83; Trinkaus *et al.* 2014). In the original publication the assemblage from the Obłazowa Cave was attributed to Pavlovian settlement and the cave itself was interpreted as a ceremonial site (Valde-Nowak *et al.* 2003). However, in my opinion, the Pavlovian attribution is not so certain at all. Only the *Conus*, sp. shells have clear connections with Pavlovian assemblages nevertheless they are also recorded at an Aurignacian site in France and Italy (Vanhaeren and d'Errico 2006, 1109–1111). It is difficult to interpret the arched curved object made from a mammoth tusk because it has no analogy in Upper Paleolithic sites but – and this has not been mentioned before – the making of similar flattened objects from mammoth tusks is close to the Aurignacian tradition, connected with the production of Mladeč points. The method of production of three tooth pendants made of Arctic fox canines discovered in the Obłazowa Cave – in which the root was prepared by scraping and perforated by rotation – is characteristic of the Aurignacian artefacts (Oliva 2006; White 2007). Moreover, the lithic inventory uncharacteristically lacking in the distinctly Pavlovian small geometric microliths, and last but not least, the early radiocarbon date of the settlement in the Obłazowa

Cave, cast doubt on its connections with the Pavlovian, which is interpreted as a local cultural group of the Gravettian existing in Moravia around 30.0–25.0 ky uncal BP (Klíma 1959; Svoboda 2002; Verpoorte 2009). The presence of Volhynian flint, which suggests penetration by the Pavlovian hunters not only of Southern Poland but also of western Ukraine, is not confirmed by the data now at hand. Consequently, I propose to interpret the distinctive inventory from the Obłazowa Cave very broadly as an MUP assemblage.

Borsuka Cave

The next site with an interesting MUP assemblage is the Borsuka Cave, located about 10 km west of Kraków (Wilczyński *et al.* 2012a). This extraordinary material, recovered from layer VI, includes six deciduous teeth of a modern Homo sapiens infant and 112 pendants made from the teeth of European elk and steppe wisent or aurochs (Figure 2).

The teeth appear to belong to a 12–18 month old child, the sex of the child cannot be determined. It is notable that no identifiable traces of a burial pit were found during the excavation. The human remains and the artifacts were intentionally placed on the surface of the ground and subsequently, as a result of natural post-depositional processes, were shifted in a NW direction in a unidirectional-linear rearrangement. The only lithic find from the excavation was a blade fragment. The lack of diagnostic stone tool types makes it very difficult to confirm to which Upper Paleolithic culture this material belongs. That is why we need to concentrate on a stylistic analysis of the pendants from the Borsuka Cave and on the results of radiocarbon dating. Two radiocarbon dates of about 27.0–25.0 ky uncal BP secured for the pendants lead us to associate these artifacts, and the human remains too,

Figure 2: Borsuka Cave, a pendants made from incisors and canines of steppe wisent or aurochs (*Bison/Bos*, sp.) and European elk (*Alces alces*).

with Pavlovian culture. On the one hand, the teeth used to manufacture the pendants (incisors of large ungulates – elk and bison/wisent) and their method of production are different than in other Pavlovian sites and are closer to the Aurignacian materials known from e.g. Mladeč Cave (Oliva 2006), although it should be noted that a single pendant similar to the find from the Borsuka cave was discovered at the Late Gravettian site at Trenčianske Bohuslavice in Slovakia (Vlačiky 2012). It may be too early at the current level of understanding of Aurignacian and Gravettian settlement in southern Poland, especially given the scarcity of well-dated Aurignacian sites, to resolve the problem of the cultural identity of the assemblage from the Borsuka Cave. Nevertheless there is no denying that the deposit from this site is the oldest human burial recorded in Poland (Wilczyński *et al.* 2014).

Henryków 15

A Gravettian site discovered relatively recently is Henryków 15 in Upper Silesia (Płonka and Wiśniewski 2004). The sizable inventory discovered here of more than one and a half thousand artifacts struck from local erratic Cretaceous. Tools are mostly atypical forms, often made on flakes or on amorphous blades. The inventory included a few fragments of small backed blades (one of them a micro-retouched specimen). The surface find of a unique leaf point presumably associated with the same occupation episode is compatible with Pavlovian and Late Gravettian materials known from Moravia and Silesia (Klíma 1963; Svoboda 2002; Oliva 2007; Novák 2008). Also, OSL and radiocarbon dates secured at Henryków 15 correspond to Pavlovian settlements of southern Moravia (Wiśniewski *et al.* 2015). Thus, the site may be interpreted as a short-term hunting camp associated with blanks production.

Wójcice

The study of the site at Wójcice in Upper Silesia, discovered in the 1960s, is not complete. Its lithic inventory of several thousand pieces is mostly struck from erratic Cretaceous flint. Retouched tools make up a significant percentage of this assemblage, with the burin as the most common form, there are also several backed blades and an atypical shouldered point (Ginter 1966; Dagnan and Ginter 1970). With no radiocarbon dates and lacking a detailed description of the inventory a closer cultural attribution of Wójcice is very difficult. Also difficult to confirm is its relationship to Pavlovian settlement, something that was suggested in the first report on the research at Wójcice, and the site's association with Late Gravettian settlement.

Cyprzanów I

This site was investigated by H. Lindner during the first half of the twentieth century and by M. and W. Chmielewski in 1954 (Kozłowski 1964). Unfortunately, the excavated inventory was never published in a comprehensive manner and the site is no longer available for study, making it impossible to interpret this material. The stratigraphic position of the finds was at the end of the main phase of the Last Glacial,

and the presence of a single massive atypical backed blade and a double-platform core in this inventory are insufficient for a more conclusive cultural attribution.

Kraków Spadzista, trench C2, cultural level IV

In the monographic study of the lithic inventory from Kraków Spadzista trench C2, archeological material discovered in layer 6 was distinguished into four horizons of which level IV was interpreted as Pavlovian (Kozłowski and Sobczyk 1987). This view was reiterated recently (Kozłowski and Kozłowski 1996; Kozłowski 2007) but the findings from excavations made at Kraków Spadzista in 2011–12 and new radiocarbon dates make this point of view no longer possible to maintain (Wilczyński *et al.* 2015b). We may conclude at present that layer 6 was redeposited and transformed substantially during the Last Glacial Maximum (LGM) and became mixed with several different Gravettian levels into a single cultural horizon. Secondary redeposition is visible not only among the lithic finds but animal remains too, most notably, larger bone fragments and mammoth teeth dated to around 24.0 ky uncal BP which were discovered below the Gravettian layer 6 in a layer of yellow clay containing a small number of Aurignacian forms. This shows that we cannot separate a single stratigraphic level which would correspond to a Pavlovian occupation. The absence of an older cultural horizon is indicated also by the results of radiocarbon dating of the bone remains from Kraków Spadzista, where out of 30 dates none is older than 25 ky uncal BP.

Late Gravettian – Willendorf-Kostienkian (24.0–20.0 ky uncal BP) – Two cases, significant distinctions

Late Gravettian settlement is characterized by the presence in the stone inventories of shouldered points and Kostienki knives which, although known in earlier Pavlovian inventories, have increased significantly in their proportion and have become common forms. The presence in Gravettian inventories dated to 24.0 – 20.0 ky uncal BP of these characteristic tool forms persuaded the researchers to separate, in Central Europe, the Willendorf-Kostienkian culture, and later, the "shouldered point horizon" within the Gravettian (Grigorev 1968, 1993; Kozłowski 1969, 1986, 1996). In Poland Late Gravettian settlement is concentrated in Lesser Poland with several cave sites recorded in the Kraków-Częstochowa Upland (Figure 3).

Of open-air sites the two most notable are Kraków Spadzista and Jaksice II (Kozłowski *et al.* 1974; Kozłowski and Sobczyk 1987; Wilczyński *et al.* 2012b; Wilczyński *et al.* 2015a). In contrast to these two sites, assemblages from other open-air sites (Kraków-Zwierzyniec I, Kraków-Przegorzały, Przemyśl, Kraków-Nowa Huta) are less numerous and often lack a clear chronology. The cave sites in the Kraków-Częstochowa Upland (the Deszczowa, Nietoperzowa and Jasna Caves, the cave in Dziadowa Skała) have mostly yielded scanty and not easily dated stone assemblages. Only the inventory from the Mamutowa Cave is larger but, unfortunately have not yet been analyzed and published.

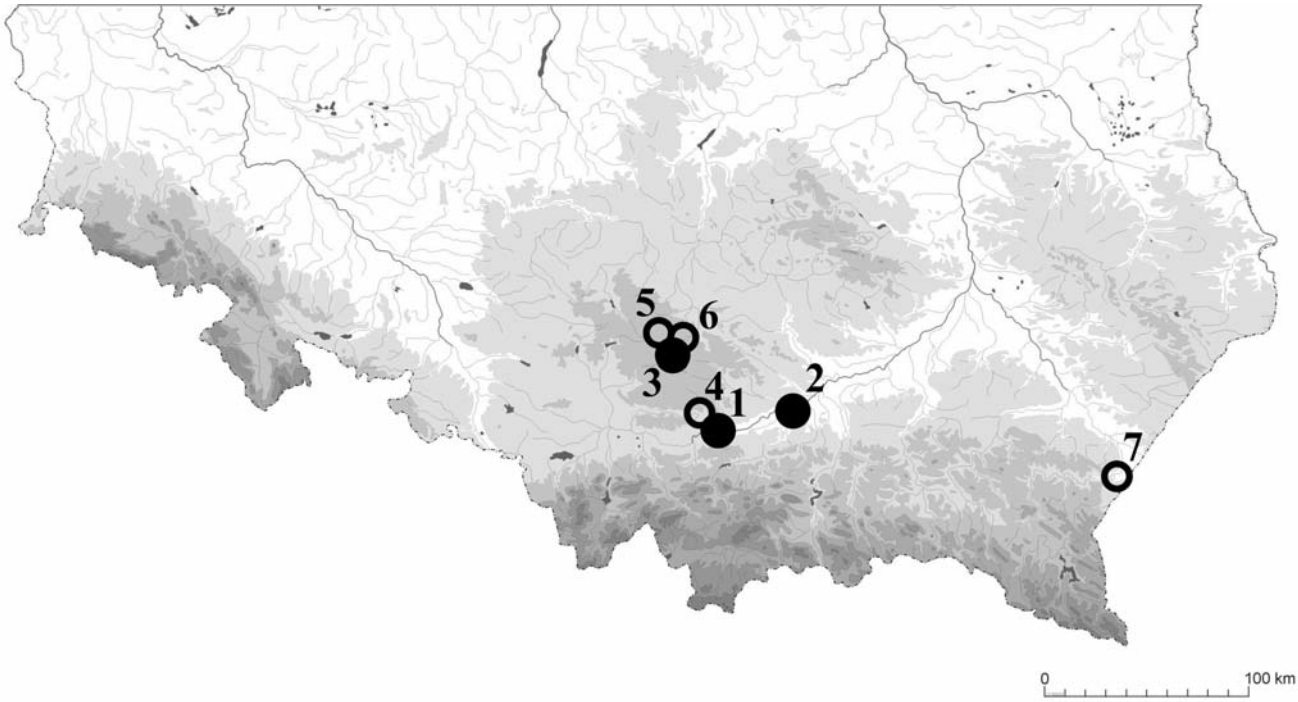


Figure 3: Location of the Late Gravettian sites: 1 – Kraków Spadzista, 2 – Jaksice II, 3 – Deszczowa Cave, 4 – Mamutowa Cave, 5 – Jasna Cave, 6 – Cave in Dziadowa Skała, 7 – Przemyśl. Black dots – Late Gravettian sites. Black circles – unclear Late Gravettian sites.

Kraków Spadzista – layer 6

One of the most important Upper Paleolithic open-air sites in Poland is Kraków Spadzista. It yielded Aurignacian, Gravettian and Epigravettian lithic inventories as well as an impressive assemblage of Pleistocene fauna (especially, woolly mammoth) associated with the Gravettian occupation. The fieldwork started in 1968 and continued intermittently until 2013 (Kozłowski *et al.* 1974, 1975; Drobniewicz *et al.* 1976; Kozłowski and Sobczyk 1987; Sobczyk 1995, 1996; Escutenaire *et al.* 1999; Kalicki *et al.,* 2007; Wilczyński *et al.* 2015b). It led to the discovery of a significant accumulation of mammoth remains and a rich Gravettian stone inventory accompanied by a small number of bone tools and ornaments (Kozłowski and Sobczyk 1987; Wilczyński *et al*. 2012b). Initially, the mammoth bone accumulation was interpreted as the remains of dwellings but a later detailed taphonomic analysis of this material led to the rejection of this explanation (Kozłowski and Kubiak 1972; Wojtal and Sobczyk 2003, 2005). It now appears that Kraków Spadzista, layer 6, is a place where mammoths were killed and dismembered (Wilczyński *et al.* 2012b). Gravettian settlement at Kraków Spadzista is dated to the period 24.5–20.0 ky uncal BP. Currently, more than 30 radiocarbon dates have been secured from different areas of Kraków Spadzista which are within this time interval. The lithic inventory is mostly in local Jurassic flint with a few artifacts struck from a non-local raw resource (e.g., radiolarite, obsidian, limnic quartzite). Blanks were obtained from well prepared double-platform cores with a common striking surface (Figure 4).

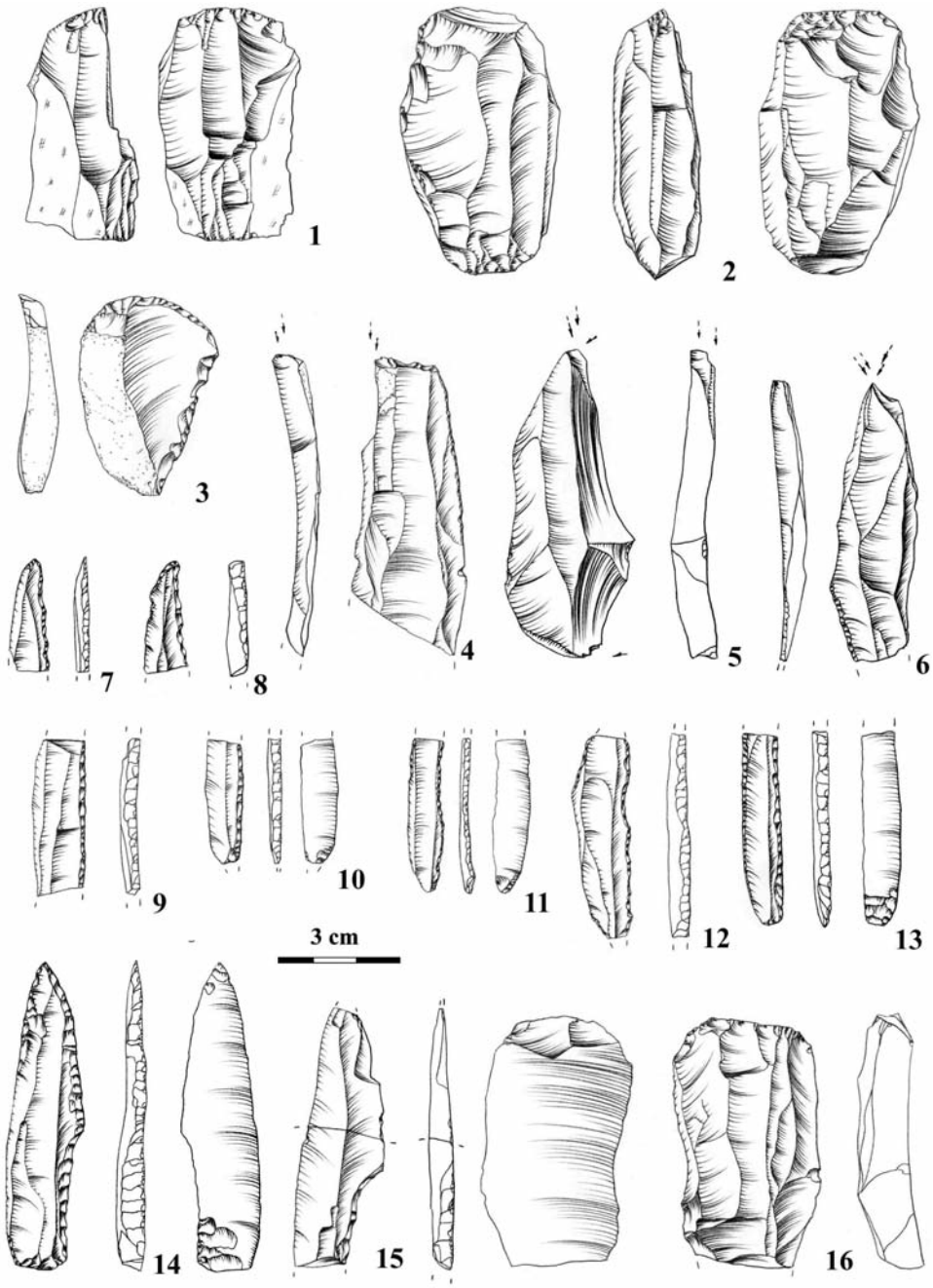


Figure 4: Kraków Spadzista layer 6. 1, 2 – cores, 3 – endscraper, 4–6 – burins, 7–13 – backed blades, 14, 15 – shouldered points, 16 – Kostienki knife.

Among the retouched tools a very high ratio of shouldered points is observed – especially in the area B + B1 where they account for around 20% of tools. This is the highest percentage observed among other similarly dated Gravettian sites in Central Europe, e.g., Petřkovice I, Milovice I in the Czech Republic, and Moravany Lopata II, Kašov 1 and Trenčianske Bohuslavice in Slovakia (Kozlowski 1998; Novák 2004, 2008; Žaár 2007; Oliva 2009). Backed blades are quite numerous, and the number of

Kostienki knives is quite large (Wilczyński *et al.* 2012b). The fauna is represented mainly by the woolly mammoth and Arctic fox. Other species such as horse, reindeer, wolf and bear, are usually represented by solitary skeletal fragments (Wilczyński *et al.* 2012b). The analysis of spatial distribution of the lithic artifacts, the results of a taphonomic analysis of the animal remains and radiocarbon dates obtained from Kraków Spadzista all indicate that this site was occupied in succession in a number of recurrent episodes of rather short-term duration (Sobczyk 1995; Wilczyński et al. 2012b), evidenced by an area with an accumulation of mammoth bone, interpreted as the site of killing and butchery, a workshop area and a camp area.

Jaksice II

The site was discovered in 1912 by L. Kozłowski and W. Kuźniar who identified a hearth and some flint artifacts in a loess exposure (Kozłowski and Kuźniar 1914). Other finds included the remains of Pleistocene fauna (mammoth, horse) and a modest lithic inventory with a few endscrapers which appeared to be Aurignacian. Using the description of the site given in the first publication, the location of the 1912 discovery was confirmed and regular fieldwork started in 2010 (Wilczyński and Wojtal 2011). To distinguish the recently excavated assemblage from the 1912 inventory (recorded as "Jaksice"), no longer available for study, we have named it "Jaksice II". The site lies on a low (less than 10 m high) Pleistocene loess terrace of the Vistula, opposite its confluence with the Raba. This terrace is a relatively narrow bench snuggled against the eastern side of the Proszowice plateau between the Vistula and the Szreniawa rivers. Using the results of the recent excavation the site has been interpreted as a fragment of a hunting camp inhabited 24.0–20.0 ky uncal BP by groups of Late Gravettian hunters. The radiocarbon dating of the occupation of this site is surprisingly similar to the results obtained from the Kraków Spadzista site. The dominant lithic resource in the inventory is local erratic Cretaceous and white-gray Jurassic flint. A relatively high proportion of radiolarite artifacts (some of them retouched tools), is also noticeable (almost 5% of the inventory). Small, slender blades were obtained from single-platform blade cores. There is also evidence on the use at this site of heavier double-platform cores with a common flaking surface. Characteristic feature of this tool assemblage is an absence of shouldered points (except for a single atypical specimen) and of Kostienki knives, and a high percentage of backed forms and endscrapers (Wilczyński et al. 2015a). The presence in the backed tool group of distinctive rectangles, which have both their ends modified by semi-abrupt or flat retouch, always on the ventral, is also worth noting – they are referred as Late Gravettian rectangles (Figure 5).

Next to the lithic inventory Jaksice II yielded a unique ivory tool, slightly flattened in cross-section, and some polished tusk fragments. Finally, a small bead made from marine mollusk shells (family Neritidae) were discovered during wet-sieving. The remains of reindeer are the most numerous, vastly outnumbering those of other mammal species. Three long bones of reindeer (radius, metacarpal, and metatarsal) and a single tarsal bone (hamate) had evident cut marks, presumably

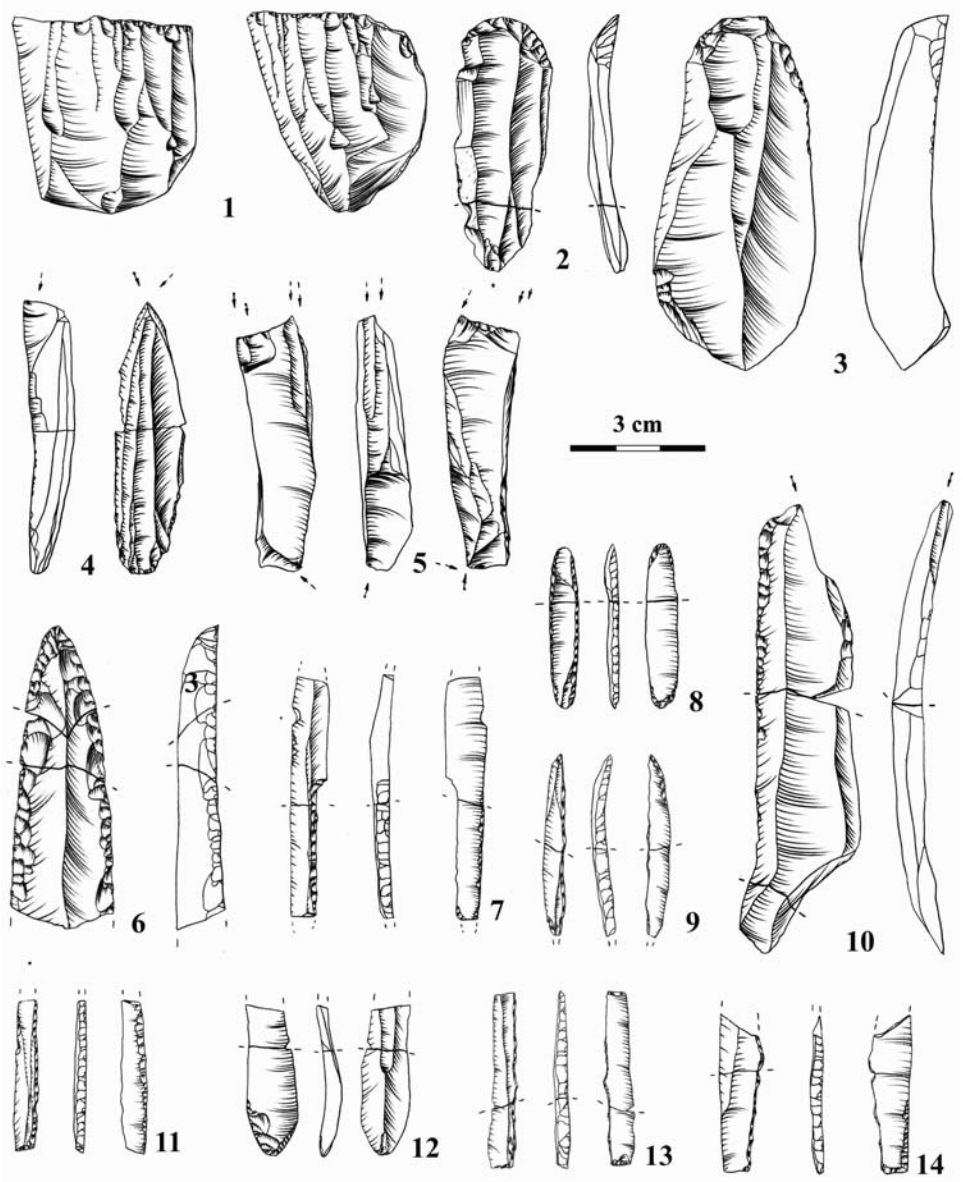


Figure 5: Jaksice II. 1 – core, 2, 3 – endscrapers, 4, 5, 10 – burins, 6 – pointed blades (*appointées*), 7 – shouldered point(?), 8, 9 – microgravette points, 11 – rectangle, 12 – *flechette*, 13, 14 – Late Gravettian rectangles.

from skinning and butchering (Binford 1981). Jaksice II, so different from the site at Kraków Spadzista, may be considered one of the most important discoveries made in recent years documenting Gravettian occupation in this part of Poland.

Kraków-Zwierzyniec I

Kraków-Zwierzyniec I lies 500 meters to the east of the site at Kraków Spadzista. Excavated in the early twentieth century it yielded a large lithic assemblage spanning the Middle and Upper Paleolithic (Sawicki 1956; Chmielewski 1975a). The series collected by Sawicki includes two shouldered points and single backed blade. They

were discovered with a few woolly mammoth bones radiocarbon dated to around 22 ky uncal BP (Nadachowski *et al.* 2011). This inventory may document short-term occupation – a hunting camp – connected with the Kraków Spadzista site (Sobczyk 1995).

Kraków Przegorzały II

Discovered during the first half of the twentieth century this site yielded hundreds of flint artifacts, contained in bottom level of younger loess (Kozłowski 1967). Of this assemblage several single platform cores, blanks and retouched tools (especially burins) were published. A more notable find is an atypical backed blade remade into a burin (Kozłowski 1967). With no radiocarbon dates available, closer dating of this inventory is extremely difficult.

Przemyśl (Słowackiego Street)

The only Gravettian site identified in the eastern area of Southern Poland at Przemyśl yielded a small collection of flint artifacts and a faunal assemblage (Osiński 1932; Kozłowski 1963). Of the modest lithic inventory only a few backed blades were described, while the faunal assemblage was found to include large mammals, also the woolly mammoth. Although the material from Przemyśl comes from early research, with some caution we may associate it with Gravettian settlement. Unfortunately, recent fieldworks carried out to confirm the site of discovery of this assemblage were not successful (Kalicki and Szmoniewski 2008).

Kraków-Nowa Huta

The construction of the Slaubing rolling-mill at Krakow-Nowa Huta brought the discovery in the younger loess sediments of the remains of a woolly mammoth and a dozen lithic flakes and blades (Kozłowski *et al.* 1970). Unfortunately, with no characteristic retouched tool forms or radiocarbon dating of the mammoth remains (two radiocarbon tests failed) a closer cultural attribution of this inventory is not possible and we can only relate it broadly to the Upper Paleolithic. Dating similar deposits found at a distance of 1.5 km from the original site of discovery of the mammoth to 27.75 ky uncal BP and association of Kraków-Nowa Huta with a Gravettian occupation seems to be a major over-interpretation (Mamakowa and Środoń 1977; Sobczyk 1995, 122; Kozłowski and Kozłowski 1996).

Kraków Witkowice

This was the site of the discovery, during a field survey on the eastern terrace of the Prądnik River, of an atypical shouldered point (Rydlewski and Valde-Nowak 1979). The authors who published this surface find dated it to the Pleistocene (possibly even earlier than LGM) arguing that its presence on the surface of the field was the result of slope erosion of the river terrace. However, given its atypical form, its discovery on the surface of the terrace, where the younger loess cover has a thickness

of a few meters and the lack of other finds from the same location, this lithic artifact is more likely to date from a more recent period.

Mamutowa Cave

This cave site was investigated for the first time during the second half of the nineteenth century and subsequently in the early twentieth century yielding a rich and diverse Upper Paleolithic assemblage (Zawisza 1884; Kozłowski 1922). Unfortunately, because of the recovery methods used at the time the cultural and stratigraphic context is unclear. The lithic inventory includes a series of Aurignacian Mladeč points made from ivory, pendants and other mobile art objects. Their closer dating is unclear – only the Mladeč points have precise radiocarbon dates of around 32.0 ky uncal BP (Wojtal 2007). The lithic inventory is a mix of Szeletian, Aurignacian and Gravettian artifacts (Kozlowski and Kozlowski 1996). Gravettian occupation is indicated by the presence of double-platform blade cores (some of them microlithic), backed blades and numerous burins. Also, a small number of pendants made from mammoth ivory have analogies in finds from the Swabian Jura (Conard and Moreau 2004). With the cave chamber damaged seriously by nineteenth-century fieldwork the excavation project carried out in the second half of the twentieth century by Stanisław Kowalski failed to secure the supplementary evidence (Gravettian and Aurignacian artifacts still resting *in situ*) needed to make a reliable attribution of the artifacts in the old series to these two cultural horizons (Kowalski 2006). Nevertheless this fieldwork did bring in a large Gravettian lithic inventory recovered from layer 2 formed by numerous burins and a small number of backed blades (Kowalski 1967). Unfortunately, the same layer (no. 2) contained no osseous artifacts to confirm the attribution of the ivory pendants from earlier research to the same Gravettian inventory. Layer 2 is dated by radiocarbon dates obtained for the Pleistocene faunal remains to the period 35.0 ky – 11.0 ky uncal BP (Wojtal 2007). The extremely broad scope and lack of dates for the osseous artifacts prevents us from linking them, if only tentatively, to the traces of Gravettian occupation discovered in the Mamutowa Cave. As such, the cultural attribution of this inventory is unclear and it has been interpreted in the past variously as Gravettian or Epigravettian (Chmielewski 1975b; Kozłowski and Kozłowski 1996). The presence of double-platform blade cores, various types of burins, many of them multiple forms, and of backed blades makes this assemblage compatible with Gravettian occupation. This is evidenced further by the absence of similar artifacts in the rich Epigravettian inventories known from Lesser Poland such as Kraków Spadzista, layer 5, and Piekary IIa and Targowisko 10 (Drobniewicz *et al.* 1976; Morawski 1981; Wilczyński 2006, 2007, 2009).

Deszczowa Cave

The second cultural level (layer VII) in this cave yielded a few flint artifacts accompanied by a single cylindrical artifact made of antler. Cultural attribution of this sparse and uncharacteristic lithic assemblage (primarily identified as Epigravettian)

was determined on the basis of two radiocarbon dates of approximately 17.0 ky uncal BP (Cyrek *et al.* 2000). Because no dates were obtained for the bone artifacts their conclusive association with a settlement site may raise reasonable doubts (Verpoorte 2009). The recent dating of a bear mandible with cut marks yielded a date of 24.58 ky uncal BP (Wojtal 2007). On this basis at least a part of the lithic assemblage from the Deszczowa Cave may be linked to Late Gravettian occupation.

Nietoperzowa Cave

During the 1914 archeological excavation made by Leon Kozłowski in the Nietoperzowa Cave, layer 4 – containing the youngest Jerzmanowician cultural horizon – yielded a single backed blade fragment (Chmielewski 1975b). This specimen is short and rather massive, and its connection with the Early Upper Paleolithic or Gravettian settlement is unclear.

Cave in Dziadowa Skała

A modest flint assemblage recovered from layer 8 at the cave in Dziadowa Skała from under Holocene humus included a single massive backed blade with a slightly irregular back and a straight, abrupt-retouched base (Chmielewski 1958). Its discoverers associated this assemblage with Gravettian settlement but its stratigraphic position and backed blade type could indicate a younger age – Magdalenian, or even later. A bird bone recovered from layer 8 yielded a single radiocarbon date around 10.0 ky uncal BP (Lorenc 2006). Unfortunately, this result cannot be considered reliable, although it seems that layer 8 is more likely to belong chronologically to the end of the Pleistocene rather than the end of the Interpleniglacial.

Jasna Cave

This cave site was excavated by Ludwik Sawicki in 1947 and 1949, which investigation led to the discovery of a single massive backed blade (Chmielewski 1958). Similarly as in the case of the finds from the cave in Dziadowa Skała, this lithic artifact is equally hard to date but its likely attribution is to settlement younger than the Gravettian.

Epigravettian (19.0–14.0 ky uncal BP) – Settlement in the glacier foreland

During the LGM the territory of Southern Poland was under a strong influence from the end of the glacier, at that time found 300 km to the north of this region, in Greater Poland and northern parts of Mazovia. No wonder there is almost no archeological record of Paleolithic settlement in Poland, especially in the period 19.0–17.0 ky uncal BP. Epigravettian settlement is documented in a number of isolated sites which have been recorded in Lesser Poland – especially in the region around Kraków – and in Upper Silesia (Figure 6).

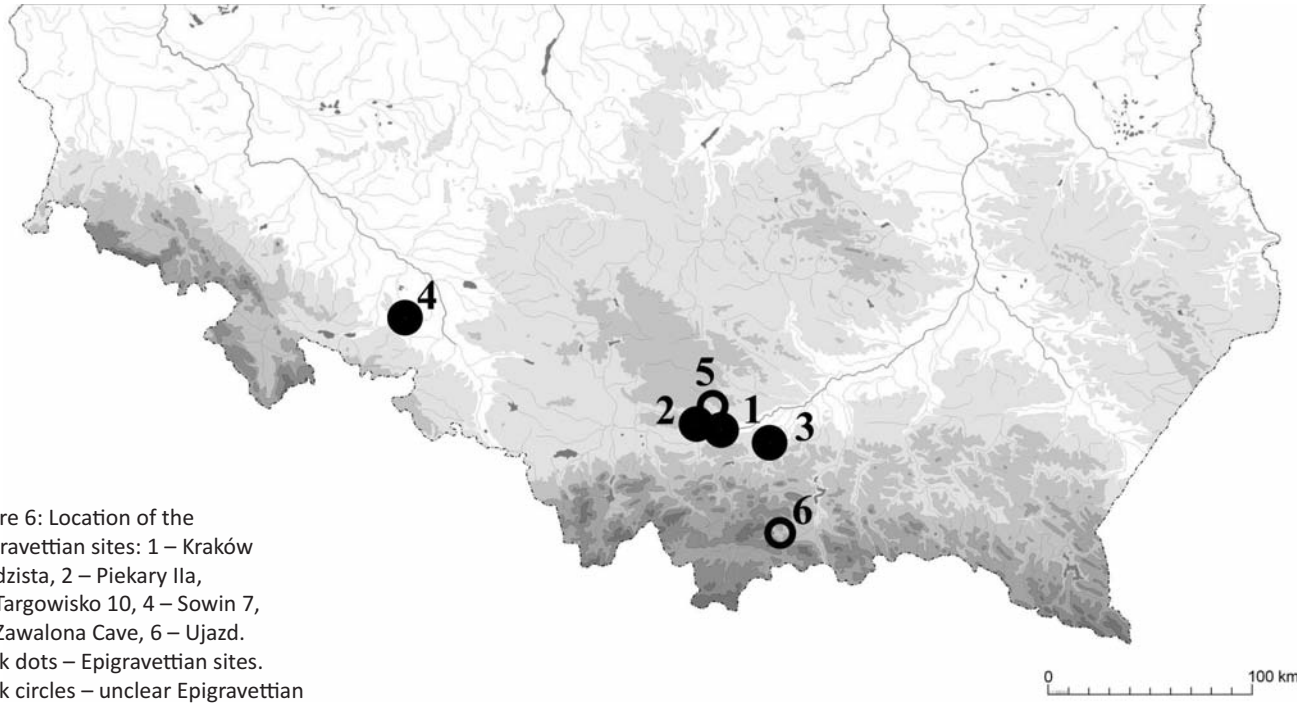


Figure 6: Location of the Epigravettian sites: 1 – Kraków Spadzista, 2 – Piekary IIa, 3 – Targowisko 10, 4 – Sowin 7, 5 – Zawalona Cave, 6 – Ujazd. Black dots – Epigravettian sites. Black circles – unclear Epigravettian sites.

Kraków Spadzista – layer 5

The lithic inventory recovered from layer 5 at Kraków Spadzista is best interpreted as the remains of an Epigravettian workshop taking advantage of a local resource – Jurassic flint. The Epigravettian settlement is observed in the north-western area of Kraków Spadzista, in trenches B + B1 and B "workshop" (Drobniewicz *et al.* 1976; Wilczyński 2007). Despite obtained a few younger radiocarbon dates, chronology of the Epigravettian occupation at Kraków Spadzista site is still unclear. The complexity of the stratigraphic sequence unearthed at Kraków Spadzista and difficulties in its interpretation are demonstrated by the failure in the past to isolate the Epigravettian inventory excavated from trench B1 and its incorrect attribution to the Gravettian inventory (Escutenaire *et al.* 1999), what was identified during recent analysis (Wilczyński 2007). The Epigravettian settlement documented by this assemblage does not seem to be associated with mammoth hunting or the presence of a mammoth bone accumulation at Kraków Spadzista.

In contrast to the Gravettian episode, double-platform blade cores disappear, and they are replaced by massive single-platform cores (some of these specimens weigh as much as 3 kg) (Figure 7). In the inventory predomination of flakes (many of them cortical) is noticeable. It is notable that not only lithic blades were produced here but also pre-cores and cores which were later taken out of the workshop. In the lithic tools inventory only few retouched tools were identified – mainly burins, retouched blades and flakes. Possible that single backed blades and atypical shouldered points discovered in layer 5, were assigned to the Epigravettian occupation only by mistake.

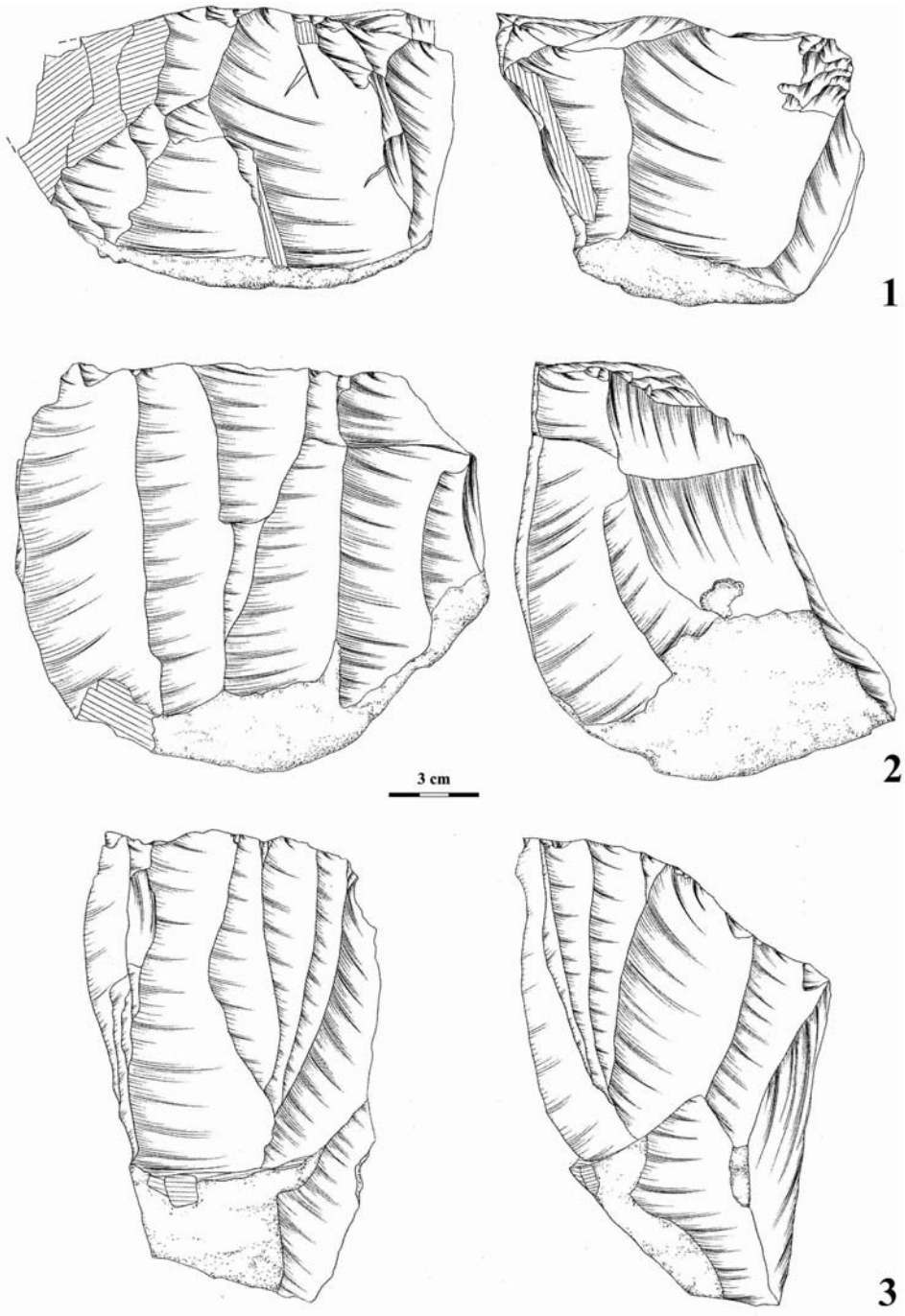
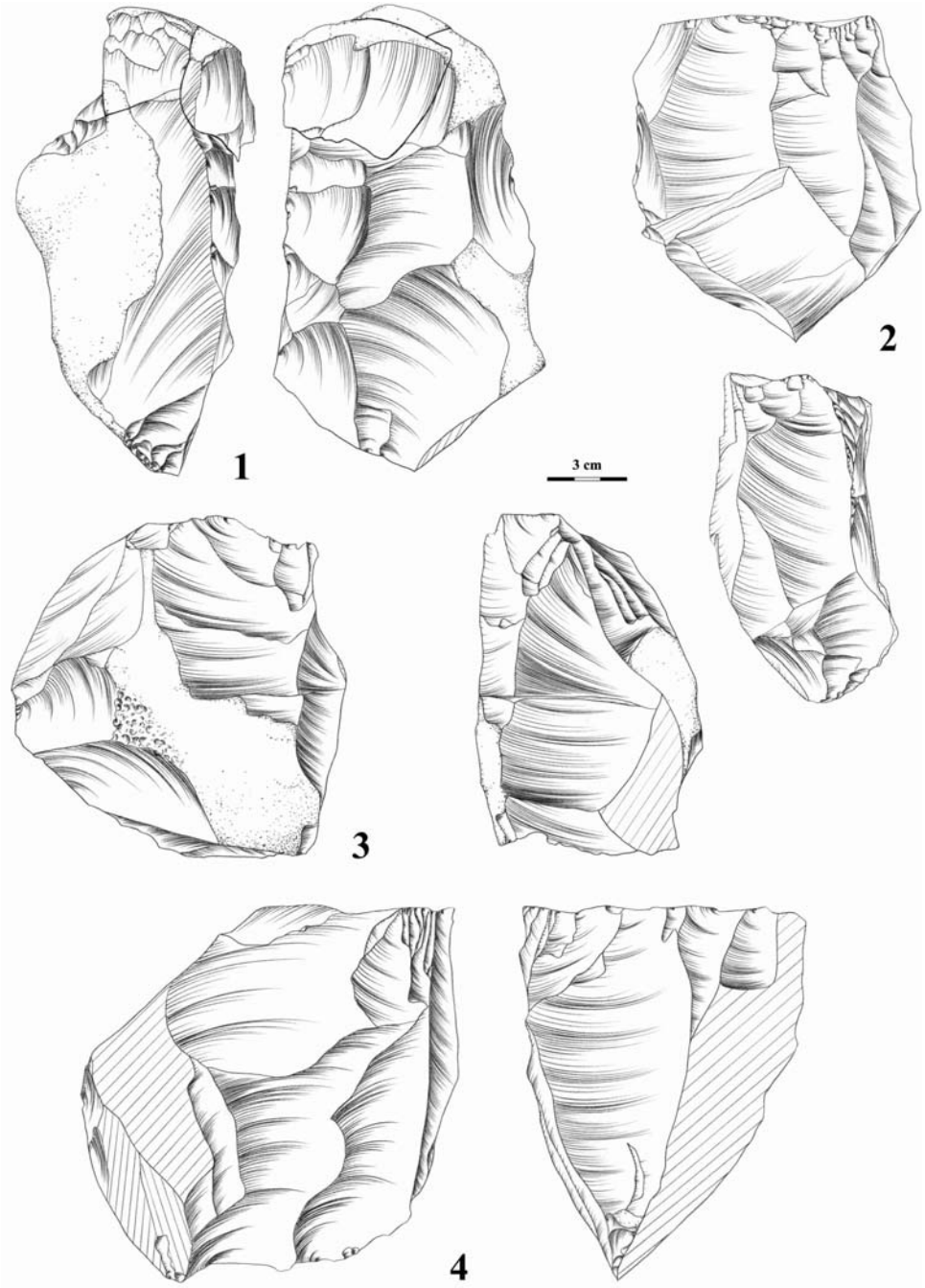


Figure 7: Kraków Spadzista layer 5. 1–3 – cores.

Figure 8: Piekary IIa – trench XIX.
1–4 – cores.



Piekary IIa

The complex of Paleolithic sites at Piekary near Kraków lies in what is known as "Tyniec Gate" – a gorge cut by the Vistula River in the southern part of the Kraków-Częstochowa Upland. The site recorded as Piekary IIa was first investigated by Władysław Morawski in 1968 and subsequently, in 1999–2002, by Krzysztof Sobczyk (Morawski 1992; Sitlivy *et al.* 2008). The inventory associated with Epigravettian occupation was recovered from a layer of strongly carbonated younger loess. At first this episode was dated by input from observations of geology to a date more recent than the LGM (Morawski 1981, 1992, Sobczyk 1995). This chronology was confirmed by a single radiocarbon date obtained in 2009 from a reindeer phalanx, 16.25 ky uncal BP. The dominant form in the lithic inventory is single-platform cores for the production of massive blades and flakes (Figure 8). Their preparation was mostly limited to the striking platform.

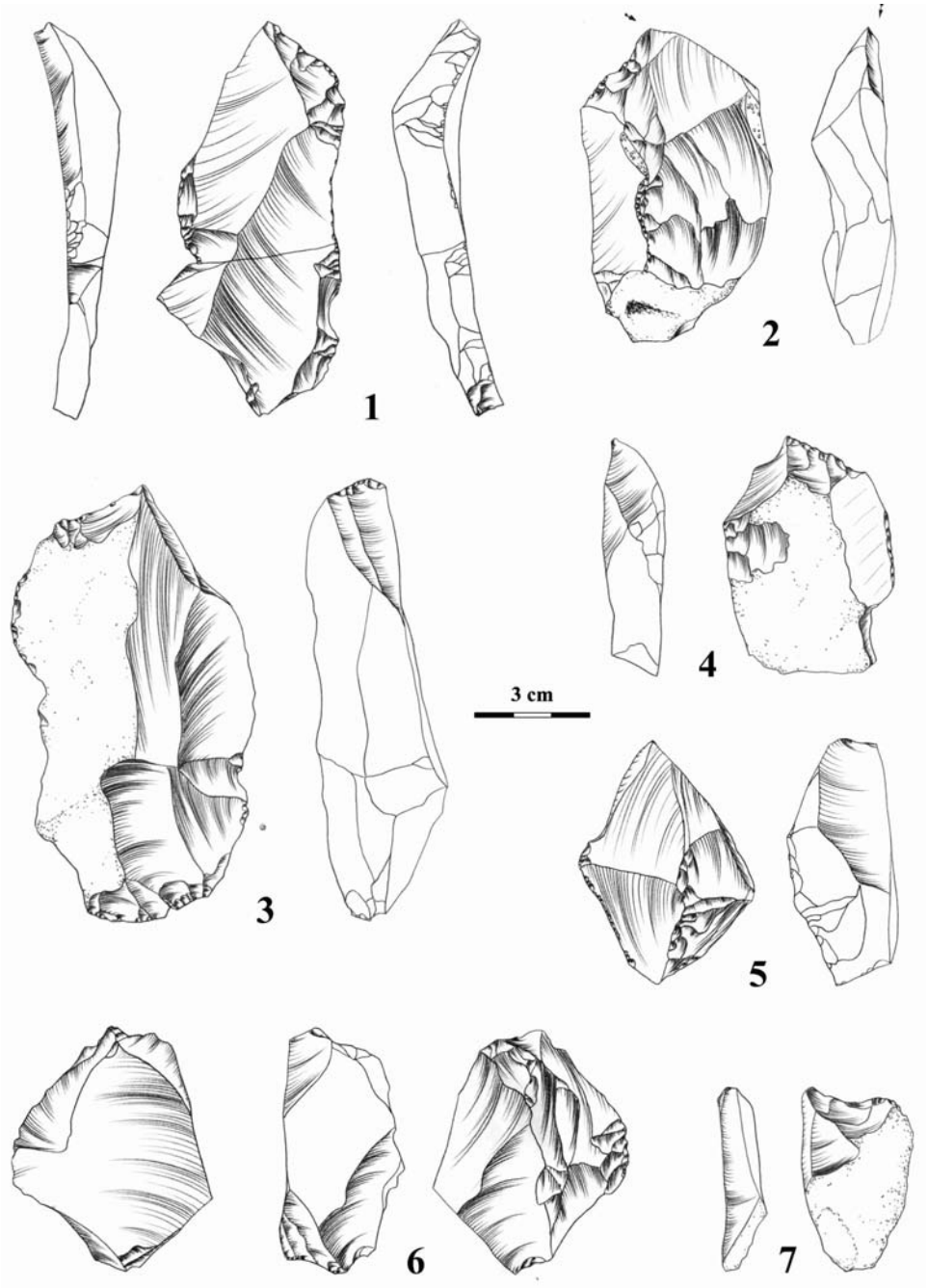
This is similar to the situation observed in the lithic inventory from the Epigravettian layer at Kraków Spadzista. But it must be noted also that the inventory from Piekary IIa includes a group of characteristic retouched tools, most notably a series of characteristic massive truncation burins, often on flakes (Figure 9). This is something characteristic only for the Piekary IIa.

Targowisko 10

The site at Targowisko (about 30 km east of Kraków) is interpreted as a Late Paleolithic short-term hunting camp. For this occupation we have four radiocarbon dates from between 14.8 and 14.5 ky uncal BP (Wilczyński 2009). The lithic resource used at this site is quite exceptional – next to several varieties of local erratic flint (Cretaceous, chocolate and Świeciechów flint extracted from secondary outcrops found about 4 km from the site) there are many blanks and a small number of tools struck from obsidian. Currently this is the longest series of obsidian artifacts recorded at a Paleolithic site in Poland. The inventory from Targowisko includes a large number of well-prepared double-platform blade cores and short endscrapers, often made on flakes, and a smaller number of burins and backed blades (Figure 10).

In addition to the lithic inventory the same site yielded an assemblage of Pleistocene fauna – horse and reindeer. The series of radiocarbon dates of around 14.0 ky uncal BP achieved for this settlement coincides with the Pre-Bölling warm oscillation. Some of the retouched tools, such as short endscrapers and backed blades, belong in the Epigravettian tradition and find analogy in the material from Carpathian Basin – e.g. Kašov 1, Grubgraben (Montet-White 1990; Bánesz *et al.* 1992). In addition, the presence of obsidian, which presumably came from outcrops found in the region of Zemplín, supports the Epigravettian attribution of the material from Targowisko. However, the technology of knapped artifacts is different than in other Epigravettian sites known from Poland, e.g. Kraków Spadzista layer 5 and Piekary IIa, both of which yielded massive, single-platform blade cores. That is why this assemblage may be interpreted as Epigravettian but, in contrast to other sites in the region of Kraków, it may be understood to belong to a different tradition

Figure 9: Piekary IIa – trench XIX.
1–7 – burins.



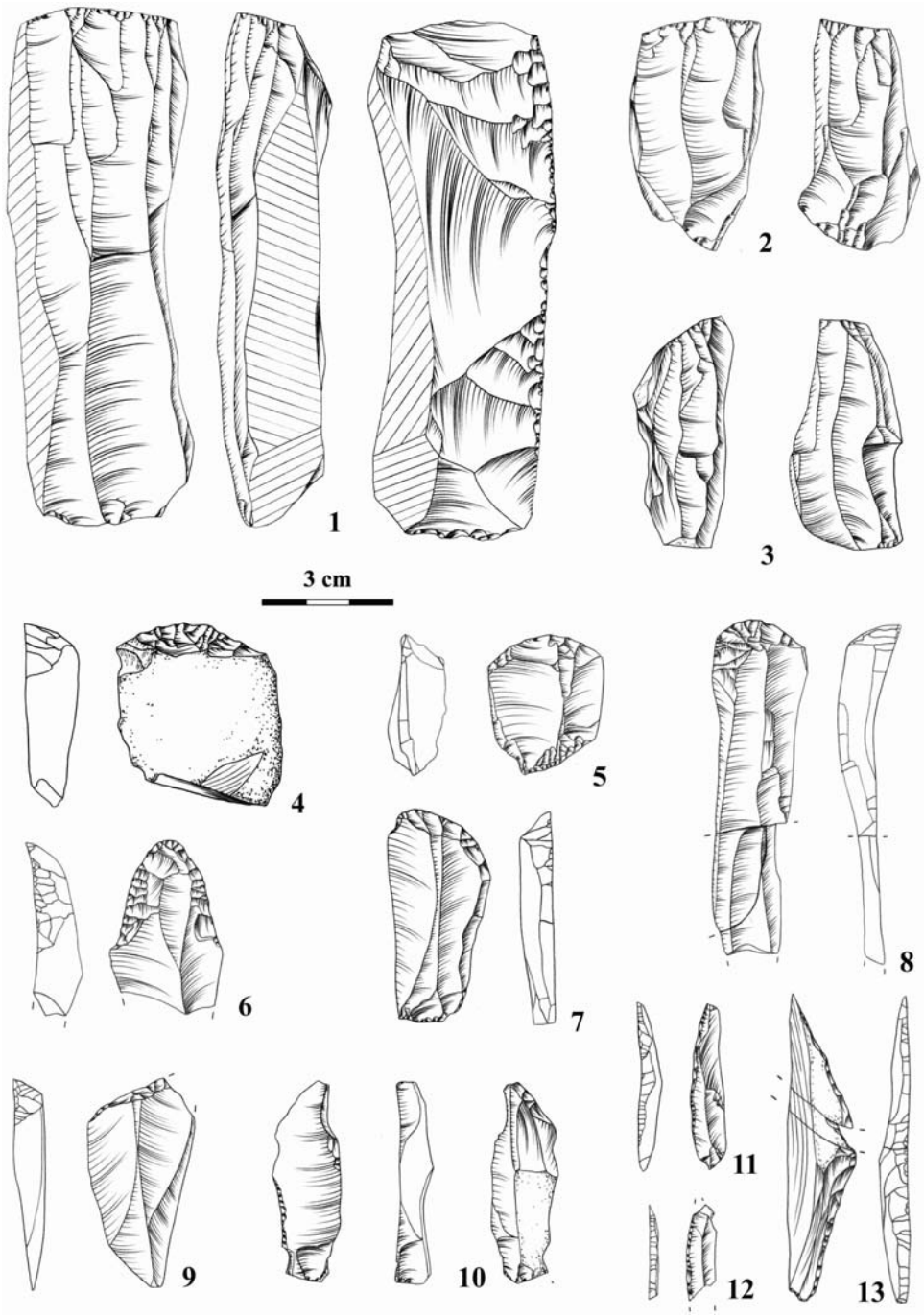


Figure 10: Targowisko 10.
1–3 – cores, 4–8 – endscrapers, 9 – truncated blade, 10 – burin, 11–13 – backed blades.

– closer to the traditions known from inventories from Molodova, layer V, Mezhirich (Ukraine) or Nadap (Hungary) which included advanced double-platform blade cores (Nuzhnyj 2006 66, 82; Lengyel personal communication).

Sowin 7

Discovered in 2000 and excavated more recently by Wiśniewski (Furmanek *et al.* 2001; Wiśniewski *et al.* 2012) this site comprises two cultural horizons: a lower (Epigravettian) and an upper (Magdalenian). The Epigravettian inventory includes flake and blade cores, the latter all single-platform forms. In the relatively large group of retouched tools the majority are specimens on flakes or on massive blades. The predominant form is burins which account for more than half of the whole tool assemblage. Other notable forms are single endscrapers and backed bladelets. Unfortunately, with no direct radiocarbon dates available for the inventory from Sowin 7, we can date it only broadly after the LGM.

Zawalona Cave

The modest lithic inventory recovered from layer E in Zawalona Cave has two radiocarbon dates of around 15.3 –14.0 ky uncal BP (Alexandrowicz *et al.* 1992). Unfortunately, the lithic inventory from this site is not characteristic enough to be ascribed to any specific taxonomic unit of the Upper Paleolithic (Alexandrowicz *et al.* 1992). It includes a few blades and flakes, as well as a single retouched blade.

Ujazd

The small atypical lithic inventory recovered at Ujazd was struck from various resources: Volhynian flint, Carpathian radiolarite, spongolite, Jurassic flint, menilithic hornstone and limnic quartzite (Valde-Nowak *et al.* 2005). Most of the artifacts are surface finds recovered from a secondary deposit. Only two were discovered in the sub-soil layer directly below the site surface. The inventory includes a single double-platform core which is, however, an initial, very amorphous form. Blanks are mostly flakes and blades, the latter massive and sometimes amorphous. A distinctive group of four tools includes specimens mostly made on cortical flakes. Thermoluminescence dates in the range of 18.0–15.0 kya obtained for this location have led some authors to interpret the discovered assemblage as Epigravettian (Valde-Nowak *et al.* 2005). However, as the authors have suggested, the results obtained from TL dating can be associated with a rapid redeposition and mixing of older material, thus the obtained TL age may be overestimated in relation to the actual deposition age (Bluszcz 2000; Valde-Nowak *et al.* 2005). It is notable that similar processes presumably were assisted by the geomorphological position of the site. Therefore, this very distinctive set of artifacts, additionally discovered in an unclear stratigraphic situation, must be regarded as much younger than Epigravettian, something that is also suggested by the variety of extralocal lithic resources used as raw material (never observed in Epigravettian sites where local materials prevail) and the technology and typology of the lithic inventory.

Discussion and conclusions

Early Gravettian settlement in Lesser Poland is known only from cave discoveries. So far we have no data about open-air sites, now that we have disproved evidence from Kraków Spadzista which in past studies used to be interpreted as Pavlovian. What is interesting is that this situation is not a reflection of the status of research because several open-air sites (Kraków Zwierzyniec, Kraków Spadzista or Piekary) are recorded in the region around Kraków and none of them, despite being multilayer sites with rich Middle and Upper Paleolithic assemblages, have yielded Pavlovian inventories. From two cave sites attributed to the MUP (Obłazowa and Borsuka respectively) we have extraordinary assemblages which were discovered in association with modern human remains. This may indicate that during the period of interest caves served a ceremonial or/and sepulchral function, as opposed to their function during the Early Upper Paleolithic and Aurignacian settlement when caves were often occupied and used as short-term shelters (except for the Mamutowa Cave). The unclear chronology of sites in Upper Silesia also does not strongly support the presence of Pavlovian groups in this area (except for Henryków 15); however, given the remarkably high proportion of exotic northern (Polish-derived) flint in Moravian inventories, the presence of Pavlovian groups in Upper Silesia seems clear.

During the Late Gravettian only the western reaches of southern Poland appear to have been penetrated by humans, but this is more an effect of the current status of research rather than of the actual situation during that age. As well as open-air sites some cave sites were also inhabited during this period, as confirmed by the discoveries made in the Mamutowa and the Deszczowa Caves. The long-standing investigation of the site at Kraków Spadzista, which has resulted in numerous studies on its geology, lithic inventories and chronology of the Gravettian settlement there, made this site until recently a "benchmark" for the Polish Gravettian. This situation changed after the discoveries at Jaksice II. Now, on the basis of inventories from Kraków Spadzista and Jaksice II sites, we propose that in the LGM period 24.0-20.0 ky uncal BP the territory of Southern Poland was penetrated by separate and distinct human groups. This is indicated by differences in (1) the choice of landscape setting of habitation sites, (2) tool production technologies and tool forms, and (3) choice of game animals hunted. Whether these differences reflect seasonal, cultural or even genetic differences we cannot answer at the present stage of research.

A similar degree of diversity is also observed in inventories from Southern Poland dated later than the LGM. What is most notable is that during this age large open-air sites are no longer recorded. The only open-air sites are workshops (Kraków Spadzista, Piekary IIa) or short-term camps (Targowisko 10, Sowin 7). This situation probably reflects deteriorating climatic conditions on the territory of southern Poland – especially at the time after the LGM. The presence of workshop assemblages at Kraków Spadzista and Piekary IIa which have yielded very special lithic inventories is apparent. On the one hand, their chronology is clearly connected with Epigravettian occupation, on the other, they are different from assemblages

known from other Central European sites such as Grubgraben (Austria), Kašov 1 (Slovakia) or Sagvar (Hungary) (Montet-White 1990; Svoboda and Novák 2004; Lengyel 2010) which are generally characterized by the presence of short scrapers, a higher percentage of local lithic resources and a diversity of methods of obtaining blanks for tool production (mostly flakes and short blades).

To summarize, we may conclude that thanks to new research which has focused on MUP settlement – most notably chronology (Kraków Spadzista), new studies of inventories from past research and taphonomic studies of the faunal assemblages (Kraków Spadzista) and above all, new fieldwork research (Henryków 15, Borsuka Cave, Jaksice II, Kraków Spadzista trench C2) – our current level of understanding of this age has changed considerably. At the same time, there is still the unresolved issue of the Early Gravettian settlement, especially in Upper Silesia, which is as unresolved as it was in the 1950s. This is perhaps the most pressing problem of MUP settlement studies in Poland, equal to the problem of the lack of Gravettian sites in Eastern Poland other than the site in Przemyśl. The only way to fill this gap is by continuing the archeological fieldwork and post-excavation study.

Résumé

Le présent article vise à apporter des informations sur les occupations gravettiennes et épigravettiennes de Pologne en s'appuyant sur les données de recherches récentes et sur l'interprétation des collections étudiées par le passé. Il s'agit également de proposer une vue d'ensemble provisoire de l'état des recherches sur les implantations gravettiennes et épigravettiennes en Pologne entre 30,0 kans et 14,0 kans non cal. BP. En Petite Pologne, l'implantation du Gravettien ancien n'est connue que par des découvertes en grotte. Les deux sites en grotte attribués au Paléolithique supérieur moyen (Obłazowa et Borsuka), ont livré d'extraordinaires assemblages associés à des restes humains attribués à l'Homme moderne. La chronologie incertaine des sites de Haute Silésie laisse planer le doute sur la présence de groupes pavloviens dans cette zone (à l'exception d'Henryków 15). Cependant, étant donné la proportion remarquablement élevée de silex erratique septentrional dans les inventaires des collections de Moravie, la présence de groupes pavloviens dans cette région de la Pologne devrait être notable. Pendant le Gravettien final, seul les cours d'eau du sud de la Pologne semblent avoir été fréquentés par les hommes préhistoriques. Désormais, sur la base des inventaires des sites de Kraków Spadzista et Jaksice II, nous pouvons affirmer que durant la période 24,0–20,0 kans non cal. BP, le Sud de la Pologne fut fréquenté par deux groupes humains distincts. On peut distinguer ces deux groupes sur la base : de différences dans le choix des implantations des habitats dans le paysage, de différences dans la technologie de production de l'outillage et des formes d'outils elles-mêmes et enfin dans le choix des gibiers chasses. La même diversité est également observable dans les inventaires des sites du sud de la Pologne datant de la période suivant le DMG. Fait remarquable, durant cette phase, on ne connait que des ateliers ou des campements de courte-durée.

Zusammenfassung

Der vorliegende Artikel hat eine Übersicht des Gravettien und Epigravettien in Polen anhand neuer archäologischer Untersuchungen und Interpretationen zum Material aus

älteren Studien zum Ziel. Es wird auch ein vorläufiger Überblick des Forschungsstandes zur Besiedlung des Gravettien und Epigravettien in Polen zwischen 30.0 ky and 14.0 ky uncal BP präsentiert. Die Besiedlung des frühen Gravettien von Kleinpolen ist lediglich durch Höhlenfunde bekannt. Von zwei Höhlen, die dem MUP (Obłazowa und Borsuka) zugerechnet werden, haben wir zwei außerordentliche Inventare, die in Verbindung mit Skelettresten des modernen Menschen entdeckt wurden. Die unklare Chronologie der Fundstellen in Oberschlesien wirft auch Zweifel hinsichtlich der Anwesenheit von Gruppen des Pavlovien in dieser Gegend auf (außer Henryków 15), jedoch wird in Anbetracht des großen Prozentsatzes von erratischem Flint in mährischen Inventaren die Anwesenheit von Gruppen des Pavlovien in dieser Region Polens deutlich. Während des späten Gravettien scheinen nur die westlichen Bereiche von Südpolen von Menschen begangen worden zu sein. Jetzt, auf der Basis der Inventare von Kraków Spadzista und Jaksice II können wir argumentieren, dass Südpolen in der Phase zwischen 24.0–20.0 ky uncal BP von zwei Gruppen von Menschen durchdrungen war. Das spiegelt sich wider in der Wahl der Lagerplätze, in Unterschieden bei der Werkzeugherstellung und den Geräteformen sowie in der Auswahl der Jagdbeute. Dieselbe Unterschiedlichkeit zeigt sich in Südpolen auch in Inventaren des folgenden LGM. Bemerkenswert ist auch, dass aus dieser Phase nur Schlagplätze und kurzfristige Lager dokumentiert sind.

UNE INVITATION À JIŘÍ SVOBODA POUR JUMELER LE COMPLEXE PAVLOVIEN DE MORAVIE ET LA GROTTE ORNÉE ET FUNÉRAIRE D'ÂGE GRAVETTIEN DE CUSSAC

Jacques Jaubert

Résumé
Le début des études pluridisciplinaires à la grotte de Cussac (2009) nous permet d'investir un site du Gravettien exceptionnel : une grotte ornée associée à des dépôts mortuaires de plusieurs individus attribués au Gravettien. Sans approfondir l'étude comparative entre le Pavlovien de Moravie et le Gravettien du bassin aquitain (Sud-ouest de la France) qui n'est qu'ébauché, une simple reconnaissance des sites respectifs permet d'envisager de fructueuses comparaisons et les spécificités propres à chaque ensemble culturel, contemporains et différents, mais relevant d'un même ensemble continental.

Mots clés
Paléolithique supérieur, enterrements, site en grotte, étude interdisciplinaire

DOI: 10.5817/CZ.MUNI.M210-7781-2015-17

Le nom de Jiří Svoboda mélange pour nous des souvenirs aussi étonnants que différents. Sa biographie indique une formation passant, entre autres, par quelque institution française (Caune de l'Arago, Marseille, université de Provence: Svoboda 1978), ce qui est tout à notre honneur. Comme nombre d'entre nous, j'ai ensuite croisé Jiří à de nombreuses reprises, au gré de colloques, symposiums, workshops et autres congrès internationaux, en France bien sûr, en Europe d'une manière générale, mais aussi bien plus loin, en Ouzbékistan par exemple et plus récemment au Japon. Sa notoriété a en effet très vite dépassé le cadre de sa chère Moravie. Le nom de Jiří Svoboda reste en effet pour beaucoup d'entre nous étroitement lié à cette Moravie truffée de sites paléolithiques qu'il a su synthétiser dans un ouvrage collectif et emblématique (Svoboda *et al.* 1996). Parmi une liste impressionnante, on retiendra en priorité le complexe de sites de Dolní Věstonice et de Pavlov, ses

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innombrables gisements ou locus, ses non moins extraordinaires habitats, ou plutôt complexes d'habitats, ses sépultures, ses statuettes, ses objets d'art mobilier ou de parure contemporains du Pléniglaciaire récent, sans évoquer les argiles cuites, les empreintes de vannerie, ces deux derniers exemples sans équivalents contemporains en Europe occidentale ou méditerranéenne (Soffer 2000).

Hormis nos régulières retrouvailles, jamais très démonstratives avec Jiří, mais si sincères, toutes empreintes d'érudition, de savoir, de références précieuses, de malice servie par un regard d'acier, le lien était tout trouvé pour ce recueil d'hommages : jumeler la symbolique funéraire de Dolní Věstonice/Pavlov et autres sites moraves (Brno) et la découverte, beaucoup plus récente et encore peu connue au plan international de la grotte de Cussac (Dordogne). Les paléolithiciens ouest européens – français notamment – peuvent jalouser sans fin le patrimoine paléolithique supérieur tchèque, morave plus particulièrement. Ainsi, dans une vie de préhistorien à recommencer, si l'on me proposait de naître tchèque plutôt que français, ou de choisir dans le cadre d'un échange standard, j'opterai sans trop hésiter d'abord pour les bilans pédo-sédimentaires d'Europe centrale, ensuite et surtout pour les accumulations structurées des sites de plein air recouverts de mètres de lœss, donc pour la qualité de la précision chrono-stratigraphique en même temps que la préservation de vastes complexes d'habitats enfouis sous les lœss protecteurs. Et si possible les deux en même temps. Donc en les échangeant contre « nos » abris sous roche ou entrées de grottes du sud-ouest de la France. Par contre, je garderai volontiers « nos » grottes ornées, les secteurs profonds et parfois inviolés durant près de deux dizaines de millénaires de quelque sanctuaire orné inscrit dans le domaine de l'endokarst. Avec leurs registres pariétaux, leurs sols vierges, leurs empreintes ou traces plus discrètes de l'appropriation du milieu souterrain et de la circulation des hommes au long de ces sombres galeries fréquentées parfois bien avant eux par les ours, donc un peu maculées. Échappons-nous donc le temps d'un bref hommage en quittant la plaine morave pour la rive gauche de la Dordogne et la grotte de Cussac.

La grotte ornée gravettienne et (peut-être) sépulcrale de Cussac : bilan de 4 années de recherche

Une découverte de la grotte et une gestion du dossier sans faille

À l'automne 2000, Marc Delluc, membre du Spéléoclub de Périgueux, à l'issue de plusieurs séances de désobstruction pénétrait, d'abord seul, puis avec deux de ses collègues dans une cavité « vierge » (du moins pour ses inventeurs !) qui allait rapidement défrayer la chronique (Delluc 2000, 2009; Aujoulat *et al.* 2000) : la grotte de Cussac, nom d'un hameau du Buisson-de-Cadouin (sud du Périgord), en rive gauche de la Dordogne, aux confins du Sarladais et du Bergeracois (figure 1). Conscients de l'importance de leur découverte, Norbert Aujoulat (Centre national de Préhistoire, Périgueux), puis le service régional de l'archéologie d'Aquitaine sont aussitôt avertis aux fins d'expertise. Tous prennent immédiatement la mesure de

Figure 1 : Carte de situation de la grotte de Cussac (Dordogne, France).
Map showing the site of Cussac cave (Dordogne, France).

l'vénement : une grotte ornée d'importance majeure, tant par son ampleur (1.6 km de galerie : figure 2), le nombre de panneaux gravés (une vingtaine), leurs dimensions parfois monumentales, la densité des œuvres, le caractère quasi intact des sols recelant de nombreuses empreintes, d'ours notamment et, comble d'originalité, des restes humains concentrés dans plusieurs secteurs de la grotte (nommés *locus 1, 2* et *3*). Ce dernier élément, puisqu'il s'agit de dépôts humains dans des bauges d'ours, nous relie indirectement aux sites du Pavlovien de Moravie (Svoboda *et al.* 1996; Trinkaus et Svoboda 2006): Brno (Oakley *et al.* 1971; Pettitt et Trinkaus 2000), Dolní Věstonice (Klíma 1983; Trinkaus *et al.* 2000; Svoboda *et al.* 2002), Pavlov (Svoboda 1991, 1994; Svoboda *et al.* 2002) et Předmostí (Svoboda 2008; Velemínská et Brůžek 2008).

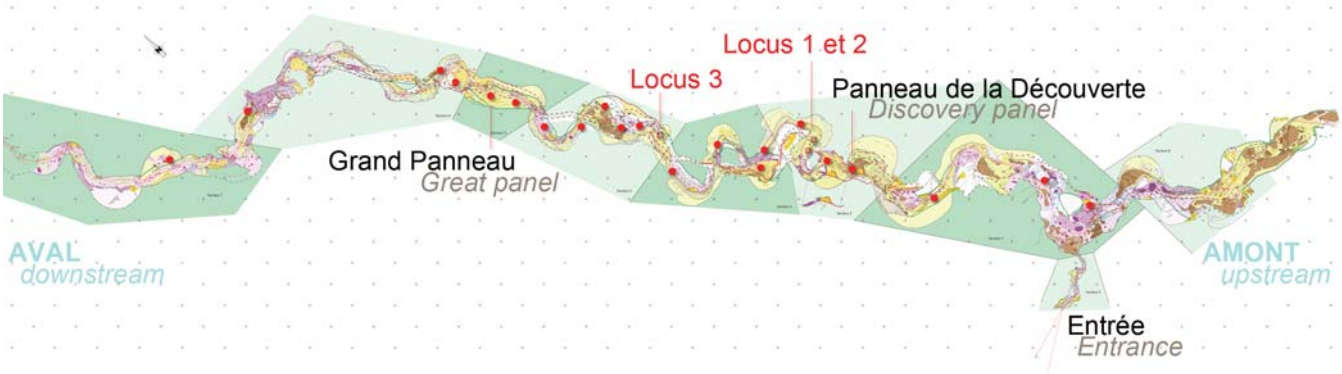

Figure 2 : Topographie générale de la grotte de Cussac avec localisation des principaux panneaux et locus aux restes humains (topographie H. Camus / Hypogée / PCR Cussac). Les séparations de couleur indiquent la sectorisation de N. Aujoulat. *General topography with the localization of the engraved pannels illustrated in the text and the site with the human remains (topography by H. Camus / Hypogée : PCR Cussac).*

Fort d'exemples précédents, au premier rang desquels la grotte Chauvet-Pont d'Arc (Ardèche), le ministère de la Culture mit en place une politique conservatoire (fermeture, balisage et équipement des passages vulnérables ou dangereux), juridique (classement au titre des monuments historiques, puis au titre des « sites ») et foncière (acquisition des parcelles réparties entre une douzaine de propriétaires !) très ambitieuse. Dans le même temps, les services du ministère de la Culture commandèrent un bilan environnemental et climatique ainsi qu'une étude hydrogéologique du massif à l'équipe GHyMaC (université de Bordeaux), ceci afin de définir un périmètre de protection (Peyraube 2011; Peyraube *et al.* 2012). Moins d'une décennie a été nécessaire pour boucler ce premier train de mesures (Fourment *et al.* 2012). Contrairement à d'autres dossiers, et sans tomber dans un angélisme ou une autosatisfaction exagérée, on peut estimer que ces actions se sont déroulées dans l'ordre, la concertation et sans contrariété majeure, hormis ici ou là quelque retard ponctuel, compréhensible vu la complexité du dossier. Donc, contrairement à ce dont la presse et les médias se font parfois l'écho pour d'autres grottes ornées alors qu'elles sont pourtant gérées avec un savoir-faire impressionnant, du moins par l'actuelle génération de conservateurs, par exemple pour Lascaux (Coye 2011).

À l'initiative de collègues bordelais, un collectif d'une trentaine de chercheurs s'ébaucha puis se mit concrètement en place courant 2008 pour l'étude de la grotte de Cussac, dont on me confia la responsabilité, en concertation avec le service régional de l'archéologie d'Aquitaine (Ministère de la Culture). Le ministère adhéra au projet, lequel se voulait global, dans un premier temps non invasif, privilégiant une étude d'ensemble de la cavité sous tous ses aspects, d'un point de vue pluri- et interdisciplinaire (Jaubert *et al.* 2010; Jaubert 2014). Le même ministère autorisa ledit programme pour une année probatoire (2009), puis pour trois ans (2010–12), en finançant pour l'essentiel les travaux de recherche, moyens dans un second temps complétés par des programmes plus ciblés pris en charge par la Région Aquitaine ou le LabEx[1] de Bordeaux. Ce sont quelques aspects de ces travaux que nous relatons ici au moment où un second programme triennal (2013–15) vient d'être reconduit.

[1] Laboratoire d'excellence (LabEx) des Sciences archéologiques de Bordeaux (LaScArBx) finançant des programmes de recherche sur appels d'offre pour les trois équipes ou laboratoires des universités de Bordeaux (PACEA) et Bordeaux 3 (Ausonius, IRAMAT).

Une archéologie de l'extrême

Même si le grand public et même une partie de la profession nous le reprochent parfois, la réalité du terrain et l'incontestable fragilité d'un patrimoine exceptionnel impose un cadre d'étude plutôt contraignant pour ne pas dire élitiste. Les grottes ornées sont en effet un milieu où l'on ne peut travailler qu'en petit nombre et au compte goutte, en minutant ses temps de présence et en étant systématiquement accompagné par un agent du ministère de la Culture (heureusement, plusieurs sont aussi membres de l'équipe). Cussac, grotte fermée au public – et même à la profession, à de rares exceptions près – ne déroge pas à la règle. Le taux de CO_2, l'exiguïté des lieux, les mille précautions à prendre pour circuler sans jamais effleurer les sols, les parois ou les voûtes truffées d'empreintes et de griffades animales, de gravures, voire d'ossements humains, imposent au collectif impliqué dans l'étude une patience et une attention à toute épreuve. Mais le site vaut de tels sacrifices et concessions. En vertu du caractère exceptionnel de la découverte associant pour la première fois des restes humains d'âge Gravettien et un art pariétal monumental contemporain (Aujoulat *et al.* 2001a, b, 2002), il fut d'ailleurs décidé de consacrer la première triennale de recherche à une étude dite non invasive (Jaubert *et al.* 2012), c'est-à-dire uniquement d'après des relevés photographiques à distance (figure 3), une couverture 3D photogrammétrie (P. Mora, B. Dutailly, Archéovision, unité associée à l'université Bordeaux 3) puis lasergrammétrie (cabinet Perazio), le tout doublé par un archivage filmique (P. Magontier).

Déposer des corps à plusieurs centaines de mètres de l'entrée

Il y a un peu moins de trente millénaires, des corps humains ont donc été déposés en plusieurs endroits de la grotte (Henry-Gambier *et al.* 2012, 2013; Villotte et

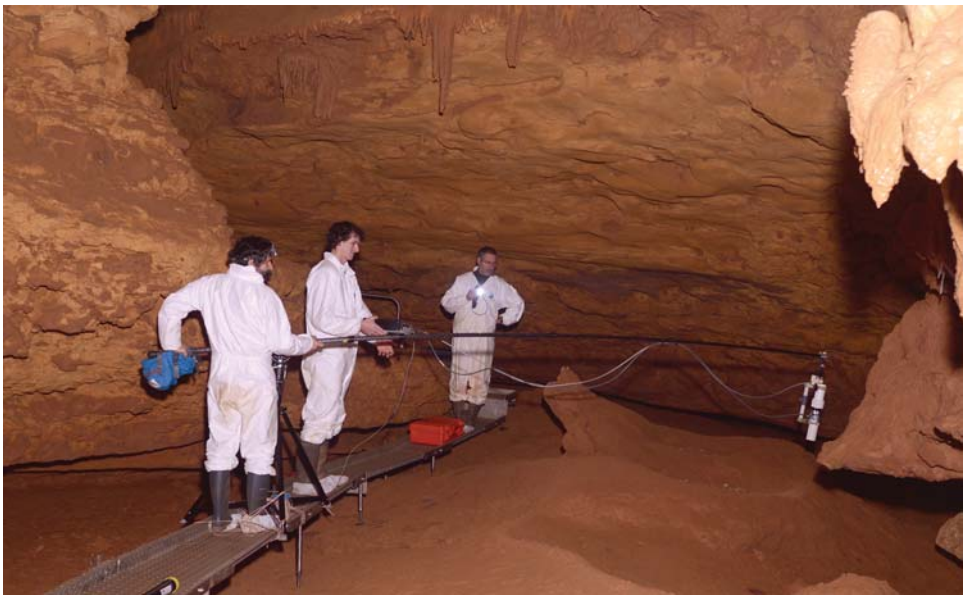

Figure 3 : Conditions de travail dans la grotte de Cussac : cheminement unique, ici sur passerelle, travail à distance, non invasif. Prospection pour la cartographie géomagnétique d'un locus à restes humains : F. Lévêque, V. Mathé (Université de La Rochelle, LIENs) et J.-Ch. Portais (photo O. Got, Université de Bordeaux / PCR Cussac).
Working conditions in Cussac cave: unique non-invasive technique for working on larger distance. Geomagnetic survey used in mapping of place with human remains: F. Lévêque, V. Mathé (University of La Rochelle, LIENs) and J.-Ch. Portais (photo by O. Got, University of Bordeaux / Cussac PCR).

Henry-Gambier 2013), entre des panneaux de gravures très certainement exécutés par des individus appartenant au même groupe. Nous venons récemment d'étayer cette hypothèse par une datation d'un charbon de bois (H. Valladas) recueilli par N. Fourment dans un secteur intermédiaire entre un panneau gravé et les dépôts de corps humains. Le bestiaire pariétal gravé, la perspective animalière adoptée, les

Figure 4 : Le squelette adulte du locus 2 (photographie N. Aujoulat / MCC) et sa photogrammétrie, vue détaillée – Modèle 3D, nuage de points à une résolution d'1 mm (P. Mora et B. Dutailly, UPS SHS 3D Archéovision, CNRS / PCR Cussac). *The Site 2 skeleton (photo by N. Aujoulat / MCC) and its 3D detailled view done by photogrammetry (P. Mora and B. Dutailly, CNRS university of Bordeaux UPR-SHS Archéovision / PCR Cussac).*

conventions graphiques (profil absolu, silhouettes filiformes, rares détails anatomiques: *e.g.* Guy 2010) évoquent la grotte de Gargas dans les Hautes-Pyrénées (Clot 1973; Barrière 1976), certaines associations thématiques originales connues sur d'autres sites contemporains comme Pech-Merle (figure 1), dans le Quercy voisin (Lorblanchet 1981, 2010), enfin les premières datations radiocarbone (^{14}C) plaident en faveur d'une fréquentation unique (en termes de générations), resserrée dans le temps. Les auteurs des gravures, identifiés dès les premières expertises (Aujoulat et al. 2001b, 2002, 2004), sont désormais confirmés : il s'agit bien des Gravettiens, qui occupaient les deux tiers méridionaux de l'Europe durant le dernier Pléniglaciaire (env. 35,000–25,000 calBP), du Portugal (Lagar-Velho: Zilhão et Trinkaus 2002) à la vallée du Don en Russie (Kostienki: Sinitsyn 2004). Ils sont réputés pour leurs ensembles sépulcraux aussi riches que diversifiés: pour D. Henry-Gambier (2008, 2013), Cussac vient encore compléter un bilan de pratiques funéraires pourtant déjà impressionnant: Paviland (Pays de Galles), Cro-Magnon (Henry-Gambier 2002), Abri Pataud (Nespoulet *et al.* 2013), pour les plus importants en France, les grottes de Grimaldi en Ligurie (Barma Grande, Barma di Caviglione, Baousso da Torre, grotte des Enfants (Henry-Gambier *et al.* 2001), Arene Candide également en Ligurie,Veneri Parabita et Ostuni, enfin Paglicci pour le reste de la Péninsule, Krems-Wachtberg en Autrichewögerer *et al.* 2006), Brno II et Předmostí (Svoboda 2008) découverts bien trop tôt, Dolní Věstonice I-II (Klíma 1949; Svoboda 1987, 1991), Pavlov (Svoboda 1994, 1997) en République Tchèque. Sans compter Soungir qui sort quelque peu de l'orbite gravettienne (pour un tableau complet et la bibliographie: cf. Henry-Gambier 2008).

À Cussac, les hommes ont élu comme lieu sépulcral des bauges creusées par les ours, puis y auraient amené des corps à plus d'une centaine de mètres de l'entrée et jusqu'à 330 m, même si, dans le détail, les modalités et l'historique de ces dépôts ne sont pas encore précisément interprétés (Henry-Gambier *et al.* 2013). Dans un second temps, des restes ont probablement été déplacés (« réduction » ?), les ruissellements, le concrétionnement, la remise en charge de la rivière souterraine déposant des limons d'inondation (étude C. Ferrier, S. Konik et A. Queffelec), le passage de petits animaux voire des hommes eux-mêmes achevant de brouiller les pistes pour compliquer sans limite l'enquête anthropologique. À l'issue de quatre années d'étude non invasive, D. Henry-Gambier, P. Courtaud et S. Villotte dénombrent un minimum de cinq individus, adultes et adolescents répartis en trois locus, le plus spectaculaire étant le corps quasi complet d'un adulte au locus 2, déposé couché sur le ventre (figure 4). La présence d'ocre rouge aux locus 1 et 3 confirme le caractère sépulcral des lieux (étude en cours H. Salomon).

Faut-il fouiller Cussac ?

Longtemps, nous nous sommes interrogés, concertés, nous avons recueilli les avis d'autres équipes car les actes archéologiques de type fouille sont rarissimes et toujours très partiels en contexte de grotte ornée, habituellement limités à de modestes sondages, par exemple à Chauvet (Clottes 2001; Geneste 2005). Après mûre réflexion et une instruction administrative et scientifique sans commune

mesure[2], nous avons finalement opté pour un projet de fouille du seul locus 1. Par la fragmentation des ossements, des absences anatomiques peu explicables, par exemple les restes crâniens, l'empilement des événements tant d'origine humaine (gestes réellement sépulcraux) que naturels (géologiques, animaux ou autres), ce locus 1 est de loin le plus complexe (Henry-Gambier *et al.* 2013) et le plus déroutant. Avec Yann Ledoux (Institut de mécanique et d'ingénierie, I2M, de l'université de Bordeaux), un équipement spécifique et réversible en matériau composite a été conçu (Labourel 2012; Gadaud 2013) afin d'accéder à l'espace de fouille avec un minimum de contact sur un sol fragile et maculé d'empreintes.

Comprendre le milieu fréquenté, investi, orné et sanctuarisé par les hommes : traquer le moindre indice

On ne peut être que désarmé, au mieux modeste devant ce type de site. Sont en effet remarquables: l'immensité des lieux, le moindre recoin exploré d'abord par les ours, puis par les hommes préhistoriques (toujours dans cet ordre), la densité des empreintes, des traces en tous genre, l'appropriation d'un environnement si original par l'Ours des cavernes, puis par les hommes et le lien qui a dû, un temps, les unir, au moins dans le choix du site.

À Cussac, les vestiges matériels sont rarissimes : une ou deux lampes, 3 lames de silex abandonnées au pied d'une paroi gravée (étude L. Klaric, H. Plisson, S. Caux), une pointe en bois de renne à 600 m de l'entrée (étude N. Goutas). Et c'est à peu près tout, du moins en l'état des prospections. Autant de vestiges qui nécessitent chacun leur spécialité (technologie lithique, osseuse), leur domaine de compétence, voire plusieurs spécialités pour un seul objet (figure 5). Ceci dans un but : d'abord inventorier, puis décrire, le cas échéant analyser avec le moins d'échantillonnages possibles le plus modeste indice de fréquentation.

Pour ce faire, nous avons repris l'acronyme proposé en son temps par Norbert Aujoulat[3] : TrAc, pour « traces d'activités » prolongeant la notion de paléospéléologie de F. Rouzaud (1978) (figure 6). Et donc les collègues investis dans cette discipline (M. Delluc, N. Fourment, M. Peyroux rejoints récemment par L. Ledoux et F. Maksud) sont bien sûr des « traqueurs »… Le parallèle avec la *forensic* est trop facile pour y revenir une nouvelle fois et désormais les congrès internationaux y consacrent souvent une session à part entière (Montelle et Bednarik 2012). Sachant qu'à Cussac la scène du « crime » non seulement s'est déroulée il y a presque 30 millénaires, mais un groupe a décidé d'élire ce qui deviendra la grotte de Cussac comme lieu sacré, réservé à des activités symboliques, au moins mortuaires, très

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[2] Par exemple, en 2013 pas moins de six avis issus de trois commissions distinctes (Service régional de l'archéologie, DRAC Aquitaine, Bordeaux + Commission interrégionale de la Recherche archéologique (CIRA) Sud-Ouest à Bordeaux + Commission nationale des Monuments historiques (CNMH), section grottes ornées à Paris) ont été émis, soit neuf pour le seul dossier Cussac.

[3] Norbert Aujoulat est hélas décédé au printemps 2011 alors que nous commencions tout juste l'étude de la grotte (Jaubert et Clottes 2011).

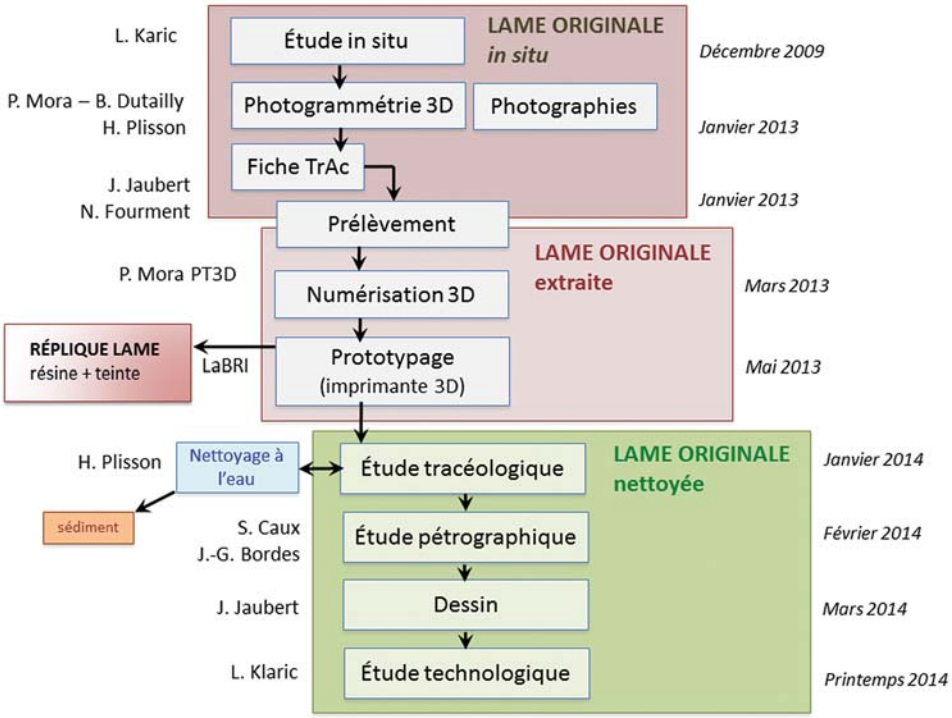

Figure 5 : Chaîne opératoire d'étude d'un vestige découvert en place et exceptionnellement échantillonné : une lame de silex (dessin J. Jaubert / PCR Cussac). *Chaine opératoire study concerning the archeological remain discovered in situ in the chamber "Animaux affrontés" and exceptionally sampled: flint blade (drawing by J. Jaubert PCR Cussac).*

probablement funéraires (Henry-Gambier *et al.* 2013) ou sépulcrales, probablement religieuses, pour nous, incontestablement artistiques (Aujoulat *et al.* 2004). Et en s'affranchissant de la difficulté de circulation dans un espace contraignant qui, habituellement, rebute plus qu'il n'attire. Certes le concrétionnement a progressivement comprimé l'espace de circulation, de même que la nature du sol (érosion, incision, sédimentation, vidanges : étude en cours H. Camus, D. Genty, C. Ferrier, S. Konik) ont pu changer quelque peu la physionomie de la cavité, mais pas au point d'en rendre la circulation au temps des premiers hommes modernes si aisée. Et de s'équiper suffisamment pour s'assurer un minimum d'éclairage, tout en s'appropriant l'espace souterrain et ses pièges cachés (puits, vides, passages en dévers…), mais aussi ses merveilles karstiques : stalagmites scintillantes, stalactites cristallines, draperies festonnées, échancrées, fistuleuses, miroirs d'eau, calcite flottante, sols caclcités immaculés, etc. Quelques-unes de ces spéléothèmes ne sont pas que des supports à analyses isotopiques ou datations numériques (Genty *et al.* 2014) mais conservent, si on sait les examiner de près d'infimes témoignages de circulation souterraine. Nombre d'entre elles ont en effet ont été balisées par des marques réalisées au manganèse noir ou à l'ocre rouge, à l'aller comme au retour, le long du cheminement qu'avaient emprunté avant eux les ours, leurs empreintes se confondant en pistes embrouillées (Jaubert *et al.* 2012; étude en cours M. Delluc, N. Fourment, L. Ledoux et F. Maksud). Des mouchages charbonneux afin de raviver la flamme des torches existent également surtout en branche Amont de la grotte. Une fois inventoriés, fichés et cartographiés, le système d'information graphique

(SIG) construit par É. Boche (Centre National de Préhistoire, Périgueux) fédèrera toutes les données sur un plan spatial et documentaire. Ces infimes traces de charbons sont précieuses pour obtenir de nouvelles datations ^{14}C comme le vestige transmis récemment à I. Théry (CEPAM, Université de Nice) pour détermination anthracologique, puis à H. Valladas (CNRS-CEA Gif-sur-Yvette) afin de la comparer à la première date obtenue sur os humain réalisée, elle, peu de temps après la découverte: 25,120 ± 120 BP (Beta 156643: Aujoulat *et al.* 2001), soit 29,500–28,835 calBP selon OxCal (Reimer *et al.* 2013).

La question de l'entrée

Cartographier l'espace souterrain (figure 2) et son emprise humaine en terme de pratiques funéraires ou artistiques a peu de sens si l'on est pas certain du cheminement d'origine. Si la topographie est désormais acquise pour les secteurs en cours d'étude (H. Camus, Société Hypogée), la question de l'entrée, ou des entrées d'origine est encore en suspens. Différentes spécialités des géosciences (géoarchéologie : C. Ferrier, S. Konik, Université de Bordeaux / PACEA / CNP Périgueux), de la paléoclimatologie, des datations et autres analyses isotopiques (D. Genty, CEA-LSCE Gif-sur-Yvette) se relaient, se complètent pour décrire les modalités de fermeture du porche actuel, l'évolution du cône d'éboulis et des concrétionnements ayant obturé la galerie d'entrée et en retracer la diachronie. Les premières datations confirment un dépôt de concrétion plutôt récent (Holocène ancien, soit vers 13,000 ans BP), soit plusieurs millénaires après le départ des Gravettiens. Or, pour que les restes humains n'aient pas été bouleversés par quelque carnivore charognard, les hommes ont certainement dû protéger leur espace sacré. Et, d'après nos observations actuelles, aucun signe ou indice d'un passage plus récent n'a jusqu'à présent été identifié.

Étudier les immenses panneaux de gravure de Cussac

L'équipe chargée de l'art pariétal initiée par N. Aujoulat puis désormais coordonné par V. Feruglio (équipe Ethnologie préhistorique, ArScAn, université Paris Ouest-Nanterre) avec le concours de C. Bourdier (université de Toulouse, Traces) a choisi d'emblé de faire de Cussac un terrain d'expériences méthodologiques. Profitant du gigantisme de certains panneaux ornés (Grand Panneau notamment), de leur difficulté d'accès (le panneau du Fond ou celui des Animaux affrontés sont éloignés du cheminement, parfois en voûte), l'équipe a choisi ne commencer les relevés proprement dits qu'une fois l'enregistrement 3D réalisé (Feruglio *et al.* 2013). Jusqu'à présent, les couvertures 3D effectuées sur d'autres sites ont accompagné les études, leur ont succédé, pour réaliser un archivage complémentaire ou concevoir des fac-similés plus qu'elles ne les ont précédés (grottes Chauvet, Lascaux, Marsoulas). Là où les graveurs de Cussac ont investi un espace à trois dimensions, il fallait donc respecter cette tridimensionnalité et s'adapter en profitant des progrès des enregistrements 3D à haute résolution (infra millimétrique) pour, systématiquement, travailler sur le modèle tridimensionnel. Et donc n'en commencer le relevé qu'une

Figure 6 : Modélisation de la fréquentation humaine de l'espace souterrain à Cussac inspiré de la paléospéléologie de F. Rouzaud (1978), modifié, complété. Dession J. Jaubert / PCR Cussac.
Model of human usage of Cussac karst area according to F. Rouzaud (1978) and the notion of "paleospeleology" (modified, supplemented) (drawing by J. Jaubert / PCR Cussac).

ACTION		EMPREINTES, TRACES, VESTIGES		
Progression	*Circulation*	Empreintes dynamiques, corporelles	Pied	'PALÉOSPÉLÉOLOGIE'
			Main	
			Glissades	
			Chutes	
	Modification de l'aire de circulation	Bris de concrétions pour le passage		
	Objets isolés, pertes ?		Artefacts en silex, MDA, matériaux allochtones divers	
Arrêt			Lampes	
	Éclairage, chauffe	Mouchages de torches		
		Charbons		
Subsistance		Structures de combustion	Foyers	
	Séjour, Activités techniques		Vidanges de foyer	
		Restes alimentaires		
		Ateliers de taille		
		Réféction d'outils		
Aménagement	*Modification du site*	Aménagements du sol		
		Structures d'habitat	en creux (fosses, trous de poteau…)	
			de maintien, protection, abris	
Cultuelle, funéraire, symbolique, mythique, autre		Sépultures		
	Modification de la paroi	Iconographie pariétale	Dessins peints, gravés…	
	Dépôts inexpliqués		Objets fichés	

fois la photogrammétrie ou la lasergrammétrie disponibles. En attendant ce précieux outil, l'inventaire des panneaux, soit une trentaine et, pour chacun d'entre eux chaque figure (appelées « entités graphiques » ou EG), depuis le plus grand bison mesurant plus de 4.5 m de long au Grand panneau jusqu'à de modestes motifs indéterminés de quelques centimètres ont été progressivement fichés, décrits, photographiés, soit près de 400 EG pour la seule Branche Aval. Et les ultimes panneaux du fond ne sont pas encore atteints côté Aval. L'équipe a achevé d'inventorier en

janvier 2014 le panneau du Passage à 420 m de l'entrée. Quant à la branche Amont, certes moins riche, remarquable par des figures isolées (rhinocéros, oie, figures féminines) elle n'a pas encore été visitée par tous les chercheurs de l'équipe !

Le bestiaire de Cussac (Aujoulat *et al.* 2004) est nettement dominé par le bison (figure 7), devançant le mammouth, puis le cheval, les autres espèces étant minoritaires (cervidés, bouquetins), voire anecdotiques (rhinocéros, carnivores, oiseaux). Un point commun à bien des cavités ornées mais toujours étonnant: le nombre d'animaux étranges, hybrides, incomplets, incompréhensibles, voire carrément monstrueux, gueules grandes ouvertes. Autre particularisme, l'omniprésence des représentations féminines ou sexuelles, pour ces derniers souvent féminines, plus rarement masculines et qui ne prêtent pas à la discussion en matière d'interprétation (figure 8). Ou encore cette thématique récurrente attestée à Cussac comme à Pech-Merle (Lot) associant mammouth et représentation féminine stylisée (figure 9).

Les conventions relèvent incontestablement du Gravettien (Aujoulat *et al.* 2001, 2002, 2004; Guy 2010; Jaubert 2008; Lorblanchet 2010; Feruglio *et al.* 2011; Jaubert et Feruglio 2013; Petrognani 2013) : profils absolus, souvent difformes, peu détaillés quant aux pelages d'animaux silhouettés à grands traits avec, pour les plus spectaculaires, des gestes d'une sûreté remarquable. Et la gravure n'autorise pas le repentir. Si de nombreuses figures sont incomplètes, voire indéchiffrables ou plutôt incompréhensibles, plusieurs comme celles du Grand Panneau (figure 9) relèvent de maîtres graveurs et forcent l'admiration.

Un point de déception: la présence infime d'ADN

Ce n'est pas faute d'avoir essayé, et avec différentes méthodes ou protocoles (Deguilloux *et al.* 2011), mais M.-F. Deguilloux et ses collaborateurs, une fois les problèmes de contamination évacués, n'ont jusqu'à présent pas réussi à identifier une quantité suffisante d'ADN, mitochondrial ou nucléaire pour statuer sur l'origine

Figure 7 : Panneau de la Découverte : rendu de la composition des bisons (dessin V. Feruglio).
Depiction of typical Gravettian bison in Cussac cave composition: panel of Discovery (drawing by V. Feruglio / PCR Cussac).

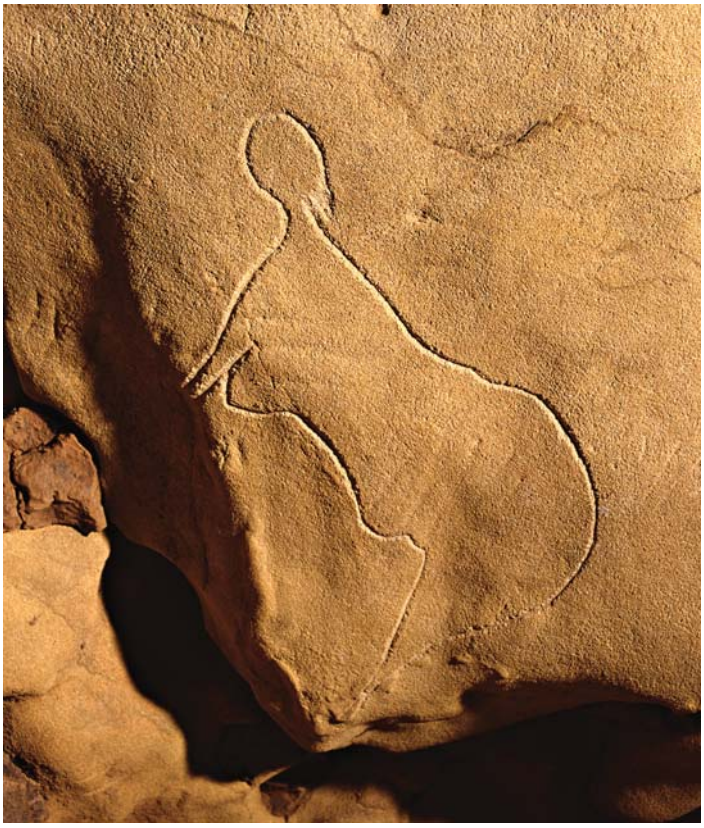

Figure 8 : Grotte de Cussac, branche Amont : figure féminine typique du Gravettien (photo N. Aujoulat / MCC).
Cussac cave, Upstream gallery: typical Gravettian female figure (photo by N. Aujoulat / MCC).

du groupe humain, ou encore ses liens de parenté (Deguilloux in Henry-Gambier *et al.* 2013). On nous explique généralement que c'est hélas souvent le cas pour les restes humains de cet âge, finalement moins favorables à l'étude paléogénétique que leurs homologues néandertaliens, bilan tout aussi décevant qu'il est peu publié… D'ultimes tentatives avec la plateforme de génomique de l'université de Bordeaux sont actuellement en cours.

Une association exceptionnelle désormais typique du Gravettien : art monumental pariétal et dépôts de corps

D. Henry-Gambier a récemment et à plusieurs reprises (2008, 2013) proposé des bilans relatifs à la question des pratiques funéraires du Gravettien. Il est à peu près consensuel pour nombre d'entre nous que les quelques millénaires qui fédèrent l'Europe durant le début du Pléniglaciaire récent entre 34,000 et 25,000 calBP et ce que nous regroupons sous le terme « Gravettien » (Otte 2013) se démarquent des cultures qui le précèdent, par exemple l'Aurignacien ou lui succèdent, du moins en Europe du sud-Ouest comme le Solutréen, l'un et l'autre particulièrement pauvres sinon même inexistants en complexes funéraires ou sépulcraux. Pour ce qui est de ce cette thématique, l'entité « Gravettien » est à ce titre assez remarquable et originale. La découverte de Cussac renforce par le nombre et l'originalité des manifestations mortuaires – et probablement funéraires – ce bilan.

Bien sûr, des ensembles régionaux permettent de nuancer ce « peuplement » gravettien qui n'est ni uniforme ni monolithique : les environnements respectifs, les registres techniques (productions lamino-lamellaires, types d'outils propres à un espace géochronologique comme le « burin » de Noailles, les pointes de Font-Robert et autres fossiles directeurs des préhistoriens du XXe siècle), le travail de la matière dure animale (*e.g.* Goutas 2013), les domaines artistiques ou de production symbolique, la parure, l'art mobilier – avec de fortes composantes régionales voire locales – sont autant d'éléments qui permettent, tout comme le domaine funéraire, de dresser un tableau aussi riche que complexe (Noiret 2013; Pesesse 2013b). Certes qui a vocation, au moins pour une partie du Gravettien *sensu lato*, à être regroupé dans le même super ensemble continental. Mais force est de constater qu'une meilleure résolution des études remettent souvent en question cette uniformité, au moins durant les phases de fondation (Gravettien le plus ancien, Bayacien : Pesesse 2013a), voire de maturation et la phase moyenne: en Europe occidentale, le « Noaillien » du sud de la France et d'Italie tyrrhénienne (David 1985; Djindjian *et*

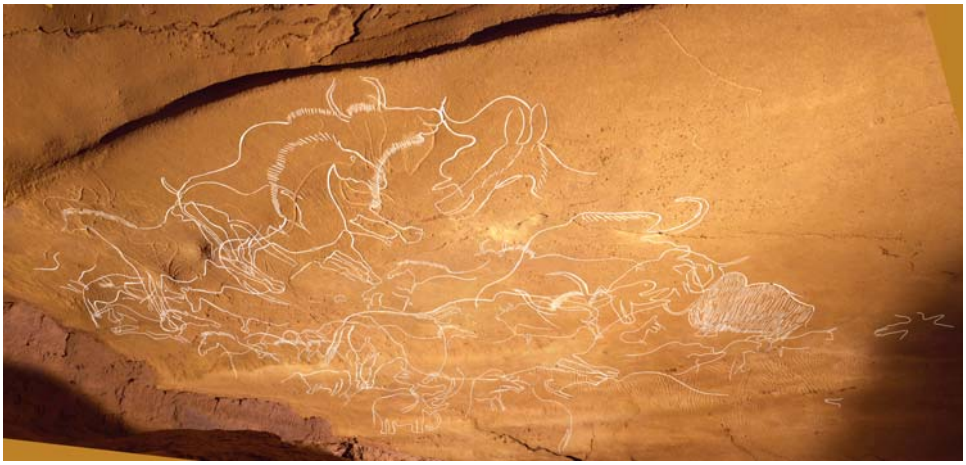

Figure 9 : Grotte de Cussac, Grand Panneau : remontage de plusieurs clichés et aide à la lecture des entités graphiques (clichés N. Aujoulat/MCC ; infographie V. Feruglio / PCR Cussac).
Cussac cave, Big Panel: Several photos reassembled for better reading of engravings (the complete panel tracing remains to be finished) (photos by N. Aujoulat / MCC; computer graphics V. Feruglio / PCR Cussac).

al. 1999) *versus* le Rayssien de France septentrionale (Klaric 2007, 2008). Ainsi, dans le domaine funéraire, et en prolongeant les synthèses de D. Henry-Gambier déjà mentionnées, il serait aisé de distinguer des groupes régionaux : méso danubien / morave (les sites tchèques et autrichiens apparentés au Pavlovien), transalpin / italien (Ligurie et Péninsule, Mussi 2002) ou encore aquitain s.l. (Cussac, Vilhonneur, Cro-Magnon, Pataud). On aura noté au passage l'emprise certaine de la géomorphologie et des structures d'accueil qui semblent, en partie du moins, guider cette partition.

A contrario, certains éléments unissent l'Europe du Gravettien (*e.g.*: Roebroeks *et al.* 2000) : une technologie lamino-laminaire dominée par des productions et armatures rectilignes, droites, à dos abattu ou encore les représentations féminines stylisées de type « vénus » dont nous avons tous en mémoire, et depuis longtemps, la cartographie continentale, du piémont pyrénéen (Brassempouy, Lespugue) à la vallée du Don (*e.g.* Delporte 1979; Kozlowski 1992; Mussi *et al.* 2000) prenant en écharpe l'Europe tempérée. Voire au-delà jusqu'aux confins du lac Baïkal, même si un décalage chronologique est désormais confirmé (Mal'ta, Bouret' : Cauwe *et al.* 1996). Et ce n'est probablement pas un hasard si Malt'a livre en même temps que ses statuettes en ivoire une sépulture d'enfant richement paré découverte par Gerasimov, même si elle fut parfois controversée, notamment par l'école soviétique (Boriskovskiy 1984).

La découverte de Cussac permet de rajouter à ces bilans un élément qui n'aura échapper à personne : l'association en un même lieu du domaine funéraire et de l'art pariétal ou, dit autrement, le *funéraire* et l'*orné*, ou encore le *sépulcral* (si cette interprétation est confirmée pour Cussac) et l'*artistique*. De manière moins spectaculaire, plus discrète, ces deux éléments étaient cependant déjà associés à la grotte Paglicci (Mezzena et Palma di Cesnola 1971, 1989–90), à Vilhonneur (Henry-Gambier *et al.* 2007) ou encore plus discrètement à Abri Pataud (Movius 1977; Nespoulet *et al.* 2013) où la notion d'abri orné, peint, au strict voisinage de Cro-Magnon parait de plus en plus s'imposer (Henry-Gambier comm. pers.). Mais Cussac permet de franchir un pas décisif dans l'interprétation du phénomène « grotte ornée » et dépôt de corps avec désormais la juxtaposition topographique

au sein d'un milieu nettement plus contraignant, difficile d'accès, de deux parmi les plus spectaculaires manifestations symboliques que les premiers hommes modernes nous ont laissées. En cela, la grotte de Cussac peut prétendre au statut de site de référence quant à un nouveau type de sanctuaire complexe associant au moins deux témoignages liés à une abstraction collective des fonctions du Sacré, probablement ancrées dans une mythologie animalière forte où le domaine de l'ours a été approprié par le groupe via le dépôt de corps en même temps que les porte-drapeaux animaux (bisons, mammouths, chevaux…) sont transposés sur la paroi gravée pour la nuit des temps. Et ne négligeons pas la figuration humaine, assez prégnante à Cussac avec plusieurs représentations féminines (figure 8, 9), aux canons parfaitement en phase avec le Gravettien moyen de Laussel (Roussot 1995) aux figurés sexuels peu équivoques.

L'invitation finale

Donc, pour ton jubilé, cher Jiří, et afin de renforcer le relationnel systémique gravettien « Europe centrale – Sud-Ouest de l'Europe », je t'offre, nous t'offrons avec mes collègues français une visite de la grotte que nous étudions. Rien que pour toi. Rien que pour nous. Nous te la devons depuis déjà quelques années : tu aurais dû être proposé comme expert dès la découverte, au moins pour la programmation du présent projet de recherche. Et comme à chaque présence d'un hôte d'importance – les deux derniers furent Erik Trinkaus et Roberto Ontañon – une interview filmée recueillera tes impressions. Dans un premier temps pour nous, puis, mais le plus longtemps possible, pour la postérité. Tu le constateras je pense par toi-même, Cussac mérite bien ta visite. Et vice-versa.

Summary
The initiation of multidisciplinary studies at the cave of Cussac allows us to introduce an exceptional Gravettian site: a painted cave associated with burials of several individuals assigned to the Gravettian. Without going deeply into the comparative study between the Pavlovian (Moravian Gravettian) and the Gravettian of Aquitaine Basin (south-west France), a simple recognition of corresponding sites allows for the consideration of useful comparisons and specific characteristics of these contemporary but different cultural groups belonging to the same continental unit.

Zusammenfassung
Der Beginn der interdisziplinären Studien in der Höhle von Cussac ermöglicht uns einen außerordentlichen Fundplatz des Gravettien vorzustellen: eine Bilderhöhle mit den Bestattungen mehrerer Individuen, die dem Gravettien zugerechnet werden können. Ohne sich auf eine nähere Vergleichsstudie zwischen dem Pavlovien (Mährisches Gravettien) und dem Gravettien des Aquitanischen Beckens (Südwest Frankreich) einzulassen, erlaubt ein einfaches Erkennen ähnlicher Fundstellen, sinnvolle Vergleiche und spezifische Charakteristiken dieser zeitgleichen aber kulturell unterschiedlichen Gruppen derselben kontinentalen Einheit zu berücksichtigen.

OLD COLLECTIONS AND NEW EXCAVATIONS IN A GRAVETTIAN KEY-SITE: THE ABRI PATAUD (DORDOGNE, FRANCE)

Roland Nespoulet[1], Laurent Chiotti[2] and Dominique Henry-Gambier[3]

Abstract
The latest excavation of Level 2 at the Abri Pataud (final Gravettian, 22.0 ky BP), proceeding since 2005, is based on a threefold analytical approach: fieldwork, archive analysis and analysis of old collections. Throughout the scientific project, these three approaches have enriched each other. They have identified precisely the potential of information as well as the limits of old data. The excavation protocol and the sampling strategy have been conceived in order to give answers to the remaining unanswered questions. The results, which have also their own methodological limitations, have clarified the status of human remains found in Level 2 as funerary deposits. The results also allowed us to gain a better understanding of the modalities of the successive occupations of this level, although the surface of excavation was voluntarily limited.

Keywords
Final Gravettian, Abri Pataud, excavation protocol, archives, collection, key-site

DOI: 10.5817/CZ.MUNI.M210-7781-2015-18

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Introduction

The history of research conducted at the Abri Pataud provides a concrete example of a paradigm shift over 50 years of distance, between the excavation of H. L. Movius and our own excavations. This paper presents, through some examples of the new results obtained on the Final Gravettian since 2005, the evolution in terms of (1) main scientific issue, (2) excavation, analysis methods and techniques, and (3) new interpretations and resulting perspectives related to the behavior of Gravettian populations in France.

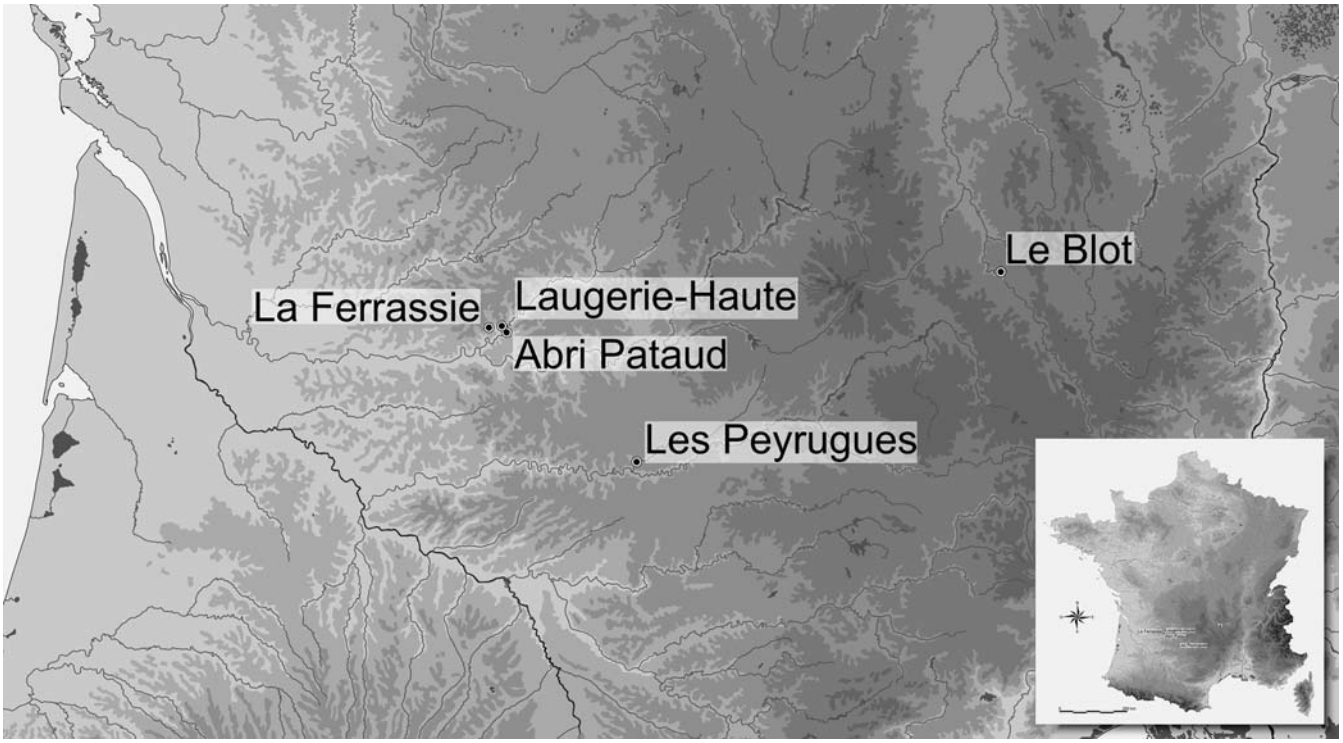


Figure 1: Location of main sites mentioned in the text (CAD by R. Nespoulet).

Abri Pataud is located in the "classical" region of Les Eyzies-de-Tayac in Dordogne, on the left bank of the Vézère valley. Close to the Cro-Magnon site, Abri Pataud is in the middle of one of the richest archeological regions, among sites very important for the regional Gravettian sequence like La Ferrassie and Laugerie-Haute (Figure 1).

At Abri Pataud, four main Gravettian levels have yielded abundant archeological material. The lithic industry, in particular, helped to revise the chronological framework of the Gravettian in France. The excavation of Pataud represents the turning point of the history of research and theoretical models, between the Peyrony model of the "Aurignacian and Perigordian", based mainly on deposits at La Ferrassie and Laugerie Haute (Peyrony 1933), and the Sonneville-Bordes proposition of the Upper Perigordian (Sonneville-Bordes 1960, 1966). The stratigraphy of the Gravettian at Pataud can be considered as a "key" to proving that the archeological sequence of Laugerie-Haute was strictly later than La Ferrassie, and not synchronous, as suggested by Peyrony.

Thus, the last Gravettian level of La Ferrassie (with Noailles burins, Peyrony level L: Peyrony 1934) corresponds to level 4 of Pataud, and the first Gravettian level at Laugerie Haute (with microgravettes, level B Peyrony: Peyrony and Peyrony 1938) corresponds to level 3 at Pataud. The archeostratigraphy of Pataud was the conclusive evidence that saw the end of the Peyrony model, while reinforcing the interpretations of Sonneville-Bordes. The Gravettian sequence of the Abri Pataud remains a reference for the French Gravettian. This is the only stratigraphic sequence providing the four main phases of the Gravettian: Early, Middle, Late and Final Gravettian.

Abri Pataud excavations

Commenced in 1953, the Movius project was an ambitious program, well-funded, in particular by the National Science Foundation, and can be considered as a "model project" (Movius 1975, 1977; Chiotti and Nespoulet 2007; Nespoulet and Chiotti 2007). During six excavation seasons (1958–1964) all the stratigraphy was excavated. The excavation revealed a very important quantity of archeological objects (around 1.5 milion) and the associated field archives were also important (around 60, 000 documents). This point is very important because the archeological collection has not been separated from the original archives, currently stored in a common place, at the Abri Pataud reserve.

Several methods utilized by the Movius team were innovative for the field archeology of Western Europe in the 1960s. For instance, the utilization of a grid-system and the fact to coordinate the important objects was accompanied by a systematic stratigraphic record. We can estimate that 10 to 15% of the total amount of objects was coordinated. The rest were grouped in bags with stratigraphic and/or square references. Unfortunately for our project, in level 2, during the first year of excavation (1958), this methodology was not applied with the same rigor as thereafter. We know that for the 1958 field season a lot of information is still missing, in particular the first days of beginning to clean the site and just after.

The Abri Pataud rock shelter evolved by rapid erosion, which contributed to a significant and rapid sedimentation. This is one of the main characteristics: a thick and "dilated" stratigraphy, recording numerous geological phases and human settlements. This is true both for the Aurignacian and Gravettian sequences. Pataud is also a site of great dimensions: Movius' excavations explored "only" 10% of its archeological potential known by test pits. The reference stratigraphy (Movius 1977) is an archeostratigraphy with numbers for each archeologically significant level, and intermediate *eboulis* which are "theoretically" sterile. Fourteen main archeological levels were identified (Figure 2):

- nine Aurignacian levels: Early Aurignacian (levels 14 to 9), Late Aurignacian (levels 8 to 6);
- four Gravettian levels: Early Gravettian (level 5), Middle Gravettian (Level 4), Late Gravettian (level 3) and Final Gravettian (level 2);
- one Solutrean level (level 1).

A well dated stratigraphic sequence

More than 100 radiocarbon dates have been obtained at Abri Pataud. Different periods and methods gave good results (Chiotti and Nespoulet 2007). The last one (Higham *et al*. 2011) gave older dates than previous ones. We also expected 16 new dates for levels 4 to 2. The whole stratigraphic sequence is well dated. Level 5 starts at 33.0 ky cal BP, and level 2 is at 27.0 ky cal BP. An interesting point is the fact that the human occupation of level 2 is situated just before or at the beginning of Heinrich event 2. It seems that these particular climatic conditions did not change

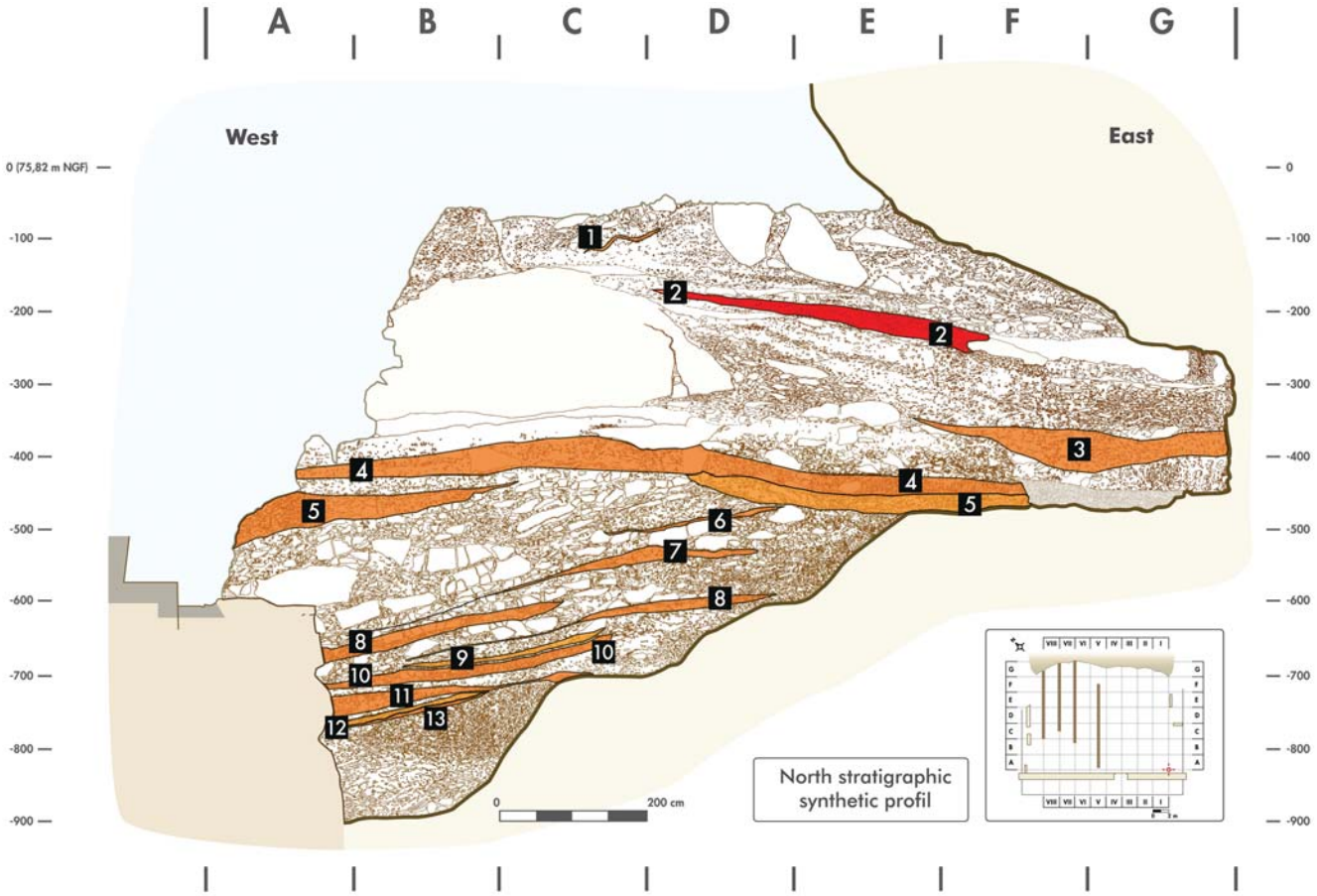


Figure 2: Stratigraphy of the Abri Pataud. Early Aurignacian: Levels 14 to 9; Evolved Aurignacian: Levels 8 to 6; Early Gravettian: Level 5; Middle Gravettian: Level 4, Recent Gravettian: Level 3, Final Gravettian: Level 2; Solutrean: Level 1 (drawing by R. Nespoulet & L. Chiotti, CAD by C. Lecante).

the process of sedimentation (Lenoble and Agsous 2012, 2013; Henry-Gambier *et al*. 2013b).

As an ambitious program, the Movius excavation was an important fieldwork project[1]. Movius' main excavation represents a large area of 12 × 12 m for levels 1 to 3 and then 12 × 6 m for levels 4 to 14. A 12 × 2 m trench had been excavated in extension in 1963. In total, 192 m² and 800 m³ were excavated, including 154 m³ of archeological deposits (112 m³ for the Gravettian levels and 42 m³ for the Aurignacian levels).

Collections: Some quantitative aspects

The Movius collection contains a very large quantity of objects. As is shown in Table 1 the retouched lithic tools represent 27, 463 pieces. The new studies have

[1] Probably impossible to achieve today in a programmed excavation, even if only for reasons of research funding.

significantly increased the amount of artifacts, particularly for small objects. Levels 5 and 4 are the richest. The reported tool counts for the whole series are:
For level 5: 96, 000 lithics and 410, 000 bones;
For level 4: 100, 000 lithics and 240, 000 bones;
For level 3: 33, 000 lithic and 93, 000 bones;
For level 2: 25, 000 lithics and 68, 000 bones.

For all the Gravettian levels, the quantity of lithics in Movius collection is more than 250, 000 objects.

Table 1: Counts of lithic tools according to archeological levels of Abri Pataud.

level	culture	Movius' count	new count	new tools	
2	Final Gravettian	1,156	1,845	689	37.34%
3	Recent Gravettian	1,309	1,662	353	21.24%
4	Middle Gravettian	5,745	13,065	7,320	56.03%
5	Early Gravettian	5,640	7,084	1,444	20.38%
6–8	Evolved Aurignacian	977	1,739	762	43.82%
9–14	Early Aurignacian	1,384	2,068	684	33.08%
total		**16,211**	**27,463**	**11,252**	**40.97%**

During Movius' excavations and the studies that followed, not all the archeological material was studied. For the lithic, only catalogued objects were taken into account, the rest, labeled as "Debitage", remained in bags. New studies since 1990 explored the bags and discovered important new proportions of tools (20 to 56% for the Gravettian, Table 1). This is also true for bags labelled "Fauna", which also contained human remains (Henry-Gambier *et al*. 2013c).

Many studies have been conducted on the Movius collections, and they also show the limits of interpretation. These limitations are the result of questioning and paradigm changes over the past 50 years. Thus, despite the richness and quality of Movius' excavations, collections and archives, the current questions, for example, geoarcheological interpretation of the deposits, spatial distribution of artifacts, lithic technology, etc., could not find answers in the old series. The reasons that motivated us to undertake new excavations and researches in the Final Gravettian are based on a series of unresolved questions coming under the topics of cultural and symbolic behaviors (Nespoulet *et al*. 2008).

The cultural facies known in Pataud level 2 (formerly called "Protomagdalenian") has many original features: no Gravette points, many backed bladelets, specialized production of large blades, etc. In addition, only four sites are historically known to

have delivered comparable industries in the same time period: Laugerie Haute (Les Eyzies-de-Tayac, Dordogne: Peyrony and Peyrony 1938), Les Peyrugues (Orniac, Lot: Allard 2009) and Le Blot (Cerzat, Haute-Loire: Delporte 1972, 1976, 1980). All these sites are located in the southern half of France (Figure 1). Final Gravettian is an original and unusual facies, its affiliation with the Gravettian mosaic remains a topic of discussion (e.g.: Klaric 2003, 2007, 2010; Surmely *et al.* 2008; Guillermin 2011; Surmely and Hays 2011). The recovery of a new excavation thus offered the opportunity to provide new informations.

Human remains were discovered in level 2 from the beginning of the excavations at Pataud, during the summer of 1958 (Movius 1977). This is explained by the fact that these remains were located stratigraphically in the upper part of the level. Level 2 has delivered a total of 429 human bones. This is the only Final Gravettian site with significant human remains. It is also one of the most important series for the French Gravettian. The value of Level 2 is to be able to know the population who produced the Final Gravettian industry (Henry-Gambier 2008; Henry-Gambier *et al.* 2013c).

Final Gravettian settlement *versus* human remains deposit?

The scientific aims of the Movius research were not focused on the study of human remains, which have been studied in a physical anthropology way, but without placing them in their archeological context (Billy 1975; Legoux 1975). In addition, the archeological study of level 2 (i.e. lithic industry, fauna) was performed without taking into account the presence of human remains (Clay 1968, 1995; Bricker 1995). In the 1977 publication, Movius therefore described in detail the archeological context of level 2, but without specifying the relationship between the human remains and archeological objects themselves (Movius 1977). Thus, after Movius' excavations, we formulated a series of questions (Nespoulet *et al.* 2008):

- Is it sure that the human remains are contemporaneous to the Final Gravettian?
- Why were no burial pits discovered?
- Why were human remains scattered on the floor, at the rear part of the rock shelter?
- Is it an intentional deposit?

Thus, the question of the Final Gravettian settlement *versus* human remains deposit therefore was not solved when we restarted the research and undertook the excavations in 2005. It can be summarized in one question: What is the status of the human remains?

The presence of many human remains in an archeological level, without any funeral/burial evidences, clearly identified during the Movius excavation was the first problem. Thanks to the analysis of the archeological context and the archives, we eliminated the assumption that the human bones were much more recent than the Final Gravettian (i.e. not belonging to level 2). So, the presence of human remains: is it accidental or natural? To this question we can answer negatively. Detailed taphonomic study of the remains showed that the presence of human bones

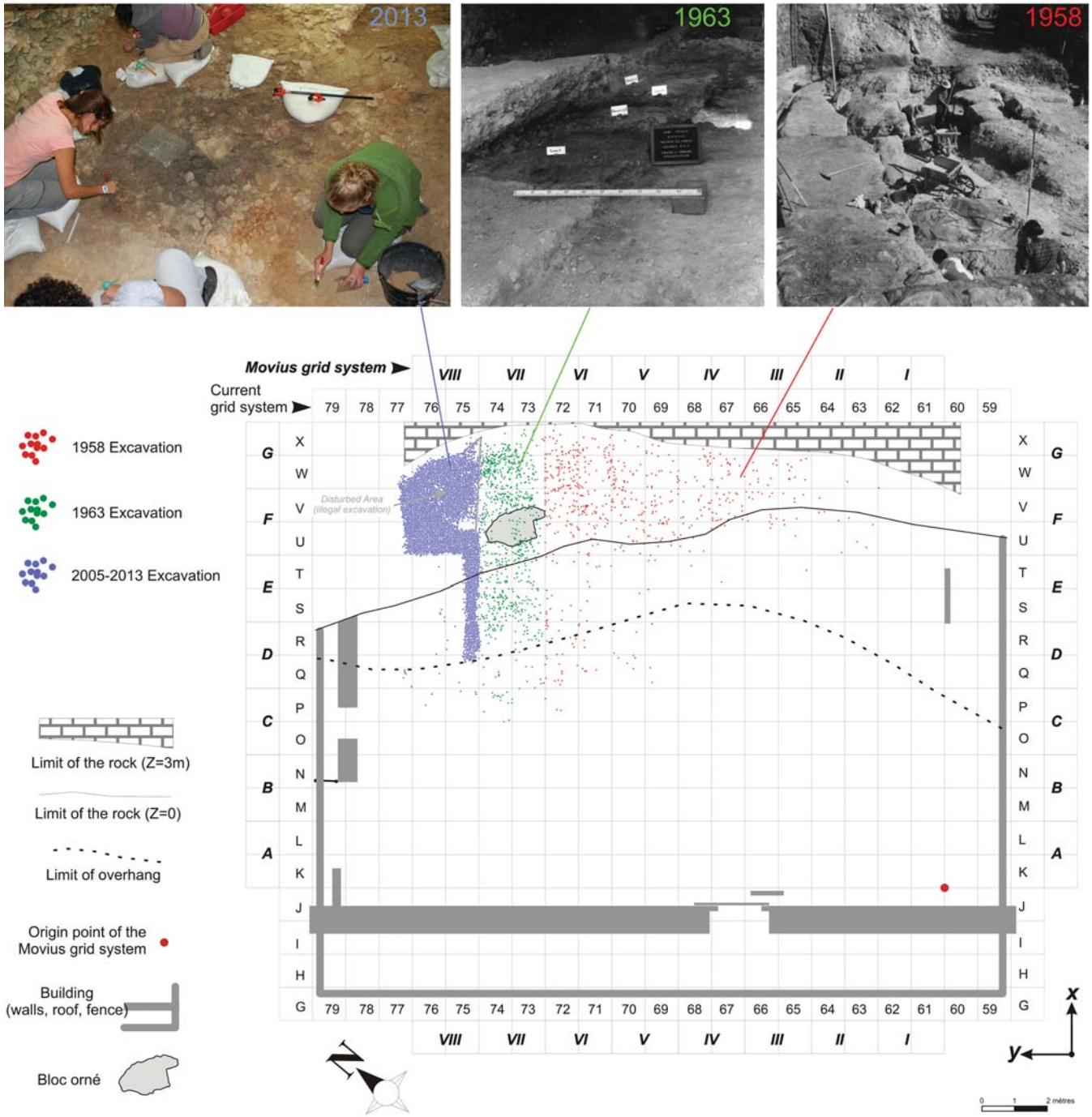


Figure 3: Plan of the main excavation of the Abri Pataud showing coordinated artifacts during the three periods of excavation (CAD R. Nespoulet & L. Chiotti, photos archives with courtesy of H. L. Movius MNHN and by R. Nespoulet).

did not result from the collapse of the roof, or the natural action of sediment, or the action of carnivores. The impact of Movius' excavation was also rejected. If natural causes have been eliminated, what is the part of anthropic action (Henry-Gambier *et al*. 2013c)? There are some of the questions that have guided our research project.

In the site, level 2 extends over 16 m along the wall of the rock shelter. An important unexcavated part of Level 2 remains in the northern area.

Level 2 can be divided into three zones, from south to north: the areas excavated in 1958, in 1963 and since 2005 (Figure 3). For each period, therefore for each zone, the quantity and the quality of the information are different. For Movius' period, there is much more and more accurate information from the 1963 excavations. So, for the collection and the archives, this is two groups of different quality. Before beginning excavations, we already had a good knowledge of the collections and archives. This allowed us to determine an excavation strategy precisely, in particular the decision not to excavate too wide an area (less than 10 m^2) because the goal was not to discover a large quantity of new objects, but to understand and document as well as possible the context of these objects. In other words, our approach was not quantitative but qualitative.

An important point of our excavation protocol, from the beginning of the excavation until today, consists in a constant dialogue between archives, collections and fieldwork. This is facilitated by the fact that all the collections and archives are stored very close to the excavated area, in the field laboratory.

Some examples of the main results

New geoarcheological interpretations have been made possible. The results of a doctoral thesis and the study conducted during each field excavation are a new lithostratigraphic study of the remplissage (and level 2 in particular) (Agsous 2008). Several natural processes have been identified over the stratigraphy. These are usually observed in rock shelters in a periglacial context: water runoff, collapse of rocks by gravity, solifluction, cryoturbation. For the Gravettian levels, the last two processes (solifluction and cryoturbation) are the main ones observed. This kind of process can affect the integrity of archeological deposits and cause mixtures of objects within or between levels. A central question during the excavation and interpretation of the level 2 deposits was: Was it disturbed or not? What was the intensity of the perturbation?

Lithostratigraphic analysis indicates that level 2 was simultaneously affected by solifluction (in the part of the internal slope) and by cryoturbation (in the rear part of the shelter). Nevertheless, a detailed analysis showed that the perturbations were limited and that geological processes had not been at a high intensity level. The main reason is that the process is developed on a minor slope and over a short distance (Lenoble and Agsous 2012, 2013).

Stratigraphic refittings were determined (Figure 4). The low degree of disturbance of archeological levels was confirmed by refitting on several hundred pieces, mostly lithic. On the profile, the lines materializing refit or conjoin between

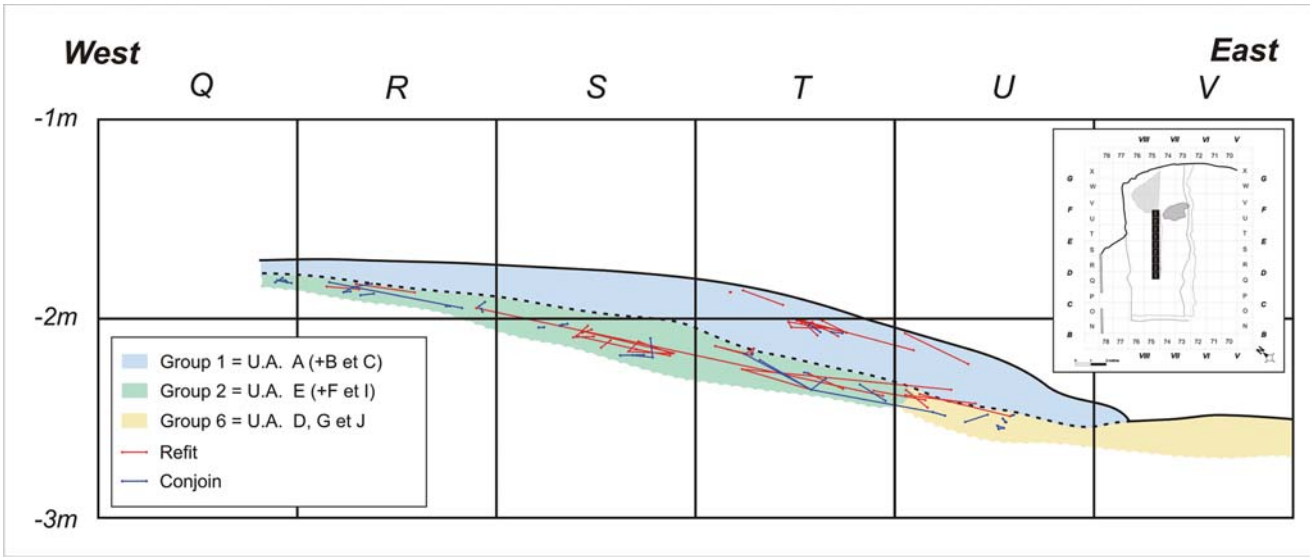


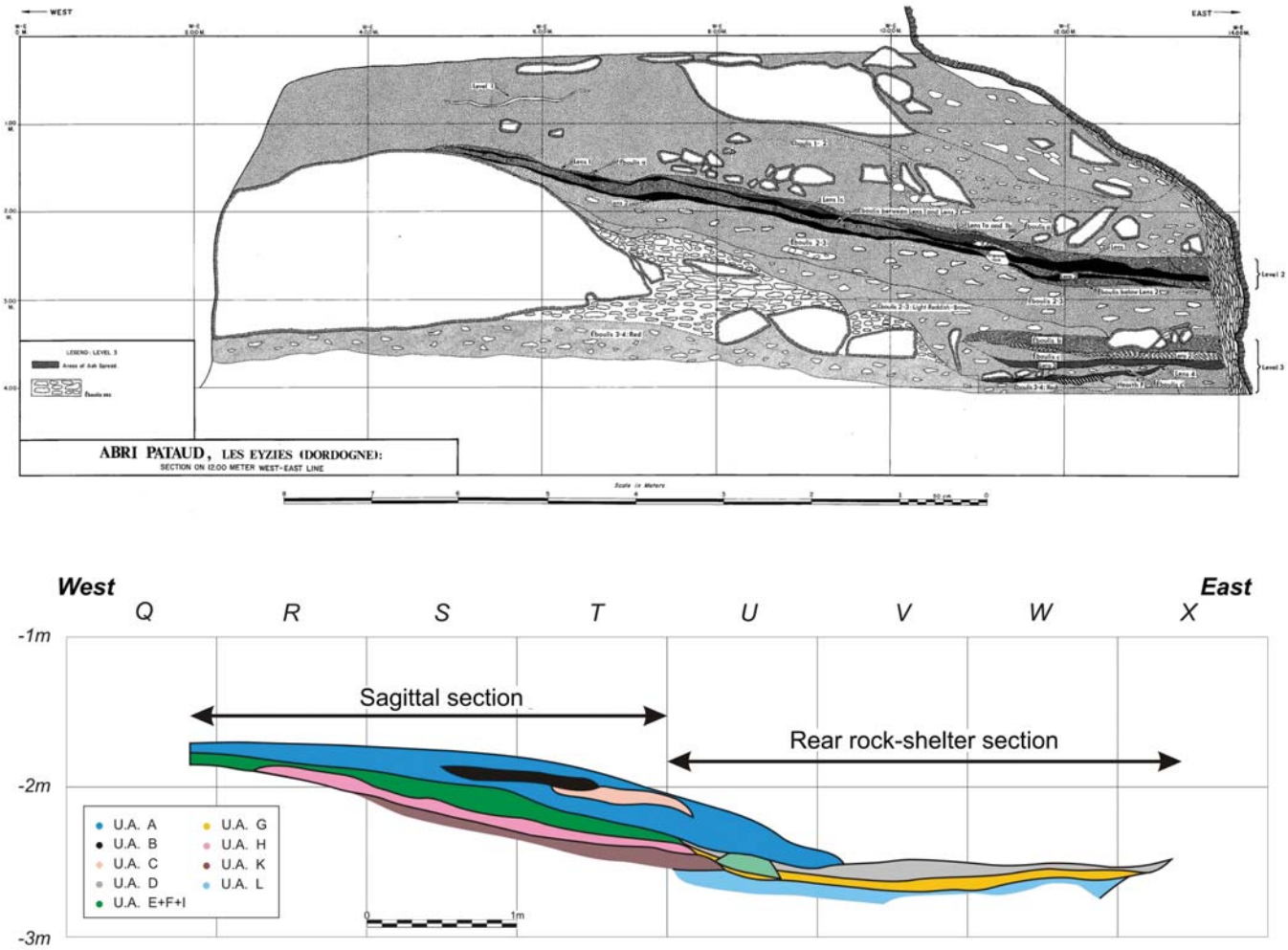
Figure 4: Projection of refitted artifacts in level 2 and refitting operation in process on the archeological material (CAD by R. Nespoulet and L. Chiotti, photo by R. Nespoulet).

Figure 5: Sections of level 2. Upper: Movius excavation (after Movius 1977). Despite the fact that a detailed stratigraphy has been achieved for the level 2, "for study purposes all artifacts from the Proto-Magdalenian horizon have been treated as though they came from a single living floor" (Movius 1977, 29). Lower: current excavation (CAD by L. Chiotti). Quantitative and qualitative changes (raw material, flint technology, burned bones, etc.) between Archeological Units suggest several different activities.

pieces follow the slope. There are no vertical lines between level subdivisions (Nespoulet *et al.* 2011; Chiotti *et al.* 2013).

As for the new archeological interpretation of level 2, our review of the Movius excavation data brings up a paradox. On one hand, there have been stratigraphic records for level 2, and the objects were assigned to different stratigraphic subdivisions. On the other hand, in the archeological description, all subdivisions are abandoned. Probably, some methodological problems of excavation explain the fact that Movius and his team did not take into account the various subdivisions, especially during the 1958 excavations (Movius 1977).

Since 2005, we have taken particular care in the method of recording field data on the site. We decided to record simultaneously and independently the geo-archeological and archeological information and evidence. A specific protocol was established. Textural units (TU) for the geoarcheological record and archeological units (AU) for the archeological record have been defined. The TU subdivisions are based on the observation of sediment texture and the lithostratigraphic



interpretation. The AU are defined by the archeological content, and by the presence or lack of remains in sediments (Chiotti and Nespoulet 2013). This protocol allowed us to test and compare, at each step of the fieldwork, the assumptions of geoarcheologists and archeologists. As the stratigraphic refittings demonstrated, there are valid subdivisions within level 2: this is a succession of human occupations without major post-depositional modifications (Figure 5).

In addition, archeological studies have shown variations in frequency in the archeological subdivisions (AU): e.g. proportion of microliths, of exogenous flint, of burned bones, etc. We interpret this as distinct phases of activities in time and/or simultaneous distinct activities areas (Chiotti *et al*. 2015).

In the near future, the fieldwork must be carried on through the entire level 2 to enable us to make a synthesis of the archeological data and to provide interpretations of the technical behavior observed in level 2. Another important point is the fact that the main occupations (domestic activities/living place) take place before the deposit of human remains.

The new excavations have made important contributions to the collection. The proportion of microliths in the Final Gravettian industry is very significant. Microliths of level 2 are primarily backed bladelets. In the Movius tool series, the proportion of backed bladelets was 42%. The average in the series of excavations since 2005 is 70%, and the proportion reaches 89% in some archeological subdivisions (Nespoulet *et al*. 2011; Chiotti *et al*. 2013, Chiotti *et al*. 2015). This is clearly related to the accuracy of the excavation and screening methods. Furthermore, in some "test squares" we screened the sediment at less than a millimeter, and we have discovered nano-scale backed bladelets, which had never been described in this industry (Nespoulet *et al*. 2008).

The reconstruction of a painted bone is another example of the contribution of new research to the collection. Some painted bone fragments were discovered during the sorting of Movius bags labeled "Fauna". They correspond to fragments of a scapula discovered in 1963. It is one of the most important art objects from level 2 (Chiotti *et al*. in press; Lebon *et al*. 2015).

A third example of the contribution of new excavations to the collection is the study of old collections to find unidentified human remains. This has increased the series, with 66 new bones. These were found mainly in Movius' fauna bags, but were also found in spoil sediment of a clandestine dig of the 1980s, which unfortunately destroyed the north part of level 2 (Nespoulet *et al*. 2013). However, this increase did not change the count of the minimum number of individuals. Human remains have been discovered across the width of the excavation area. They were all located in the rear part of the shelter. Two concentrations of remains have been identified: one in the south (in 1958) and the north (in 1963). Between these two concentrations, there were also isolated remains (Figure 6).

The minimum number of individuals is six: three adults, one child, two babies. The topographic distribution is as follows:

- South area: one adult female and one baby, one adult male
- North area: one adult female and one baby.

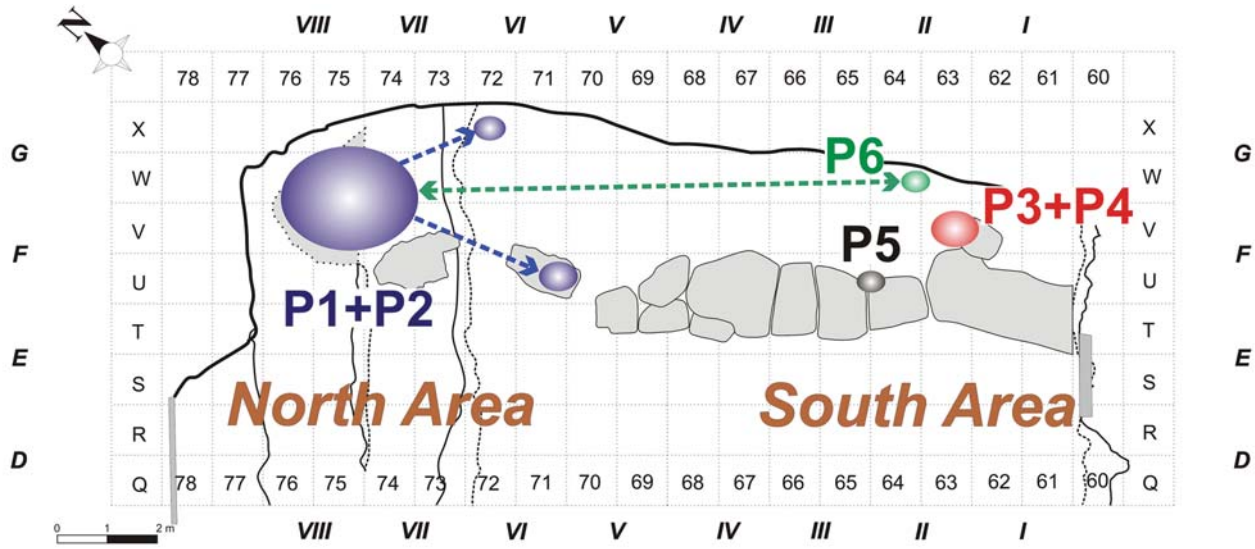


Figure 6: Localization of human remains in level 2 (drawing by D. Henri-Gambier, CAD by R. Nespoulet).

– Between the two areas: one child whose bones are scattered over 12 meters. The skeletons were incomplete, except the two babies.

In the southern area, an adult arm was found in strict anatomical connection, being evidence of a primary deposit. For the three adults, only one skull was found. There is also the absence of some long bones, especially the tibia and femur: the legs of adults are absent. Given the excellent preservation of the bones of babies, we cannot explain these absences by taphonomic factors. Why are they missing? The only answer to that question is to consider an intervention of the Final Gravettian people themselves on the bodies after decomposing, and probably a secondary deposit of some parts of the skeletons (legs and skulls) (Henry-Gambier *et al.* 2013c).

We conducted a detailed study of a series of "extra-ordinary" art objects or remarkable pieces, which are not frequently found in an ordinary living place. We also analyzed in detail their spatial distribution. All these objects are located in the same area as the human remains, but there is no strict association with human remains, except a series of beads (Figure 7). Nevertheless, their large number and location definitely give these objects a particular and original status.

In the north area, in strict association with human bones, 85 mammoth ivory beads were found. Several beads have traces of ocher; the area itself was strongly colored in red by ocher. These rectangular beads are characteristic of the Final Gravettian and also known in the sites of Le Blot and les Peyrugues (Allard *et al.* 1997; Chauvière and Fontana 2005; Chiotti *et al.* 2009, 2014).

During the new excavations, we have also discovered the remains of a wall decoration with red ocher: hundreds of fragments of painted limestone collapsed from the wall were found in level 2 (Verez *et al.* 2013). A series of non-invasive analyses compared the pigments present on fragments of collapsed limestone with painted objects found in level 2. This was also compared with some older archeological levels. The conclusion is that the decor is probably contemporary to

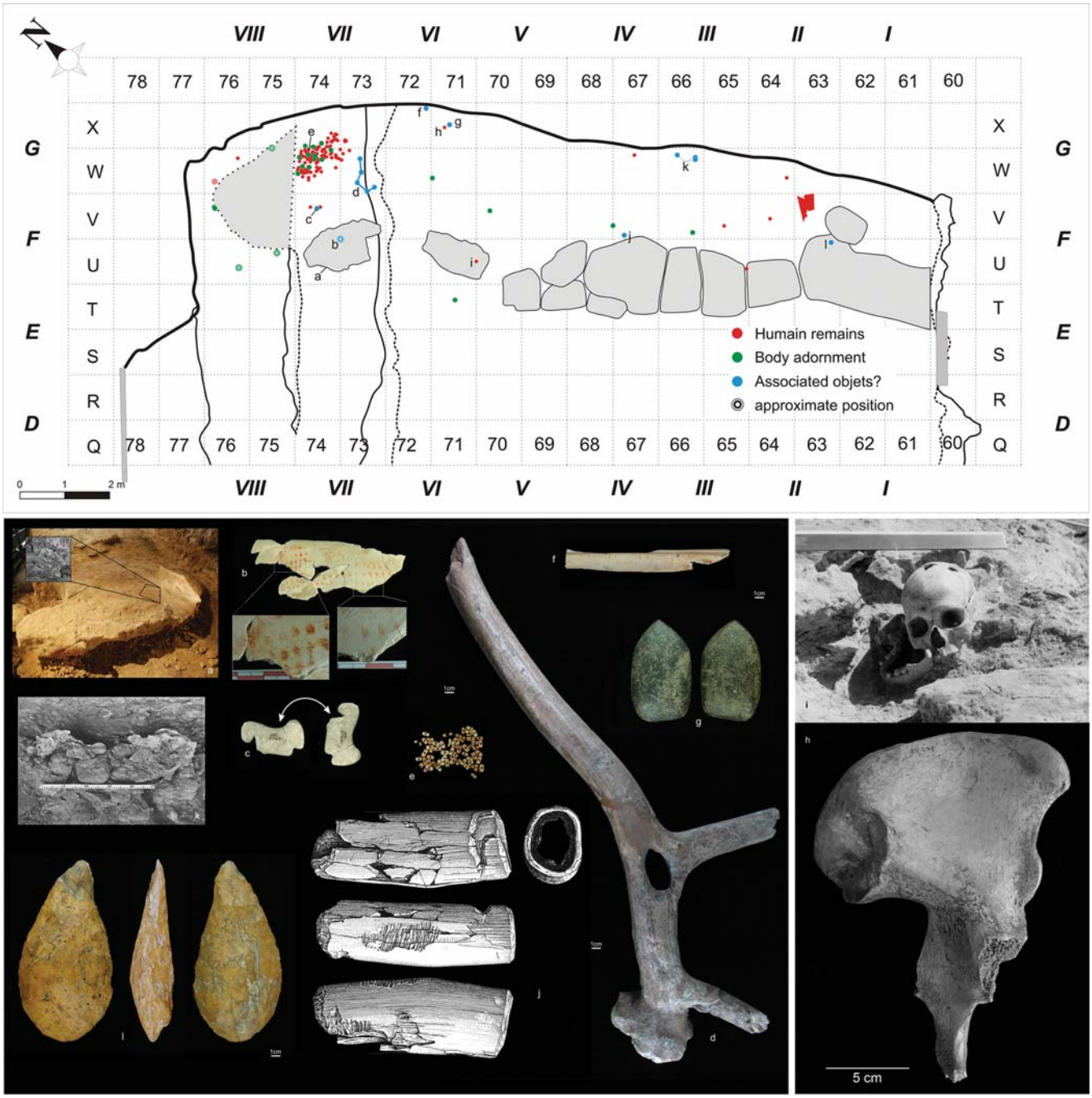


Figure 7: Localization of main “extra-ordinary” objects in level 2 (CAD by R. Nespoulet and L. Chiotti). a: Engraved block; b: Painted scapula with red dot; c: “Enigmatic art object” (female and/or animal statuette); d: Perforated reindeer antler; e: Concentration of 63 rectangular beads; f: Incised bone; g: Polished stone “Neolithic Type”; h: Coxal bone (ind. P1); i: Skull and mandible (ind. P1); j: “Mammoth Tusk Container”; k: “Deer Skull Complex”; l: Acheulean handaxe (photos: a, b, c, d, e, f, g: by L. Chiotti; h: by D. Henry-Gambier; i: by H. L. Movius).

level 2, but it is not sure that a direct link exists or not with the burials (Beck *et al.* 2011; Lebon *et al.* 2014).

In 2012, we had the opportunity to solve another question, about the fireplace in level 2. Indeed, during Movius excavations no hearth structures were found. This fact was in contradiction with the numerous burnt bones found in the level 2, which show the evidence of burning activities. In the rear part of the shelter, in AU N (probably the lower subdivision of level 2), some large flat stones, belonging to a natural pavement, show significant evidences of exposure to fire *in situ*. They are whitish, and their surface was covered in powder a few millimeters thick. The same archeological subdivision contains a large quantity of burnt bones, and a high proportion of burnt flint. Our hypothesis is that the burning activities in level 2 were made directly on the natural floor surface. This could explain the absence of identification of hearth structures (Chiotti *et al.* 2015).

Conclusion and perspectives

After eight years of excavation, we can draw some methodological conclusions and results. The exceptional Movius archives and collections offer the opportunity to carry out new investigations, but our interpretation is still limited by the lack of documentation. This can be explained by two factors: the disappearance (or destruction) of excavation documents since the '60s, and/or the fact that the field notes, especially those in 1958, were careless. Nevertheless, the historiographical work on the Movius archives was an essential tool to determine more accurately the position and conditions of discoveries of objects, in particular the human remains. This guided us throughout the interpretation and linking the two collections (from old and recent excavations).

Using a protocol and an efficient search strategy, we were able to synthesize the geoarcheological and archeological interpretations. We can conclude that the subdivision of level 2 corresponds to different phases of occupation. This is an important advance because previous archeological interpretations could not detail the chronology within level 2. It should be noted that this new diachronic interpretation of level 2 can only be applied in the area excavated since 2005 and to a lesser extent in the adjacent area excavated in 1963. It was not possible to correlate these new results with those of the 1958 excavation.

During the recent excavations, we had the opportunity to apply new analyses on artifacts both in the Movius collection and in the current collection. New radiocarbon dates have been obtained (Henry-Gambier *et al.* 2013b), a study on the physico-chemical composition of pigments has established that the parietal decoration was contemporary with the occupation of level 2 (Beck *et al.* 2011; Lebon *et al.* 2014), and the use of mammoth ivory as raw material for some beads has been proved (Vercoutère *et al.* 2011; Reiche *et al.* 2014).

If we turn back to the successive phases of occupation, we can recapitulate our main results and interpretations. The phase in which human bodies were deposited in the rear part of the shelter is dissociated from and later than the phases of habitats.

So, there is no direct association between the evidences of domestic occupation and funerary rituals. The disposition of human remains, some of which are in primary position, the existence of body manipulation, the presence of "extra-ordinary" objects in the same area as the human remains, and the presence of parietal decoration contemporary to level 2, allow us to think that we are in the presence of a complex and original funerary behavior of the upper Paleolithic (Henry-Gambier *et al*. 2013c; Chiotti *et al*. 2009, 2014). This funerary behavior is probably closer to the evidence found in other Gravettian French sites: the caves of Cussac (Dordogne) (Aujoulat *et al.* 2001a, 2001b; Henry-Gambier *et al.* 2014), Vilhonneur (Charente) (Henry-Gambier *et al*. 2007), Gargas (Hautes-Pyrénées) (Foucher *et al*. 2012) and the Cro-Magnon rock shelter (Henry-Gambier *et al.* 2013a), located a few hundred meters away from Abri Pataud. Finally, we interpret level 2 as a change in site function: it was first a living place, then a burial place.

Several questions remain unanswered, however. These questions open new perspectives of study:

- Are there portions of the Movius archives still missing? We know that there are unpublished Movius archives at the Peabody Museum of Harvard University. A mission to appraise these records will be necessary to find any documents about the context of excavation level 2, especially for the year 1958.
- Can we be precise on the hearths and fire activities in level 2? This requires continuing the excavation in the rear part of the rock shelter to be able to offer an interpretation.
- Are there burnt human bones? And traces of ocher on the human bones? How to interpret these traces?

When the excavation of Level 2 is finished, we will be able to synthesize the interpretation of the Final Gravettian at the Abri Pataud. Methodological results have already been obtained. They illustrate a deliberately quantitatively limited excavation associated with an extensive study of the old collections and archives. This has enabled us to respond to unanswered questions nearly 50 years after the first excavations. Thus, the archeological data from old excavations can serve as a useful basis for new studies and interpretations. Therefore Abri Pataud has a very important archeological potential for current studies on the Gravettian, and confirms its status as key site for the Gravettian.

Acknowledgements

Current excavations at the Abri Pataud have received financial support from the Regional Service of Archeology of Aquitaine, General Council of Dordogne, UMR 7194 "Natural history of prehistoric man", the Department of Prehistory at the National Museum of Natural History, programs funded by the ANR: MADAPCA (coordination P. Paillet), GUEROPE (coordination L. Baray) and ArBoCo (coordination I. Reiche), CNRS, and the National Museum of Prehistory. The authors sincerely thank the organizers of the EAA-session "The many faces of the Gravettian" on September 7, 2013, in Pilsen.

Résumé
Depuis 2005, la reprise des fouilles dans le niveau 2 de l'Abri Pataud (Gravettien final, -22,000) repose sur une triple démarche analytique : fouille, analyse des archives, analyse des collections anciennes. Tout au long du projet scientifique, ces trois démarches se sont enrichies mutuellement. Elles ont permis d'identifier précisément le potentiel informatif et les limites des données anciennes. Le protocole de fouille et la stratégie d'échantillonnage ont été conçus pour tenter d'apporter des réponses aux questions restées auparavant sans réponse. Les résultats obtenus, qui présentent eux aussi leurs propres limites méthodologiques, ont ainsi permis de préciser le statut des vestiges humains découverts dans le niveau 2 : il s'agit de dépôts funéraires. Ils nous ont également permis de mieux comprendre les modalités des occupations successives de ce niveau, bien que la surface de fouille ait été volontairement limitée.

Zusammenfassung
Seit 2005 baut die neue Ausgrabung von Niveau 2 im Abri Pataud (Spätgravettien -22ka) auf einem dreifachen analytischen Ansatz auf: Feldforschung, Analyse im Archiv und Analyse der alten Sammlungen. Während des Forschungsprojektes haben einander diese drei Ansätze gegenseitig bereichert. Sowohl die Möglichkeiten der Information als auch die Grenzen der alten Daten konnten genau festgestellt werden. Das Ausgrabungsprotokoll und die Strategie der Probennahme wurden so konzipiert, dass sie Antworten auf die bisher unbeantworteten Fragen geben. Die Ergebnisse, die auch ihre eigenen methodologischen Grenzen haben, konnten den Status der menschlichen Überreste aus Niveau 2 klären: es handelt sich um Bestattungen. Die Ergebnisse ermöglichten auch ein besseres Verständnis der Art und Weise der aufeinanderfolgenden Nutzungen dieses Niveaus obwohl die Ausgrabungsfläche bewusst begrenzt war.

FROM UPPER PERIGORDIAN TO THE CURRENT NON-HIERARCHICAL GRAVETTIAN IN THE CANTABRIAN REGION (NORTHERN SPAIN): RECENT CHANGES, CURRENT CHALLENGES

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Abstract
As a result of different research foci, e.g. the Middle to Upper Paleolithic transition, information about the Gravettian technocomplex was for a long time relatively scarce in the Cantabrian region. While our understanding of this specific time period had undergone perpetual shifts and changes since the definitions first of Breuil and later of Peyrony and Garrod, the last two decades have seen a fundamental expansion of our knowledge. This is mainly due to new fieldwork and artifact studies, directly tackling missing key information. From the altered significance of an important fossil directeur and expanding radiocarbon chronology, to new models for cultural transition and enhanced data for environmental living conditions, all subject areas have thereby been affected. Following a recent international conference bringing together this new data and the publications of the proceedings, it may be a good time for a brief overview about the state of the art of Gravettian research in northern Spain.

Keywords
Techno-complex, Upper Paleolithic, chronology, cultural transition, Cantabrian region

DOI: 10.5817/CZ.MUNI.M210-7781-2015-19

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Introduction and historical background

The Gravettian period in the Cantabrian region is, for several reasons, of high scientific interest. One is the long history of Paleolithic research in this area, resulting in a comprehensive archeological dataset. Moreover, the diverse geographic and climatic conditions provide great scope for the analysis of hunter-gatherer adaptation. Additionally, it lies in the direct neighbourhood of the key archeological sites in the Aquitaine basin and the French Pyrenees.

The Cantabrian region, as understood in this paper, spans the north-western part of the Iberian Peninsula. In terms of modern administrative units, it covers the provinces of Asturias and Cantabria, the Basque Country and Navarre. Galicia, whose natural conditions are similar to the rest of the Cantabrian region, is omitted due to the overall lack of archeological data (Rodríguez-Álvarez and Lombera Hermida 2011). These natural conditions are largely influenced by the ocean, hence it follows that 90% of the known Gravettian sites are situated in the Atlantic environmental zone (European Environmental Zones; Mücher *et al.* 2010). This is also valid for the Aquitaine basin, with important Gravettian sites like Isturitz (Lacarrière *et al.* 2011), which forms a homogenous area with a large part of the Cantabrian region. The remaining known sites are located in the southern hinterland, like Prado or Mugarduia sur, which lie on the other side of the Ebro watershed in a more Mediterranean environment, and the cave site of Zatoya, which geographically displays more similarities with sites in the French Pyrenees, e.g. Gargas (Foucher *et al.* 2008). While far from representing a complete Gravettian settlement area, this recent picture (Figure 1) shows a clear transformation of the view of the Gravettian occupation held only 20–30 years ago.

This is mainly due to new fieldwork and artifact studies, which have directly tackled missing key information. The former have significantly enhanced our

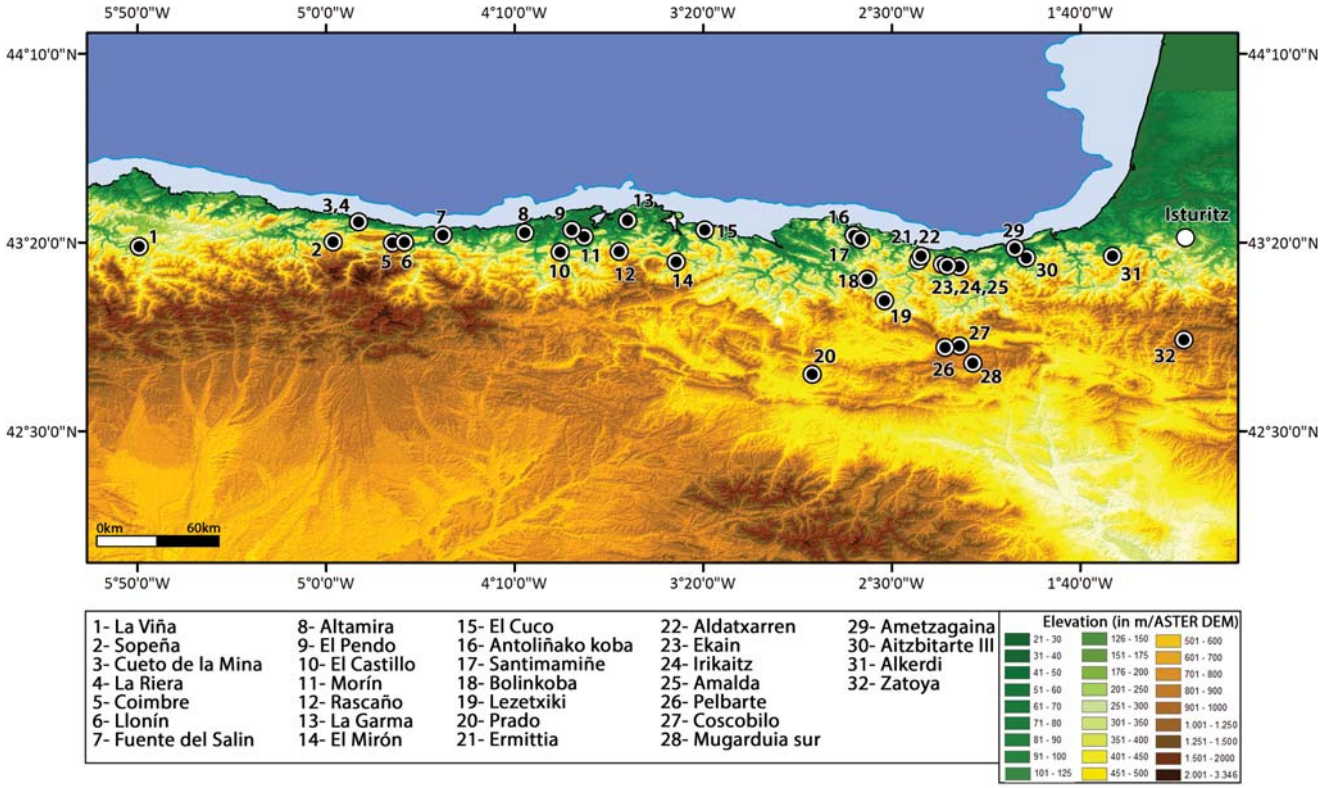

Figure 1: Overview of the mentioned archeological sites of Gravettian age in the Cantabrian region. Background: Digital Elevation Model derived from ASTER DEM. The blue line marks the coast line in conditions of -100 m above sea level.

knowledge of site distribution and stratigraphic context. With the previous image mainly influenced by cave sites situated in the limestone formations in the coastal area, new research led to the appearance of an occupation in the hinterland, sometimes at unexpectedly high altitudes (Mugarduia sur, Zatoya), which had previously been excluded from the reconstructions (e.g. Butzer 1986; cf. Arrizabalaga and Iriarte-Chiapusso 2010). With these, a new site class also appeared, one that was unknown before: open-air sites. Currently five of these are known; Mugarduia sur (Barandiarán *et al*. 2013), Pelbarte (Sáenz de Buruaga 2004), Irikaitz (Arrizabalaga and Iriarte-Chiapusso 2010), Prado (Sáenz de Buruaga *et al*. 2005) and Ametzagaina (Tapia *et al*. 2009; Calvo 2012). Based on the new stratigraphic data and a growing dataset of combined techno-typological studies (cf. Arrizabalaga 1995; Cava *et al*. 2009; De la Pena 2011; Calvo 2012; Bradtmöller 2014), the concept of the archeological culture itself also changed rapidly.

The first archeological assemblages assigned to this period in the western part were Cueto de la Mina in Asturias (Vega del Sella 1916) and Cueva Morín in Cantabria (Vega del Sella 1921). Using the recently developed French typo-chronological framework (Breuil 1912), these assemblages were classified as *Aurignacien superieur*. In the eastern part the first classifications as *Perigordien superieur* were made in Santimamiñe (Aranzadi and Barandiarán 1935) and Bolinkoba (Barandiarán 1950), following the French system introduced by D. Peyrony (1933). In the early 1970s for the first time a regional subdivision of the *Perigordien superieur* was made with the construction of the so called Noaillian phase, with Noaillian burins and Isturitz points as the main fossil directeur (McCollough 1971). While during the next two decades further studies established chronological systems, mainly based on the occurrence of specific artifact types (cf. De la Peña 2009), in recent years the analysis of the complete lithic *chaîne opératoire* has come into the focus. This is based also on the circumstance that the typological system, as far as can be said today, is not suitable for describing the internal structure of the Gravettian culture in Northern Spain. This could now be illustrated best with the identified chronological spread of Noaillian burins from the evolved Aurignacian into the Solutrean (s.1.3). But whereas, based on the *chaîne opératoire*, a comprehensive subdivision has recently been proposed for the French sites (Klaric 2003; Klaric *et al*. 2009; Simonet 2009; Pesesse 2010) this subdivision actually seems not to be possible for the Cantabrian region.

One reason for problems with the construction of an internal chronology is the still small number of radiometric data available (chapter Geochronological evidence). A second cause seems to be the high variability of the lithic reduction systems, often reflecting the local raw material procurement pattern and the problematic objective classification of the established fossil directeur, like Gravette points, Microgravettes and specific burin types.

This development led to the current fluid situation of a non-hierarchical system of the Gravettian. And naturally, this is also affecting our understanding of the beginning and end of the techno-complex described by its relationship to the evolved Aurignacian and the Solutrean.

The Aurignacian-Gravettian transition

The circumstances of what was known of the evolved Aurignacian in Northern Spain, just a few years ago, suggested the existence of a clear break between both techno-complexes and their actors. Continuity in the habitat had only been identified in Level 5 in Cueva Morín. Indeed, the evolved Aurignacian itself had rarely been identified; Hornos de la Peña, El Otero 4 and 6, and El Cierro VII and VI were the classic citations. From the early 1990s onwards (Arrizabalaga 1995; Barandiarán *et al*. 1996), the number of references to evolved Aurignacian levels increased (El Ruso IV, Cofresnedo 4.3, La Viña XI, La Garma A, Zatoya Iibam), and above all, a larger number of situations of stratigraphic continuity between the evolved Aurignacian and the Gravettian were recognized (La Viña, Aitzbitarte III, Antoliñako koba, Bolinkoba) (Altuna *et al*. 2011; Aguirre 2013; Iriarte-Chiapusso and Arrizabalaga 2013; Martínez and Rasilla 2013; Rasines and Muñoz 2013). From the chronological point of view, the period of 29.0–28.0 ky uncal BP still displays the most ambiguous situations although the new circumstances have greatly attenuated the appearance of a fracture between the two techno-complexes. The vision of the Gravettian as an intrusive culture in northern Spain should be nuanced (Ríos-Garaizar *et al*. 2013).

Since the stratigraphic record has been normalized, the main differences are in connection with the techno-complexes. The lozenge and fusiform evolved Aurignacian assegai points still tend to have a flattened cross-section and are clearly different from the massive Gravettian assegai points with their more circular cross-section (Cabrera *et al*. 2004; De la Rasilla and Straus 2004). Change within the lithic record is even more difficult to classfiy and to interpret, is (Arrizabalaga and De la Peña 2013) although both techno-complexes can be seen as forming a single unit, within their marked polymorphism. Some authors (Ríos-Garaizar *et al*. 2013) highlight the aspect of continuity (role of splintered pieces, increase of burins on truncations and the use of blades with marginal retouch) over the differences (management of raw materials and the segmented production of blades and bladelets, the latter sometimes in the design of carinated end-scrapers). Other scholars (Arrizabalaga and De la Peña 2013), based on the descriptions of assemblages from such sites as Ametzagaina, discriminate the Gravettian and evolved Aurignacian through techno-typological factors. The changing mobility pattern of Gravettian groups, which may be reconstructed by their raw material procurement and the continuum they exhibit in blade and bladelet knapping, have already been mentioned. In addition, changes of local occupation pattern were recently discussed for some sites (cf. Bradtmöller 2014).

From the typological standpoint, the representation of tools with simple retouching (retouched end-scrapers and blades) during the evolved Aurignacian will be displaced by the increase in abrupt and/or burin modes, which are always predominant in Gravettian assemblages.

In short, although the debate between continuity and hiatus applied to the transition from evolved Aurignacian to Gravettian is far from being settled, the material dimension of the change is significant and all scenarios regarding the initial Gravettian in Northern Spain are still possible.

The end of the Gravettian

The twilight of the Gravettian techno-complex and its transition to the Solutrean is a complex and currently poorly known phenomenon, mainly due to the scarcity of archeological levels and available information. The end of the Gravettian, extending to 25.0 ky cal BP (maybe up to 24.0–23.0 ky cal BP?), is characterized by a main group of levels in which Gravette and Microgravette points and, essentially, backed blades and bladelets, are the most significant tools (La Garma E and F, Altamira 8, Aitzbitarte III external area III and II, Amalda V) (Arrizabalaga 1995; Alvarez-Fernández 2007; Rios *et al*. 2011; Heras *et al*. 2013). These are associated with a progressively better-known bladelet production, which preferentially used burin-cores (Busqué or dihedral types) and pyramidal cores (Rios *et al*. 2011). In this group, burins are also significant, especially in the eastern half of the Cantabrian region (Aitzbitarte III external area III and II, Amalda V), in some cases of the Noailles type (in the Basque Country). Not included in this group are such sites as Hornos de la Peña (D), La Riera (1) or El Cuco (III of the rock shelter), which are dominated by simple retouched tools, such as end-scrapers (carinated type in La Riera), side-scrapers and denticulates (El Cuco), "Aurignacian style" retouched blades and Dufour bladelets (La Riera and El Cuco) (Bernaldo de Quirós 1982; Straus and Clark 1986; Rasines and Muñoz 2013). Any Gravettian or Solutrean ascription type are practically absent.

The Gravettian-Solutrean transition was also an ambivalent phenomenon. On the one hand, there were significant novelties in the industry; especially the emergence of flat retouch in foliate morpho-types, at dates around 23.9 ky cal BP (e.g. Las Caldas 16, 15 and 12b, Cueto de la Mina Vb/E, Mirón 127, Antoliñako Koba Lmc) (Calvo and Prieto in press), as well as the appearance of new bone tools, such as medially flattened spear points (mainly in the western Cantabrian region) or plano-convex rods (e.g. Aitzbitarte IV and Ermittia) (Mujika 1993). In contrast, there were clear cultural continuities; the persistence of Noailles burins in Solutrean levels in the Basque Country (Amalda IV, Antoliñako Koba Lmc or Bolinkoba IV) is noteworthy (Arrizabalaga 1994; Aguirre 2000), without obviating the continuity in the manufacture of much of the Gravettian equipment, especially of backed elements (e.g. Cueto de la Mina Vb/E or Antoliñako Koba Lmc) (Rasilla 1994; Aguirre 2000). In this way, the Solutrean cultural response to the new paleoenvironmental conditions of the LGM consisted of the variation of only a portion – more or less important – of the Gravettian equipment and technological background. The fabrication of foliate tools undoubtedly led a new technological process, but in many cases this was the only one and, probably, was for many assemblages not the most dominant aspect.

Geochronological evidence

The geochronological sequence that can be drawn up for the Gravettian in the Cantabrian region is still tentative and it is likely that it will change further in the forthcoming years. The reasons for this provisional situation are several: first,

Gravettian sites with a well described typo-technological sequence are still scarce and are mainly concentrated in the eastern area (Table 1) and, second, because sites dated comprehensively are even rarer (mainly Aitzbitarte III and Antoliñako Koba). Additionally, some sites with adequate technological descriptions do not yet have a chronological framework, such as Irikaitz, Ametzagaina or Cueva Morín (Arrizabalaga 1995; Tapia *et al*. 2009; Arrizabalaga and Iriarte-Chiapusso 2010). Moreover, most of the dates at hand for the Gravettian in the Cantabrian region come from the Basque Country (Table 1), so there is an evident inequality in the geographical distributions of dates. The chronology and industries of the central and western part are still poorly understood. Additionally, it must be remembered that the chrono-stratigraphic situation of the Early Upper Paleolithic in Western Europe is still under discussion, and new methodologies developed for radiocarbon dating (for example, acid-base-oxidation: stepped combustion for charcoal or ultrafiltration for bone remains) (Higham *et al*. 2006; Higham 2011) might soon change the current view of this period.

The Cantabrian sites attributed to the Gravettian, and with the oldest chronology, are Aitzbitarte III (external area), Zatoya IIbam, Antoliña Lab+Lmbk and Alkerdi 2 (Altuna *et al*. 1990; Aguirre 1998/2000; Barandiarán and Cava 2008; Cava *et al*. 2009; Altuna *et al*. 2011). All of these sites can be dated to 34.0–32.0 ky cal BP (Figure 2). To this oldest group we could add some of the sites which have, from a typo-technological point of view, Evolved Aurignacian assemblages, such as Bolinkoba 6 or Ametzagaina W (Calvo *et al*. 2013; Iriarte-Chiapusso and Arrizabalaga 2013). These old occupations are contradicting for the moment the idea of a superregional emigration process as the explanation for the transition in Upper Paleolithic technocomplexes (Otte and Keeley 1991; Conard and Bolus 2003). Moreover, some of the oldest dates postulated for the beginning of the Gravettian in central Europe (for example, Willendorf, Hohle Fels, Geissenklösterle or Maisières Canal) (cf. Jacobi *et al*. 2010; Jöris *et al*. 2010; Moreau 2010) have more or less the same antiquity as dates from Aitzbitarte III (external area) or Antoliña (Altuna *et al*. 2011; Aguirre 2013).

Furthermore, taking into account all the dates (Table 1, Figure 2) for the Gravettian in this area, it seems a lengthier phenomenon, because its beginning is dated around 34.0 ky cal BP and its end about 25.0 ky cal BP. Even though a lithic typological schema has been recently proposed (with four specific developments) (see above and Arrizabalaga and de la Peña (2013) for a further discussion), this variability is still very difficult to order diachronically.

One of the most striking features of the chronological framework of the Gravettian in the Cantabrian region is that the so-called Noaillian sites (supposedly characteristic of the Middle Gravettian in the French/Perigordian model) are found throughout the technocomplex in this region. They appear particularly in extremely old contexts, such as Antoliña or Aitzbitarte III (external area), or in extremely young ones, even in Solutrean contexts (Arrizabalaga 1995). In other words, they do not seem to mark a particular cultural period; on the contrary, they seem to appear throughout the sequence of this technocomplex (Figure 2).

Paleoclimatic framework

Northern Spain, owing to its location and biogeographical characteristics (latitude, altitudes, distance from the sea, relief, etc.) is a region of great interest with diverse vegetation units. These factors have considerably influenced the way the different geographical zones adapt to general climate dynamics. In the case of the Gravettian, paleo-environmental information comes solely from archeological sites (mainly karst caves) and no data has been obtained from deposits with a non-anthropic origin. For several reasons (absence of continuous stratigraphic records for this cultural period, poor conservation of organic remains, studies occasionally not covering the whole stratigraphic sequence, and the intermittent chronological series, etc), continuous paleo-environmental evolution cannot be established for the Gravettian period (Iriarte-Chiapusso and Murelaga 2013). This discontinuity hinders the reliability of correlations between the paleo-environmental records and the Dansgaard-Oeschger cycles and Heinrich events (Figure 2). Despite this, it has been shown that environmental conditions varied significantly during the Gravettian.

Stadial conditions predominate in most deposits, although to different extents. For example, in this succession of climate episodes, littoral and sub-littoral areas were more humid than areas inland and at higher altitudes (Gómez-Orellana 2002). This situation was reflected in the vegetation by the development of heaths and grasslands, together with a scarce and intermittent representation of steppe taxa during the coldest phases in addition to the maintenance of certain tree species. Between 34.0 and 29.0 ky cal BP, open vegetation associated with a cold climate predominated. In this landscape, with little forest cover, pine is the most common element, with juniper and/or birch usually accompanying it in smaller proportions (Aitzbitarte III – Iriarte-Chiapusso 2011a; El Miron – Iriarte-Chiapusso unpublished). However, there are exceptions as in the Gravettian levels in Cueva de Amalda (Dupré 1990), where the vegetation, equally characterized by little tree cover, included the discontinuous presence of some deciduous taxa (*Corylus*, sp. and *Quercus pedunculado* tp.). The same pattern is seen at more recent Gravettian sites, for example, Morín (Leroi-Gourhan 1971) and Santimamiñe (Iriarte-Chiapusso 2011b).

However, in some of these periods, the amelioration of climate conditions was important enough to allow forest masses to expand and deciduous taxa to predominate. It is more than a coincidence that the only two palynological studies for open-air sites, located in very different geographical areas (Ametzagaina, Donostia, Gipuzkoa, at 110 m above sea level, and Mugarduia sur, in the Urbasa Mountains, at 905 m above sea level) represent this improved climate (Tapia *et al.* 2009; Iriarte-Chiapusso 2013). The absence of absolute dates for Ametzagaina means this site cannot be situated within the paleo-environmental sequence. In the case of Mugarduia sur, the dates for the base of the sequence locate the record in a Dansgaard-Oeschger event, after the fourth.

Table 1: Radiometric dates.

siteca	layer/ level	method	lab. reference	material	C14 age	SD	calibration (p.95%)	reference for the date	technocomplex /cultural attribution	reference for the typo-technological study
Aizbitarte III (Int)	V	C14	I-15208	bone	24, 910	770	31, 470 - 27, 950	Altuna *et al.* 2011	Gravettian (with Noaillian burins)	
Aizbitarte III (Int)	V	AMS	Ua-2243	bone	23, 230	330	28, 660 - 27, 220			
Aizbitarte III (Int)	VI	AMS	Ua-2244	bone	25, 380	430	31, 250 - 29, 490	Altuna *et al.* 2011	Gravettian (with Noaillian burins)	
Aizbitarte III (Int)	VI	AMS	Ua-1917	bone	21, 130	290	25, 960 - 24, 520			
Aizbitarte III (Int)	VI	AMS	Ua-2245	bone	24 ,920	410	30, 650 - 28, 930			
Aizbitarte III (Int)	VI	AMS	Ua-2626	bone	24, 545	415	30, 320 - 28, 240			
Aizbitarte III (Int)	VI	AMS	Ua-2627	bone	24, 635	475	30, 530 - 28, 210			
Aizbitarte III (Int)	VI	AMS	Ua-2628	bone	23, 830	345	29, 730 - 27, 850			
Aitzbitarte III Ext	Va	AMS	Ua-24967	bone	26, 350	475	32, 030 -30, 190	Altuna *et al*. 2011	Gravettian	De la Peña 2011; Rios *et al*. 2011; Altuna *et al*. 2011
Aitzbitarte III Ext	Va	AMS	Ua-24966	bone	27, 165	520	32, 700 - 31, 020			
Aitzbitarte III Ext	Va	AMS	Ua-37962	bone	28, 530	645	34, 290 - 31, 770			
Aitzbitarte III Ext	Va	AMS	Ua-18466	bone	28, 950	655	34, 580 - 32, 060			
Aitzbitarte III Ext	Va	AMS	Ua-18467	bone	31, 210	860	37, 240 - 33, 720			
Aitzbitarte III Ext	IV	AMS	Ua-11146	bone	24, 240	365	30, 010 - 28, 130	Altuna *et al*. 2011	Gravettian	
Aitzbitarte III Ext	IV	AMS	Ua-37961	bone	26, 260	480	31, 990 - 30, 110			
Aitzbitarte III Ext	IV	AMS	Ua-18464	bone	27, 580	550	33, 190 - 31, 350			
Aitzbitarte III Ext	IV	AMS	Ua-24965	bone	22, 420	290	28, 100 - 26, 020			
Aitzbitarte III Ext	IV	AMS	Ua-18465	bone	28, 320	605	34, 070 - 31, 670			
Aitzbitarte III Ext	III	AMS	Ua-37960	bone	19, 400	210	23, 680 - 22, 800	Altuna *et al*. 2011	New independent technological variety	Altuna *et al*. 2011
Aitzbitarte III Ext	III	AMS	Ua-18463	bone	19, 715	235	24, 110 - 23, 150			
Aitzbitarte III Ext	III	AMS	Ua-11147	bone	20, 405	130	24, 780 - 23, 980			
Aitzbitarte III Ext	III	AMS	Ua-11150	bone	18, 400	215	22, 730 - 21, 410			
Aitzbitarte III Ext	III	AMS	Ua-11149	bone	20, 290	260	24, 860 - 23, 580			
Aitzbitarte III Ext	III	AMS	Ua-24964	bone	19, 230	200	23, 520 - 22, 640			

siteca	layer/ level	method	lab. reference	material	C14 age	SD	calibration (p.95%)	reference for the date	technocomplex /cultural attribution	reference for the typo-technological study
Aitzbitarte III Ext	III	AMS	Ua-24963	bone	22, 580	295	28, 140 - 26, 420			
Alkerdi	II	C14	GrN-20322	bone	26, 470	530	32, 160 - 30, 200	Barandiarán 1997	Gravettian	Cava *et al*. 2009
Amalda	VI	C14	I-11664	bone	27, 400	1,100	34, 100 - 29, 980	Altuna *et al*. 1990	Gravettian (with Noaillian burins)	Baldeón 1990; Arrizabalaga 1995
Amalda	VI	C14	I-11665	bone	27, 400	1,000	33, 930 - 30, 170			
Amalda	V	C14	I-11663	bone	17, 880	390	22, 650 - 20, 450	Altuna *et al*. 1990	Gravettian (with Noaillian burins)	Bradtmöller 2014
Amalda	V	C14	I-11372	bone	19, 000	340	23, 570 - 22, 130			
Antoliñako Koba	Lab	AMS	Beta-233766	bone	22, 640	120	28, 000 - 26, 760	Aguirre Ruiz de Gopegui 2013		Aguirre Ruiz de Gopegui 1998/2000
Antoliñako Koba	Lmbk sup	AMS	Beta-215542	bone	26, 080	200	31, 610 - 30, 370	Aguirre Ruiz de Gopegui 2013		
Antoliñako Koba	Lmbk sup	AMS	Beta-230282	bone	26, 710	180	31, 880 - 31, 280			
Antoliñako Koba	Lmbk sup	AMS	Beta-251299	bone	26, 720	180	31, 890 - 31, 290			
Antoliñako Koba	Lmbk sup	AMS	Beta-251300	bone	27, 100	190	32, 080 - 31, 560			
Antoliñako Koba	Lmbk sup	AMS	Beta-230279	bone	27, 520	190	32, 430 - 31, 750			
Antoliñako Koba	Lmbk sup	C14	GrN23786	bone	27, 390	320	32, 520 - 31, 560			
Zatoya	IIbam	C14	GRN-23999	bone	28, 870	760	34, 640 - 31, 880	Barandiarán and Cava 2008		Barandiarán and Cava 2008
Cuco	III	AMS	GrNA-32097	bone	23, 400	210	28, 480 - 27, 880	Muñoz *et al*. 2007	Gravettian	Muñoz *et al*. 2007
Altamira	8	AMS	GrA-32765	bone	21, 910	90	26, 790 - 25, 790	de las Heras *et al*. 2013	Gravettian	de las Heras *et al*. 2013
Altamira	8	AMS	GrA-27739	bone	21, 930	100	26, 820 - 25, 820			
Fuente de Salin	II	C14	GrN18574	charcoal	22, 340	510	28, 350 - 25, 350	González Morales and Moure Romanillo 2000		
La Garma A	F	C14	TO-11697	bone	22, 200	170	27, 320 - 25, 960	Álvarez-Fernández 2007		

siteca	layer/ level	method	lab. reference	material	C14 age	SD	calibration (p.95%)	reference for the date	technocomplex /cultural attribution	reference for the typo-technological study
La Garma A	E	C14	AA-45566	bone	21, 650	760	28, 100 - 24, 020	Álvarez-Fernández 2007		
Rascaño	VII	C14	BM1456	bone	27, 240	950	33, 690 - 30, 090	González Morales and Barandiarán 1981		
Morín	5a	C14	Si-953	charcoal	20, 107	350	24, 840 - 23, 280	González-Echegaray and Freeman 1978	Gravettian/evolved Aurignacian	González-Echegaray and Freeman 1978; Arrizabalaga 1995; Bradtmöller 2014
El Mirón	L128	AMS	GX-27113	charcoal	27, 580	210	32, 540 - 31, 740	González Morales and Straus 2013	Gravettian?	González Morales and Straus, 2013
El Castillo	14	AMS	Beta 298432	bone	29, 740	190	34, 500 - 33, 700	Bernaldo de Quirós *et al*. 2015		
El Castillo	14	AMS	Beta 298433	bone	29, 600	180	34, 440 - 33, 520			
El Castillo	12	AMS	Beta 298430	bone	25, 920	140	31, 430 - 30, 270	Bernaldo de Quirós *et al*. 2015		
El Castillo	12	AMS	Beta 298431	bone	25, 520	140	31, 430 - 30, 270			
El Castillo	12	AMS	Beta 242617	bone	24, 070	150	29, 650 - 28, 250			
Cueto de la Mina	VII (=F andG?)	AMS	Ua-3587	bone	26, 470	520	32, 160 - 30, 200	de la Rasilla and Santamaría 2006	Gravettian	de la Rasilla and Santamaría 2006 (VII); Martínez and de la Rasilla 2013 (VII); Bradtmöller 2014 (G andH)
La Riera	1	C14	UCR-1270A	bone	19, 620	390	24, 470 - 22, 630	Straus and Clark 1986		
La Riera	1	C14	Ly-1783	bone	20, 360	450	25, 210 - 23, 330			
La Riera	1	C14	BM-1739	bone	21, 100	420	26, 240 - 24, 240			
Sopeña	III	AMS	Beta-198144	bone	21, 020	100	25, 130 - 24, 770	Pinto Llanes *et al.* 2012		
Sopeña	II	AMS	Beta-198143	bone	24, 300	170	29, 910 - 28, 430	Pinto Llanes et al. 2012		

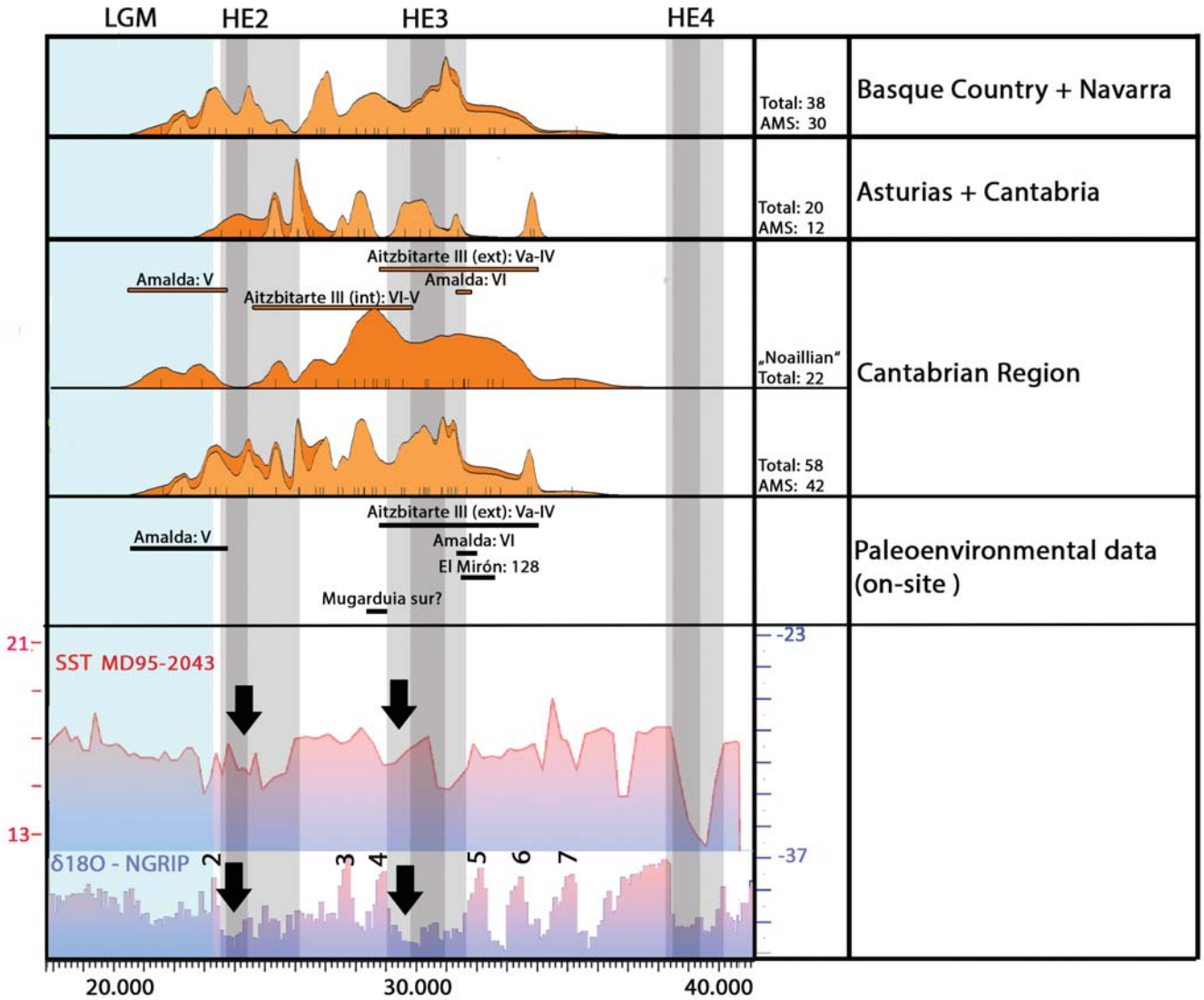

Figure 2: Radiometric and paleoenvironmental data. Chronology for the Heinrich Events (HE) (Fletcher and Sánchez Goñi 2008), NGRIP δ18O Curve (Rasmussen et al. 2006), MD95-2043 SST (Cacho *et al.* 2001). Radiometric data, see Table 1.

Discussion

Of the various approaches that could have been taken in this brief paper, we opted to update the state of research, as symbolically reflected in the title, which refers to variations in the systematization of the period. The changes in the last thirty years have been spectacular. One of the conclusions of the classic study of Bernaldo de Quirós (1982) established the image of the mirror for the visibility of the Gravettian and the Aurignacian in Northern Spain and in the Mediterranean regions of the country; whereas the Aurignacian was well known in the north and little-known in the Mediterranean, the opposite was true of the Gravettian. It is now possible to draft a new regional synthesis because, unlike the situation in the past, the Gravettian is well represented in Northern Spain. The large increase in the number

of sites included in the inventory over the last thirty years is striking, although for different reasons (very poor levels, re-assessment of old excavations, difficulties in obtaining radiocarbon dates, absence of paleo-environmental studies, etc.) they are not all sufficiently informative.

The first aspect to highlight in this new state of the art is the determinant factor of geography. Even today, different geomorphologic, hydrological and climatic circumstances within the small region of Northern Spain produce a wide range of variations. If these circumstances are superimposed on the Pleistocene environmental cycles, the variety of scenarios during the nine millennia must have been kaleidoscopic. Recent studies, particularly at open-air sites, open a window to this reality, although it is still poorly understood. A more solid framework of dates and different types of analysis needs to be constructed.

It is a frequent paradox in the history of science that an increase in information does not always result in clarifying paradigms. Indeed, after duplicating the length of time to be considered Gravettian and the exponential increase in the information available for the region, various aspects "facts" are now again unverified. One of the most important of these is the link between the sequence in Northern Spain and that in central France, where complex systematics and a canonical techno-typological evolution exist. Situations seen clearly in the Dordogne are still difficult to rank chronologically in Northern Spain. The regional Gravettian is defined by the contrast with the evolved Aurignacian, with the transition taking place about 33.0 ky cal BP. In contrast, the transition from the Gravettian to the Solutrean is less precise chronologically and materially. To improve our understanding of the Gravettian, for several decades we would need to concentrate our research on the least known aspects of the record, attempting to excavate and study more open-air camps, locate a stratified Gravettian sequence able to build up an internal framework for the period, and refine the resolution of geoarcheological analyses and osseous industry studies for the period.

Much has been said about whether or not the Gravettian was intrusive in Western Europe. When the historicist program had been overcome, attention was directed towards the origin of the ideas and technological innovations, rather than to the people who developed the culture. Certainly, according to different cultural, social and material parameters, the Gravettian appears to suggest a more significant change of cycle than in other transitions during the Upper Paleolithic. As regards the previous Aurignacian, the mobility of the populations increased considerably, as seen in the circulation of lithic raw materials, changes in hunting models attest a more logistic view of the territory, evidence of cave art is more abundant and lithic assemblages are easily discriminated with the first expansion of points and other backed artifacts. It thus seems undeniable that the introduction of multiple innovations in the region coincided with the Gravettian although the mechanisms of transmission are now thought to have been cultural and not paleo-ethnographic. The absence of any clear differences in chronology with nearby regions (French Pyrenees) or more distant ones (Swabia and the Danube valley) suggest that the speed of adoption of the novelties was rapid. Logically, the similarities with the

region of the French Pyrenees make it possible to propose provisionally that a large Northern Spain-Pyrenean cultural region existed. Like all the proposals put forward in this paper, this idea is pending the evolution of research in the coming decades. Yet it is more consistent than those associating the Northern Spanish Gravettian with Mediterranean Spain or the Dordogne.

Acknowledgements
The authors are grateful for the opportunity to contribute to this monograph. The writing of this paper has been made possible thanks to: a Marie Curie Fellowship of the Gerda Henkel Foundation for M.B., a postdoctoral scholarship of the National Research Foundation of South Africa and the University of the Witwatersrand for P.P. and a pre-doctoral fellowship from the Department of Education, Universities and Research of the Basque Government for A.C.

Résumé
Dans la région cantabrique, l'engouement suscité par certaines problématiques, comme celle de la Transition Paléolithique moyen/supérieur, a longtemps occulté le développement des recherches sur techno-complexe gravettien. Alors que notre perception de cette période spécifique a connue de nombreux changements et une perpétuelle évolution depuis les définitions proposées par Breuil et après lui Peyrony et Garrod, les deux dernières décennies ont vu un développement fulgurant de nos connaissances. Ceci est principalement lié aux nouveaux travaux de terrain et aux études de mobilier qui nous ont fourni de nouvelles informations clefs. De la signification des fossiles directeurs en passant par l'expansion de la chronologie radiocarbone, l'élaboration de nouveaux modèles de transition culturelle ou encore la précision accrue des reconstitutions paléo-environnementales des cadres de vie, tous les domaines semblent avoir progressés significativement. Après une récente conférence internationale où furent exposées nombre de ces nouvelles données et la publication des actes de cette rencontre, le moment semble bien choisi pour établir un bref état de la recherche sur le Gravettien du Nord de l'Espagne.

Zusammenfassung
Als Resultat abweichender Forschungsschwerpunkte, wie z.B. dem Übergang vom Mittel- zum Jungpaläolithikum, war der Umfang an verfügbaren Informationen zum Gravettien in Nordspanien für einen langen Zeitraum vergleichsweise überschaubar. Und obwohl unser Verständnis dieser archäologischen Kultur seit ihrer frühen Beschreibung durch Breuil und Peyrony einem kontinuierlichen Wandel unterliegt, brachten erst die letzten zwei Jahrzehnte im vorgestellten Untersuchungsgebiet fundamentale neue Erkenntnisgewinne. Diese konnten dabei vor allem durch neu initiierte Feldarbeiten und umfassende Untersuchungen wichtiger Artefaktklassen gewonnen werden. Von der Signifikanz einzelner fossil directeur, über die Ausdehnung des absoluten Datierungszeitraums und den Modellen zum kulturellen Übergang, bis hin zu neuen paläoklimatischen Informationen zum Lebensraum wurden alle Bereiche von diesem Prozess erfasst. Daher ist es ein idealer Zeitpunkt für eine kurze Einführung in die neuen Einsichten, welche umfassender auch im dem vor kurzen erschienenen Konferenzband der ersten Internationalen Tagung zu Gravettien in Nordspanien vorgestellt werden.

TEMPORAL CHANGES IN THE OBSIDIAN PROCUREMENT AND REDUCTION STRATEGY AT THE UPPER PALEOLITHIC SITE OF MINAMIMACHI-2, HOKKAIDO (JAPAN): AN APPROACH BY XRF

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Abstract
Here we discuss temporal changes in the obsidian procurement and reduction strategy of the Lower and the Upper assemblages at the Upper Paleolithic Site of Minamimachi-2, through refitting analysis and the determination of the reduction sequences of the lithic assemblages, and the analysis of the artifacts by pXRF to determine the geologic sources. Result shows that obsidian sources utilized for the two assemblages in the Minamimachi-2 site are clearly different. In the lower assemblage, obsidian was procured as local cobbles from Tokachi-Mitsumata while the other assigned samples were acquired from a distant or hyper distant locality (Tokachi-Shikaribetsu, Shirataki-Akaishiyama, Rubeshibe, and perhaps the primary locality of Tokachi-Mitsumata). Side scrapers and endscrapers were made of obsidian flakes procured at various loci from distant to local, likely suggesting that these expedient tools were made with local raw materials as the foragers traveled from one short-term camp to another rather than imported from distant sources to the long term residential locality of Minamimachi-2. In the upper assemblages, on the other hand, obsidian raw materials were transported from distant or hyper distant localities includes Shirataki-Akaishiyama, while small amounts of obsidian were supplied from the local or distant locality of Tokachi-Mitsumata. Although we need further analysis by NAA to confirm our source assignments to rule out geochemically similar sources of Akaigawa, Monbetsu, or Kushiro-Shitakara which visible characteristics are clearly different among the four sources, the kind of integration of geochemical analysis and lithic reduction sequence analysis discussed in this chapter is essential to understanding how hunter-gatherer lithic procurement was related to the production and use of tools and how it changed over time.

Keywords
Lithic procurement, obsidian, geochronology, Upper Paleolithic, Japan

DOI: 10.5817/CZ.MUNI.M210-7781-2015-20

Introduction

Recent progress in Upper Paleolithic research on Hokkaido, Northern Japan has utilized an accumulation of reliable geochronology and behavioral lithic analysis to address three primary questions relating to Northeast Asia: (1) the timing, processes, and mechanisms of the emergence of both anatomically and behaviorally modern humans (Goebel 2007; Mellars 2006a, b), (2) the possibility of a human exodus from Siberia at the Last Glacial Maximum, perhaps between 24.0 – 20.0 ky cal BP (Goebel 1999, 2002; Graf 2008, 2009, 2010; Fiedel and Kuzmin 2007; Kuzmin 2008; Kuzmin and Keates 2005; Kuzmin and Orlova 1998), and (3) the role of newly-developed microblade technology in human adaptation to the cold, harsh environment of the arctic zone and its role in human dispersal to the Americas (Buvit and Terry 2010; Goebel 1999, 2002; Goebel *et al*. 2000, 2003, 2008; Graf 2010, 2013; Izuho 2013; Izuho and Akai 2005; Izuho and Takahashi 2005; Izuho *et al*. 2012; Nakazawa *et al*. 2005). In addition to this progress, obsidian compositional studies on Hokkaido have resulted in high resolution obsidian raw material procurement and reduction strategies (Izuho *et al*. 2013, 2014), particularly in terms of the implementation of systematic source characterization studies that have identified and characterized 21 chemically-distinct sources using a combination of X-ray fluorescence (XRF) and neutron activation analysis (NAA) (Ferguson *et al*. 2014) and the application of portable XRF (pXRF) technology aimed a systematic approach to artifact sourcing that minimizes time, expense, and sample destruction while achieving a high rate of confident source assignment by employing a comprehensive source database. This systematic approach is expected to play important role both in advancing local Upper Paleolithic research in Northeast Asia and furthering methodological developments to reconstruct the hunter-gatherer lithic raw material procurement patterns applicable to other regions of the globe (Izuho *et al*. 2014).

This paper consists of: (1) a description of the Minamimachi-2 site, (2) a summary of the reduction sequence of Minamimachi-2 assemblages, (3) assignment of artifacts by pXRF to specific geologic sources of obsidian, and (4) an examination of the correlation between geologic source and reduction strategy. In conclusion, we address how hunter-gatherer lithic procurement was related to production and use of tools, as well as its changes through time.

The Minamimachi-2 site

The Minamimachi-2 site is located on the southern terraces of the southeastern Tokachi Plain, eastern Hokkaido (N 42°51'54", E 143°10'08") at the edge of the Motomatsu terrace of the Satsunai River at an altitude of 79 m above sea level (Figure 1). Three archeological layers were found in eolian units that measure 120 cm in depth, classified from top to bottom as a Jomon component in the Black Humus soil above the Ta-d tephra (7.0 ky cal BP) labeled layer I, 20 cm below the ground surface; a microblade assemblage in an eolian loam between the Ta-d tephra and En-a tephra (20.0 ky cal BP), labeled layer III (50–70 cm in depth); as well as a flake assemblage in

an eolian loam between the En-a tephra and Spfa-1 tephra (40–45 ky) labeled layer VI (100–120 cm in depth) (Izuho and Akai 2005; Izuho *et al.* 2013; Obihiro Board of Education 1995). Among them, the layer VI flake assemblage falls within the interval of 26.2–25.5 ky cal BP (21, 610 ± 70 ^{14}C BP) and the layer III microblade assemblage falls within 17.9–17.2 ky cal BP (14, 450 ± 80 ^{14}C BP) (Izuho *et al.* 2013).

In geological layer VI, a total of 2,228 lithic specimens were recovered from a flake assemblage concentration. The raw material mainly consists of obsidian (54.9%), followed by andesite (34.7%), and agate (3.3%). The lithic assemblage consists of endscrapers and retouched flakes, as well as flakes, flake cores, and pebbles (Figure 2). Primary reduction involved the production of flakes, which were used to produce triangular and trapezoidal flakes from discoidal cores. Endscraper edge preparation and marginal retouch are common secondary reduction strategies.

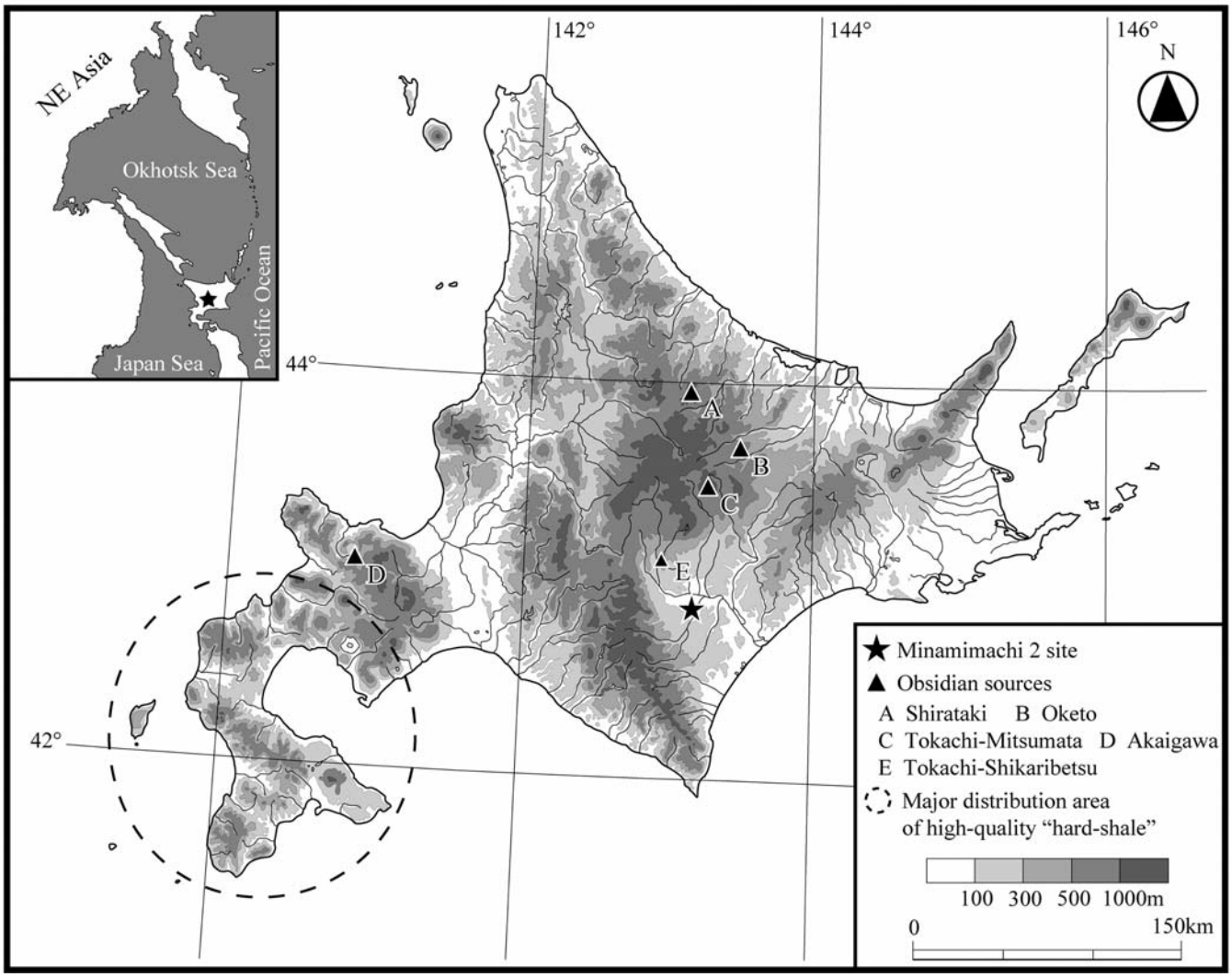


Figure 1: Topography of Hokkaido and the location of the Minamimachi-2 site. Obsidian sources and major distribution areas of high quality "hard-shale" mentioned in the text are also presented.

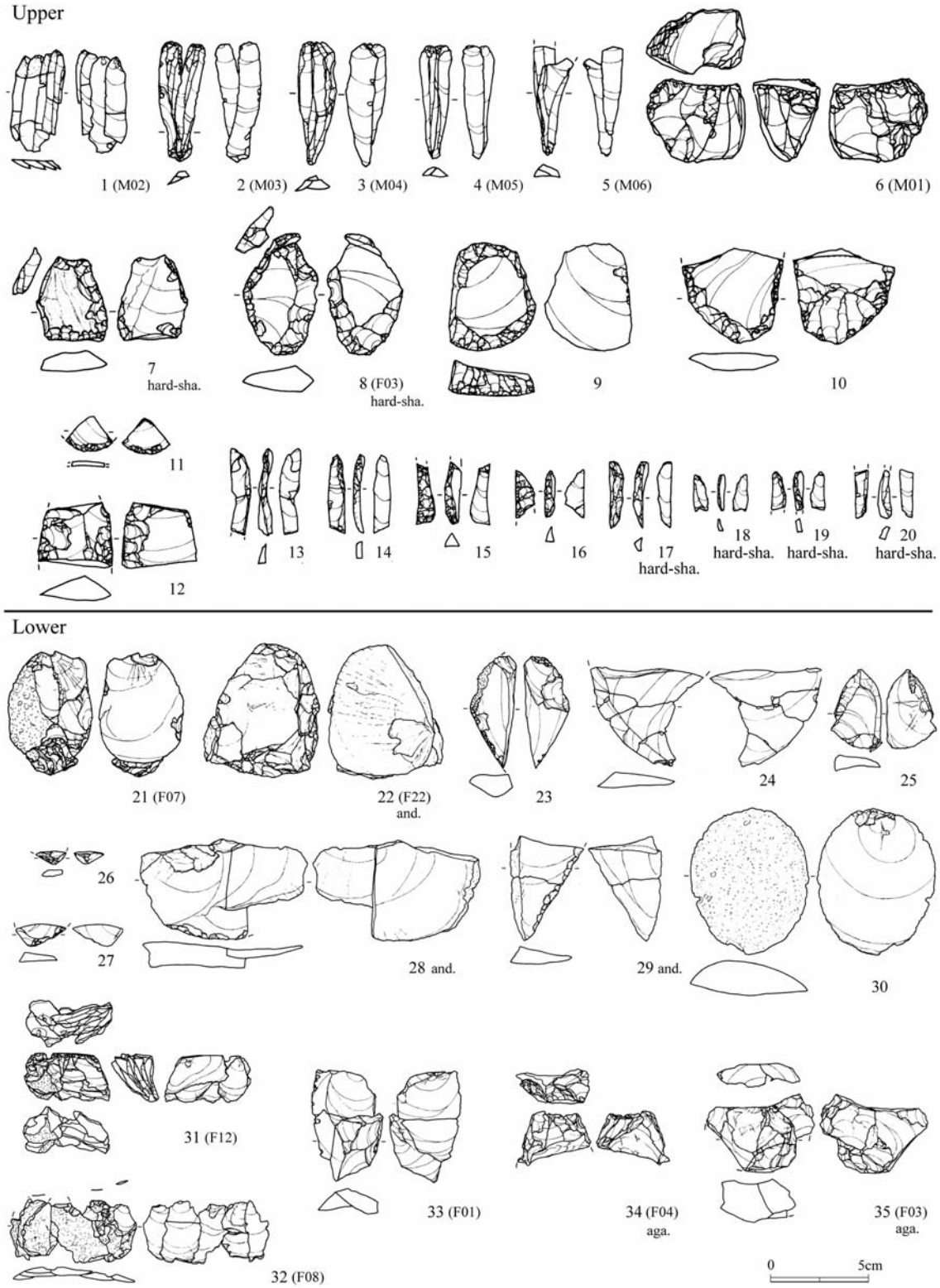


Figure 2: Lithic specimens and major lithic refits of flake and microblade assemblages at the Minamimachi-2 site. 1–5: microblade refit, 6: refit of a microblade core and flakes, 7: burin, 8: refit of burin and spall, 9: endscraper, 10-12: retouched flake, 13–20: burin spall, 21–22: refit of an endscraper and flakes, 23–29: retouched flake, 30: flake, 31–32: endscraper edge forming flakes refit, 33: flake refit, 34–35: refit of a core and flakes.

In geological layer III, a total of 574 lithic specimens were recovered from a lithic concentration. Raw material mainly consists of obsidian (74.0%) followed by "hard-shale" (26.0%). The lithic assemblage consists of burins, endscrapers, retouched flakes, and microblades, as well as burin spall, flakes, and a microblade core. Primary reduction involved the production of microblades, which were produced from a Sakkotsu type microblade core by the Yubetsu method (Nakazawa *et al.* 2005; Sato and Tsutsumi 2007; Tsurumaru 1979; Yoshizaki 1961). Burin technology and endscraper edge forming on bifacial thinning flakes are common secondary reduction strategies.

Material and methods

The detailed interpretation of the lithic assemblage involves two parts: (1) refitting analysis and the determination of the reduction sequences and (2) the analysis of the artifacts by pXRF to determine the geologic sources.

Material

The lithic materials discussed in this paper are 2,228 stone artifacts from the flake assemblage (the lower layer of Minamimachi-2) and 574 stone artifacts from the microblade assemblage (the upper layer). The lower assemblage consists of obsidian (n = 1,223; 54.9%), andesite (n = 842; 37.8%), and agate (n = 73; 3.3%) for chipped stone tools as well as coarse-grained igneous rocks (n = 90; 4.0%) for cobble and cobble tools. The upper assemblage consists of obsidian (n = 425; 74.0%) and "hard-shale" (n = 149; 6.0%) only for chipped stone tools (Table 1). Tool composition by raw materials is also shown in Table 1.

Obsidian geochemical analysis

A total of 329 obsidian artifacts from the flake assemblage and a total of 138 obsidian artifacts from the microblade assemblage were submitted for analysis by XRF (Table 2). The XRF analysis was conducted using two Bruker III-V+ portable handheld XRF instruments. The XRF spectrometers have Rh-based X-ray tubes operated at 40 kV and use thermoelectrically-cooled silicon detectors. The obsidian calibration incorporates a set of 40 well-characterized obsidian standards with elemental compositions based on previous inductive coupled plasma mass-spectrometry (ICP–MS), XRF, and NAA measurements (Glascock and Ferguson 2012; Ferguson *et al.* 2014). The samples were counted for three minutes each to measure minor and trace elements. The elements measured include Mn, Fe, Zn, Ga, Pb, Th, Sr, Y, Zr, and Nb; however, due in part to the small size of the artifacts, only data for Rb, Sr, Y, Zr, and Nb are considered reliable. Although both instruments utilized the same calibration standards, minor variations between instruments preclude direct comparison of the data from the two assemblages. Each assemblage is directly compared to the geologic source samples analyzed on the same instrument. Thus, the source assignments are comparable, but the raw data are not.

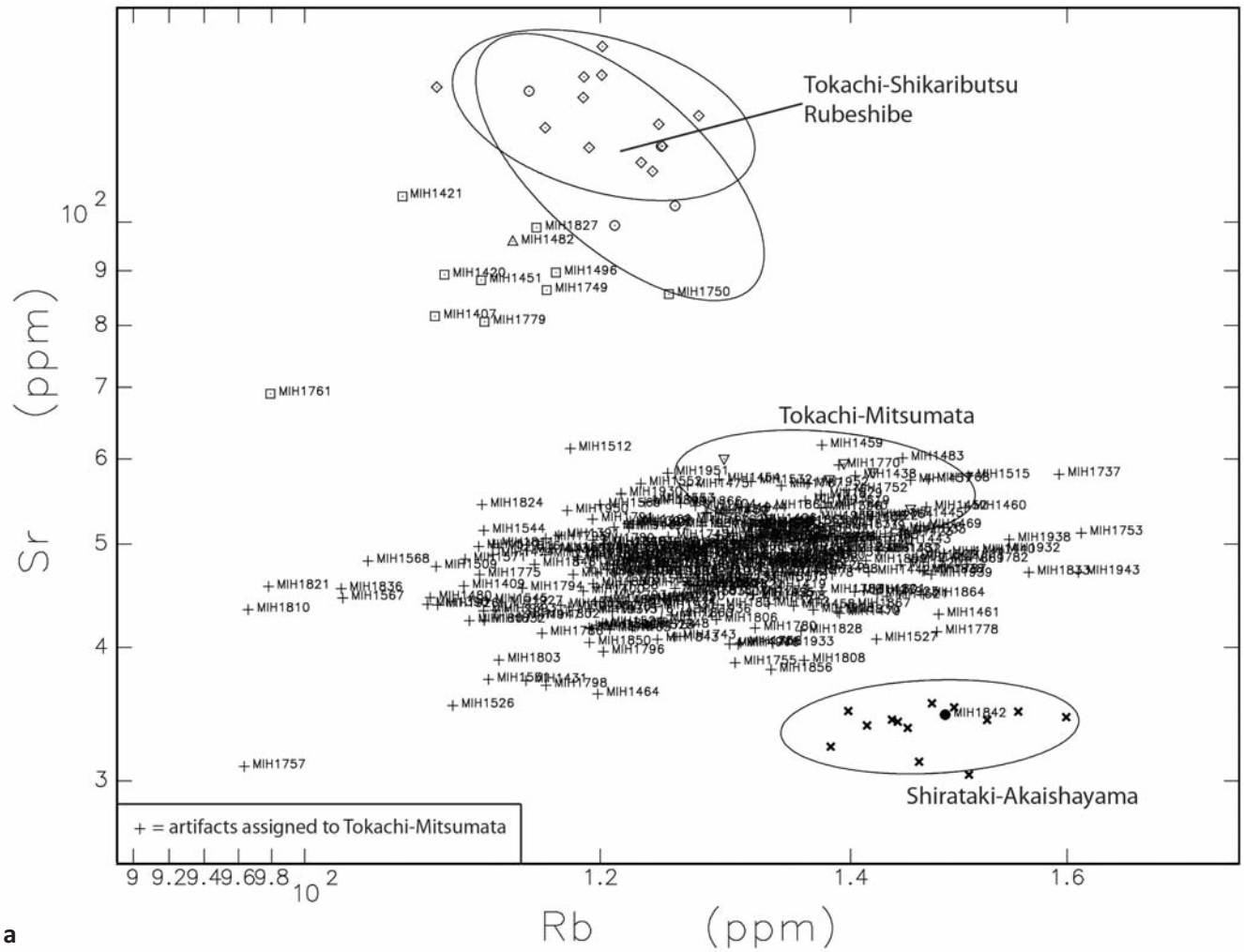
Statistical analysis of the data was carried out on base-10 logarithms of concentrations for the XRF data. The use of log concentrations rather than raw data compensates for differences in magnitude among the major, minor, and trace elements. Transformation to base-10 logarithms also yields a more normal distribution for many trace elements. The interpretation of the compositional data obtained from the analysis of archeological materials is discussed in detail elsewhere (e.g., Baxter and Buck 2000; Bieber *et al*. 1976; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000). The main goal of data analysis is to identify distinct homogenous groups within the analytical database and match these groups to the chemical signatures of known geologic sources.

The main complicating factor in this analysis is the size of the artifacts. The difficulty of small/thin artifacts is that the resulting X-rays from the different elements in the sample that make it to the detector can originate from different depths in the sample (Ferguson 2012). Thus, a thin sample will show a difference in the relative size of the peaks within a specimen when compared to a thicker piece from the same source. Normalization allows for some correction, but the changes are not consistent for each element because the calibration treats all areas of the spectra as the same, resulting in misleading concentrations for elements with peaks far from the portion of the spectra used for normalization. Rb, Sr, Y, Zr, and Nb are all close to the normalization region of the spectra, therefore providing the most reliable results for smaller flakes (Ferguson *et al*. 2012). The shift in the data due primarily to artifact size is apparent in the plots as the small artifacts tend to plot to the lower left (along a correlation line) of the data for the geologic source samples.

Obsidian sources in Hokkaido and the distance away from the Minamimachi-2 site

A total of 21 obsidian sources are currently known on Hokkaido. Among them, 13 of these are primary sources: Akaigawa, Engaru, Ikutahara, Kushiro (Shitakara), Monbetsu (Kamimobetsu), Oketo (Oketoyama), Oketo (Tokoroyama), Okushiri (Katsumayama), Rubeshibe (Iwayama), Rubeshibe (Kayokozawa), Shirataki (Akaishiyama), Shirataki (Tokachi-Ishizawa), and Tokachi-Mitsumata. The remaining eight sources are only found in secondary deposits created by the transport of obsidian away from the primary source areas, which are now covered or obscured by erosion, landslides, and other factors. The secondary sources include Asahikawa (Higashitakasu), Asahikawa (Syunkodai), Kushiro (Kucyorogawa), Nayoro, Omu, Takikawa, Tokachi (Shikaribetsu), and Toyoura (Ferguson *et al*. 2014; Izuho and Hirose 2010). Recent geochemical studies revealed that only three scatter plots are required by NAA to separate the 21 sources in Hokkaido while with ED-XRF it is possible to separate 17 sources by using seven scatter plots, and the other four sources are not clearly distinguishable by ED-XRF. The four overlapping sources are Monbetsu (Kamimobetsu), Kushiro (Shitakara), Tokachi-Mitsumata, and Akaigawa (Ferguson *et al*. 2014).

The distances between the Minamimachi-2 site and the six obsidian sources discussed in this paper are shown in Table 3. These obsidian sources are divided into



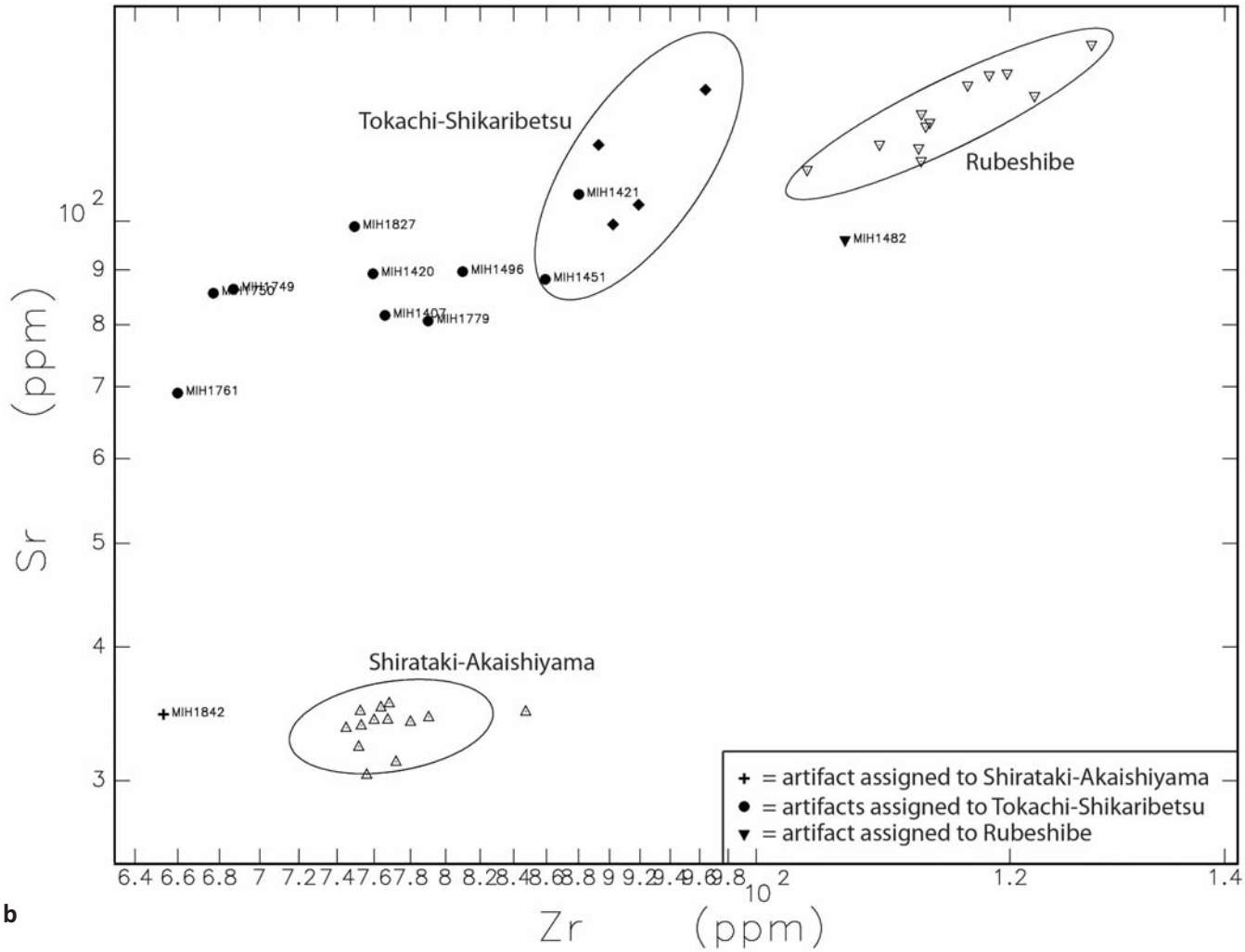
↑→ Figure 3: Bivariate plot of (a) Rb vs. Sr concentration and (b) Zr vs. Sr concentration (in ppm) showing all of the likely source reference groups along with all of the artifacts from the lower layer (the flake assemblage). Ellipses represent 90% confidence intervals for membership in the source group.

three groups: (1) local (< 10 km, the secondary locality of Tokachi-Mitsumata), (2) distant (< 10 km and < 100 km, from nearest to far, the secondary locality of Tokachi-Shikaribetsu, the primary locality of Tokachi-Mitsumata, the secondary locality of Shirataki-Akaishiyama, both localities of Rubeshibe, and the secondary locality of Kushiro-Shitakara), and (3) hyper distant (< 100 km, the primary locality of Shirataki-Akaishiyama and both localities of Akaigawa). The hunter-gatherer obsidian raw material procurement locality (primary or secondary) can be distinguished based on the cortex type, if present (Izuho 1997; Izuho and Hirose 2010).

Results of obsidian source assignment

Flake assemblage

The vast majority of the obsidian from the flake assemblage context is from the Tokachi-Mitsumata source (n = 317; 96.4%), with minor amounts from Rubeshibe

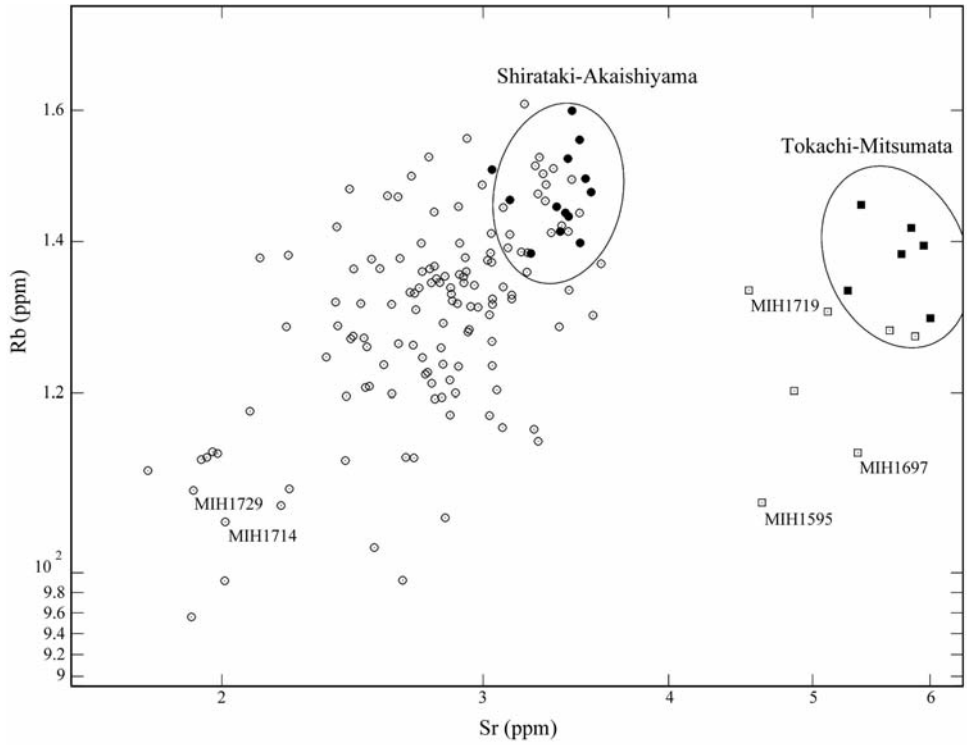


b

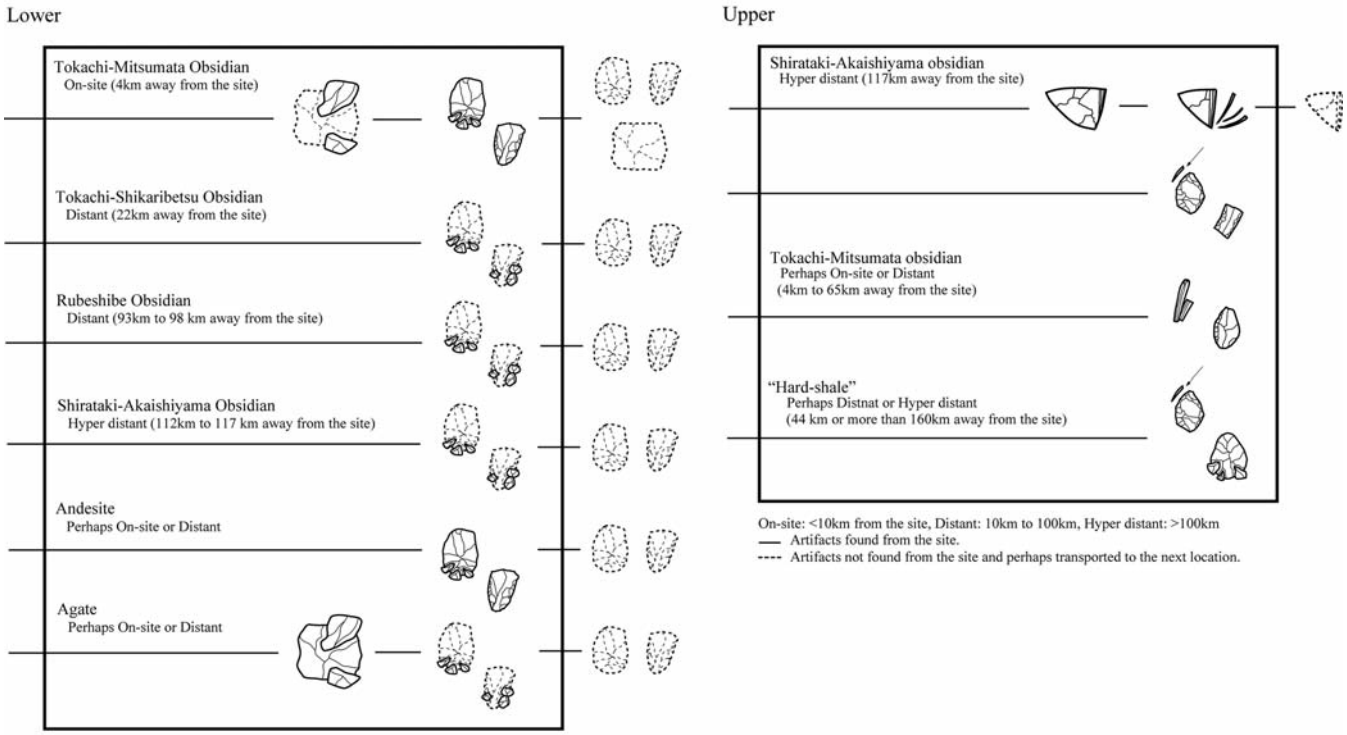
(n = 1; 0.3%) and Shirataki-Akaishiyama (n = 1; 0.3%) and 10 artifacts (3.0%) from Tokachi-Shikaribetsu. Figure 3 is a bivariate plot of the artifacts and the respective geologic sources. Ellipses represent 90% confidence intervals for membership in the source group. The artifacts do not always fit within the confidence ellipse for a given source, mostly due to the small size of the artifacts. As described, sample size/thickness has variable effects on the data and tends to spread the artifacts along a correlation line.

The results of compositional data are shown in Table 2. Also, a summary of sources utilized and the frequency of stone tool types is shown in Table 4. The largest number (n = 317; 96.4%) was assigned to the Tokachi-Mitsumata obsidian source. Smaller percentages were assigned to the Tokachi-Shikaribetsu source (n = 10; 3.0%), Rubeshibe (n = 1; 0.3%), and Shirataki-Akaishiyama (n = 1; 0.3%). Samples with a gravel cortex are evident among the Tokachi-Mitsumata obsidian (n = 16), but many of the other samples are without a cortex (Table 5). Tokachi-Mitsumata is

Figure 4: Bivariate plot of Rb vs. Sr concentrations (in ppm) showing all of the likely source reference groups along with all of the artifacts from the upper layer (the microblade assemblage). Ellipses represent 90% confidence intervals for membership in the source group.



↓ Figure 5: Reconstructed lithic reduction sequences of the lower layer (the flake assemblage) and the upper layer (the microblade assemblage) at the Minamimachi-2 site. Reduction flows are from left to right.



the dominant source for each tool type while only small flakes are evident in the other three sources.

Microblade assemblage

Most samples were assigned to the Shirataki-Akaishiyama obsidian source (n = 131; 95%). Seven samples (5%) were assigned to the Tokachi-Mitsumata obsidian source. The compositional data for the XRF analysis for the artifacts is presented in Figure 4, showing the separation of the relevant source groups and the assigned artifacts. Ellipses represent 90% confidence intervals for membership in the source group. The five artifacts (MIH1595, 1697, 1714, 1719, and 1729) with a questionable source assignment by XRF would require being subjected to short-irradiation NAA for further clarification. For now, they are considered as provisionally assigned to Tokachi-Mitsumata.

Shirataki-Akaishiyama obsidian is the dominant source in the each of the tool categories. Tokachi-Mitsumata obsidian is rarely used in primary microblade reduction. The presence of only the primary type cortex on the Shirataki-Akaishiyama obsidian (n = 3), indicates that the hunter-gatherers acquired large, blocky obsidian debris at the primary source while there is no cortex on the rest of artifacts (Table 5).

Discussions and Conclusions

Obsidian sources utilized for the two assemblages in the Minamimachi-2 site are clearly different (Figure 5, Table 6). In the lower assemblage, gravel cortexes, which represent the materials analyzed, were procured as local cobbles from Tokachi-Mitsumata while the other assigned samples were acquired from a distant or hyper distant locality (Tokachi-Shikaribetsu, Shirataki-Akaishiyama, Rubeshibe, and perhaps the primary locality of Tokachi-Mitsumata). Side scrapers and endscrapers were made of obsidian flakes procured at various loci from distant to local, likely suggesting that these expedient tools were made with local raw materials as the foragers traveled from one short-term camp to another rather than imported from distant sources to the long term residential locality of Minamimachi-2.

In the upper assemblages, on the other hand, a primary cortex is evident at Shirataki-Akaishiyama, suggesting that obsidian raw materials were transported from distant or hyper distant localities while small amounts of obsidian were supplied from the local or distant locality of Tokachi-Mitsumata.

However, it is important to remember that the Tokachi-Mitsumata assignment is really just a best guess, and we cannot rule out Akaigawa, Monbetsu, or Kushiro-Shitakara by using XRF alone (Ferguson *et al*. 2014; Izuho *et al*. 2014). Even though discrimination of these sources is difficult by XRF, the visible characteristics, such as inclusion and litho-faces, are clearly different among the four sources; Tokachi-Mitsumata is of the highest quality and has the largest blocky cobbles at the primary source (Kitazawa 1999), linear flow structure is always evident in the Akaigawa

obsidian (Akai 2009; Terasaki 2005), and it is only possible to find low quality and very small obsidian fragments at Mombetsu and Kushiro-Shitakara (Mukai 2010; Sawa 1974). Although we need further analysis by NAA to confirm our source assignments, the kind of integration of geochemical analysis and lithic reduction sequence analysis discussed in this chapter is essential to understanding how hunter-gatherer lithic procurement was related to the production and use of tools and how it changed over time.

Table 1: Lithic assemblages of the Minamimachi-2 site.

	stone tool type	obsidian	"hard-shale"	andesite	agate	others	total
flake assemblage	endscraper	1	-	1	-	-	2
	retouched flake	5	-	3	-	-	8
	flake	1,217	-	838	70	-	2,125
	core	-	-	-	3	-	3
	anvil stone	-	-	-	-	4	4
	pebble	-	-	-	-	86	86
	total	**1,223**	**0**	**842**	**73**	**90**	**2,228**
microblade assemblage	microblade	167	-	-	-	-	167
	burin	-	2	-	-	-	2
	endscraper	-	1	-	-	-	1
	retouched flake	3	-	-	-	-	3
	burin spall	15	15	-	-	-	30
	microblade core	1	-	-	-	-	1
	flake	239	131	-	-	-	370
	total	**425**	**149**	**0**	**0**	**0**	**574**

Table 3: Distances between the Minamimachi-2 site and the obsidian sources discussed in this paper. Distances for secondary sources are the nearest straight distance.

	to primaly locality (km)	to nearest secondary locality (km)
Tokachi-Mitsumata	63	4
Tokachi-Shikaribetsu	unknown	30
Shirataki-Akaishiyama	117	91
Rubeshibe	97	92
Akaigawa	195	195
Kushiro-Shitkara	unknown	94

Table 2: Element concentrations by hXRF (in ppm) of artifacts from the Minamimachi-2 site.

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1382	lower	8-6,7	endscraper	254	7539	124	49	28	76	2	Tokachi-Mitsumata
MIH1383	lower	9-6,251	retouched flake	98	7724	126	50	27	80	3	Tokachi-Mitsumata
MIH1384	lower	8-6,651	retouched flake	143	7437	130	48	28	77	3	Tokachi-Mitsumata
MIH1385	lower	8-6,788	flake	152	7232	126	49	22	79	6	Tokachi-Mitsumata
MIH1386	lower	8-6,995	flake	134	7729	126	48	30	77	2	Tokachi-Mitsumata
MIH1387	lower	9-6,467	flake	64	8268	142	49	23	77	4	Tokachi-Mitsumata
MIH1388	lower	8-6,698	flake	103	7732	121	48	24	90	1	Tokachi-Mitsumata*
MIH1389	lower	9-6,73	flake	143	7227	123	49	28	80	5	Tokachi-Mitsumata
MIH1390	lower	8-6,348	retouched flake	108	6730	108	44	23	68	4	Tokachi-Mitsumata
MIH1391	lower	8-6,82	retouched flake	59	7769	117	51	25	72	1	Tokachi-Mitsumata
MIH1392	lower	8-6,915	retouched flake	73	7554	121	48	29	80	5	Tokachi-Mitsumata
MIH1393	lower	8-6,1035	flake	61	6275	112	43	25	70	3	Tokachi-Mitsumata
MIH1394	lower	8-6,257	flake	84	6493	112	43	24	70	3	Tokachi-Mitsumata
MIH1395	lower	8-6,1159	flake	229	7186	133	51	26	75	2	Tokachi-Mitsumata
MIH1396	lower	8-6,1090	flake	115	7879	137	54	26	79	4	Tokachi-Mitsumata
MIH1397	lower	9-6,104	flake	120	7301	134	48	27	73	4	Tokachi-Mitsumata
MIH1398	lower	9-6,470	flake	173	7049	122	52	30	77	6	Tokachi-Mitsumata
MIH1399	lower	8-6,77	flake	124	7887	123	48	26	77	3	Tokachi-Mitsumata
MIH1400	lower	8-6,591	flake	141	6811	119	45	27	77	4	Tokachi-Mitsumata
MIH1401	lower	8-6,1144	flake	136	7307	136	50	27	77	4	Tokachi-Mitsumata
MIH1402	lower	8-6,214	flake	188	7397	123	49	24	77	3	Tokachi-Mitsumata
MIH1403	lower	8-6,680	flake	53	7308	122	52	27	74	4	Tokachi-Mitsumata
MIH1404	lower	No sign	flake	103	7297	127	54	26	73	3	Tokachi-Mitsumata
MIH1405	lower	No sign	flake	131	7400	134	49	25	77	3	Tokachi-Mitsumata
MIH1406	lower	No sign	flake	241	6938	132	53	23	76	5	Tokachi-Mitsumata
MIH1407	lower	No sign	flake	102	8431	108	82	21	77	4	Tokachi-Shikaribetsu*
MIH1408	lower	No sign	flake	128	6362	133	45	26	77	5	Tokachi-Mitsumata
MIH1409	lower	No sign	flake	189	6215	110	46	26	73	4	Tokachi-Mitsumata
MIH1411	lower	8-6,274	flake	45	7123	121	48	27	80	3	Tokachi-Mitsumata
MIH1412	lower	8-6,524	flake	140	7548	133	44	26	75	3	Tokachi-Mitsumata
MIH1413	lower	8-6,493	flake	126	9169	136	55	21	75	2	Tokachi-Mitsumata

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1414	lower	8-6,326	flake	107	6793	129	48	27	72	2	Tokachi-Mitsumata
MIH1416	lower	8-6,300	flake	135	6584	120	47	21	72	5	Tokachi-Mitsumata
MIH1417	lower	8-6,265	flake	19	8073	145	48	25	78	5	Tokachi-Mitsumata
MIH1418	lower	8-6,243	flake	173	7966	138	50	27	77	5	Tokachi-Mitsumata
MIH1419	lower	8-6,68	flake	141	7816	133	46	26	77	5	Tokachi-Mitsumata
MIH1420	lower	8-6,191	flake	0	9263	109	89	17	76	2	Tokachi-Shikaribetsu*
MIH1421	lower	8-6,94	flake	157	11600	106	106	24	88	3	Tokachi-Shikaribetsu*
MIH1422	lower	8-6,91	flake	66	7245	126	48	29	73	1	Tokachi-Mitsumata
MIH1423	lower	8-6,63	flake	200	7839	144	51	25	76	0	Tokachi-Mitsumata
MIH1424	lower	8-6, 41	flake	171	7876	127	50	31	79	4	Tokachi-Mitsumata
MIH1425	lower	8-6,38	flake	57	7956	136	48	24	75	4	Tokachi-Mitsumata
MIH1426	lower	8-6,28	flake	143	8761	144	52	28	74	1	Tokachi-Mitsumata
MIH1427	lower	8-6,22	flake	0	7785	140	45	21	72	2	Tokachi-Mitsumata
MIH1428	lower	8-6,678	flake	227	7158	134	47	29	76	4	Tokachi-Mitsumata
MIH1429	lower	8-6,706	flake	59	7638	132	52	26	74	5	Tokachi-Mitsumata
MIH1430	lower	8-6,720	flake	219	9085	128	54	24	74	2	Tokachi-Mitsumata
MIH1431	lower	8-6,741	flake	82	6323	115	37	26	71	4	Tokachi-Mitsumata
MIH1432	lower	8-6,687	flake	194	7921	143	49	27	72	4	Tokachi-Mitsumata
MIH1433	lower	8-6,660	flake	128	7344	130	50	27	69	1	Tokachi-Mitsumata
MIH1434	lower	8-6,622	flake	58	8022	130	51	27	76	2	Tokachi-Mitsumata
MIH1435	lower	8-6,591	flake	104	7660	131	52	28	72	2	Tokachi-Mitsumata
MIH1436	lower	8-6,577	flake	49	7864	124	47	19	64	1	Tokachi-Mitsumata
MIH1437	lower	8-6,569	flake	89	6706	129	50	26	69	1	Tokachi-Mitsumata
MIH1438	lower	8-6,555	flake	151	7257	140	58	29	79	5	Tokachi-Mitsumata
MIH1439	lower	8-6,542	flake	102	7255	135	52	24	73	2	Tokachi-Mitsumata
MIH1440	lower	8-6,782	flake	271	7364	151	49	20	73	1	Tokachi-Mitsumata
MIH1441	lower	8-6,783	flake	22	7028	123	44	27	70	2	Tokachi-Mitsumata
MIH1442	lower	8-6,792	flake	51	7873	142	47	30	78	8	Tokachi-Mitsumata
MIH1443	lower	8-6,830	flake	104	8971	143	50	22	82	0	Tokachi-Mitsumata
MIH1444	lower	8-6,828	flake	304	8785	148	49	22	74	1	Tokachi-Mitsumata
MIH1445	lower	8-6,826	flake	252	8308	145	53	29	76	3	Tokachi-Mitsumata
MIH1446	lower	8-6,819	flake	148	7328	132	48	23	74	5	Tokachi-Mitsumata

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1447	lower	8-6,795	flake	68	8218	126	49	28	75	2	Tokachi-Mitsumata
MIH1448	lower	8-6,794	flake	104	8301	126	45	26	71	4	Tokachi-Mitsumata
MIH1449	lower	8-6,839	flake	263	7138	128	53	27	76	3	Tokachi-Mitsumata
MIH1450	lower	8-6,857	flake	256	7827	129	47	21	77	3	Tokachi-Mitsumata
MIH1451	lower	8-6,901	flake	127	9766	111	88	18	86	4	Tokachi-Shikaribetsu*
MIH1452	lower	8-6,865	flake	118	8277	147	54	22	73	5	Tokachi-Mitsumata
MIH1453	lower	8-6,905	flake	119	6808	118	49	23	73	6	Tokachi-Mitsumata
MIH1454	lower	8-6,907	flake	246	7465	129	57	30	78	3	Tokachi-Mitsumata
MIH1455	lower	8-6,957	flake	56	7679	132	45	35	77	0	Tokachi-Mitsumata*
MIH1456	lower	8-6,971	flake	91	7391	118	49	26	75	9	Tokachi-Mitsumata
MIH1457	lower	8-6,973	flake	644	10716	145	57	30	76	3	Tokachi-Mitsumata
MIH1458	lower	8-6,1029	flake	123	6655	135	44	26	74	4	Tokachi-Mitsumata
MIH1459	lower	8-6,1028	flake	0	7568	138	62	20	74	1	Tokachi-Mitsumata*
MIH1460	lower	8-6,1025	flake	149	7855	150	54	26	69	1	Tokachi-Mitsumata
MIH1461	lower	8-6,1019	flake	0	7601	148	43	25	71	1	Tokachi-Mitsumata
MIH1462	lower	8-6,1018	flake	62	7052	122	53	23	75	3	Tokachi-Mitsumata
MIH1463	lower	8-6,991	flake	54	6918	129	50	21	76	6	Tokachi-Mitsumata
MIH1464	lower	9-6,24	flake	77	7132	120	36	27	79	3	Tokachi-Mitsumata**
MIH1465	lower	8-6,978	flake	19	6902	121	42	34	79	5	Tokachi-Mitsumata*
MIH1466	lower	8-6,1128	flake	174	7096	120	44	27	74	4	Tokachi-Mitsumata
MIH1467	lower	8-6,1081	flake	94	6987	123	49	27	75	3	Tokachi-Mitsumata
MIH1468	lower	8-6,1072	flake	215	8168	139	53	27	71	6	Tokachi-Mitsumata
MIH1469	lower	8-6,1071	flake	226	9638	146	52	29	74	2	Tokachi-Mitsumata
MIH1470	lower	8-6,1069	flake	53	7348	119	43	25	74	4	Tokachi-Mitsumata
MIH1471	lower	8-6,1057	flake	96	7596	128	52	27	76	4	Tokachi-Mitsumata
MIH1472	lower	8-6,1066	flake	167	8393	135	50	24	74	4	Tokachi-Mitsumata
MIH1473	lower	8-6,1068	flake	24	7324	115	49	29	73	3	Tokachi-Mitsumata
MIH1474	lower	8-6,1047	flake	30	6689	112	49	26	75	3	Tokachi-Mitsumata
MIH1475	lower	8-6,1041	flake	94	7274	127	57	24	77	5	Tokachi-Mitsumata
MIH1476	lower	8-6,1042	flake	110	7429	120	47	23	73	4	Tokachi-Mitsumata
MIH1477	lower	8-6,1171	flake	219	7574	126	49	26	74	3	Tokachi-Mitsumata
MIH1478	lower	8-6,1163	flake	215	8268	135	47	24	66	2	Tokachi-Mitsumata

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1479	lower	8-6,1155	flake	157	8664	139	43	24	74	1	Tokachi-Mitsumata
MIH1480	lower	8-6,1151	flake	45	6886	108	45	24	68	5	Tokachi-Mitsumata
MIH1481	lower	8-6,1146	flake	175	7204	129	51	25	78	5	Tokachi-Mitsumata
MIH1482	lower	8-6,1138	flake	105	9931	114	96	20	107	4	Nayoro* (maybe Rubeshibe)
MIH1483	lower	8-6,1136	flake	191	9033	145	60	24	73	0	Tokachi-Mitsumata
MIH1484	lower	8-6,1127	flake	41	7987	131	50	27	78	3	Tokachi-Mitsumata
MIH1485	lower	8-6,1116	flake	0	7542	141	51	25	72	3	Tokachi-Mitsumata
MIH1486	lower	8-6,1115	flake	93	7634	140	49	22	80	4	Tokachi-Mitsumata
MIH1487	lower	8-6,1111	flake	135	7483	134	49	25	73	3	Tokachi-Mitsumata
MIH1488	lower	8-6,1108	flake	214	9161	137	47	28	78	2	Tokachi-Mitsumata
MIH1489	lower	8-6,1096a	flake	221	6930	132	52	26	76	4	Tokachi-Mitsumata
MIH1490	lower	8-6,1096b	flake	198	6995	132	51	24	78	2	Tokachi-Mitsumata
MIH1491	lower	8-6,1228	flake	151	7286	127	47	24	78	5	Tokachi-Mitsumata
MIH1492	lower	8-6,1123	flake	195	7344	122	52	29	76	5	Tokachi-Mitsumata
MIH1493	lower	8-6,1221	flake	130	7331	131	48	24	80	4	Tokachi-Mitsumata
MIH1494	lower	8-6,1218	flake	111	6790	130	40	26	76	2	Tokachi-Mitsumata
MIH1495	lower	8-6,1197	flake	151	7399	131	48	27	76	5	Tokachi-Mitsumata
MIH1496	lower	8-6,1195	flake	98	9406	117	90	23	81	1	Tokachi-Shikaribetsu*
MIH1497	lower	8-6,1190	flake	102	8283	135	50	28	77	2	Tokachi-Mitsumata
MIH1498	lower	8-6,1185	flake	150	7381	120	49	28	75	4	Tokachi-Mitsumata
MIH1499	lower	8-6,1180	flake	257	7995	128	49	26	72	4	Tokachi-Mitsumata
MIH1500	lower	8-6,1035	flake	74	7930	136	49	25	74	3	Tokachi-Mitsumata
MIH1501	lower	9-6,27	flake	87	7672	123	49	26	75	4	Tokachi-Mitsumata
MIH1502	lower	9-6,23	flake	208	9762	146	49	25	78	2	Tokachi-Mitsumata
MIH1503	lower	9-6,28	flake	140	7648	126	45	26	72	4	Tokachi-Mitsumata
MIH1504	lower	9-6,31	flake	108	8560	135	48	27	78	5	Tokachi-Mitsumata
MIH1505	lower	9-6,32	flake	63	7332	122	46	26	78	2	Tokachi-Mitsumata
MIH1506	lower	9-6,48	flake	200	7374	133	51	23	73	1	Tokachi-Mitsumata
MIH1507	lower	9-6,50	flake	237	7162	121	47	25	74	2	Tokachi-Mitsumata
MIH1508	lower	9-6,62	flake	4	8139	135	48	29	79	2	Tokachi-Mitsumata
MIH1509	lower	9-6,68	flake	285	6344	108	48	24	68	1	Tokachi-Mitsumata
MIH1510	lower	9-6,78	flake	105	7920	126	47	30	69	5	Tokachi-Mitsumata

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1511	lower	9-6,92	flake	33	7131	135	49	27	81	4	Tokachi-Mitsumata
MIH1512	lower	9-6,96	flake	156	7516	118	61	32	77	6	Tokachi-Mitsumata
MIH1513	lower	9-6,250	flake	49	6822	125	50	23	71	4	Tokachi-Mitsumata
MIH1514	lower	9-6,228	flake	146	6968	119	42	22	72	4	Tokachi-Mitsumata
MIH1515	lower	9-6,225	flake	179	7751	151	58	20	76	2	Tokachi-Mitsumata
MIH1516	lower	9-6,209	flake	117	6803	121	43	25	80	7	Tokachi-Mitsumata
MIH1517	lower	9-6,170	flake	90	8322	138	49	28	78	1	Tokachi-Mitsumata
MIH1518	lower	9-6,150	flake	155	6610	118	47	26	74	3	Tokachi-Mitsumata
MIH1519	lower	9-6,124	flake	232	7126	138	55	23	66	0	Tokachi-Mitsumata
MIH1520	lower	9-6,100	flake	191	7053	144	48	24	77	4	Tokachi-Mitsumata
MIH1521	lower	9-6,451	flake	27	8449	143	45	26	72	1	Tokachi-Mitsumata
MIH1522	lower	9-6,607	flake	124	7677	132	50	33	75	5	Tokachi-Mitsumata
MIH1523	lower	9-6,611	flake	75	7939	132	52	25	77	5	Tokachi-Mitsumata
MIH1524	lower	9-6,384	flake	35	7198	120	42	27	79	4	Tokachi-Mitsumata
MIH1525	lower	9-6,367	flake	151	6979	122	42	28	71	1	Tokachi-Mitsumata
MIH1526	lower	9-6,320	flake	0	6210	110	35	27	68	2	Tokachi-Mitsumata
MIH1527	lower	9-6,319	flake	0	7284	142	41	26	75	8	Tokachi-Mitsumata
MIH1528	lower	9-6,303	flake	338	6285	124	50	24	69	5	Tokachi-Mitsumata
MIH1529	lower	9-6,298	flake	65	8170	132	52	30	72	0	Tokachi-Mitsumata
MIH1530	lower	9-6,289	flake	149	8191	127	46	28	75	1	Tokachi-Mitsumata
MIH1531	lower	9-6,280	flake	0	6123	112	37	24	70	0	Tokachi-Mitsumata
MIH1532	lower	9-6,386	flake	202	7850	132	57	23	72	7	Tokachi-Mitsumata
MIH1533	lower	9-6,359	flake	36	8136	145	51	30	70	3	Tokachi-Mitsumata
MIH1544	lower	9-6,8	flake	335	6936	112	51	19	72	4	Tokachi-Mitsumata
MIH1545	lower	9-6,1	flake	263	6978	112	44	22	74	0	Tokachi-Mitsumata
MIH1546	lower	9-6,3	flake	92	6989	119	42	18	73	1	Tokachi-Mitsumata
MIH1547	lower	9-6,5	flake	118	6718	111	50	21	73	7	Tokachi-Mitsumata
MIH1551	lower	9-7,2	flake	472	7541	132	46	26	73	0	Tokachi-Mitsumata
MIH1552	lower	9-7,3	flake	203	7400	123	57	23	72	1	Tokachi-Mitsumata
MIH1553	lower	9-7,6	flake	511	8705	124	55	18	80	3	Tokachi-Mitsumata
MIH1567	lower	9-6,287	flake	182	5978	102	45	25	67	3	Tokachi-Mitsumata
MIH1568	lower	No sign	flake	158	6646	104	48	23	72	1	Tokachi-Mitsumata

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1569	lower	9-5,33	flake	55	7595	120	54	22	66	0	Tokachi-Mitsumata
MIH1570	lower	9-5,17	flake	327	8263	118	48	19	74	5	Tokachi-Mitsumata
MIH1571	lower	9-5,126	flake	237	7925	110	48	22	77	3	Tokachi-Mitsumata
MIH1736	lower	8-6,3	flake	68	8001	120	50	24	57	4	Tokachi-Mitsumata
MIH1737	lower	8-6,4	flake	278	9906	159	58	18	61	2	Tokachi-Mitsumata
MIH1738	lower	8-6,11	flake	20	7931	118	44	24	72	0	Tokachi-Mitsumata
MIH1739	lower	8-6,12	flake	59	9747	139	52	21	79	3	Tokachi-Mitsumata
MIH1740	lower	8-6,18	flake	157	7322	138	54	28	73	3	Tokachi-Mitsumata
MIH1741	lower	8-6,34	flake	14	11361	125	43	19	71	4	Tokachi-Mitsumata
MIH1742	lower	8-6,39	flake	101	8431	119	48	28	75	0	Tokachi-Mitsumata
MIH1743	lower	8-6,65	flake	99	7805	126	41	29	79	3	Tokachi-Mitsumata
MIH1744	lower	8-6,78	flake	92	7601	129	47	24	73	1	Tokachi-Mitsumata
MIH1745	lower	8-6,80	flake	0	8543	125	51	23	75	3	Tokachi-Mitsumata
MIH1746	lower	8-6,81	flake	33	8455	128	49	19	72	4	Tokachi-Mitsumata
MIH1747	lower	8-6,88	flake	99	7573	121	47	29	79	4	Tokachi-Mitsumata
MIH1748	lower	8-6,92	flake	296	10109	124	42	18	61	6	Tokachi-Mitsumata
MIH1749	lower	8-6,98	flake	115	10954	116	86	19	69	0	Tokachi-Shikaribetsu*
MIH1750	lower	8-6,101	flake	51	11855	125	86	16	68	0	Tokachi-Shikaribetsu*
MIH1751	lower	8-6,112	flake	46	7082	134	46	23	75	1	Tokachi-Mitsumata
MIH1752	lower	8-6,121	flake	163	8657	140	56	24	67	7	Tokachi-Mitsumata
MIH1753	lower	8-6,126	flake	171	10884	161	51	26	64	0	Tokachi-Mitsumata
MIH1754	lower	8-6,132	flake	104	8945	123	42	14	61	3	Tokachi-Mitsumata*
MIH1755	lower	8-6,153	flake	195	9062	130	39	19	72	5	Tokachi-Mitsumata
MIH1756	lower	8-6,161	flake	165	8753	131	40	24	72	0	Tokachi-Mitsumata
MIH1757	lower	8-6,178	flake	517	9452	96	31	17	54	0	Tokachi-Mitsumata*
MIH1758	lower	8-6,183	flake	8	7870	120	46	24	68	0	Tokachi-Mitsumata
MIH1759	lower	8-6,198	flake	96	8045	121	48	24	67	4	Tokachi-Mitsumata
MIH1760	lower	8-6,211	flake	51	8483	133	48	19	71	5	Tokachi-Mitsumata
MIH1761	lower	8-6,218	flake	0	10303	98	69	17	66	3	Tokachi-Shikaribetsu*
MIH1762	lower	8-6,219	flake	77	8456	128	52	26	67	2	Tokachi-Mitsumata
MIH1763	lower	8-6,220	flake	152	7603	136	50	26	87	5	Tokachi-Mitsumata
MIH1764	lower	8-6,247	flake	176	8248	142	53	30	77	1	Tokachi-Mitsumata

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1765	lower	8-6,252	flake	88	7058	122	50	27	68	2	Tokachi-Mitsumata
MIH1766	lower	8-6,264	flake	0	7710	127	53	37	77	6	Tokachi-Mitsumata*
MIH1767	lower	8-6,269	flake	85	7442	134	57	25	73	0	Tokachi-Mitsumata
MIH1768	lower	8-6,291	flake	110	10487	147	57	19	71	1	Tokachi-Mitsumata
MIH1769	lower	8-6,298	flake	160	8035	127	46	23	71	3	Tokachi-Mitsumata
MIH1770	lower	8-6,375	flake	351	9524	139	59	18	68	3	Tokachi-Mitsumata
MIH1771	lower	8-6,374	flake	134	7813	126	47	23	68	0	Tokachi-Mitsumata
MIH1772	lower	8-6,372	flake	64	7527	124	44	21	70	2	Tokachi-Mitsumata
MIH1773	lower	8-6,357	flake	41	8066	131	45	24	71	3	Tokachi-Mitsumata
MIH1774	lower	8-6,344	flake	0	8342	124	44	24	63	1	Tokachi-Mitsumata
MIH1775	lower	8-6,319	flake	198	9865	111	47	24	70	3	Tokachi-Mitsumata
MIH1776	lower	8-6,497	flake	27	9756	131	40	21	69	0	Tokachi-Mitsumata
MIH1777	lower	8-6,490	flake	160	8002	122	44	20	72	0	Tokachi-Mitsumata
MIH1778	lower	8-6,485	flake	21	8430	148	41	23	72	0	Tokachi-Mitsumata
MIH1779	lower	8-6,486	flake	76	10549	112	81	16	79	3	Tokachi-Shikaribetsu*
MIH1780	lower	8-6,478	flake	64	7580	132	42	24	66	3	Tokachi-Mitsumata
MIH1781	lower	8-6,483	flake	204	8248	122	48	25	65	0	Tokachi-Mitsumata
MIH1782	lower	8-6,469	flake	181	9140	150	48	21	74	5	Tokachi-Mitsumata
MIH1783	lower	8-6,444	flake	251	7836	138	45	33	74	2	Tokachi-Mitsumata
MIH1784	lower	8-6,435	flake	274	9728	116	49	23	57	0	Tokachi-Mitsumata
MIH1785	lower	8-6,421	flake	0	9146	124	48	21	67	1	Tokachi-Mitsumata
MIH1786	lower	8-6,586	flake	233	6923	116	41	28	63	1	Tokachi-Mitsumata
MIH1787	lower	8-6,589	flake	205	7737	147	47	29	77	3	Tokachi-Mitsumata
MIH1788	lower	8-6,582	flake	229	7674	137	51	21	66	1	Tokachi-Mitsumata
MIH1789	lower	8-6,574	flake	125	7389	119	50	28	75	3	Tokachi-Mitsumata
MIH1790	lower	8-6,566	flake	192	7273	125	44	20	78	3	Tokachi-Mitsumata
MIH1791	lower	8-6,561	flake	76	8454	119	53	27	72	0	Tokachi-Mitsumata
MIH1792	lower	8-6,545	flake	151	9828	122	49	36	64	1	Tokachi-Mitsumata*
MIH1793	lower	8-6,544	flake	90	7173	120	45	22	70	4	Tokachi-Mitsumata
MIH1794	lower	8-6,531	flake	363	9797	114	45	23	62	2	Tokachi-Mitsumata
MIH1795	lower	8-6,523	flake	0	8625	116	51	17	65	0	Tokachi-Mitsumata
MIH1796	lower	8-6,519	flake	37	7684	120	40	23	68	0	Tokachi-Mitsumata

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1797	lower	8-6,515	flake	507	10454	139	49	30	71	2	Tokachi-Mitsumata
MIH1798	lower	8-6,512	flake	70	7687	116	37	19	68	4	Tokachi-Mitsumata
MIH1799	lower	8-6,505	flake	0	7442	126	50	28	72	3	Tokachi-Mitsumata
MIH1800	lower	8-6,504	flake	85	7422	119	46	21	65	5	Tokachi-Mitsumata
MIH1801	lower	8-6,502	flake	144	9084	141	45	16	62	3	Tokachi-Mitsumata
MIH1802	lower	8-6,600	flake	1	8118	116	43	27	60	0	Tokachi-Mitsumata
MIH1803	lower	8-6,621	flake	53	7722	113	39	21	73	0	Tokachi-Mitsumata
MIH1804	lower	8-6,628	flake	113	10166	127	50	17	64	2	Tokachi-Mitsumata
MIH1805	lower	8-6,666	flake	0	8305	134	48	23	71	0	Tokachi-Mitsumata
MIH1806	lower	8-6,682	flake	0	8684	129	42	27	68	0	Tokachi-Mitsumata
MIH1807	lower	8-6,773	flake	134	7842	111	42	24	66	0	Tokachi-Mitsumata
MIH1808	lower	8-6,787	flake	0	8535	136	39	19	71	5	Tokachi-Mitsumata
MIH1809	lower	8-6,757	flake	201	8063	127	46	23	79	5	Tokachi-Mitsumata
MIH1810	lower	8-6,744	flake	85	6848	97	43	29	70	2	Tokachi-Mitsumata
MIH1811	lower	8-6,708	flake	84	6808	112	50	25	74	1	Tokachi-Mitsumata
MIH1812	lower	8-6,705	flake	108	7510	120	42	27	81	3	Tokachi-Mitsumata
MIH1813	lower	8-6,875	flake	381	8753	127	49	19	72	5	Tokachi-Mitsumata
MIH1814	lower	8-6,806	flake	0	8470	133	51	19	64	2	Tokachi-Mitsumata
MIH1815	lower	8-6,891	flake	164	7363	132	48	24	79	3	Tokachi-Mitsumata
MIH1816	lower	8-6,890	flake	141	7989	113	50	32	76	1	Tokachi-Mitsumata
MIH1817	lower	8-6,885	flake	87	8408	132	51	25	71	1	Tokachi-Mitsumata
MIH1818	lower	8-6,883	flake	38	7344	127	45	25	76	5	Tokachi-Mitsumata
MIH1819	lower	8-6,881	flake	183	10533	133	52	24	65	3	Tokachi-Mitsumata
MIH1820	lower	8-6,867	flake	259	8278	134	48	36	75	1	Tokachi-Mitsumata*
MIH1821	lower	8-6,864	flake	0	7945	98	46	23	65	3	Tokachi-Mitsumata
MIH1822	lower	8-6,859	flake	28	7112	129	46	22	71	2	Tokachi-Mitsumata
MIH1823	lower	8-6,836	flake	95	9692	128	46	24	62	2	Tokachi-Mitsumata
MIH1824	lower	8-6,946	flake	50	8465	112	54	24	69	2	Tokachi-Mitsumata
MIH1825	lower	8-6,986	flake	109	8268	129	49	23	72	5	Tokachi-Mitsumata
MIH1826	lower	8-6,984	flake	193	7860	137	51	21	70	2	Tokachi-Mitsumata
MIH1827	lower	8-6,981	flake	153	9371	115	99	19	75	0	Tokachi-Shikaribetsu*
MIH1828	lower	8-6,964	flake	106	8238	136	41	21	73	0	Tokachi-Mitsumata

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1829	lower	8-6,958	flake	103	9066	137	56	26	66	2	Tokachi-Mitsumata
MIH1830	lower	8-6,952	flake	206	7679	139	43	20	68	2	Tokachi-Mitsumata
MIH1831	lower	8-6,928	flake	246	8626	129	44	18	62	0	Tokachi-Mitsumata
MIH1832	lower	8-6,922	flake	84	8951	112	42	19	70	2	Tokachi-Mitsumata
MIH1833	lower	8-6,916	flake	213	8272	156	47	21	70	2	Tokachi-Mitsumata
MIH1834	lower	8-6,900	flake	149	8535	125	48	29	72	2	Tokachi-Mitsumata
MIH1835	lower	8-6,1230	flake	136	6576	117	44	21	73	0	Tokachi-Mitsumata
MIH1836	lower	8-6,1076	flake	0	6186	102	45	24	67	2	Tokachi-Mitsumata
MIH1837	lower	8-6,1070	flake	293	8923	139	52	22	77	4	Tokachi-Mitsumata
MIH1838	lower	8-6,1067	flake	250	9928	146	47	21	67	4	Tokachi-Mitsumata
MIH1839	lower	8-6,1063	flake	90	7089	131	50	22	77	4	Tokachi-Mitsumata
MIH1840	lower	8-6,1045	flake	106	8059	117	49	22	68	4	Tokachi-Mitsumata
MIH1841	lower	8-6,1038	flake	0	7347	121	49	21	69	4	Tokachi-Mitsumata
MIH1842	lower	8-6,1020	flake	170	8244	148	35	18	65	1	Shirataki-Akaishiyama*
MIH1843	lower	8-6,1017	flake	19	7820	124	41	28	73	0	Tokachi-Mitsumata
MIH1844	lower	8-6,1012	flake	0	7668	123	55	21	71	2	Tokachi-Mitsumata
MIH1845	lower	8-6,1194	flake	0	7419	120	49	26	70	4	Tokachi-Mitsumata
MIH1846	lower	8-6,1152	flake	0	7294	120	50	29	71	0	Tokachi-Mitsumata
MIH1847	lower	8-6,1158	flake	83	7631	123	50	30	70	4	Tokachi-Mitsumata
MIH1848	lower	8-6,1140	flake	92	6929	115	48	26	76	1	Tokachi-Mitsumata
MIH1849	lower	8-6,1170	flake	0	8308	134	51	24	70	3	Tokachi-Mitsumata
MIH1850	lower	8-6,1142	flake	141	7601	119	40	27	69	0	Tokachi-Mitsumata
MIH1851	lower	8-6,1129	flake	208	8440	136	49	25	74	0	Tokachi-Mitsumata
MIH1852	lower	8-6,1121	flake	0	7849	136	51	27	73	4	Tokachi-Mitsumata
MIH1853	lower	8-6,1104	flake	288	8643	134	52	19	59	3	Tokachi-Mitsumata
MIH1854	lower	8-6,1222	flake	148	7390	128	46	21	75	6	Tokachi-Mitsumata
MIH1855	lower	8-6,1220	flake	60	7870	128	48	25	79	4	Tokachi-Mitsumata
MIH1856	lower	8-6,1219	flake	172	8429	133	38	19	72	0	Tokachi-Mitsumata
MIH1857	lower	8-6,1214	flake	0	8049	132	48	21	67	3	Tokachi-Mitsumata
MIH1858	lower	8-6,1211	flake	7	9113	127	46	22	71	0	Tokachi-Mitsumata
MIH1859	lower	9-6,623	flake	107	6814	141	48	23	80	6	Tokachi-Mitsumata
MIH1860	lower	9-6,623	flake	29	6912	125	43	24	76	0	Tokachi-Mitsumata

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1861	lower	9-6,623	flake	89	6862	133	54	24	72	3	Tokachi-Mitsumata
MIH1862	lower	9-6,623	flake	47	7013	131	48	28	75	4	Tokachi-Mitsumata
MIH1863	lower	9-6,623	flake	265	7531	133	50	28	74	2	Tokachi-Mitsumata
MIH1864	lower	9-6,623	flake	74	7307	146	45	30	76	3	Tokachi-Mitsumata
MIH1865	lower	9-6,623	flake	17	7804	135	52	30	75	4	Tokachi-Mitsumata
MIH1866	lower	9-6,623	flake	161	7796	126	55	31	73	6	Tokachi-Mitsumata
MIH1867	lower	9-6,623	flake	199	7868	140	44	25	79	10	Tokachi-Mitsumata
MIH1868	lower	9-6,623	flake	132	8028	128	50	29	79	3	Tokachi-Mitsumata
MIH1869	lower	9-6,623	flake	124	8160	148	48	26	75	2	Tokachi-Mitsumata
MIH1920	lower	9-6,70	flake	61	7926	123	46	24	71	7	Tokachi-Mitsumata
MIH1921	lower	9-6,60	flake	0	7759	124	44	25	70	0	Tokachi-Mitsumata
MIH1922	lower	9-6,45	flake	160	8037	141	53	26	74	4	Tokachi-Mitsumata
MIH1923	lower	9-6,43	flake	118	9267	142	45	24	68	4	Tokachi-Mitsumata
MIH1924	lower	9-6,115	flake	30	7345	129	52	28	79	3	Tokachi-Mitsumata
MIH1925	lower	9-6,133	flake	14	7404	132	45	28	78	1	Tokachi-Mitsumata
MIH1926	lower	9-6,151	flake	57	8160	109	44	27	75	1	Tokachi-Mitsumata
MIH1927	lower	9-6,182	flake	140	7601	113	44	17	71	0	Tokachi-Mitsumata
MIH1928	lower	9-6,235	flake	222	8421	137	43	27	70	2	Tokachi-Mitsumata
MIH1929	lower	9-6,252	flake	45	7865	124	47	33	70	2	Tokachi-Mitsumata*
MIH1930	lower	9-6,284a	flake	54	8259	122	56	28	77	1	Tokachi-Mitsumata
MIH1931	lower	9-6,284b	flake	54	7292	124	44	24	75	4	Tokachi-Mitsumata
MIH1932	lower	9-6,284c	flake	178	9589	153	49	20	79	2	Tokachi-Mitsumata
MIH1933	lower	9-6,296	flake	111	8425	133	40	22	67	0	Tokachi-Mitsumata
MIH1934	lower	9-6,300	flake	0	7784	126	52	28	72	6	Tokachi-Mitsumata
MIH1935	lower	9-6,302	flake	96	8368	137	53	28	76	0	Tokachi-Mitsumata
MIH1936	lower	9-6,305	flake	370	8239	127	43	20	71	3	Tokachi-Mitsumata
MIH1937	lower	9-6,321	flake	43	6964	119	43	25	69	4	Tokachi-Mitsumata
MIH1938	lower	9-6,322	flake	238	8689	154	51	25	81	2	Tokachi-Mitsumata
MIH1939	lower	9-6,348	flake	153	7182	147	47	20	76	5	Tokachi-Mitsumata
MIH1940	lower	9-6,387	flake	256	9792	140	50	31	70	0	Tokachi-Mitsumata
MIH1941	lower	9-6,423	flake	22	7455	122	47	22	73	4	Tokachi-Mitsumata
MIH1942	lower	9-6,472	flake	0	8693	123	48	25	71	3	Tokachi-Mitsumata

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1943	lower	9-6,506	flake	124	8043	161	47	22	75	3	Tokachi-Mitsumata
MIH1944	lower	9-6,532	flake	82	8706	130	54	26	76	5	Tokachi-Mitsumata
MIH1945	lower	9-6,535	flake	118	8069	123	50	26	75	6	Tokachi-Mitsumata
MIH1946	lower	9-6,546	flake	0	8559	121	52	24	73	4	Tokachi-Mitsumata
MIH1947	lower	9-6,548	flake	216	6315	114	43	23	68	3	Tokachi-Mitsumata
MIH1948	lower	9-6,578	flake	237	7812	118	49	25	75	1	Tokachi-Mitsumata
MIH1949	lower	9-6,580	flake	0	8974	131	47	26	67	4	Tokachi-Mitsumata
MIH1950	lower	9-6,608	flake	227	7569	118	54	24	69	4	Tokachi-Mitsumata
MIH1951	lower	9-6,621a	flake	123	9150	125	58	22	83	5	Tokachi-Mitsumata
MIH1952	lower	9-6,621b	flake	226	8963	136	57	22	65	3	Tokachi-Mitsumata
MIH1595	upper	13-7,73	flake	110	7479	107	46	21	66	6	Tokachi-Mitsumata*
MIH1596	upper	13-7,131	burin spall	6	7088	124	28	21	72	3	Shirataki-Akaishiyama
MIH1597	upper	13-7,282	flake	0	7902	123	28	20	61	2	Shirataki-Akaishiyama
MIH1598	upper	13-7,331	flake	142	6135	120	24	22	70	3	Shirataki-Akaishiyama
MIH1602	upper	13-7,266	microblade	70	9921	150	33	22	67	0	Shirataki-Akaishiyama
MIH1603	upper	13-7,291	flake	12	7715	148	24	26	75	3	Shirataki-Akaishiyama
MIH1604	upper	14-7,120	flake	96	7608	127	59	22	78	2	Tokachi-Mitsumata
MIH1605	upper	14-7,1	microblade core	95	7319	126	28	19	69	1	Shirataki-Akaishiyama
MIH1606	upper	14-7,105	burin?	194	6882	126	26	22	63	4	Shirataki-Akaishiyama
MIH1607	upper	13-7,267	retouched flake	73	7872	128	34	20	66	4	Shirataki-Akaishiyama
MIH1608	upper	13-7,69	microblade	102	6977	151	33	16	63	3	Shirataki-Akaishiyama
MIH1609	upper	13-7,224	microblade	153	7188	130	36	27	64	2	Shirataki-Akaishiyama
MIH1610	upper	13-7,18	microblade	4	7337	128	24	24	69	2	Shirataki-Akaishiyama
MIH1611	upper	13-7,8	microblade	124	7342	117	30	25	63	1	Shirataki-Akaishiyama
MIH1612	upper	13-7,148	burin spall	75	7880	141	30	16	67	3	Shirataki-Akaishiyama
MIH1613	upper	14-7,11	microblade	164	8600	144	28	22	72	0	Shirataki-Akaishiyama
MIH1614	upper	14-7,2	microblade	68	7122	130	30	25	67	3	Shirataki-Akaishiyama
MIH1615	upper	13-7,213	microblade	145	8153	147	26	18	64	1	Shirataki-Akaishiyama
MIH1616	upper	13-7,263	microblade	143	7350	119	28	25	71	0	Shirataki-Akaishiyama
MIH1617	upper	13-7,110	retouched flake	188	7479	128	56	28	76	5	Tokachi-Mitsumata
MIH1618	upper	13-8,1	burin spall	18	7243	123	29	23	67	5	Shirataki-Akaishiyama
MIH1619	upper	13-7,1	burin spall	125	8157	128	29	29	67	5	Shirataki-Akaishiyama

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1620	upper	14-7,94	burin spall	90	7192	121	25	21	70	2	Shirataki-Akaishiyama
MIH1621	upper	13-7,153	burin spall	325	7158	107	22	16	53	1	Shirataki-Akaishiyama
MIH1622	upper	13-7,53	burin spall	0	7735	140	29	16	67	3	Shirataki-Akaishiyama
MIH1623	upper	13-7,47	burin spall	59	8254	155	29	23	62	6	Shirataki-Akaishiyama
MIH1624	upper	14-7,51	microblade	0	8575	133	31	27	86	3	Shirataki-Akaishiyama
MIH1625	upper	14-7,87	microblade	110	6547	121	28	19	65	3	Shirataki-Akaishiyama
MIH1626	upper	14-7,92	microblade	26	8691	144	35	24	63	0	Shirataki-Akaishiyama
MIH1627	upper	14-7,46	microblade	181	8304	136	27	30	68	0	Shirataki-Akaishiyama
MIH1628	upper	13-7,264	microblade	0	7976	141	31	21	64	5	Shirataki-Akaishiyama
MIH1629	upper	13-7,122	microblade	17	7785	135	29	25	67	3	Shirataki-Akaishiyama
MIH1630	upper	14-7,123	microblade	35	8876	137	36	27	64	4	Shirataki-Akaishiyama
MIH1631	upper	14-7,108	microblade	5	8463	151	33	21	68	2	Shirataki-Akaishiyama
MIH1632	upper	14-7,80	microblade	75	7697	134	30	24	71	7	Shirataki-Akaishiyama
MIH1633	upper	14-7,56	microblade	101	7598	122	28	29	69	0	Shirataki-Akaishiyama
MIH1634	upper	13-7,183	microblade	80	8323	148	30	22	68	2	Shirataki-Akaishiyama
MIH1635	upper	14-7,32	microblade	241	8138	106	28	19	55	1	Shirataki-Akaishiyama
MIH1636	upper	13-7,(2)	microblade	257	7980	112	27	16	58	3	Shirataki-Akaishiyama
MIH1637	upper	13-7,330	microblade	217	9546	131	30	25	64	0	Shirataki-Akaishiyama
MIH1638	upper	13-7,191	microblade	212	7879	134	28	21	74	4	Shirataki-Akaishiyama
MIH1639	upper	13-7,113	microblade	54	9104	132	29	28	70	1	Shirataki-Akaishiyama
MIH1640	upper	13-7,108	microblade	139	8560	109	19	14	56	0	Shirataki-Akaishiyama
MIH1641	upper	13-7,281	microblade	165	7586	124	24	27	59	2	Shirataki-Akaishiyama
MIH1642	upper	14-7,30	microblade	187	8017	122	27	22	68	6	Shirataki-Akaishiyama
MIH1643	upper	14-7,129	microblade	105	9335	161	32	19	74	1	Shirataki-Akaishiyama
MIH1644	upper	14-7,77	microblade	76	7550	103	25	24	69	2	Shirataki-Akaishiyama
MIH1645	upper	13-7,66	microblade	78	9765	126	27	17	57	3	Shirataki-Akaishiyama
MIH1646	upper	13-7,227	microblade	0	7050	112	27	22	59	3	Shirataki-Akaishiyama
MIH1647	upper	14-7,72	microblade	128	7995	133	27	23	63	1	Shirataki-Akaishiyama
MIH1648	upper	13-7,123	microblade	292	7221	116	32	16	66	3	Shirataki-Akaishiyama
MIH1649	upper	13-7,243	microblade	100	8985	135	28	23	64	5	Shirataki-Akaishiyama
MIH1650	upper	13-7,132	microblade	225	8237	119	28	25	67	1	Shirataki-Akaishiyama
MIH1651	upper	13-7,270	microblade	0	9090	137	28	16	55	1	Shirataki-Akaishiyama

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1652	upper	13-7,156	microblade	66	7715	135	28	23	62	1	Shirataki-Akaishiyama
MIH1653	upper	13-7,102	microblade	173	8237	131	30	27	68	5	Shirataki-Akaishiyama
MIH1654	upper	14-7,97	microblade	21	7516	126	25	17	62	0	Shirataki-Akaishiyama
MIH1655	upper	13-7,63	microblade	141	7737	141	33	17	54	3	Shirataki-Akaishiyama
MIH1656	upper	13-7,65	microblade	164	7162	138	25	23	66	0	Shirataki-Akaishiyama
MIH1657	upper	13-7,32	microblade	73	8716	133	27	18	63	0	Shirataki-Akaishiyama
MIH1658	upper	13-7,23	microblade	24	7866	114	33	15	60	2	Shirataki-Akaishiyama
MIH1659	upper	13-7,119	microblade	106	7667	127	25	14	64	2	Shirataki-Akaishiyama
MIH1660	upper	13-7,209	microblade	31	7918	123	30	21	61	5	Shirataki-Akaishiyama
MIH1661	upper	13-7,245	microblade	0	8530	131	29	25	62	0	Shirataki-Akaishiyama
MIH1662	upper	13-7,249	microblade	243	8458	109	22	20	54	0	Shirataki-Akaishiyama
MIH1663	upper	13-7,59	microblade	57	8627	149	34	14	74	1	Shirataki-Akaishiyama
MIH1664	upper	13-7,58	microblade	117	8754	134	27	19	62	1	Shirataki-Akaishiyama
MIH1665	upper	14-7,61	microblade	217	8989	136	25	19	55	6	Shirataki-Akaishiyama
MIH1666	upper	13-7,238	microblade	505	9398	121	25	10	60	2	Shirataki-Akaishiyama
MIH1667	upper	13-7,17	microblade	23	7912	133	29	19	67	3	Shirataki-Akaishiyama
MIH1668	upper	13-7,259	microblade	0	8487	138	32	16	69	1	Shirataki-Akaishiyama
MIH1669	upper	14-7,13	microblade	30	7967	127	25	29	71	1	Shirataki-Akaishiyama
MIH1670	upper	13-7,172	microblade	136	8182	131	25	18	65	5	Shirataki-Akaishiyama
MIH1671	upper	13-7,68	microblade	290	7922	141	34	22	69	6	Shirataki-Akaishiyama
MIH1672	upper	14-7,127	microblade	142	8303	142	34	20	64	5	Shirataki-Akaishiyama
MIH1673	upper	14-7,113	microblade	319	8838	148	33	23	66	6	Shirataki-Akaishiyama
MIH1674	upper	13-7,223	microblade	0	8748	138	26	23	73	2	Shirataki-Akaishiyama
MIH1675	upper	13-7,257	microblade	115	8944	140	27	26	71	1	Shirataki-Akaishiyama
MIH1676	upper	13-7,161	microblade	175	8665	146	33	23	67	2	Shirataki-Akaishiyama
MIH1677	upper	13-7,185	microblade	147	7818	145	29	24	67	4	Shirataki-Akaishiyama
MIH1678	upper	13-7,799	microblade	10	9109	153	33	18	59	1	Shirataki-Akaishiyama
MIH1679	upper	14-7,89	microblade	151	9179	147	33	19	66	3	Shirataki-Akaishiyama
MIH1680	upper	13-7,10	microblade	311	9568	139	31	14	60	3	Shirataki-Akaishiyama
MIH1681	upper	13-7,334	microblade	149	9817	136	26	19	63	0	Shirataki-Akaishiyama
MIH1682	upper	14-7,52	microblade	77	9484	118	21	16	55	0	Shirataki-Akaishiyama
MIH1683	upper	13-7,231	microblade	95	9692	105	20	11	56	0	Shirataki-Akaishiyama

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1684	upper	13-7,64	microblade	247	9892	99	26	18	61	2	Shirataki-Akaishiyama
MIH1685	upper	14-7,3	microblade	0	8306	120	31	23	67	2	Shirataki-Akaishiyama
MIH1686	upper	14-7,110	microblade	265	8002	126	30	30	61	4	Shirataki-Akaishiyama
MIH1687	upper	13-7,79	microblade	259	7395	132	24	27	70	3	Shirataki-Akaishiyama
MIH1688	upper	13-7,155	microblade	111	7898	138	29	21	63	2	Shirataki-Akaishiyama
MIH1689	upper	13-7,140	microblade	86	7249	117	29	26	64	0	Shirataki-Akaishiyama
MIH1690	upper	14-7,5	microblade	258	9198	153	28	15	72	6	Shirataki-Akaishiyama
MIH1691	upper	13-7,190	microblade	126	7942	133	34	21	73	2	Shirataki-Akaishiyama
MIH1692	upper	14-7,107	microblade	227	8566	134	28	23	75	4	Shirataki-Akaishiyama
MIH1693	upper	13-7,116	microblade	218	9463	150	27	18	71	2	Shirataki-Akaishiyama
MIH1694	upper	13-7,98	microblade	104	8756	128	29	17	55	0	Shirataki-Akaishiyama
MIH1695	upper	13-7,144	microblade	0	8194	142	24	17	63	2	Shirataki-Akaishiyama
MIH1696	upper	13-7,106	microblade	0	9059	131	26	19	61	2	Shirataki-Akaishiyama
MIH1697	upper	13-7,274	microblade	251	7230	113	54	18	67	1	Tokachi-Mitsumata*
MIH1698	upper	13-7,221	microblade	80	8674	127	24	22	62	2	Shirataki-Akaishiyama
MIH1699	upper	13-7,260	microblade	16	9018	116	31	17	70	2	Shirataki-Akaishiyama
MIH1700	upper	13-7,21	microblade	84	8307	120	29	22	53	0	Shirataki-Akaishiyama
MIH1701	upper	14-7,131	microblade	310	7918	145	31	19	59	2	Shirataki-Akaishiyama
MIH1702	upper	13-7,168	microblade	134	8487	136	32	27	57	1	Shirataki-Akaishiyama
MIH1703	upper	13-7,5	microblade	256	7754	147	26	22	70	2	Shirataki-Akaishiyama
MIH1704	upper	13-7,97	microblade	54	7907	138	32	28	69	1	Shirataki-Akaishiyama
MIH1705	upper	14-7,34	microblade	211	8653	112	20	19	63	0	Shirataki-Akaishiyama
MIH1706	upper	13-7,2117	microblade	189	7990	128	22	16	64	0	Shirataki-Akaishiyama
MIH1707	upper	14-7,12	microblade	30	9352	124	26	18	52	5	Shirataki-Akaishiyama
MIH1708	upper	13-7,50	microblade	162	8219	131	29	23	65	5	Shirataki-Akaishiyama
MIH1709	upper	13-7,311	microblade	122	8324	132	30	19	63	1	Shirataki-Akaishiyama
MIH1710	upper	13-7,333	microblade	254	8856	136	29	21	60	2	Shirataki-Akaishiyama
MIH1711	upper	14-7,84	microblade	173	8076	96	19	21	57	2	Shirataki-Akaishiyama
MIH1712	upper	13-7,169	microblade	1	9124	132	31	20	60	2	Shirataki-Akaishiyama
MIH1713	upper	14-7,125	microblade	360	8608	112	19	17	55	0	Shirataki-Akaishiyama
MIH1714	upper	13-7,222	microblade	77	8443	113	20	16	48	1	Shirataki-Akaishiyama*
MIH1715	upper	13-7,145	microblade	0	7500	135	29	22	64	0	Shirataki-Akaishiyama

ID	assemblage	artifact No.	stone tool type	Mn	Fe	Rb	Sr	Y	Zr	Nb	source assignment
MIH1716	upper	13-7,329	microblade	72	9294	138	22	23	67	4	Shirataki-Akaishiyama
MIH1717	upper	14-7,91	microblade	56	7710	130	51	26	73	3	Tokachi-Mitsumata
MIH1718	upper	13-7,244	microblade	211	8242	120	49	27	65	2	Tokachi-Mitsumata
MIH1719	upper	14-7,45	microblade	160	7835	133	45	15	67	7	Tokachi-Mitsumata*
MIH1720	upper	14-7,12	microblade	0	8934	99	20	15	47	0	Shirataki-Akaishiyama
MIH1721	upper	13-7,246	microblade	286	9099	120	26	20	67	3	Shirataki-Akaishiyama
MIH1722	upper	13-7,174	microblade	113	10006	131	27	20	58	6	Shirataki-Akaishiyama
MIH1723	upper	14-7,9	microblade	177	8953	112	24	19	58	3	Shirataki-Akaishiyama
MIH1724	upper	13-7,215	microblade	182	8091	134	29	25	64	0	Shirataki-Akaishiyama
MIH1725	upper	14-7,4	microblade	243	8300	136	28	16	63	1	Shirataki-Akaishiyama
MIH1726	upper	13-7,115	microblade	151	8510	129	28	13	64	2	Shirataki-Akaishiyama
MIH1727	upper	14-7,74	microblade	171	9307	124	27	17	58	5	Shirataki-Akaishiyama
MIH1728	upper	14-7,90	microblade	55	7962	134	31	18	58	7	Shirataki-Akaishiyama
MIH1729	upper	14-7,33	microblade	303	7993	111	18	19	48	0	Shirataki-Akaishiyama*
MIH1730	upper	13-7,7	microblade	188	7353	134	29	23	69	1	Shirataki-Akaishiyama
MIH1731	upper	13-7,114	microblade	220	7810	138	30	22	62	5	Shirataki-Akaishiyama
MIH1732	upper	13-7,332	microblade	126	7256	113	20	19	60	0	Shirataki-Akaishiyama
MIH1733	upper	13-7,109	microblade	18	9032	137	30	18	56	5	Shirataki-Akaishiyama
MIH1734	upper	13-7,78	microblade	60	9388	138	21	17	56	5	Shirataki-Akaishiyama
MIH1735	upper	13-7,187	microblade	151	10962	137	30	22	60	2	Shirataki-Akaishiyama

*These are difficult to differentiate using only XRF. It would be possible to increase the confidence of the source assignments by using non-destructive short-irradiation neutron activation analysis.

Table 4: Results of obsidian source assignment of the assemblages at the Minamimachi-2 site.

	stone tool type	Tokachi-Mitsumata	Tokachi-Shikaribetsu	Shirataki-Akaishiyama	Rubeshibe	total
flake assemblage	endscraper	1	-	-	-	1
	retouched flake	5	-	-	-	5
	flake	311	10	1	1	323
	total	317	10	1	1	329
microblade assemblage	microblade	4	-	118	-	122
	retouched flake	1	-	2	-	3
	burin spall	0	-	7	-	7
	microblade core	0	-	1	-	1
	flake	2	-	3	-	5
	total	7	-	131	-	138

Table 5: Cortex type frequency of the assemblages at the Minamimachi-2 site.

assemblage	cortex type	Tokachi-Mitsumata	Tokachi-Shikaribetsu	Shirataki-Akaishiyama	Rubeshibe
(lower) flake	debris	-	-	-	-
	gravel	16	-	-	-
	none	301	10	1	1
(upper) microblade	debris	-	-	3	-
	gravel	-	-	-	-
	none	7	-	128	-

→ Table 6: Lithic refits at the assemblages of the Minamimachi-2 site.

assemblage	refit no.	refitted artifact (N)	lithic raw material	refitted artifact No.	stone tool type	no. in fig 2.	on site reduction	artifact no. analyzed by XRF	source assignment
lower	F01	3	obs.	8-6,2	flake	-	flake reduction	9-6,470	Tokachi-Mitsumata
				9-6,470	flake	-			
				9-6,425					
lower	F02	3	obs.	8-6,368	flake	-	flake reduction	8-6,77	Tokachi-Mitsumata
				8-6,246	flake	-			
				8-6,77	flake	-			
lower	F03	4	aga.	8-6,767	flake	-	flake reduction	-	-
				8-6,514	flake	-			
				unknown	flake	-			
				8-6,70	core	35			
lower	F04	4	aga.	9-6,130	flake	-	flake reduction	-	-
				unknown	flake	-			
				unknown	flake	-			
				9-8,130	core	34			
lower	F05	2	aga.	unknown	flake	-	flake reduction	-	-
				unknown	flake	-			
lower	F06	2	aga.	8-6,824	flake	-	flake reduction	-	-
				8-6,870	flake	-			
lower	F07	7	obs.	8-6,824	flake	-	endscraper edge forming	8-6,7	Tokachi-Mitsumata
				8-6,1074	flake	-			
				8-6,902	flake	-			
				8-6,737	flake	-			
				8-6,437	flake	-			
				8-6,870	flake	-			
				8-6,7	endscraper	21			
lower	F08	7	obs.	8-6,1035	flake	-	endscraper edge forming	8-6,1035	Tokachi-Mitsumata
				8-6,906					
				unknown	flake	-			
				unknown					
				unknown	flake	-			
				unknown	flake	-			
				unknown	flake	-			

assemblage	refit no.	refitted artifact (N)	lithic raw material	refitted artifact No.	stone tool type	no. in fig 2.	on site reduction	artifact no. analyzed by XRF	source assignment
lower	F08	7	obs.	8-6,1035	flake	-	endscraper edge forming	8-6,1035	Tokachi-Mitsumata
				8-6,906					
				unknown	flake	-			
				unknown					
				unknown	flake	-			
				unknown	flake	-			
				unknown	flake	-			
lower	F09	3	obs.	8-6,738	flake	-	scraper edge forming	8-6,1159	Tokachi-Mitsumata
				8-6,1159	flake	-			
				8-6,157	flake	-			
lower	F10	2	obs.	8-6,1090	flake	-	scraper edge forming	8-6,1090	Tokachi-Mitsumata
				unknown	flake	-			
lower	F11	2	obs.	9-6,104	flake	-	scraper edge forming	9-6,104	Tokachi-Mitsumata
				8-6,255	flake	-			
lower	F12	7	obs.	9-6,79	flake	-	endscraper edge forming	8-6,591 8-6,680	Tokachi-Mitsumata
				9-6,81	flake	-			
				8-6,591	flake	-			
				9-6,87	flake	-			
				8-6,655	flake	-			
				9-6,214	flake	-			
				8-6,680	flake	-			
lower	F13	3	obs.	unknown	flake	-	scraper edge forming	8-6,1144	Tokachi-Mitsumata
				unknown	flake	-			
				8-6,1144	flake	-			
lower	F14	2	obs.	unknown	flake	-	scraper edge forming	8-6,214	Tokachi-Mitsumata
				unknown	flake	-			
				8-6,214	flake	-			
lower	F15	3	obs.	8-6,274	flake	-	scraper edge forming	8-6,274	Tokachi-Mitsumata
				8-6,774	flake	-			
				8-6,1103	flake	-			
lower	F16	3	obs.	8-6,905	flake	-	scraper edge forming	8-6,905	Tokachi-Mitsumata
				8-6,913	flake	-			
				8-6,96	flake	-			
lower	F17	2	obs.	8-6,1128	flake	-	scraper edge forming	8-6,1128	Tokachi-Mitsumata
				8-6,1086	flake	-			

assemblage	refit no.	refitted artifact (N)	lithic raw material	refitted artifact No.	stone tool type	no. in fig 2.	on site reduction	artifact no. analyzed by XRF	source assignment
lower	F18	2	obs.	8-6,1151	flake	-	scraper edge forming	8-6,1151	Tokachi-Mitsumata
				8-6,1187	flake	-			
lower	F19	2	obs.	8-6,1221	flake	-	scraper edge forming	8-6,1221	Tokachi-Mitsumata
				8-6,707	flake	-			
lower	F20	2	obs.	8-6,1218	flake	-	scraper edge forming	8-6,1218	Tokachi-Mitsumata
				8-6,707	flake	-			
lower	F21	3	obs.	9-6,287	flake	-	scraper edge forming	8-6,287	Tokachi-Mitsumata
				9-6,615					
				8-6,463	flake	-			
lower	F22	6	and.	unknown	flake	-	endscraper edge forming	-	-
				unknown	flake	-			
				unknown	flake	-			
				unknown	flake	-			
				unknown	flake	-			
				unknown	endscraper	22			
lower	F23	2	and.	unknown	flake	-	scraper edge forming	-	-
				unknown	flake	-			
upper	M01	6	obs.	unknown	flake	-	microblade core reduction	14-7,1	Shirataki-Akaishiyama
				unknown	flake	-			
				unknown	flake	-			
				unknown	flake	-			
				unknown	flake	-			
				14-7,1	microblade core	6			
upper	M02	2	obs.(debris)	13-7,161	microblade	1	microblade reduction	13-7,17 13-7,185	Shirataki-Akaishiyama
				13-7,99		1			
				14-7,13	microblade	1			
				14-7,71	microblade	1			
				13-7,185					
				13-7,17	microblade	1			
upper	M03	2	obs.	13-7,39	microblade	2	microblade reduction	13-7,8	Shirataki-Akaishiyama
				13-7,8	microblade	2			
upper	M04	2	obs.	14-7,9	microblade	3	microblade reduction	14-7,87	Shirataki-Akaishiyama
				14-7,87	microblade	3			
upper	M05	4	obs.	14-7,114	microblade	4	microblade reduction	14-7,51	Shirataki-Akaishiyama
				13-7,272	microblade	4			
				14-7,50	microblade	4			
				14-7,51	microblade	4			
upper	M06	2	obs.	13-7,140	microblade	5	microblade reduction	13-7,79	Shirataki-Akaishiyama
				13-7,223	microblade	5			
				13-7,79		5			
upper	M07	2	obs.	14-7,127	microblade	-	microblade reduction	14-7,127 13-7,172	Shirataki-Akaishiyama
				13-7,172	microblade	-			
				14-7,99		-			

assemblage	refit no.	refitted artifact (N)	lithic raw material	refitted artifact No.	stone tool type	no. in fig 2.	on site reduction	artifact no. analyzed by XRF	source assignment
upper	M08	3	obs.	unknown	microblade	-	microblade reduction	13-7,69	Shirataki-Akaishiyama
				13-7,55	microblade	-			
				13-7,69	microblade	-			
upper	M09	5	obs.	13-7,224	microblade	-	microblade reduction	13-7,224	Shirataki-Akaishiyama
				unknown	microblade	-			
				unknown	microblade	-			
				13-7,60	microblade	-			
				14-7,38	microblade	-			
upper	M10	3	obs.	13-7,18	microblade	-	microblade reduction	13-7,18	Shirataki-Akaishiyama
				14-7,85	microblade	-			
				13-7,310		-			
upper	M11	4	obs.	14-7,92	microblade	-	microblade reduction	14-7,92	Shirataki-Akaishiyama
				13-7,308	microblade	-			
				14-7,75		-			
				13-7,262		-			
upper	M12	2	obs.	13-7,47	microblade	-	microblade reduction	14-7,46	Shirataki-Akaishiyama
				13-7,62	microblade	-			
				14-7,46	microblade	-			
upper	M13	2	obs.	14-7,123	microblade	-	microblade reduction	14-7,123	Shirataki-Akaishiyama
				13-7,265	microblade	-			
upper	M14	3	obs.	unknown	microblade	-	microblade reduction	14-7,56	Shirataki-Akaishiyama
				14-7,56	microblade	-			
				13-7,279	microblade	-			
upper	M15	2	obs.	14-7,53	microblade	-	microblade reduction	13-7,243	Shirataki-Akaishiyama
				13-7,243	microblade	-			
upper	M16	2	obs.	14-7,62	microblade	-	microblade reduction	13-7,259	Shirataki-Akaishiyama
				13-7,259	microblade	-			
upper	M17	2	obs.	13-7,112	microblade	-	microblade reduction	13-7,155	Shirataki-Akaishiyama
				13-7,155	microblade	-			
upper	M18	2	obs.	13-7,186	microblade	-	microblade reduction	13-7,131	Shirataki-Akaishiyama
				14-7,131	microblade	-			
upper	F01	4	obs.	13-7,12	burin spall	-	burination	13-7,148	Shirataki-Akaishiyama
				13-7,11					
				13-7,148					
				13-7,164	burin spall	-			
upper	F02	2	obs.	13-7,341	burin spall	-	burination	13-7,94	Shirataki-Akaishiyama
				13-7,94	burin spall	-			
upper	F03	2	"hard-sha."	13-7,188	burin spall	-	burination	-	-
				13-7,51	burin	-			

Acknowledgements
We thank Minoru Kitazawa (Obihiro Centennial City Museum) for help carrying out the pXRF analysis. We also thank Sandra Sázelová for her editorial effort on this paper.

Résumé
Les récents progrès des recherches sur le Paléolithique supérieur d'Hokkaido dans le nord du Japon ont été rendus possibles par l'accumulation de données géochronologiques fiables et d'analyses comportementales des pratiques de taille. Ces nouvelles données visaient à répondre à trois questions essentielles pour l'Asie du Nord-Est : la première porte sur le timing, les processus et les mécanismes d'émergence de l'Homme moderne (aussi bien du point de vue anatomique que comportemental), la deuxième concerne la possibilité d'un exode humain en provenance de Sibérie durant le DMG (peut-être entre 24,000–20,000 ans cal. BP) et la troisième traite de la technologie micro-lamellaire nouvellement développée comme adaptation à l'environnement froid et rigoureux de la zone artique et de son rôle dans la dispersion humaine dans les Amériques. En plus de ces récents résultats, l'étude de la composition des obsidiennes d'Hokkaido a largement avancée, notamment grâce aux progrès des études et caractérisations des sources de matière première. Ces progrès ont conduit à une meilleure compréhension des stratégies d'approvisionnements et d'économie des matériaux et des débitages. Cette approche systématique devrait jouer un rôle important aussi bien dans l'avancement des études sur le Paléolithique supérieur local de l'Asie du Nord-Est que dans le développement de nouvelles méthodes visant à reconstruire les stratégies d'approvisionnement en matières premières des chasseurs-cueilleurs. Ces nouvelles méthodes pourront sans doute être applicables à d'autres régions du globe. Cet article présente une description du site de Minamimachi-2, un résumé des procédés de débitage identifiés sur le gisement, une détermination géologique des sources d'obsidienne utilisée pour la confection des artefacts (par spectométrie de fluorescence – pXRF –), et enfin un examen des corrélations que l'on peut établir entre les sources de matière première et les stratégies de débitage. En conclusion nous nous intéressons à comment l'approvisionnement lithique des chasseurs-cueilleurs était relié tant aux méthodes de production qu'à l'usage des produits. Ce qui éclaire également la question des changements qui affectèrent ces derniers au fil du temps.

Zusammenfassung
Neueste Fortschritte der Forschungen zum Jungpaläolithikum in Hokkaido – Nordjapan – basieren auf einer Kombination von gesicherten geochronologischen Daten und Analysen am Silexmaterial unter dem Gesichtspunkt des menschlichen Verhaltens um drei Hauptfragen in Nordostasien zu begegnen wie: dem Zeitpunkt, den Abläufen und Mechanismen des Auftretens des sowohl anatomisch als auch verhaltensmäßig modernen Menschen, der Möglichkeit der Herkunft aus Sibirien während des letzten Kältemaximums der Eiszeit – ungefähr zwischen 24.000–20.000 cal yr BP – und die Rolle der neu-entwickelten Mikroklingentechnologie bei der Anpassung der Menschen an eine kalte und raue Umwelt der arktischen Zone sowie dessen Rolle bei der Ausbreitung der Menschen nach Amerika. Zusätzlich hat die Kombination dieser Methoden am Obsidian von Hokkaido zu detaillierten Ergebnissen hinsichtlich der Rohmaterialbeschaffung beim Obsidian und der Abbautechniken geführt, besonders durch den Einsatz systematischer Studien zur Charakteristik der Rohmaterialquellen. Von diesem systematischen Ansatz wird erwartet, dass er eine wichtige Rolle in zweierlei Hinsicht spielen könnte: in einem Fortschritt der paläolithischen Forschung in Nordostasien und in einer methodologischen Weiter-entwicklung bei der Rekonstruktion von Rohmaterialversorgungsnetzen von Jägern

und Sammlern, die auch auf andere Regionen anwendbar sind. Diese Arbeit besteht aus einer Beschreibung der Fundstelle Minamimachi – 2, einer Zusammenfassung der Abbausequenzen der Minamimachi – 2 Fundensembles, einer Zuweisung der Artefakte zu einer bestimmten Obsidianrohmaterialquelle mittels pXRF und einer Untersuchung der Wechselwirkung zwischen dem Material einer bestimmten Lagerstätte und der verwendeten Abbautechnik. Zusammenfassend wird dargestellt, wie die Rohmaterialbeschaffung mit der Produktion und dem Gebrauch in Verbindung stehen sowie deren Veränderungen im Laufe der Zeit.

PART III

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PERCEIVING ANIMALS, PERCEIVING HUMANS: 'ANIMISM' AND THE AURIGNACIAN MOBILE ART OF SOUTHWESTERN GERMANY

Martin Porr and Kara de Maria

Abstract
This paper presents an innovative comparative case study to infer some of the motivations behind the Aurignacian mobile art of Southwest Germany, ca. 30.0–40.0 kya. It explores the potentials of using a systematic comparison between mobile art objects from a contemporary collection from Inuit artists of Canada and the Aurignacian of Southwest Germany. The comparison is aimed at investigating the possibility that the Aurignacian mobile art reflects an animistic worldview. For the latter, this study employs a concept of animism as explicated by Tim Ingold in his book The Perception of the Environment (2000), where "animism" is systematically and analytically distinguished from "totemism" as well as their respective artistic expressions. The analysis points to similarities between these cases related to a particular understanding of the relationships between animals, humans and the land within a non-western framework of being and perceiving. These insights appear to be valuable in the understanding of cultural contexts for which there is no access to ethnographic information. The analysis suggests that during the Aurignacian people most likely had an animistic worldview and a way of viewing the relationships between humans and animals in their environment – as outlined by Ingold. However, the study also highlights some important limitations and restrictions of employing such a tightly controlled comparison, which does not cover all aspects and features of the Aurignacian collection of mobile art objects from Southwest Germany.

Keywords
Upper Paleolithic, portable art, interpretation, animism, Aurignacian

DOI: 10.5817/CZ.MUNI.M210-7781-2015-21

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Introduction – Some cautionary considerations

The concept of animism is possibly one of the most famous in the history of anthropological thought. Originally developed by E. B. Tylor (1871) in the nineteenth century it was meant to describe the world-view of a range of non-Western people who were encountered during the European colonial expansion. As has been explicated in great detail elsewhere (Anderson 2007), this dazzling variability of cultures and people was interpreted as the remains of earlier stages of humanity's historical ascent to modern industrialized civilization. Tylor saw "animism" as "*the earliest coherent form of religion [which] was based on 'the theory which endows the phenomena of nature with personal life*" (Tylor quoted in Kuper 1988, 80). As such, "animism" supposedly relates to a false understanding of reality and has to be understood as an element in the colonial representation of non-Western societies as childish and immature. The concept has a deeper ancestry in Western thought and is related to modern European views about a progressive structure of human history. "Animism" played its role in the construction of the colonial imagination of a mirroring of space and time in which distance from the centres of the colonial powers (e.g. London or Paris) was equated with distance in time and a lower stage of human intellectual development. Together with the notion of "totemism" it was integral to the "invention of primitive society" (Kuper 1988) and contributed to the justification of global colonial exploitative practices.

In the light of these observations it is surprising that Tylor's idea of "animism" continues to enjoy a widespread popularity in recent literature (see Porr and Bell 2012, 168–171). This is a problematic development as it continues a tradition that assumes that non-Western ways of knowing can easily be categorized, objectified and put into boxes that are opposed to scientific thinking. Bird-David (1999) has made the seminal observation that what is usually called "animism" is rather recognition of the relational constitution of persons in ongoing dynamic relationships with the environment as a whole. "Animism" is not an illusion, but is a reflection of fundamental characteristics of all organisms. Continuing in the spirit of Bird-David's work, one of us recently made the case that "animism" should be discarded as an analytical concept that has no place in a post-colonial world (Porr and Bell 2012). Working today with Aboriginal Australian people on aspects of heritage management and protection makes one very much aware of how a whole range of imposed Western analytical concepts, words and notions continue to undermine indigenous self-determination and a symmetrical dialogue. The famous notion of "Dreamtime" has recently been described by a senior Aboriginal knowledge holder to contain "*many inappropriate colonial connotations; it suggests childlike fantasy and a complete lack of any chronology in events, thereby installing myth to replace all Aboriginal history. It was used in response to poor translations particularly between missionaries, police and pastoralists and others, and has no place in 2013*" (Doring and Nyawarra 2014, 5–6).

In this spirit, one of us has explored Australian indigenous rock art as well as the basis of our current understanding of the so-called origins of modern

humans/thought (Porr 2014; Porr and Bell 2012). These considerations also need to be taken into account when we engage in the interpretation of the deep past and representations we cannot connect with direct ethnographic information. It needs to be recognized that the past should not become a justification of the present and its power relationships. We need to reflect carefully on the history, content and implications of the notions we are using and the inferences we are building. While these considerations need to be kept in mind in all approaches towards the past, the scope of this chapter is much narrower. It is a short exploration of a comparison between an archeological and an ethnographic collection of mobile art objects to assess if they are connected to a particular understanding of an "animistic" or animic world view. The concept of the latter is not related to Tylor's exposition, but was proposed by Ingold (2000) to describe the particular nature of relationships between animals and humans among circumpolar hunter-gatherers and their representation in figurative art objects. As such, this exploration here should not contribute to the general narrative of "animism" in human history. It rather serves to provide a very specific analogical framework to interpret some aspects of a collection of archeological objects that enables to understand some common features within it and might lead to further insights in the future.

The Aurignacian art of Southwestern Germany and the interpretation of Paleolithic art

The interpretation of the Paleolithic art of Europe has a long and complex history. It has intrigued the imagination of the general public, artists and academics for more

Figure 1: A mammoth figure made from ivory found at the Geissenklösterle near Blaubeuren in Southern Germany (photo by P. Frankenstein and H. Zwietasch; with courtesy of Landesmuseum Württemberg, Stuttgart)

than 100 years. The intellectual history of this fascinating theme has been described many times and needs not to be repeated here (Bahn and Vertut 1988; Porr 2013). For a long time the spectacular parietal art in the caves of northern Spain and southern France has dominated discussions and largely overshadowed the significant variability in material artistic expressions from the European Paleolithic. Mobile figurative objects form a significant category in this respect and they are of particular importance for Central and Eastern Europe in the Early Upper Paleolithic (Conkey *et al.* 1997; Cook 2013).

The so-called Aurignacian techno-complex falls within the Early Upper Paleolithic in Central and Eastern Europe and is usually regarded as evidence for the migration of the first anatomically and behaviourally modern humans into Europe after 45.0 ky BP. Technological elements that are associated with the Aurignacian, such as carinated scrapers and micro-blade technology, can be found over a large geographical area between Spain, the Levant and the Crimean Peninsula. Another element that has been put forward as particularly characteristic of this techno-complex is the intensified use of organic raw materials for the production of utilitarian tools, such as projectile points. The Aurignacian further sees the regular use of personal ornaments, in the form of shells or animal teeth (Floss and Rouquerol 2007).

The Aurignacian is the time period during which in several contexts in Europe the first figurative representations can be observed. While there are isolated instances of figurative expressions during earlier periods, the Early Upper Paleolithic record in Europe has yielded so far the earliest clear collections of figurative representations, including parietal images (Clottes 2003). With respect to mobile representations, the most prominent today are the statuettes from the Swabian Jura Mountains in Southwest Germany, which are dated to between ca. 35.0 and 32.0 kya (Hahn 1986; Conard 2003; 2009; Floss 2007). As I have argued elsewhere, the figurines provide unprecedented insights into a range of aspects that can be seen as reflections of the relational and situated construction of identity (Porr 2010a, b).

The figurative representations during the Aurignacian are almost completely dominated by representations of large adult terrestrial animals. Felids and mammoths are best represented. Individual and clearly identifiable depictions of human beings are missing altogether. An exception seems to be the recently discovered "Venus" from Hohle Fels (Conard 2009). But even this statuette has been turned into an abstract representation through the removal of its head which would have allowed it to be attached to an individual person or object. The figurative mobile art of Southwest Germany is characterized by a tension between the individuality of the design and use of each object and the similarities that are visible in the design choices of the representation of different animal species. The latter relate to observable behavioral attributes of the animals, including social behaviors. This allows the construction of a core opposition between mammoths and lions, which are separated by their social hierarchical and feeding behaviors, but are united by their overall dominance in the environment. During the Aurignacian, Pleistocene lions were the dominant predators that were most likely organized in harem systems,

dominated by a single male individual (Kahlke 1994; Anton and Turner 2000). In contrast, there is solid evidence that Pleistocene mammoths – as dominant herbivores – were organized into herds around older female individuals or matriarchs (Haynes 1991, 2006; Maschenko *et al.* 2006; Lister and Bahn 2007). The statuettes consequently contain statements and reflections about gender and subsistence practices, but probably reflections of acceptable social behaviors as well.

Animism and the art of hunters and gatherers

This chapter employs a very particular approach to the notion of animism and its representation in artistic or figurative objects. In his book, *The perception of the environment* Ingold (2000, 111–132) draws a distinction between a "totemic" and an "animic" view of the relationship between animals and humans (and the landscape). According to this terminology, totemic and animic ontologies are fundamentally distinguished by the relative priority given either to form or process (Ingold 2000, 112). In a totemic understanding, the form of living beings is already given and it is contained in the life force that is itself contained in features, textures and contours of the land. This view of life and landscape can be mostly found among Australian Aborigines: *"human beings and other creatures come and go: they emerge from the land, live out their time, and are reincorporated into it when they die. But the land is always there, and will continue to bring forth new life so long as those who dwell upon it – by fulfilling their custodial responsibilities towards it, or 'looking after' it in the proper way – do not allow the powers to be dissipated"* (Ingold 2000, 113). In contrast, among hunter-gatherers in the circumpolar North, a different ontological model is predominant, where especially the land does not have the same significance. The land – and the totemic ancestors contained therein – is no power source itself, but *"the powers that bring forth life* […] *are rather distributed among the manifold beings that inhabit it"* (Ingold 2000, 113). In the animic understanding, the connection between humans and animals is direct and dialogical. This difference has important consequences for the significance of everyday interactions between humans and animals, especially in the context of hunting. In the circumpolar North, the hunt is a part of the renewal of the world itself, because it is part of an exchange of life force. The animal gives up its life force to the hunter so that the latter can live and, if the animal is treated properly in death, it can enter the cycle again in subsequent reincarnation (Ingold 2000, 114).

The particular role of animals in this animic ontology has profound consequences for their treatment in visual and artistic depictions. Animals and humans are generally depicted as revealing powers of agency, intentionality, and sentience embodied in a living, moving being. In short, animals tend to be depicted realistically and engaged in a particular behaviour or activity. As was mentioned above, in an animic system, the continuity of the world depends on the proper exchange of life force between hunter and prey. This exchange is played out during the course of the hunt, its preparation, execution and the treatment of the animal body. Consequently, these details indeed have a deep significance and consequently

Figure 2: An isolated lion head carved from mammoth ivory from the Vogelherd in Southern Germany (photo by P. Frankenstein and H. Zwietasch; with courtesy of Landesmuseum Württemberg, Stuttgart)

tend to be depicted accordingly and are also told in the respective stories and myths. Within an animic system, hunting animals is participating in the re-creation of the world. The hunter does not impose his or her will onto the animal, but rather needs to learn its personality and characteristics. Hunting is not about control, but about a dialogue in which the hunter learns to understand the intricate and multi-layered relationships between himself, the animal and the world (Ingold 2000, 126).

This understanding of the relationships between humans and animals is expressed in the circumpolar North in the carving of realistic animal figurines, which "*is probably one of the most distinctive features of animic depiction*" (Ingold 2000, 126). Among circumpolar hunter-gatherers, the carving and handling of small animal statuettes is a way of keeping animals in mind. It is part of the deep and personal relationship that humans have with animals. Because of its importance for the subsequent discussion of the Aurignacian art of Southwest Germany, it is worth following this in greater detail:

> *These tiny objects are the material embodiments of thoughts, or more strictly they are thoughts. For the carver would not separate thinking in the head from thinking with the hands, nor, consequently, would he distinguish the products of these respective activities. But as embodied thoughts, carvings are of such a microcosmic scale that they can be turned around in the hand as can images in the mind. They are not designed to be set upon a pedestal and looked at, indeed most will not stand up unless artificially mounted. Rather, like memories, they are held close to the person – generally fastened to the clothing – and are carried around with that person wherever he or she goes* (Ingold 2000, 126–127).

For these figurines, their dynamic use is of critical importance. It is in their close practical association with people that they gain their significance. "*Moreover it is the process – of dwelling on the animals in one's thought – that is important, rather more than the products – the carvings themselves – which are readily lost or discarded*" (Carpenter 1966 in Ingold 2000, 126).

In the production and use of these figurines, the different emphasis on process rather than form in the animic system of thought is replicated. The exact depiction of the animal's behavior is important and not its static and timeless form, because the behavior of the animal is part of the "*ongoing relationship of give and take between the human hunters and the spirit beings on whose continued generosity the supply of game depends*" (Ingold 2000, 127). The interaction between human and animal is direct and unmediated. Getting to know the animals, their habits and behaviors is important in the animic system of thought, because this determines the interaction between human and animal and the re-creation of the world. In the following sections, we apply these general insights to assess if the Aurignacian art of Southwest Germany can be described as reflecting such an animic or animistic world view.

Animism in art – A comparative approach

As was mentioned above, Ingold discussed a number of ways in which an animic world view might be reflected in mobile art objects and their practical use. We have attempted to approach this aspect in a more standardized form and have identified a number of traits that one would regularly expect in this context and which would allow an assessment of both ethnographic as well as archeological collections in this respect.

These are

- a depiction of a relationship between animals and humans on equal terms in which both meet and interact with each other symmetrically;
- a naturalistic depiction of animals;
- the representation of particular and realistic behaviors, expressions and behavioral traits of animals (and humans);
- the representation of retractable hoods or skin coverings as well as the mixing of body parts or morphing between different animals and humans;
- a high frequency of animals in the art;
- art objects that follow the natural characteristics of raw materials; and
- miniature figurines, pendants or sculptures not designed to stand upright but made to be suspended and carried.

As Ingold developed his approach with particular reference to ethnographic Inuit art objects, we have taken one early and substantial collection of Inuit art to examine the presence of these traits in a context that is known to be related to an animic world view. George Swinton was one of the most influential individuals in the Inuit art trade in North America in the twentieth century and his activities led to a greater awareness of Inuit art in the wider public. He assessed and collected a large number of carvings in the 1950s in Canada and published over 500 of these in

the book *Sculpture of the Eskimo* (Swinton 1972). It is not possible here to discuss our findings in great detail, but in Swinton's collection virtually all features that are mentioned above are well represented. A large number of representations show realistic animal behaviors and facial expressions; often these animals are shown in direct interaction with humans and in hunting scenes. Different animals seem to be combined in some statuettes, pointing to fluid boundaries between them, and this seems to be represented by the use of clothing, skins and hoods as well. The latter are used to reflect on the dialectic between outer appearance and inner qualities and the juxtaposition of animal and human qualities. Clothing made from animal hides and fur clearly further blurs the boundaries between animals and humans. There are, however, also a number of significant differences, which appear to be – at least in part – due to modern influences and the necessities of the art trade. The latter probably accounts for the large proportion of relatively large objects that also are designed to stand on a flat surface (such as a desk). This latter feature, for example, is virtually absent from prehistoric Inuit sculpture (for example, during the Dorset period between ca. 800 BCE and CE 1000) (McGhee 2006).

In the Aurignacian mobile art from Southwest Germany a significant number of the characteristics identified above are also represented. The collection is dominated by animal depictions and figures that blur the boundaries between animals and humans. Most statuettes are very small and were either handled over some time or were attached to clothing or some other portable object. The depiction of the animals is mostly realistic and specific behaviors were chosen to be represented. The unstable boundary between humans and different animals is possibly also reflected by the presence of isolated body parts (such as the isolated lion head or the headless felid from the Vogelherd) (Porr 2010b, 93, 99) that refers to ideas of fragmentation and recombination. However, a number of differences can also be observed. There is no clear indication of clothing visible in the Aurignacian collection and any particular meaning attached to this. There are also no scenes depicted that would allow an assessment of the position of animals and humans relative to each other. Overall, at least five out of the seven characteristics we have identified above apply to both the Aurignacian as well as the Inuit collection of mobile art objects. There is a focus on the depiction of animals, many of which are not simply portrayed but display specific behaviors; we have therianthropic figures that suggest an understanding of human/animal combination and recombination and in both cases the art tends to be small and often used as pendants, amulets and personal items.

From these observations we conclude that the Aurignacian mobile art from Southwest Germany reflects to a large extent an animic world view as outlined by Ingold (see above). This conclusion applies both to the meanings that are attached to animals and humans in this context and to the role of the objects themselves. Our comparison has demonstrated that people during the Aurignacian placed particular value on the personal interaction with animals and that intimate knowledge of animal behaviors was of particular importance. As was mentioned above, this inference is very much in line with previous interpretations of one of use of this

body of mobile art. It has previously been suggested that the Aurignacian art was foremost a reflection of the relational constitution of identity that included both animal as well as human behaviors (Porr 2010a, b). From a large number of ethnographic sources we know that this assessment surely applies to Inuit art objects as described in numerous contexts, but as we hope to have demonstrated, this very much applies to the Aurignacian objects as well. We believe that this assessment can now open up further comparative inquiries to explore the meaning and significance of Paleolithic figurative representations in far greater detail.

Conclusion

It might appear particularly dangerous to explore a notion of "animism" here when the overall aim should be to critically question the concept and eventually to leave it behind (Porr and Bell 2012). We acknowledge that this is a dangerous combination, indeed, and there is every possibility that this endeavor might disintegrate or even have the opposite effect. However, we hope to have demonstrated the value of applying a very specific interpretative concept of animism, while remaining aware of the wider implications of the terminologies that are employed. The analysis has shown that the Aurignacian mobile art can indeed be seen as representing an animistic or animic world view in the specific sense outlined above. It needs to be stressed that we do not want to imply any historical connections based on these similarities, but rather assume that the latter are a product of a comparable engagement between humans and animals within a small-scale hunting and gathering context.

The similarities in the statuettes reflect a similarity in the sociality of engagement between humans and animals. This engagement is direct and personal and reflects careful observation of animals' social and subsistence behaviours. In that sense, the statuettes do not so much reflect a world view, but they are a part of it. They participate in the relational constitution of humans and animals. They *are* thoughts and *are* relationships that bind humans and animals to each other in a fundamental way. It is exactly these relationships that human beings during the Early Upper Paleolithic recognized and reflected upon in a very real way, by making things and making art.

Résumé

Ce chapitre présente une étude de cas explorant les motivations à l'origine de la production de l'art mobilier aurignacien du Jura Souabe (Bade-Wurtemberg, Allemagne) il y a 40,000–30,000 ans, et, à cet égard, le potentiel d'utiliser une comparaison entre ces objets d'art mobilier préhistorique et ceux d'une collection d'art contemporain d'artistes Inuit du Canada. Partant de cette étude comparative, nous explorons l´hypothèse suivant laquelle l'art mobilier aurignacien reflète une conception animiste du monde. Le terme « animisme » est employé dans le sens qu´en donne Tim Ingold dans son ouvrage « The Perception of the Environment » (2000). Animisme y est systématiquement distingué du « totémisme », ainsi que leurs expressions artistiques respectives. Notre étude met en

évidence les similitudes entre les deux productions, qui semblent refléter toutes deux une compréhension particulière du lien étroit entre les animaux, les humains et la terre, suivant une perception du monde très différente de celle du monde occidental. Notre analyse suggère que les Aurignaciens partageaient vraisemblablement une vision animiste du monde, telle que décrite par Ingold. Ce genre de mise en parallèle s'avère très utile à la compréhension des contextes culturels préhistoriques, en l´absence de données ethnographiques directement exploitables. Cependant, notre étude souligne également les limites de l'emploi de telles comparaisons, dans la mesure où elles ne prennent pas en compte certains aspects et caractéristiques de l'art mobilier aurignacien du Jura Souabe.

Zusammenfassung

Dieser Text präsentiert eine innovative vergleichende Studie, um die Motivationen und Vorstellungen im Zusammenhang mit der 30.000 bis 40.000 Jahre alten südwestdeutschen Kleinkunst des Aurignacien zu erschließen. Hierzu wird untersucht, ob es sinnvoll und möglich ist, eine gegenwärtige Sammlung von Inuit-Kunst aus Kanada mit der Aurignacien-Kunst zu vergleichen. Der hier verwendete Ansatz verwendet ein Konzept von 'Animismus', welches von Tim Ingold in seinem Buch The perception of the Environment (2000) vorgeschlagen worden ist und nach welchem 'Animismus' systematisch und analytisch von 'Totemismus' unterschieden wird, einschließlich der jeweils damit verbundenen künstlerischen Objekte. Die Analyse der beiden Sammlungen deutet in der Tat auf Ähnlichkeiten hin, die ein nicht-westliches Verständnis der Beziehungen zwischen Menschen und Tieren reflektiert. Diese Ergebnisse erscheinen insbesondere wichtig zur Interpretation von bildlichen Darstellungen in prähistorischen Kontexten ohne begleitende ethnographische Informationen. Die Studie hier deutet darauf hin, dass die Menschen während des Aurignacien in Südwestdeutschland einer animistischen Weltsicht folgten, wie dies von Ingold vorgeschlagen worden ist. Die Analyse zeigt aber auch die Grenzen eines solchen speziellen Ansatzes auf, durch den nicht alle Merkmale und Aspekte im archäologischen Befund erklärt werden können.

THE FIRST FIGURATIVE PORTABLE ART IN THE EXTREME OF WESTERN EUROPE: CHARATERIZATION AND CHRONOLOGICAL ISSUES

Marcos García-Diez and Blanca Ochoa

Abstract
Portable objects with figurative decoration found at sites in the Iberian Peninsula (Hornos de la Peña, Salitre, El Castillo, Covalejos, Morín, Lumentxa, Antoliñako Koba, Les Mallaetes and El Parpalló) are presented and discussed. The stratigraphic position of each object is assessed, characterizing and, in some cases, discussing the nature of the decoration. The oldest figurative mobile art in the Iberian Peninsula can be attributed, based on the study of the portable ensembles, to about ~31.5 ky cal BP. Its morpho-stylistic characterization reveals a graphic construction focusing on simple depictions in which the outlines of the animals are given priority.

Keywords:
Portable art, origins of figurative representation, chronology, Aurignacian, Gravettian, Iberian Peninsula

DOI: 10.5817/CZ.MUNI.M210-7781-2015-22

Introduction

The origin of graphic language is currently a topic of scientific debate. When and where did it take place? Who was responsible for it? What are its characteristics? (White 1992; Lorblanchet 1999; Conard 2005, 2009; Barandiarán and García-Diez 2007; Floss and Rouquerol 2007; Sauvet *et al.* 2007; Henshilwood and d'Errico 2011; Zilhão 2011). In recent years, the reappraisal of concepts and ideas, new discoveries and the application of new dating methods are achieving more precise ideas of the origin and development of art: Paleolithic graphic language (Pettit and Pike 2007; Ochoa 2011; Pike *et al.* 2012).

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In connection with the origin of art, the questions posed refer to the time, place and characteristics of the first figurative art. The answers to these questions are not only linked to an understanding of the earliest capabilities of summarizing and transposing materiality. The conclusions will also help to understand more precisely the age of rock art ensembles through data from chronologically established contexts.

This paper aims to address these issues about the earliest figurative animal art in the extreme west of Europe. To do this, portable objects with figurative depictions attributed to a time before ~24.0 ky cal BP (pre-Solutrean) in the Iberian Peninsula will be described and assessed. In order to assess the quality of the information, the anthropic nature of some decorations and the chronological context of each object will be discussed.

The available information: characterization and limitations

In the Iberian Peninsula (Figure 1), several objects, from the sites of Hornos de la Peña, El Salitre, El Castillo, Covalejos, Morín, Antoliñako Koba, Lumentxa, Les

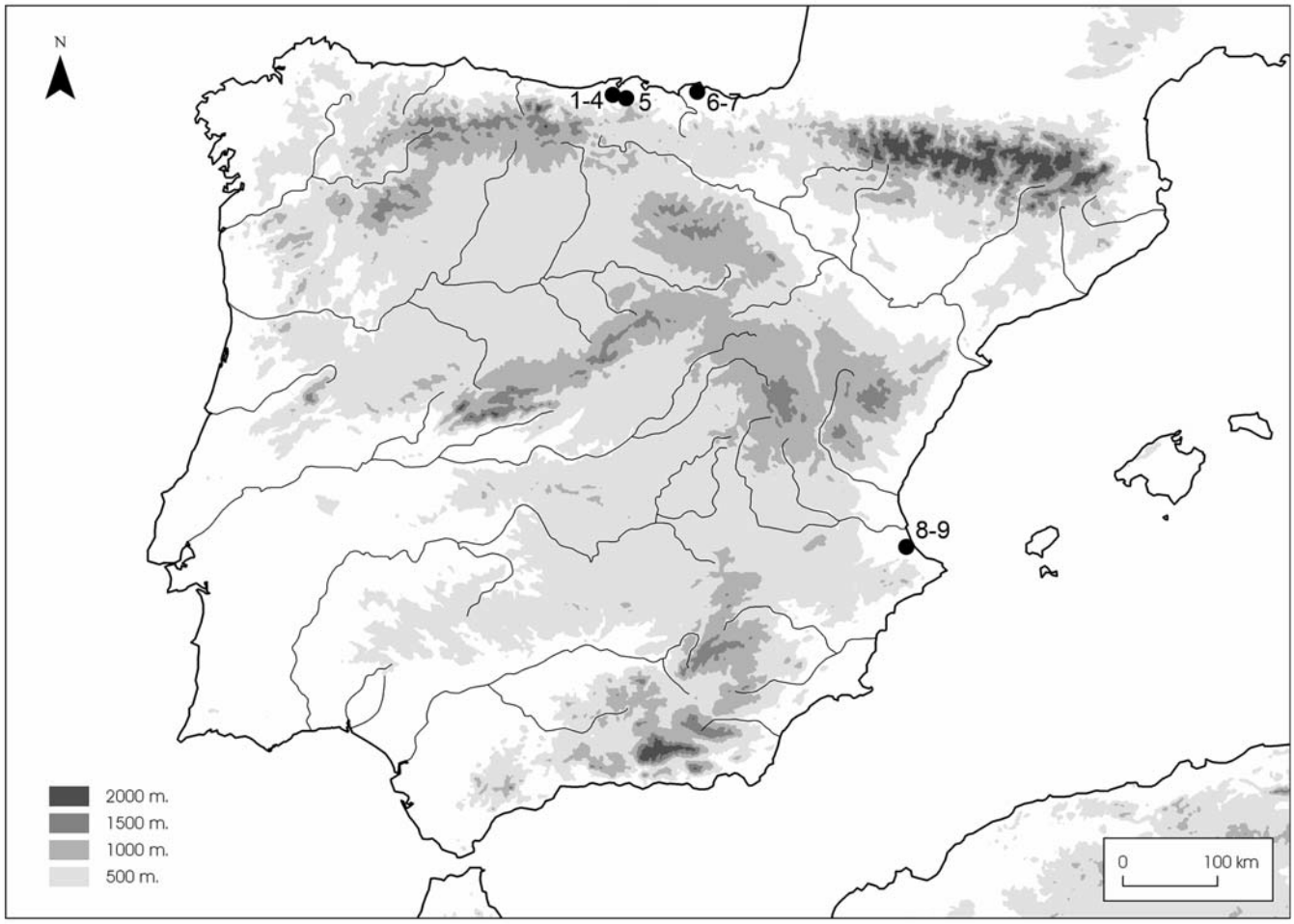


Figure 1: Situation of Iberian archeological sites with figurative mobile art:
1 to 4 Hornos de la Peña, El Castillo, Morín and Covalejos; 5 El Salitre; 6 and 7 Antoliñako Koba and Lumentxa; 8 and 9 El Parpalló and Les Mallaetes

Mallaetes and El Parpalló, have been published and attributed to times before ~24.0 ky cal BP (Aurignacian and Gravettian levels). Each one of these objects is described and discussed below.

Hornos de la Peña (San Felices de Buelna, Cantabria) (Figure 2a)

In Level D, a fragment of a horse frontal bone was found engraved with the hindquarters of a horse (Alcalde *et al.* 1911; Breuil and Obermaier 1912; Barandiarán 1973). This object is of special interest as Breuil used it to characterize the first figurative art. However, the stratigraphic deposit where it was found is problematic. According to the excavators, the bone was found at the base of a level of yellowish clay that was very homogeneous from the sedimentary point of view whereas its archeological content was diverse: "*les silex aurignaciens se localisaient sur tout à la base, tandis que les fragments de feuilles de laurier solutréennes ne se retrouvaient que dans la partie la plus élevée*" (Breuil and Obermaier 1912, 7). At about the same time, its stratigraphic position was described in *Les Cavernes de la Région Cantabrique*:

> *Il [the Magdalenian level] reposait sur un niveau moyen argileux, tres profondé mentremaniée beaucoup de points et sans stratification apparente, contenant des silex caractéristiques, les uns du Solutréen, les autres de l'Aurignacien. Il faut citer des fragments importants de feuilles de lauriers, des grattoirs carénés, des poinçons et autres objets d'os travaillé, quelques uns ornés de coches en série, comme les "marques-de-chasse" aurignaciennes ou solutréennes. Tout à la base, un frontal de cheval a été recueilli…* (Alcalde del Río *et al.* 1911, 88).

Some years later, Obermaier (1925) pointed out that the object came from Level D: "Yellow clay with Middle Aurignacian industry", although "the levels were badly disturbed". Since then, this object has been included in several catalogues of Paleolithic mobile art. Barandiarán (1973) stressed, and again in 1994, the problematic stratigraphic assignation ("very dubiously dated in the Middle Aurignacian"), maintaining the opinion expressed some years previously by Leroi-Gourhan (1965). Corchón (1986) attributed the object to the "(recent) typical Aurignacian (?)", which shows, once more, the doubts about its chronological assignation.

Bernaldo de Quirós' s (1982) reappraisal of the industry associated with the bone concluded that the basal part of the archeological assemblage in Level D corresponds to the evolved Aurignacian, although osseous material from this level was dated (Burleigh *et al.* 1982: Bowman *et al.* 1990) by radiocarbon to 20, 930 ± 370 BP (25, 934–24, 318 cal BP[1]). Recently, Tejero *et al.* (2008) have repeated that, according to the original documentation, this mobile art object was found in the

[1] The C^{14} AMS dates were calibrated with the INTCAL13 curve (Reimer *et al.* 2013) using the OxCal Program, version 4.2 (Bronk-Ramsey 2009) at 95.4% probability (2 sigma).

lower part of the level and consequently it should be attributed to the Aurignacian.

The mixture of archeological material belonging to two different periods (Aurignacian and Solutrean) in the same sedimentary layer, the existence of a Solutrean radiocarbon determination, the uncertainties of the excavators themselves and its location in a somewhat interior sector with sedimentary deposits in a secondary position, do not allow the confirmation of its Aurignacian chronology.

El Salitre (Ajanedo, Cantabria) (Figure 2b)

The chronological assignation of a bone with a cervid or caprid painted in red found in this cave (Carballo and Larín 1933; Pericot 1942; Almagro 1947) is equally uncertain. The object has been missing for over 60 years (Barandiarán 1973; Corchón 1986). It has been suggested (Almagro 1947) that it was found in an Aurignacian layer, although the stratigraphy, its exact stratigraphic position and the materials associated with it have never been published. In addition, the stratigraphic section visible today suggests that the deposits are in a secondary position.

El Castillo (Puente Viesgo, Cantabria) (Figure 2c, d and e)

In Level 12 or Layer M in the vestibule of this cave (Obermaier 1925), a cobble-stone was found with animal figurative and linear decoration (Figure 2c) (Cabrera 1984). Barandiarán (1973) described it as a "flat schist cobble-stone with signs at one end that [it] could have been used as a pressure flaker" in which "the outline of an animal (a feline?) facing right seems to be represented, although the figure is not too clear" and he dates it in the Gravettian. For Corchón (1986) it is a "quartzite pressure flaker" with "the outline of an animal" dated in the evolved Perigordian.

This is a quartzite pressure flaker with evidence of use on the right side of the upper face, by the animal's head. The object is complete. The upper face displays a zoomorph with an elongated body, head with no anatomical details – a large open mouth, long naso-frontal line and small protuberance on the frontal line (which might be an ear) – a very sinuous cervical-dorsal line due to the marked convexity of the withers, a very low croup whose elongation might represent the tail (ending in a bifurcation), a hind leg that connects with a slightly concave belly and the outline of a fore limb represented by parallel lines incorrectly placed as appearing from the animal´s chest. The perspective is lateral uni-angular, in absolute profile. The figure was engraved as a simple outline with fine narrow lines which are modulated, while the connections between parts are smooth and slightly rigid (chest/belly). Whilst admitting the scarce definition of the figure, the sinuosity of the cervical-dorsal line, the elongated body and lack of definition of the face is reminiscent of the bison on the Ceiling of the Hands in the same cave (García-Diez *et al*. 2008, 73–74).

The lithic assemblage of Level 12 associated with this object(Cabrera 1984) is characterized as "Upper Perigordian with no further attributions" (like Bernardo de Quirós in 1982) although it presents "the problem of pieces with Solutrean retouching, which suggests several possibilities: a problem of mechanical contamination in the

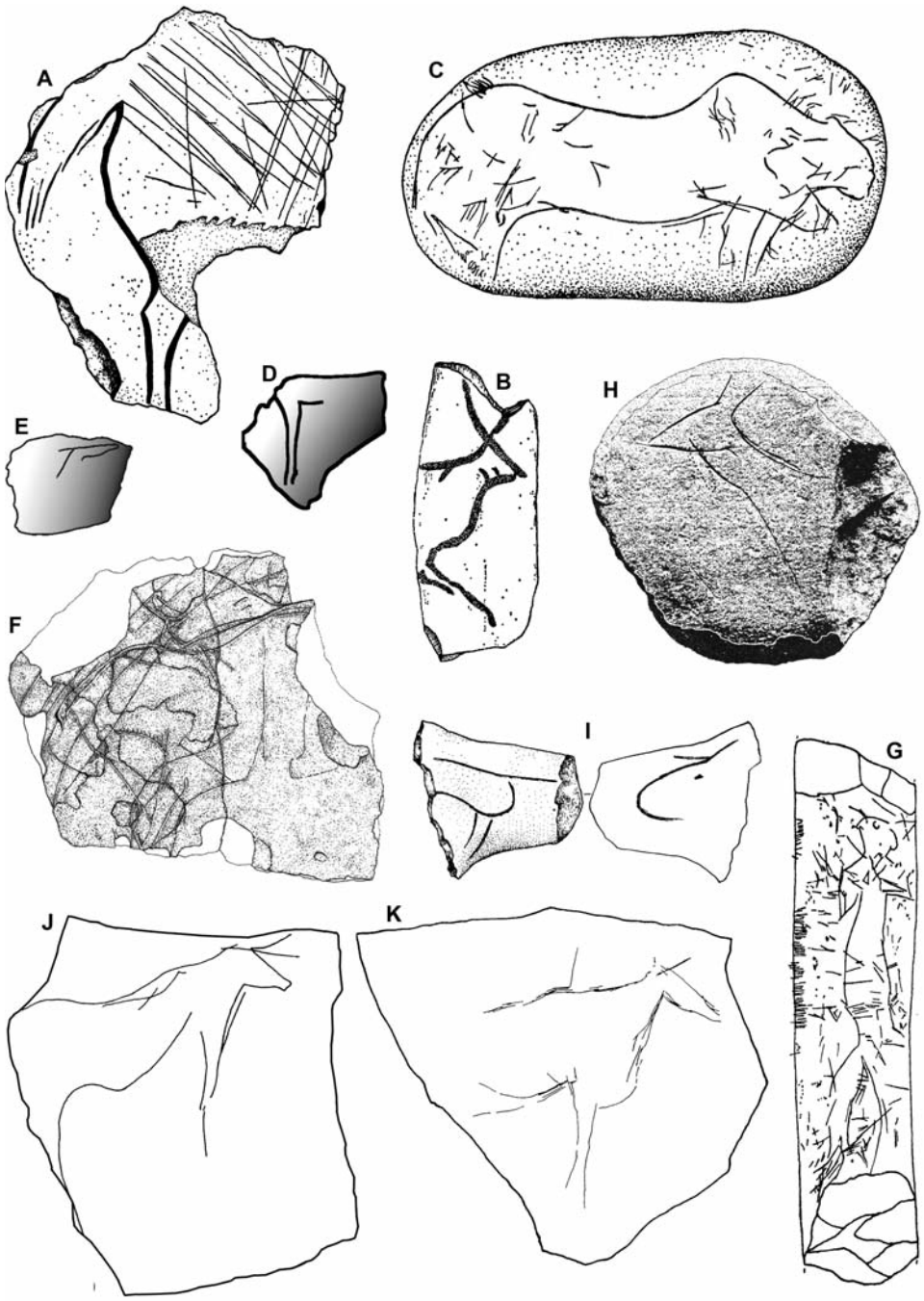


Figure 2: Drawings of figurative mobile art at Iberian Peninsula: a – Hornos de la Peña (Barandiarán 1973); b – El Salitre (Almagro 1947); c, d and e – Castillo (Barandiarán 1973; Tejero *et al.* 2003); f – Covalejos (Monteas and Sanguino 2005); g – Morín (Barandiarán 1973); h – Antolinako Koba (Aguirre and González Sainz 2011); i – Lumentxa (Barandiarán 1973); j – Mallaetes (Villaverde 2001); and k – Parpalló (Villaverde 1994)

level, an excavation problem, including two different units, or that it was a transition level towards the Solutrean" (Cabrera 1984). Two radiocarbon dates (Bernaldo de Quirós *et al.* 2013) have recently been obtained for this Level 12: 25, 920 ± 140 (30, 643–29, 684 cal BP) and 25, 520 ± 140 BP (30, 178–29, 240 cal BP).

In this cave, level 18b (37.0–40.0 ky BP) yielded a red deer hyoid bone fragment with lines painted in manganese that have been interpreted as part of an animal figure (Figure 2d; Cabrera *et al*. 2001). In Sub-level 18c (39.8–42.2 ky BP), a small bone was found with lines painted with graphite forming an animal's head (Figure 2e; Cabrera *et al*. 2004), according to the excavators. A second examination of the former by Zilhão and d'Errico (2003) proposed that the lines were natural grooves formed by roots. Later, Tejero *et al*. (2003) reiterated their anthropic nature. A preliminary review of both objects suggests that the lines on both objects are natural and therefore cannot be regarded as evidence of graphic activity.

Cueva de Covalejos (Velo, Cantabria) (Figure 2F)

Four sandstone plaquettes with linear motifs were found in this cave in Level B (or 2) (Montes and Sanguino 2005). This level was dated to 30, 380 ± 250 BP (34, 818–33, 936 cal BP) and assigned to the Aurignacian.

According to the excavators in a preliminary presentation, one of these plaquettes displays "some cervical-dorsal lines of quadrupeds (including a very clear one of a horse)". The illustration shows some markedly sinuous lines, but none of them can be interpreted as a recognizable simple representation of an animal. It will be necessary to wait for the definitive publication to be able to discuss the animal representation in the composition.

Cueva Morín (Villaescusa, Cantabria) (Figure 2g)

In this cave, González Echegaray and Freeman (1971) retrieved a fragment of a "pressure flaker made from very hard shale, with a perfectly polished surface in which some rather entangled engraved lines can be seen. Our collaborator Mr McCollough interprets these as the figure of a possible anthropomorph, with both legs, a tail, a body of slightly sinuous lines and a possible, indistinct animal's head, perhaps indicating an eye and two horns". Barandiarán (1973) acknowledged this as an anthropomorph, whereas Corchón (1986) doubted that it represented a human.

This is a shale pressure flaker, fragmented at both ends. The upper face represents a complete anthropomorphic figure. It consists of the head, with an eye and possibly the nose and hair (owing to the discontinuous broken lines with which the outline is drawn), an elongated body which is wider in its central part, two flexed upper limbs drawn like appendices, and the outline of at least one lower limb with few details and drawn as the continuation of the body. In addition, a second lower limb and even the incipient representation of the genitalia might be considered. The perspective is uni-angular, from an oblique position of about 45º. The lines and connections between anatomical regions are rigid. It is a figure engraved as a simple outline with fine narrow lines.

It was found in Level 4, dated in the Late or Evolved Gravettian, "in a very late phase" (González Echegaray and Freeman 1973), or Upper Perigordian (Bernaldo de Quirós 1982). Anomalous dates were obtained for this level and a further two for the levels underlying it (Soto 2003).

Antoliñako Koba (Gautegiz-Arteaga, Basque Country) (Figure 2h)

In this cave (Aguirre 2007; Aguirre and González 2011), an object was found in the "contact zone between the Gravettian and Aurignacian levels". It is assigned to the Gravettian, which was dated very near to the engraved object to 27, 100 ± 190 BP (31, 347–30, 853 cal BP) and 26, 720 ± 180 BP (31, 156–30, 650 cal BP).

This is a hammerstone-abrader with negatives on its left side. The upper face displays the partial figure of a red deer hind, consisting of the head with the frontal and maxilla lines rather straight and convergent, two straight parallel ears, neck and chest (modulated possibly to represent its throat). The perspective of representation is multiple: lateral for the head and body and frontal for the ears. The lines and connections between anatomical regions combine a rigid and modulated form. The figure was engraved as a simple outline.

Cueva de Lumentxa (Lequeitio, Basque Country) (Figure 2i)

In Lumentxa cave an engraved antler fragment was recovered, on one of the sides an outline corresponding to a bovid head was engraved and in the other side, the hind quarters of an unidentifiable zoomorph (Barandiarán 1973: 142; Corchón 1986, 342). Its adscription displays some problems, which make it unreliable. Initially, Barandiarán (1973) ascribed it to a Typical Aurignacian stratum and Corchón (1986) to the Inferior Magdalenian. Afterwards, Barandiarán (1994, 1996) pointed out the doubts regarding its first adscription. In fact, it is probable that the identification of an Aurignacian occupation was due to an error that occurred during the publication of the excavation report, in which was inserted a figure with materials from another site.

Cueva de Les Mallaetes (Barx, Valencia) (Figure 2j)

During Pericot's excavations at this site (Ballester 1949; Fortea 1978; Villaverde 2005), a plaquette was found in his Level 13, which is associated with Stratum IX in the eastern sector of Fortea and Jordá' s (1976) excavations and attributed to the Final Gravettian (Fortea 1978). The date of 25, 120 ± 240 BP (29, 759–28, 645 cal BP) (Arsuaga *et al*. 2002) for Level 12 gives an *ante quem* limit.

This is a limestone plaquette that has not been fragmented by recent actions. A partial figure of an aurochs was engraved on its upper face. It consists of the head with a straight frontal and maxilla with a slight modulation in the distal part that might suggest the shape of the mentonian muscle, and a straight naso-frontal line that is oblique so that the upper part suggests the nasal area, two straight horns pointing forwards, top of the head drawn with an separate line, neck, slightly curved cervical-dorsal line, hind limb, sinuous belly with a markedly upwards line, outline of a fore limb and chest (partially drawn with a double line). Inside its body, corresponding to the central part of the cervical-dorsal line, there are two lines. It might be thought that the hind part of the animal, the end of the croup, buttocks

and one hind limb, are represented by the shape of the side of the plaquette, which would imply a prior conceptual fitting of the design of the animal to the graphic field of the object. The perspective of representation is multiple: oblique for the horns and lateral for the rest of the body. The lines and connections between anatomical regions are mostly rigid, although the connection between the hind limb and the belly is exaggeratedly modulated. The figure was engraved as an outline with fine narrow lines.

Cueva de El Parpalló (Gandía, Valencia) (Figure 2k)

A major ensemble of Paleolithic mobile art was found in this cave during Pericot' s excavations (Villaverde 1994). In the first reports, Pericot (1942) included 20 plaquettes with 11 zoomorphic motifs within the Upper Aurignacian level, which is now classed as Gravettian. The latest study (Villaverde 1994) identified nine plaquettes. The differences between Pericot' s and Villaverde' s inventories and assignations (see the explanation in García Robles and Villaverde 2002; Villaverde 2005) means that, for the present study, only the pieces which can be definitely attributed to the oldest human occupation in the cave (Gravettian) should be considered. As a result, only the plaquette listed as 16005 by Villaverde (1994) is studied here as it is doubtful that the others can be attributed to this level and they may even be Solutrean (Villaverde 1994).

The archeological component of the level has been classed by Fullola (1979) as advanced Gravettian, whereas Miralles (1982) attributes it to an initial phase of the same period. The two dates obtained are regarded as anomalous (Davidson 1974; Shotton *et al*. 1975; Fullola 1979, 72).

Piece no. 16005 is a limestone plaquette. It is whole and the engraved motif is undamaged. The upper face displays the partial engraving of an aurochs. It consists of the head with two lines (a straight frontal line and a slightly curved maxilla), straight horn facing forward, the start of an ear, neck, cervical-dorsal line as far as the dorsal, which is quite straight, the anterior part of the belly drawn with two lines (the upper one concave and the lower one straight) suggesting the abdominal bulge and transmitting body volume, the outline of an open fore limb whose posterior line is modulated at the height of the knee, the coat and the chest. Associated with the back of the animal and outside it, a slightly oblique straight line might be interpreted as a hunting object or projectile. The perspective of representation is uni-angular. The figure was engraved with a simple outline that becomes multiple in the cervical-dorsal line, start of the belly, chest and partially in the frontal and maxilla, using fine narrow lines.

Discussion

Quality of the information and chronological attribution

Some of the objects feature serious doubts about their stratigraphic position (Hornos de la Peña, Salitre and Lumentxa) and/or their anthropic nature (the two objects from

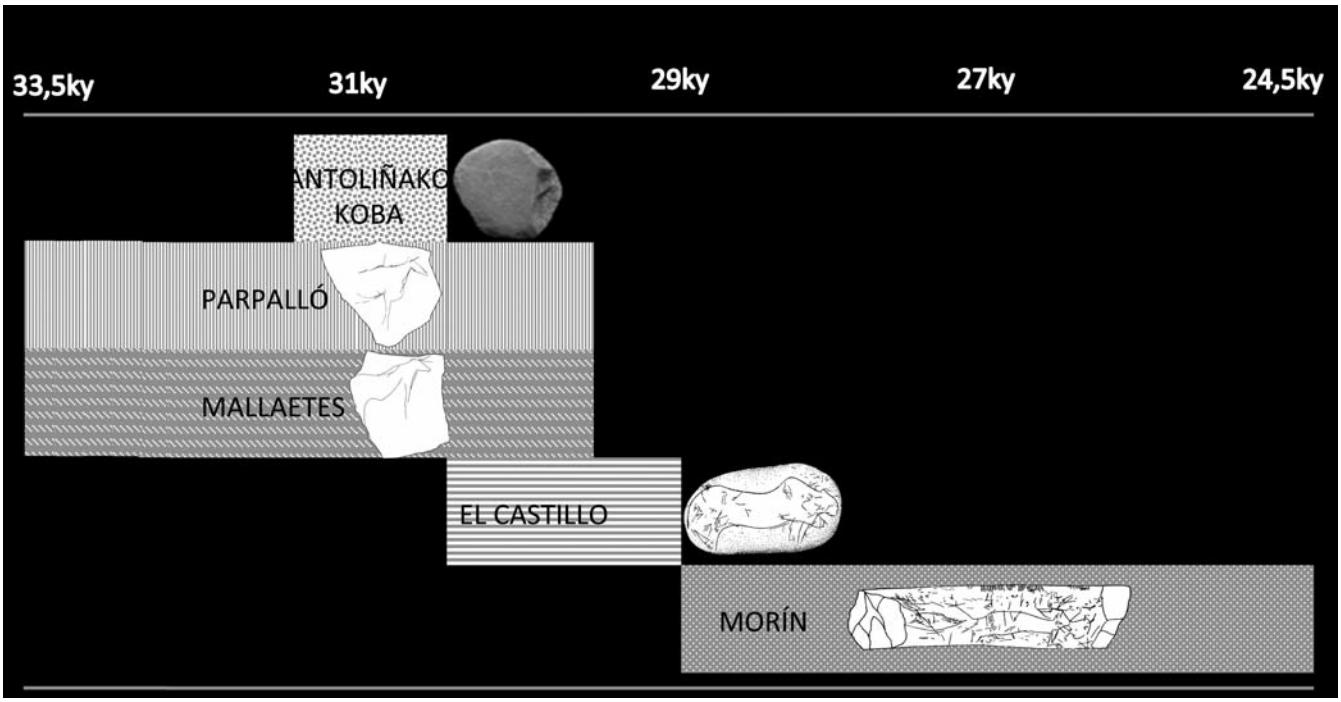
El Castillo), which means they are of little value for the present study. Similarly, it is necessary to wait for the definitive publication of the object from Covalejos to be able to discuss the figurative animal interpretation of the decoration. The other objects, with greater or lesser resolution, constitute the most solid foundation with which to establish the time when the first figurative animal art appeared on portable objects in the extreme west of Europe (the Iberian Peninsula) and to be able to characterize it.

The mobile art objects from Morín and Antoliñako Koba, the cobble-stone from El Castillo, and the plaquettes from Les Mallaetes and El Parpalló display certain problems as regards the lack of stratigraphic precision and radiocarbon dates, which means the chrono-cultural assignation of each object must be assessed.

The techno-typological context of the cobble-stone from El Castillo Cave cannot be determined with any precision, since the research of Cabrera and Bernaldo de Quirós, as they themselves conclude, suffers from the absence of correspondence between the material they examined and that which the excavators studied. The dates for Level 12 imply it should be ascribed to the Middle Gravettian, to the time between 30, 643 and 29, 240 cal BP. This period and even a more recent date may also be maintained for the cobble-stone from Morín, as the absence of Noailles burins and the significant presence of backed pieces support an assignation to the first half of the Gravettian (Arrizabalaga 1999). In turn, Antoliñako Koba would be assigned to an earlier period, between 31, 347–30, 650 cal BP.

Level 13 at Les Mallaetes was attributed to a late phase of the Gravettian, but the recent date obtained for the overlying level limits it to a time before 29, 759–28, 645 cal BP. Owing to radiometric precision and the excavation of Les Cendres Cave

Figure 3: Sequential table with the chronological (years cal BP) and chrono-cultural assignation of the earliest portable objects with figurative decoration in the Iberian Peninsula



(Villaverde and Roman 2004), the lithic assemblage can be assigned to an initial phase of the Gravettian (Fullola *et al.* 2007). This time is also acceptable, in accordance with the lithic assemblage (Villaverde 2001, 189), for the object from El Parpalló.

In conclusion (Figure 3):

- There is no certain evidence of figurative animal decoration in the Aurignacian. If the figurative nature of the decoration on the object from Covalejos is confirmed, its presence should be accepted at a time of about 34, 818–33, 936 cal BP.
- For early phases of the Gravettian, there is evidence in both the Mediterranean and Cantabrian regions: the cobble-stone from Antoliñako Koba was decorated about 31, 347–30, 650 cal BP, whereas the plaquettes from Les Mallaetes and El Parpalló correspond to time before 29, 759 cal BP but not earlier than ~33.5 ky cal BP.
- There is no evidence in the Mediterranean area for later phases of the Gravettian. The pressure-flaker from El Castillo is dated in a time between 30, 643 and 29, 240 cal BP, while the object from Morín must be assigned to a longer time span, between ~29.0 ky and ~24.5 ky cal BP.

Characterization of the depictions

Despite the small number of decorated objects, certain formal and stylistic elements are seen to characterize the depictions.

- A summarized expression of the anatomy, limited to representing the outline with no interior details, except in rare cases (the eye in Morín), and with a very basic structure.
- The outline is generally reduced to the expression of a line (El Castillo, Morín and Les Mallaetes), creating figures in profile. This tendency is a little different in the object from El Parpalló, where the localized use of a multiple line represents in a very simple way the volume of the animal (bulge in the jaw and cheek). In a similar way, the double line in the belly indicates the abdominal bulge.
- Different forms of the lines marking the animals' outlines: modulating (Antoliñako Koba, Les Mallaetes and El Parpalló), extremely modulating (El Castillo and Les Mallaetes) and rigid (Antoliñako Koba, Morín, Les Mallaetes and El Parpalló). In some cases more than one form are combined together.
- The articulation of anatomical regions may be modulating (Antoliñako Koba, El Parpalló and Les Mallaetes) or angular (Antoliñako Koba, El Castillo, Morín, Les Mallaetes and El Parpalló).
- Use of the modulated outline to individualize anatomical details in the region of the head: Antoliñako Koba (throat), Les Mallaetes (mentonian muscle), Morín (nose and hair) and possibly El Castillo (ear).
- Construction of anatomical parts depending on the neighbouring parts by elongating the outline: El Castillo (line from the neck to the croup, and line from the hind limb to the chest) and Les Mallaetes (line from the fore limb to the belly and line from the chest to the fore limb).

- Incoherence in the position of appendices: El Castillo (fore limb too far forward) and El Parpalló and Les Mallaetes (horns pointing forward).
- Lack of internal coherence in the size of the anatomical parts, causing disproportions between regions or as regards a real model: elongation and narrowing of the body or portion of the body, linked to a longitudinal conception of the figure (El Castillo, Morín and Les Mallaetes) or of the head (El Parpalló), exaggerated height of the head (El Castillo) and of the hind quarters (El Castillo and Les Mallaetes), limbs too short (El Castillo and Morín) and mouth too large (El Castillo).
- The perspective of representation may be lateral uni-angular (El Castillo and El Parpalló), oblique uni-angular (Morín) or multiple by combining lateral and oblique (Les Mallaetes) or lateral and frontal (Antoliñako Koba).
- Variability of the anatomical format: in the Cantabrian area the figures are represented with the total or partial anatomical structure, whereas in the Mediterranean, the figures are incomplete and share the depiction of the anterior or mesial part of the animal. However, the animal from Les Mallaetes uses the shape of the side of the object to represent the posterior part.
- No representations of movement, as the limbs are vertical and rigid in their articulation.
- Lack of attitude, or static attitude in the representation. In the latter case it may be noted that (a) the oblique and forwards position of the forelimb of the animal from El Castillo may indicate the position as it walks, and (b) the flexed and raised upper limbs of the anthropomorph from Morín may indicate an attitude that cannot be identified.
- Possible use of the shape of the object for the anatomical characterization of the animal (Les Mallaetes).

Conclusion

The study of the portable decorated objects is able to establish solid foundations for the characterization of the earliest figurative art in the extreme west of Europe. The information currently available[2] does not support the existence of figurative art before ~31.5 ky cal BP, in the absence of confirmation of the figures on the object from Covalejos. The first figurative art, therefore, appears in the early/middle Gravettian (between about ~33.5 and ~29.0 ky cal BP), in both the Mediterranean area (El Parpalló and Les Mallaetes) and in the Cantabrian region (Antoliñako Koba, early Gravettian). Portable graphic activity is not documented in a later phase of the Gravettian in the Mediterranean, whereas in Cantabria it continues in an immediately later time at El Castillo (middle/early Gravettian) and at Morín (where the chronological attribution corresponds to a generic ~29.0 – ~24.5 ky cal BP). The

[2] The publication of the INTCAL13 calibrating scale has modified the chronological and cultural adscription of the same pieces previously analyzed (García-Diez and Ochoa 2012).

morpho-stylistic characterization shows that the graphic construction was based on simple abbreviated models in which the animals' outlines were prioritized.

Acknowledgements
This research was conducted with the financial support of the Basque Government (Consolidated Research Group on Prehistory UPV/EHU IT622-13). Research by one of the authors (BO) was funded by a PIF (Personal de Investigación en Formación) contract of the University of the Basque Country (UPV/EHU).

Résumé
En cet article les supports mobiliers avec décoration figurative localisés dans gisements situés à la Péninsule Ibérique (Hornos de la Peña, El Salitre, El Castillo, Morín, Antoliñako koba, Les Mallaetes et El Parpalló) sont présentés et évalués. La position stratigraphique, chronologique et culturelle de chaque pièce est évaluée et la décoration, dans quelques cas, est caractérisée. Conséquemment, le premier art mobilier figuratif dans la Péninsule Ibérique ne peut être attribué, considérant l'étude des collections d'art mobilier, qu'une chronologie de ~31,500 calBP. La caractérisation morfo-stylistique dénote la construction graphique basée en schèmes constructifs simples et synthétiques où le contour de l'animal est priorisé.

Zusammenfassung
Der Artikel präsentiert und diskutiert Objekte der beweglichen Kunst mit figurativer Verzierung aus Fundstellen der iberischen Halbinsel (Hornos de la Peña, Salitre, El Castillo, Covalejos, Morín, Lumentxa, Antoliñako Koba, Les Mallaetes und El Parpalló). Die stratigraphische Lage jedes Objektes wird festgestellt und die Art der Verzierung charakterisiert und diskutiert. Die älteste bewegliche Kunst mit figurativer Verzierung der Iberischen Halbinsel kann auf der Basis der Inventare auf etwa 31.500 cal BP datiert werden. Ihre morphologisch-stilistische Charakteristik enthüllt eine graphische Konstruktion, die auf einfache Darstellungen fokussiert ist, in denen den Umrissen der Tiere der Vorzug gegeben wird.

PALEOLITHIC FIGURINES – STYLISTIC CONCEPT AND ARTISTIC INDIVIDUALITY

Walpurga Antl

Abstract
The aim of this contribution is not another effort to unveil the meaning of Paleolithic iconography but only to suggest a more structured view to it as a base for further interpretations. Regarding the variety of Paleolithic figurines, one might be tempted to see a random series of mainly female representations augmented with some male and abstract statuettes. Regional and supra regional similarities as well as individually modelled objects will be discussed. The article also outlines the development of Paleolithic figurines throughout the Upper Paleolithic with a special focus on the Gravettian figurines.

Keywords
Upper Paleolithic, interpretation, mobile art, anthropomorphes

DOI: 10.5817/CZ.MUNI.M210-7781-2015-23

Introduction

Paleolithic sites from France to Siberia have yielded a big variety of female, male and figurines with indeterminate sex. At first sight they can be regarded as highly individual pieces of art which represent females of all ages: slim, corpulent and pregnant women, small and big pieces, naturalistic and abstract figurines. Having a closer look, there are similarities which cannot be neglected. Therefore we have to ask whether there is one consistent concept in Paleolithic three-dimensional art or different categories such as chronologically and/or regionally based concepts.

The first effort to define the structure of Paleolithic figurines was made by Leroi-Gourhan (1965). He found that Paleolithic figurines are more or less rhombic in shape. The circle inscribed to this rhombus covers the area of breast, belly and pubic

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triangle. This characteristic has been applied to figurines from France to Russia. The most perfect example of his concept is certainly the Venus of Lespugue where breasts, belly and buttocks are circulating as spheres around the center of the body. Delporte (1979) questioned this model because it produces a prominent series of "misfits". As a consequence he distinguished four groups of representations: (1) engraved vulvae which are characteristic of the Aurignacian period and can be still found during the Gravettian and Magdalenian; (2) figurines and reliefs of the Gravettian; (3) naturalistic engravings and figurines of the early Magdalenian, with representations shown in profile and bent forward during the middle Magdalenian, and finally (4) the rather stylized representations of the late Magdalenian. The main framework as presented by Delporte is a geographic one. Within this framework he discussed chronological or stylistic developments and differences.

Starting with an analysis of the Balzi Rossi figurines, Mussi (2000) formulates three types of representations: the "Lespugue-Kostienki type", "masks" and the "Western type" comprising the more abstract figurines. The figurines presented in this model are a very restricted group of representations. From each of the mentioned sites only one example is presented, which neglects the great variety of representations within one locality. This fact has already been mentioned by Svoboda (2004), who paid attention to the discrepancy between the effort to find pan-European similarities and the visible variety even in one site which is a sort of fingerprint of an individual group of people.

Although the local assemblage in its diversity is a unique historical document the local and the supra-regional approach do not necessarily contradict each other: they just show different aspects of a very complex system of thoughts. The regional evidence could be either part or a variety of supra-regional ideas. Marshack (1991) suggested that there were different symbol systems and modes of use which were parts of complex conceptual systems. It is necessary to reflect on these images including their cultural background.

The discussion presented here concerning the discrepancy between a strict stylistic concept as a product of social understanding, on the one hand, and recognizable individual elements of artistic freedom on the other is only a first step towards an attempt to interpret Paleolithic art. The examination of detailed archeoological records containing all the information concerning the finding of the figurines and every aspect of the archeoological context such as the raw material, traces of use, ancient damage, use of color, the variety of other anthropomorphous and zoomorphic figurines, tools and a detailed spatial analysis is an important precondition for a comprehensive interpretation which of course would exceed the size of this contribution.

This study tries to determine whether supra-regional, regional and individual aspects in Paleolithic art can be distinguished. Whether the Paleolithic iconographic record as part of a mythologized and metaphorical frame can be regarded as art (Marshack 1991) is not part of this study. That would require a more detailed discussion about the conception of art. It would be necessary to discuss whether our conception of art can be applied to historical periods and to what extent in each

period artistic production and its authors played a distinct and historically based role within their society. Art as a reflection of a distinct set of cultural components will differ from one period to another as will the conception of it in the respective period.

Here the focus is on the different chronological periods because it seems obvious that archeoological cultures defined by their content may also differ as far as their artistic expressions are concerned.

Aurignacian

From the Aurignacian we only have a few human representations, like the drawing of a woman in the Grotte Chauvet and drawings of anthropomorphs on small stone plates from Grotta Fumane. Plastic representations are especially rich in the Aurignacian sites of Southern Germany, witness Geissenklösterle, Hohle Fels and Hohlenstein-Stadel. They are all made of ivory. The figurine from Stratzing near Krems in Lower Austria was carved from local amphibolite schist.

The portrayed beings are all in an upright position. The figurine from Stratzing holds one arm upwards and the other one rests on the hips. With the breast sculptured on the right side of the body it seems to show a person turning around. The relief from Geisenklösterle and the drawing from Grotta Fumane represent beings with raised arms. The arms of the so called Lion Man from Hohlenstein-Stadel are directed downwards but they are not just hanging, they reflect a sort of preparedness to move. Not even the arms of the figurine from the Hohle Fels are really resting because the breasts held straight forward show the tension of the body. In most cases the legs are separated and parallel except with the figurine from Stratzing where they are separated but converging. The posture of the Aurignacian anthropomorphous representations reflects strength and power or aggression, as Joachim Hahn formulated in his book (1986).

Regarding the objects portrayed there are two female figurines: the plastic figurine from Hohle Fels, with big breasts and distinct primary sex characteristics, and the figurine from Stratzing near Krems in Lower Austria, a cut out relief with the breast on the right side of the body carved in profile. The other representations are beings of undetermined sex. The figurine from Hohle Fels with its clear sex characteristics may be seen as a link to the Gravettian figurines (Conard 2010) but the posture is similar to that of the other Aurignacian representations.

Searching for common aspects, it can be observed that a straight powerful posture, often combined with signs of movement, is the most obvious link between these representations. Apart from these similarities there are many individual aspects, starting with the chosen art form: relief or cut out relief, plastic or painting. Whereas the relief from Geissenklösterle, the figurine from Stratzing and the painting from Grotta Fumane are silhouettes, the Lion Man and the Venus from Hohle Fels are powerful plastic objects. They are sophisticated compositions of naturalistic and abstract elements. The statue of the Lion Man is a combination of human and animal characteristics; the head of a lion even supports the impression

of power. The Venus from Hohle Fels obviously served as a pendant. The lower legs are shortened and the line of the back is straight and flat. The arms are almost in correct proportion to the body of the figurine. The breasts are the same size as those of the Gravettian figurines but in contrast to the Gravettian ones they are protruding straight forward. Like the Lion Man, the Venus from Hohle Fels has incisions on both arms.

The Aurignacian anthropomorphous representations are similar in their posture but they are individual in many details. There is a sort of common thread without exact parallels.

Gravettian

Pavlovian

The oldest Gravettian figurines are the ceramic figurines from Dolní Věstonice. The Pavlovian figurines from Southern Moravia are a unique assemblage of figurines with naturalistic elements, with female, male, sexually ambiguous and stylized representations. It is an individual group of representations with no real parallels (Svoboda 2004a). The predominant material is ceramic which is typical of the Pavlovian in Southern Moravia and even in Austria (Einwögerer 2000).

The so-called Venus from Dolní Věstonice is an upright figurine; the head is straight and rounded at the top. The neck starts above the clearly modeled collar bone but there is practically no separation between the neck and the head. At the front there are two oblique incisions for the eyes and on top of the head there are four points. The arms disappear into the body mass shortly below the shoulders, the breasts are big and pendulous comparable to the figurines of the younger Gravettian. There is no special focus to the belly. The legs are separated from the upper body by an incision around the body below the navel. This principle can also be seen on some other fragments from Dolní Věstonice. The legs are only separated by an incision.

There are also ambiguous pieces, like the bar with breasts or testicles or the pendants formed like breasts or testicles. Svoboda (2004a) even considers the Venus from Dolní Věstonice to be constructed following this dualism. The way of modeling the legs and the separation from the upper body by a horizontal line is consistent within the Dolní Věstonice material. This detail clearly distinguishes the figurines from Dolní Věstonice from the figurines of the younger Gravettian, which show the pubic triangle or even the vulva.

Apart from that, Svoboda clearly demonstrates that at least with some of the figurines, which show just the lower part of the body, the legs could also be seen as representations of vulvae (Svoboda 2004a). A fragment of a ceramic figurine from Pavlov in principle follows the same scheme, but there the grooved line is substituted by a twisted ribbon and the appearance is more naturalistic. Apart from the figurines, among the fragments of figurines, there is a beautifully modeled face on an isolated head and a face incised into a thin piece of ivory commonly called “the mask”.

Regarding the Pavlovian assemblages from Dolní Věstonice and Pavlov a sort of common outline may be observed which distinguishes them from the Aurignacian as well as from the younger Gravettian. There are obvious similarities between the Venus from Dolní Věstonice and the fragments as parts of originally complete figurines. The bar with breasts or testicles and the breast/testicles pendants are made from ivory and are more stylized than the figurines. The sculptured head with a face and the mask are completely individual creations. Although the sites of Dolní Věstonice and Pavlov are very close to each other there are clear differences between the two sites. The individuality in this assemblage is underlined by a very individual series of adornments.

As there are no contemporaneous assemblages with which to compare the materials from Dolní Věstonice and Pavlov we do not know if the stylistic elements are a chronological phenomenon or a regional one.

Willendorf/Kostienki

The younger Gravettian or Willendorf/Kostienki phase is also known as the "phase of the figurines" with the Venus I of Willendorf as the dominant type. Each effort to define a structure for the figurines either tried to explain all figurines according to the same concept or the concept was reduced to those which fitted and the other ones were neglected. Delporte (1979), who realized that the system defined by Leroi-Gourhan could not be applied to all figurines, rejected it as a useful tool to characterize these figurines and implemented a regional model instead, comprising representations from the Aurignacian to the Magdalenian. Other scholars like Röder (1998; Röder *et al.* 1996) regarded the figurines as a random set of female representations from the Paleolithic. It was Mussi (2000) who tried to group a certain series of figurines according to stylistic principles. An important aspect of this approach was to drop the idea of finding one structure for all figurines and to establish different groups.

Lespugue-Kostienki type

Regarding the variety of Gravettian representations, there is one type with striking similarities which can be found from France to Russia. Mussi named this group the Lespugue-Kostienki type (Mussi 2000). It comprises figurines from Brassempouy, Lespugue, Laussel, Termo Pialat, Willendorf, Moravany, Kostienki, Avdeevo, Gagarino and Khotylevo. This does not mean that all figurines from these sites can be attributed to this type, in some cases there is a great variety of representations within one site.

These figurines are more or less corpulent women with big, pendulous breasts, stout hips, proportionally short arms and legs, no face and no feet and clear primary sex characteristics. The head is inclined and the arms and hands are in a resting position below or above the breasts. In some cases they disappear below the breasts. The shoulders are bent forward which underlines the impression of a focus to the centre of the body. The primary sex characteristics with pubic triangle are clearly visible. The presentation of the vulva is a characteristic of Western and Central

European figurines. They represent rather mature women and some of them seem to represent really old women. The strictly formal similarity between these figurines suggests a widespread mental concept which was connected with this sort of representation. This does not mean that its content was necessarily identical.

Apart from the above mentioned criteria for this type of figurine, there are a series of optional extras which show regional or individual variations. Among the Russian figurines Gvozdover (1995) distinguishes upright, semi sitting and sitting figurines. The type of figurines characterized above only comprises upright and semi sitting figurines. Different sorts of ribbons are mainly seen on Russian figurines. If the ornament at the back of the Venus from Lespugue represents clothing, is still being discussed. Hairstyles or headdresses are designed rather individually. Pregnancy is clearly visible in a series of figurines but it is probably not as widespread as Duhard (1993a; 1993b) suggested. The variety of shortened body elements and the exaggerations of Paleolithic female representations do not allow the expectation of a true picture of different stages of pregnancy.

Apart from ivory, the use of marl is typical of the Russian area with figurines (Abramova 1967; Iakovleva 2000). Some figurines from Kostienki are also made of limestone (Praslov 1993). The Venus I from Willendorf is made of oolithic limestone and the yellow Venus from the Balzi Rossi collection is made of steatite. The figurines from Brassempouy and Lespugue are made of ivory. Occasionally red color is connected with this type of figurine.

In Avdeevo, figurines numbers 5 to 10 correspond to this type. Interestingly figurine 7, the only one with a clear face and even an ear, was found together with figurine 6 which has no face. Face and hairstyle underline the impression of a rather young person. But there are also other figurines from Avdeevo which are different from this type of figurines.

The very rich assemblage found in habitation structure 1 of layer 1 at Kostienki I demonstrates the variety of plastic art especially in Eastern Europe (Iakovleva 2000). Four of the figurines have been sculptured from ivory. Apart from very minor differences they are identical. The regional variety of the above mentioned type in Eastern Europe is connected with the presentation of various sorts of ribbons and decorations on the figurines from Kostienki (Iakovleva 2000; Praslov 1993) and Avdeevo (Gvozdover 1995) and the way of presenting the pubic region. Two examples made of limestone show further some individual characteristics probably from another author: an almost complete figurine, which is – except the ribbons – very similar to the Venus from Willendorf, and a fragment of a figurine representing a pregnant woman (Praslov 1993). These figurines are clearly within the stylistic concept of the Eastern European figurines of the Lespugue-Kostienki type but they are different than the above mentioned ivory figurines from Kostienki and Avdeevo. There is also an ivory statuette from Kostienki I which is similar to this second variety (Svoboda 2008a, fig. 44). There are also unfinished or rather different figurines. Some of the figurines from Gagarino are very similar to the Venus from Willendorf but there is also a nice series of individually designed figurines. The assemblage of Khotylevo also comprises figurines of that type (Mussi 2000).

The Lespugue-Kostienki type figurines follow a rather strict scheme with some regional differences but it is only one phenomenon among the plastic representations of this time. In most of the sites with this type of figurines there are also other varieties of anthropomorphous representations.

Slim figurines

Apart from this very impressive type there are also rather slim females which can be found from France to Russia. The posture of these figurines is upright. Figurines from Pechialet and Abri Pataud in France, Petřkovice in Moravia and a marl figurine from Avdeevo probably representing a young pregnant woman with small breasts are rather naturalistic. More stylized representations of slim females are for instance "the girl" from Brassempouy and the Venus II from Willendorf. There are great differences between the figurines of the Lespugue-Kostienki type and the representations of slim females. This second group is an assemblage of rather different pieces. They have only one aspect in common: they have no face, like the first group. The materials used are bone, ivory, marl and stone.

The most impressive example of this group is the torso from Petřkovice which is made from hematite and looks like the torso of an antique figurine. Svoboda describes it as the body of a girl which shows slight traction and tension compared with the more static representations of that time (Svoboda 2008a).

Abstract representations

Another type of Gravettian figurines are abstract pieces. They are regarded as female (Delporte 1979), if big buttocks can be regarded as sufficient to determine sex. They have no head, only a rounded end of a sort of stick and no breasts. Therefore they can be regarded as sexually ambiguous representations (Svoboda 2004a, 2008a). This type is known from Tursac and Sireuil in France, Mauern in Germany and Pavlov in Moravia which also shows a flat stylized breast. Another piece from the area of the Lake Trasimeno might be compared to this group. A figurine from Enval in France which is similar to this type is attributed to the Magdalenian. The figurine from Savignano, showing a similar ending at the side of the head, is different to this type in many respects: big breasts, a protruding belly and the presence of the pubic triangle are reminiscent of the accentuation of the middle of the body of the Lespugue-Kostienki type. Mussi (2000) describes this figurine as part of her "western" group. It may be regarded as part of this group as far as the sexual ambiguity is concerned but not in stylistic respects.

All the figurines of this group, apart from that from Pavlov, are made of stone. For the representations of Mauern and Tursac red ochre is important: the figurine from Mauern is covered with red ochre and the figurine from Tursac was found in an area with red ochre. The representations of Mauern and Tursac are in a combination with red ochre. From a stylistic point of view this group is rather homogenous but, concerning their chronological position, they are not. The figurine from Pavlov was found in an older Gravettian context and the piece from Enval is

dated to the Magdalenian. The figurines from Sireuil, Lake Trasimeno and Savignano are unstratified. They are distributed from Central to Western Europe. Unlike the other figurines, all of them apart from Pavlov are found in or attributed to places which have not yielded other examples of plastic art.

Another type of stylized figurines is represented by the so called Venus III from Willendorf (Antl 2008) and a figurine from Zaraysk in Russia (Amirkhanov and Lev 2008). Both have a silhouette like Russian dolls. The different parts of the body are accentuated by simple cuts. In this respect the Venus III from Willendorf is even more reduced because there only the head is separated in this way. The question whether Paleolithic people saw in this piece a figurine or just an unfinished something of ivory will never be answered.

The faces

None of the figurines described so far, except figurine 7 from Avdeevo, show facial features. Therefore the beautifully modeled faces from Brassempouy, Dolní Věstonice and the Balzi Rossi assemblage demonstrate that Paleolithic people were able to model faces. Compared with each other these faces clearly represent different individuals. The ivory head from Brassempouy probably represents the facial features of a rather young girl with a round face and pointed chin. A remarkable detail is the absence of the mouth which has to be considered intentional. The head from Dolní Věstonice, the oldest facial representation from the Pavlovian, shows a long slim face with eyes, nose and mouth. The hair is probably long, bound together and worn up on the head. The hair of the Brassempouy figurine is separated into two parts: the hair from the top of the head is bound together at the back of the head; the rest is falling down on both sides and at the back, the hair is as long as the neck, which is rather long compared with that of figurine 7 from Avdeevo. The hair of figurine 7 from Avdeevo seems to be bound at the back of the head in such a way that at least one ear is clearly visible. The rest of the hair is falling to the neck. The head is relatively rounded and the chin is not especially accentuated. The mouth begins immediately below the nose. The size of the two separate heads, at 3.5 and 4.8 cm, clearly exceeds the size of the heads of figurines that represent whole persons. Whereas the head from Brassempouy is broken off at the neck, the head from Dolní Věstonice was clearly designed as a separate piece. The isolated heads from the Grotte du Prince and the Barma Grande also show facial features. The hair of the sculpture from the Grotte du Prince is indicated similarly to the head from Brassempouy but it is not falling down to the neck. At the beginning of the twentieth century scholars considered this head as the portrait of an African woman. Today's interpretations are more cautious (Schwab 2008). The head from the Barma Grande is a face with no mouth, surrounded either by hair or a headdress (White and Bisson 1998; Mussi 2000).

These faces build a sort of counterpart to the faceless representations. This is additionally underlined by the fact that figurine 6 from Avdeevo (without face) and figurine 7 (with face) were found together. They are faces of individual persons who are looking straight ahead, in contrast to the inclined heads of the complete

figurines. The oldest one comes from Central Europe and the others from Western and Eastern Europe. The heads from the Grotte du Prince and the Barma Grande seem to be the youngest among this collection. Three faces are produced from ivory and two are made of stone. Each of them was found in places with a series of faceless and other representations. Therefore it seems that they are an integral part of the whole spectrum of representations, and not just an accidental decision of an individual artist. Yet they are individual faces and do not follow supra-regional or regional stylistic patterns, which are demonstrated by the different faces from the Balzi Rossi caves or the Siberian faces.

Male figurines

Female figurines certainly dominate Paleolithic plastic art but there is also a small and therefore often neglected series of male representations. They are distributed similarly to the other figurines: Brassempouy and Laussel in France, Dolní Věstonice and Brno in Moravia, Avdeevo in Russia.

Two fragments of male figurines were found at Brassempouy. Although at least one of them is clearly male they have been judged rather differently (Hahn 1986; Schwab 2008). A relief from Laussel represents a male person from a side view. The two Moravian examples are clearly male representations. A ceramic figurine from Dolní Věstonice is a torso with broken legs and is also broken in the middle of the body. The ivory figurine from Brno – the only figurine from a grave – was produced with flexible arms, legs and head. A rather roughly cut ivory figurine from Avdeevo is modeled in a straight upright posture with head held high. Although it has no clear sex characteristics the straight body is more likely the body of a male. The appearance of this figurine is similar to that of the Lion Man.

Compared with the female figurines, the male ones do not follow a supra-regional pattern. The style of these representations is mainly influenced by the local style: delicately modeled ivory at Brassempouy, a stone relief at Laussel, a ceramic figurine at Dolní Věstonice and a piece probably cut from fossil ivory like some other figurines from Avdeevo.

Regional varieties

Apart from the figurines mentioned above there is a certain number of individually modeled pieces which cannot be attributed to one group or another, as for instance an example from Gagarino with fully plastic arms and hands pointing to the face.

In addition to that, there are regional types, like a set of figurines from Italy and France. These Mediterranean figurines are very stylized with exaggerated breasts, buttocks and sex characteristics with big open vulvae. The fifteen objects from the Balzi Rossi caves between Italy and France are an assemblage with great variety. There are two heads with hair or headdress, double beings, a mask, ambiguous figurines like the hermaphrodite and a series of female figurines. The raw material of the figurines is mostly steatite or chlorite but there are also two pieces of ivory and one made from antler. As far as the style is concerned, the Yellow Venus is rather

near to the Lespugue-Kostienki type (Mussi 2000). The ivory figurines differ considerably from the steatite/chlorite collection. The heads of the ivory figurines are rather round in contrast to the pointed heads of, for instance, the "Lozenge", the "Punchinello" and the "Goitered Lady". Although their exact stratigraphic position is unclear these statuettes are probably the youngest Gravettian figurines from different stages of the Epigravettian, dating between 17.0 and 14.0 ky BP (White and Bisson 1998). From a stylistic point of view the figurine from Monpazier in France can also be attributed to this group although it is not as rhombic as the mentioned figurines from the Grimaldi caves. The focus on buttock, belly and vulva is even more exaggerated.

Comparing the Mediterranean figurines with the Lespugue-Kostienki type it can be noticed that both share the focus on the middle of the body but there are also visible differences: in the Mediterranean variety the breasts are smaller, and in contrast, buttocks, belly and vulva are extremely big. Although the figurines of the Lespugue-Kostienki type can certainly not be regarded as naturalistic images of women they are a harmonious combination of naturalistic details, whereas the authors of the Mediterranean figurines clearly exaggerated parts of the body. As in other regions there are, apart from the dominant type, other types of representations probably illustrating different topics.

The figurines from Siberia – Mal'ta, Buret' etc. – are a completely different set of figurines. The most striking difference is the presence of facial features. Most of the facial features are rather uniform, in contrast to one figurine from Mal'ta which has an individual face and an open mouth. Breasts and pubic triangle are only indicated by shallow incisions. They represent rather slim persons and some of them are reduced to slim sticks. The upper part of the body is usually short; the lower part is elongated with convergent legs thus forming a triangle. Many of them are perforated and could have been used as pendants or amulets. Individual aspects are different hairstyles and clothing. Some figurines are completely covered with incisions (Vasil'ev 2000) which have been interpreted as representing furs.

Gravettian anthropomorphous figurines comprise a great variety of representations and styles. Regarding the assemblage as a whole we can see a sort of structure within it. Figurines of the Lespugue-Kostienki type follow a rather strict scheme of representation. This leads us to suggest that these are more than accidental similarities (Delporte 1979, Leroi-Gourhan 1965, Mussi 2000) but we should not try to explain all female representations according to that scheme. The type of figurines named Lespugue-Kostienki type (Mussi 2000) is only one part of the rather complex Gravettian iconography. It comprises regional variations as well as individual differences within one region. It can be concluded that the figurines of the Lespugue-Kostienki type embody a supra-regional topic represented by a female image. As there are different areas of distribution, there are regional varieties of this type. Even in one place we can detect details of different personal styles.

In some respects the Mediterranean examples could also be regional expressions of the same topic but there are considerably bigger differences than between the regional varieties of the Lespugue-Kostienki type. The existence of the faces

strengthens the impression that there is a special message behind the faceless figurines.

Abstract figurines are typical of the younger Gravettian in Central and Western Europe although there are already stylized representations in the Pavlovian. Similar to some pieces from Dolní Věstonice these abstract pieces can be regarded as female or male representations. Apart from these rather ambiguous representations there is also a series of male figurines which can be found in all main areas with figurines except the Mediterranean and Siberia. The Siberian figurines are an independent set of representations which might have the supra-regional topic in mind but the image of it is completely different.

Gravettian plastic art is a complex system of representations. Each group probably had a distinct meaning for the Gravettian people. Within this set of topics even the rather formal types like the Lespugue-Kostienki figurines demonstrate that there was enough space not only for regional styles but also for an individual design decided by a person according to a personal artistic concept.

Magdalenian

During the Magdalenian plastic art as a whole was not as dominant as during the Gravettian period and within plastic art the main focus was on animal representations. Delporte (1979) distinguished among Magdalenian representations an earlier phase with figurines still influenced by a more naturalistic style like the famous "Unchaste Venus" from Laugerie Basse, or the fragments of slim female bodies from Angles-sur-l'Anglin. Incised female bodies from La Marche represent rather corpulent, possibly pregnant women in different postures. The statuette from Enval, which has already been mentioned, consists of just the upper legs, the buttocks and part of the body. The style is very close to that of the Gravettian abstract figurines.

Towards the end of the Magdalenian, the figurines are increasingly stylized. A special characteristic is the presentation of the female body in profile. Breasts are still part of many figurines but a special focus is on the buttock area which is shown in profile often reduced to a triangle. The figurines from Gönnersdorf are made of ivory, antler or schist. The focus is clearly on the female profile with small or no breasts and nearly triangular buttock. The same silhouettes can be seen incised in plates of stone. The figurines have no heads, which was also a characteristic of the older Magdalenian figurines. Similar silhouettes were found at Petersfels in Germany where they were obviously worn as amulets. The material is jet, which was frequently used for this sort of adornment. Three flat statuettes made of antler were found in a Magdalenian site near Nebra and also at Ölknitz. They are almost identical to the figurines of Gönnersdorf (Bosinski 1986).

In Eastern Europe the plastic representations from Mezin follow that scheme but they are not flat like the examples from Western Europe. They are fully plastic, richly decorated pieces. Whereas the western figurines in most cases are silhouettes of slim, clearly female, persons the eastern figurines are ambiguous.

Towards the end of the Magdalenian the plastic representation of females was increasingly reduced to a silhouette which was rather uniform in Western and Central Europe. The female body appears like a sign which scarcely allows individual variation. Among the Eastern European pieces there is a little more variety.

Conclusion

When we regard Paleolithic art under the aspect of individuality within the mental concept of each period we realize clear differences between Aurignacian, Gravettian and Magdalenian representations. Apart from the general impression of motion and power in Aurignacian figurines and reliefs there seem to be rather different, apparently individual, representations of humans. Nevertheless one has to be aware of the small number of human representations from this period.

Compared with the Aurignacian, the iconographic record of the Gravettian is very rich. It consists of a variety of phenomena which can be observed from France to Russia. Formal types of representations can be distinguished but even these formal types consist of different regional varieties and within a region different individual styles are recognizable. This reflects a personal interpretation of an idea probably spread all over Europe. Apart from the formal types there are individual creations like the faces and also a series of individually modeled figurines. Gravettian art consists of a complex set of representations which is probably inspired by mythological thoughts. The figurines may be a combination of universal thoughts and the personal intentions of a creative artist. Individually modeled portraits and figurines are known from each of the big concentrations of Paleolithic art. Therefore they could be part of a general concept but it cannot be excluded that they are completely autonomous creations.

During the Magdalenian figurines develop from stylized plastic objects of – in a broad sense – naturalistic character to silhouettes which have the focus on the side view of the buttock and in many cases also on the breast. The head is missing, which is a further step from a generalized female representation to a sign for a distinct content combined with the alienated body of a woman.

Summary

This contribution has tried to give an overview of the development of anthropomorphous figurines from the Aurignacian to the Magdalenian from a stylistic point of view including general trends and individual elements. Aurignacian representations show a straight and powerful posture, often combined with signs of movement. Among the plastic representations of the Gravettian there are types which follow a rather strict scheme like the Lespugue-Kostienki type (Mussi 2000) which can be found from France to Russia. They possibly embody a supra-regional topic represented by a female image. Even the rather formal types like the Lespugue-Kostienki figurines demonstrate that there was enough space not only for regional styles but also for an individual design decided by a person according to a personal

artistic concept. The individually modeled faces and figurines strengthen the impression that there is a special message behind the typical faceless figurines.

Apart from the rather naturalistic figurines there are also abstract ones. Similar to some pieces from Dolní Věstonice these abstract figurines can be regarded as either female or male representations. Apart from these ambiguous objects there are also a series of male representations from all main areas with figurines. The Siberian figurines are an independent set of representations which could have the supra-regional topic in mind but the image of it is completely different. Towards the end of the Magdalenian the plastic representation of females was increasingly reduced to a silhouette. The female body appears like a sign which scarcely allows individual variation.

Résumé

L´objectif de cette contribution n´est pas d´entreprendre le décriptage du sens de l´iconographie paléolithique, mais plutôt d´en suggérer une approche plus structurée sur base de laquelle des interprétations peuvent être dégagées. Étant donné la variabilité des figurines paléolithiques l´on serait tenté d´y voir une série arbitraire de représentations avant tout féminines, complétées par quelques rares statuettes masculines voire abstraites. Dans cette étude, nous discutons l´existence de similarités régionales et supra-régionales parmi les figurines paléolithiques, par rapport aux objets au modelé davantage individuel. Qui plus est, cet article passe en revue le développement des thèmes iconographiques du Paléolithique supérieur, avec une attention particulière pour les figurines du Gravettien.

Zusammenfassung

Dieser Beitrag versucht von einem stilistischen Gesichtspunkt aus einen Überblick über die anthropomorphen Plastiken vom Aurignacien bis zum Magdalenien zu geben, wobei allgemeine Züge und individuelle Elemente in der Gestaltung besonders betrachtet wurden. Die Figuren des Aurignacien weisen eine aufrechte und kraftvolle Haltung auf, die oft auch mit einem Ansatz der Bewegung verbunden ist. Unter den eher statischen plastischen Darstellungen des Gravettien gibt es Figuren, die einem gemeinsamen Gestaltungskanon folgen wie der von Mussi so benannte “Lespugue/Kostienki- Typ”, der von Frankreich bis Russland zu finden ist. Die Figuren dieses Typs verkörpern möglicherweise ein überregionales Thema, das durch das Bild einer Frau dargestellt wird. Die stilistisch sehr eng gefassten Figuren des Lespugue/Kostienki- Typs zeigen aber auch, dass es ausreichend Platz für regionale Varianten und auch individuelle Ausführungen nach persönlichen Vorstellungen gab. Die sehr individuell gestalteten Köpfchen und Figuren mit Gesichtern verstärken den Eindruck, dass mit den gesichtslosen Figuren eine besondere Botschaft verbunden ist. Neben den eher naturalistisch gestalteten Figuren gibt es im Gravettien auch abstrakte Plastiken. Ähnlich wie einige Objekte von Dolní Věstonice tragen sie sowohl weibliche als auch als männliche Züge. Außer diesen eher ambivalenten Objekten gibt es aber auch eindeutig männliche Darstellungen aus allen Gegenden, in denen Figuren vorkommen. Die sibirischen Figuren sind eine stilistisch eigenständige Gruppe von Darstellungen, die zwar dasselbe oder ein ähnliches Thema zum Inhalt haben könnten, von dem aber ein anderes Bild bestand. Gegen Ende des Magdalenien wurde die plastische Darstellung der Frau immer mehr auf eine Silhouette reduziert. Der weibliche Körper erscheint wie ein Zeichen, das kaum individuelle Varianten in der Darstellung erlaubt.

REDISCOVERING PALEOLITHIC ART: OVERLOOKED CERAMIC FIGURINES FROM THE PAVLOVIAN

Rebecca A. Farbstein and William Davies

Abstract
This paper presents the first results from a new research project that focuses on the emergence of ceramic technologies across Paleolithic Europe. Pavlovian ceramics from Moravia provide the earliest known evidence of these technologies, with one of the largest assemblages from the site of Pavlov I. This paper presents new analyses of both the figurative art and the broader assemblage of worked "pellets," shedding new light on the range of technologies employed when working with this innovative material. Using both macro- and microscopic analyses, we identified four distinct *chaînes opératoires* across the figurative and non-figurative ceramics that were excavated from Pavlov I in the 1950s—1960s, demonstrating a more diverse range of manufacturing sequences than scholars previously purported. In particular, analyzing the "pellets" demonstrates that studying the figurative sculptures in isolation may lead to biased interpretations of the importance of some techniques, such as engraving.

Keywords
Ceramic technologies, mobile art, *chaîne opératoire*, Gravettian, Czech Republic

DOI: 10.5817/CZ.MUNI.M210-7781-2015-24

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Introduction

Tens to hundreds of ceramic figurines depicting men, women, and animals have been excavated from secure Upper Paleolithic (Pavlovian) contexts across Moravia, and international attention has been drawn to these assemblages since the discovery of the Venus of Dolní Věstonice in 1925. These ceramics, which date from *ca.* 30.0 ky BP, challenge widely held notions that ceramics were first invented by sedentary, agricultural societies (*ca.* 10.0 ky BP) to make functional pottery and vessels. Many

of the first publications on Pavlovian ceramics focused on the evocative and iconic statuettes of voluptuous women and animals such as lions, rhinoceros, and mammoths (e.g. Absolon 1949; Klíma 1958). Early interest in these most stylistically striking artefacts may have encouraged the subsequent fifty years of research, which privileged the appearance of objects as the primary locus of meaning. This paper presents the first results of our re-analysis of one of the classic Pavlovian ceramic assemblages from Pavlov I, with emphasis on the finds from the 1950s–1960s. Using a combination of macro- and microscopic methodologies and investigating not just the most striking figurative art but also the so-called "pellets," we discovered previously overlooked *chaînes opératoires*, which led to the recognition of new types of ceramic artefacts. This newly re-analysed assemblage of ceramic material culture sheds new light on the various ways innovative materials impacted both technological production and artistic expression in the Paleolithic.

Chrono-cultural contexts

Archeologists long purported that ceramic technologies first developed in sedentary societies, probably after the Pleistocene-Holocene transition, to make functional pottery (e.g. Childe 1936). However, the discovery of pottery in hunter-gatherer Jomon contexts in Japan and, more recently, in several distinct Pleistocene contexts

Table 1: Radiocarbon dates from occupation horizons excavated in the 1950s-60s at Pavlov I. Data collated from results from the Stage Three Project (Davies 2001) and Svoboda (2005, 30). Dates calibrated using OxCal 4.2 (INTCAL13) (Bronk Ramsey 2009) and CalPal2007Hulu (Weniger and Jöris 2007).

					"BC/AD"; 95.4% confidence		calBC (95%)		calBP (95.4%)		calBP: 95%
excavation context	**laboratory number**	**radio-carbon date**	**S.D. (+ve)**	**S.D. (-ve)**	**OxCal13 MIN (calBC)**	**OxCal13 MAX (calBC)**	**CalPal 2007HULU Min**	**CalPal 2007HULU Max**	**OxCal13 Min (calBP)**	**OxCal13 Max (calBP)**	**CalPal 2007HULU**
1953 occupation horizon (SE)	GrA-192	25, 530	110	110	27, 346	28, 152	28, 040	28, 720	29, 296	30, 102	30, 670–29, 990
1956 cultural horizon (SE)	GrN-1325	25, 020	150	150	26, 760	27, 504	27, 720	28, 280	28, 710	29, 454	30, 230–29, 670
1961 (?) culture horizon	GIN-104	26, 000	350	350	27, 492	28, 967	28, 130	29, 770	29, 442	30, 917	31, 720–30, 080
1956 occupation horizon (SE)	GrN-1272	26, 620	230	230	28, 503	29, 214	29, 020	29, 980	30, 453	31, 164	31, 930–30, 970
1953 occupation horizon (SE)	GrN-19539	26, 650	230	230	28, 541	29, 229	29, 090	29, 970	30, 491	31, 179	31, 920–31, 040
1957 occupation horizon (NW)	GrN-20391	26, 170	450	450	27, 470	29, 156	28, 130	29, 970	30, 420	31, 106	31, 920–30, 080
1956 occupation horizon (SE)	GrN-4812	26, 730	250	250	28, 586	29, 286	29, 180	30, 020	30, 536	31, 236	31, 970–31, 130
1954 occupation horizon (SE)	KN-1286	26, 580	460	460	27, 769	29, 431	28, 430	30, 230	29, 719	31, 381	32, 180–30, 380
1954 occupation horizon (SE)	GrN-22303	26, 400	310	310	27, 932	29, 162	28, 530	29, 970	29, 882	31, 112	31, 920–30, 480
1954 occupation horizon (SE)	GrN-22304	25, 160	170	170	26, 836	27, 669	27, 770	28, 450	28, 786	29, 619	30, 400–29, 720
1954 occupation horizon (SE)	GrN-22305	25, 840	290	290	27, 431	28, 811	28, 050	29, 610	29, 381	30, 761	31, 560–30, 000

in China and Russia, has pushed back the evidence for ceramic pottery to at least *ca.* 20.0 ky BP (Craig *et al.* 2013; Gibbs and Jordan 2013; Wu *et al.* 2012). Furthermore, there is now considerable evidence that non-sedentary societies past and present, living in diverse environments, make pottery, calling into question the purported link between sedentism, agriculture, and ceramic pottery (see contributions to Jordan and Zvelebil 2010). Despite increasing evidence of ceramic technologies in unexpected contexts, most archeologists still consider ceramics to be anachronistic in the Paleolithic. Our research aims to raise awareness of this dataset and to compare the many iterations of ceramics that pre-date the Holocene.

Pavlovian archeological sites in Southern Moravia demonstrate not just the antiquity of ceramic traditions but also their artistic, rather than function, origins. The earliest ceramics, which pre-date the Neolithic in Central Europe by more than 20.0 ky, are hand-held statuettes of animals and humans, rather than functional pottery and vessels. The radiocarbon chronology for the Pavlovian sites is constantly being revised and revisited, as excavations continue to discover new sites (see, for instance, Svoboda *et al.* 2009) and long-known sites are re-excavated. Most of the radiocarbon dates from areas excavated in 1953, 1954, 1957, and 1961 fall between 24.99 -26.98 uncal BP (see Table 1).

Methodology

Establishing a cohesive methodology for studying Paleolithic ceramic figurines remains a challenge. Most ceramic methodologies relate to the study of later prehistoric ceramic vessels, relying upon typologies built around the shapes of pot rims and bases, and iconic decorative motifs; these typologies are largely irrelevant for Pavlovian ceramics which are figurines, rather than vessels. Likewise, as we discuss below, the stylistic and iconographic typologies often used to interpret Paleolithic art made in ivory, bone, and stone are limiting as many Pavlovian ceramics do not ascribe to these narrow iconographic and stylistic criteria. Thus, it is necessary to first build a methodology that facilitates analysis of Pavlovian ceramics in new ways. *Chaînes opératoires* methodology (Dobres 2010; Farbstein 2010, 2011; Leroi-Gourhan 1964; Schlanger 1994) encourages engagement with ceramic artefacts in the same way as Paleolithic craftspeople, from raw material selection, through material modification and artefact manufacture, to use, and ultimately discard. Comparing and quantifying stages in the production of a large assemblage of materially-cohesive artefacts facilitates the construction of a common nomenclature, while shifting focus away from the final appearance and recognisability of subject matter to modern audiences and towards the experiences of Paleolithic craftspeople through an artefact's life history. Interpretations based on subject matter are inherently influenced by contemporary biases, as well as by the variable preservation of Paleolithic artefacts. These biases are especially problematic when studying Pavlovian ceramics because subject matter and intended "style" is not always apparent due to pre- and post-depositional fragmentation, damage, and deformation. We propose that, for the study of Pavlovian ceramic

artefacts, *chaînes opératoires* methodology is a more productive approach than traditional efforts to group and interpret artefacts according to their subject matter (e.g. comparisons of anthropomorphic figurines: Abramova 1960; Conroy 1993; Gvozdover 1989; Marshack 1991; Svoboda 2007; Verpoorte 2001).

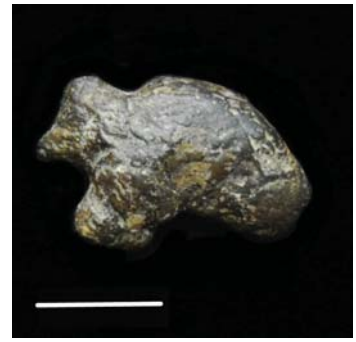

Figure 1: Mammoth figurine from Pavlov I ("M3"), made using Sequence I.

The assemblage

One of the largest assemblages of Pavlovian ceramic art was found at Pavlov I. We focus our discussion here on the ceramics excavated during the first 12 years of research at the site, between 1952–1964, which numbers 5,630 artefacts studied to date. 97 of these were previously identified and widely published examples of clearly figurative art; the remaining 5,533 pieces were artefacts previously classified as worked or formed "pellets" or pieces of ceramic that do not show strong evidence of human manufacture. The majority of the "pellets" were found during excavations in 1957 (N = 2,492), which focused on the NW section of the site, with a particular concentration of ceramics in Square 9 (Jarošová 1997; Soffer and Vandiver 1997). Excavations in 1953 (N = 1,450) and 1954 (N = 710) also yielded large quantities of ceramics.

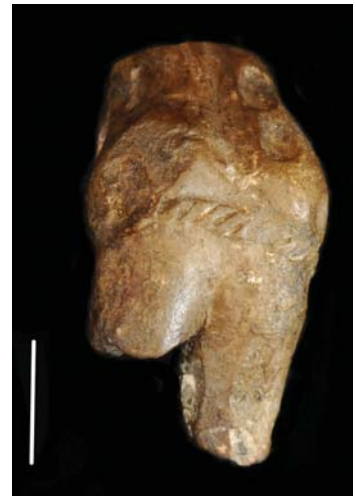

Figure 2: Anthropomorphic figurine ("A4") from Pavlov I (1962 excavations).

Manufacturing sequences for figurines and "art"

Broadly, we identified four distinct ceramic *chaînes opératoires* at Pavlov I. The first *chaîne opératoire*, which is primarily additive, involved rolling and smoothing wet paste between hands and fingers to make separate components of a figurine (such as torso, head, legs, and tail); once formed, these pieces were joined together (following Vandiver *et al.* 1989; Soffer and Vandiver 1994, 1997, 2005). Occasionally, fingernails made what were likely both intentional and unintentional surface marks. We refer to this *chaîne opératoire* as Sequence I. An example of this technology is a small mammoth figurine whose limbs were apparently formed as separate pieces and subsequently joined to torso and head. There are no engravings visible on the surface of this figurine (Figure 1).

This technology is further suggested in the many "limb" fragments from Pavlov I, which demonstrate the additive manufacturing sequence but which lack any engravings. With these fragments, it remains impossible to ascertain whether the craftsperson engraved other parts of the complete figurine to which these limbs were once attached.

Figure 3: Detailed photograph of the engraved belt-motif on "A4."

A distinct *chaîne opératoire* (hereafter Sequence II) follows the same initial stages as Sequence I, from material acquisition through the additive manufacture of the figurine's basic shape. However, in Sequence II, the craftsperson subsequently used a tool, such as a flint or bone point, or perhaps a perishable material such as a stick, to engrave, incise, impress, and/or carve the figurine. Some of these marks further articulate the overall shape and silhouette of the figurine, while others are fine engravings that indicate facial features or decorative motifs. One of the female figurines from Pavlov I illustrates this *chaîne opératoire* in the finely-engraved, braided waistband (Figures 2 and 3). Thus, the key differences between Sequence I

Figure 4: Zoomorphic figurine ("589357") with shortened limbs made by pinching wet loess away from a core torso.

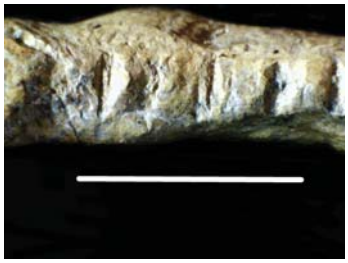

Figure 5: Micrograph (40× magnification) of the fingernail incisions along the backline of figurine #589357.

and Sequence II lie in the later stages of artefact manufacture; figurines were made exclusively with a craftsperson's hands following Sequence I, whereas additional tools, technologies and gestures were introduced and implicated when Sequence II was employed.

Soffer and colleagues did not discuss any other Pavlovian ceramic *chaînes opératoires* in detail but we noted two additional and distinct sequences. In the first of these newly recognised *chaînes opératoires* (hereafter Sequence III), a core shape was formed by rolling and smoothing wet paste. Subsequently, pinching gestures were used to "extract" extremities, appendages, and details such as ears from the

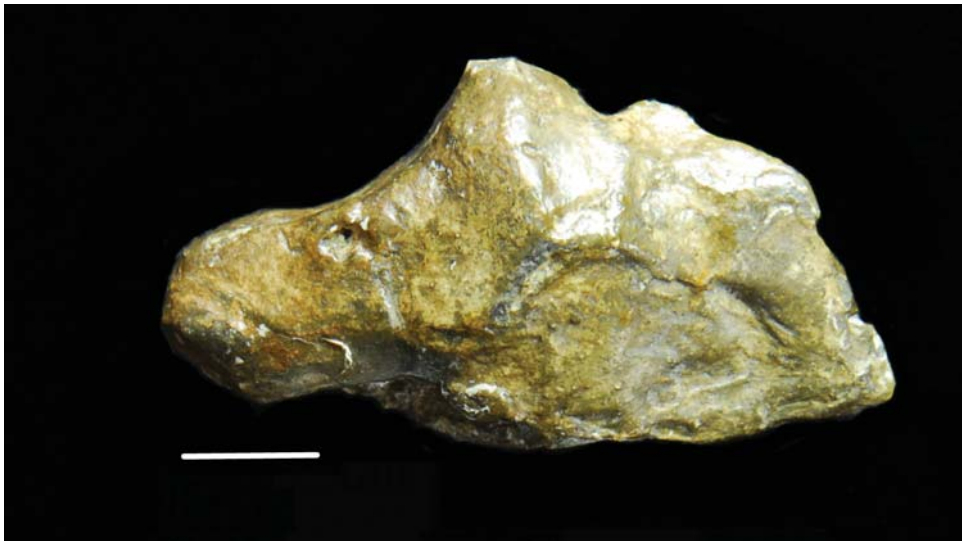

Figure 6. "Rhinoceros" head ("52053") from Pavlov I, made using Sequence IV.

core shape, rather than rolling these components as separate entities. A small, flattened zoomorph with fingernail incisions along its backline ("589357") illustrates this sequence (Figures 4 and 5).

When engravings or marks were made with a synthetic tool after the overall shape of a figurine was pinched to form, we classified the artefact as following Sequence IV *chaînes opératoires*. An example of this *chaîne opératoire* seems to be one of the purported "rhinoceros" heads ("52053") (Figure 6), which was excavated from Square IV/8 in 1953 (Klíma 1994). The head was apparently pinched to form but was never attached to a larger body or torso. Rather, the neck is pinched-off without evidence of a break or join. Eyes are depicted as pricked or punctured holes, indicating the use of a synthetic tool.

A small number of artefacts were made in a less structured way, which never resulted in the production of a representational figurine. Additionally, a few objects were so damaged or fragmented that it was impossible to determine their *chaînes opératoires* (see Table 2).

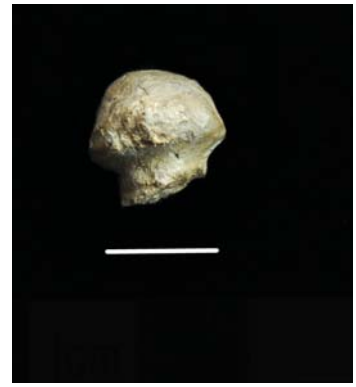

Figure 7: A ceramic "biconical head," whose "neck" has been formed by scooping and scraping away wet loess paste and reinforce the overall shape of the object.

Table 2: Ceramic *chaînes opératoires* within figurative assemblage at Pavlov I.

sequence I (additive)	32
sequence II (additive + engraved)	42
sequence III (pinched)	9
sequence IV (pinched and engraved)	7
material worked in less structured way	6
indeterminable *chaîne opératoire*	1
total	**97**

Further elaborating upon these *chaînes opératoires,* "surface engraving" was occasionally so intensive that it involved removing wet paste from the figurine, creating deep and wide gouges. This variant of the Sequence II *chaîne opératoire*, which was identified on 16 artefacts, may be described as first additive and subsequently reductive as the craftsperson carved or scooped away material to modify the artefact's overall form. Some ceramic biconical heads (Figure 7) and several of the rhinoceros heads exhibit these gestures and sequences.

Techno-artistic Prevelances and "Preferences"

Early stages of the chaînes opératoires: *building versus pinching*

Among the previously studied, most recognizably worked or figurative artefacts from Pavlov I (N = 97), additive technologies (Sequences I and II) are dominant, identified in about 78% of the figurines and figurine fragments. 15% of the figurines were made by pinching (Sequences III and IV); although this is quantitatively a

secondary technology, there are enough examples of artefacts made using these pinching-based *chaînes opératoires* to suggest that they were accepted as viable alternatives at Pavlov I.

Beyond exclusively technological choices, there are important differences in the application of certain ceramic *chaînes opératoires* to depict certain subjects. For instance, pinching gestures (*chaînes opératoires* III and IV) were never recognized among the securely identifiable anthropomorphic figurines at Pavlov I (Table 3).

Table 3: Ceramic *chaînes opératoires* preferences in the figurative assemblage from Pavlov I.

	anthropomorphic	zoomorphic	**total**
sequence I	7	10	**17**
sequence II	14	24	**38**
sequence III	0	1	**1**
sequence IV	0	6	**6**
total	**21**	**41**	**62**

Instead, anthropomorphic figurines were always made additively, while both pinching gestures and additive sequences were employed to depict zoomorphic subjects. There are no apparent technological or material constraints that could explain the lack of pinching *chaînes opératoires* to make anthropomorphic figurines. Although the lack of malleability of the loess paste would have made it difficult to create naturalistic anthropomorphic statuettes without employing additive technology, the material limitations would have been equally challenging when making animal figurines. Pavlovian artists employed a range of styles and variable degrees of realism to make ceramic zoomorphs using Sequences III and IV, resulting in shortened, compact, or compressed limbs and generalized silhouettes rather than detailed depictions. These strategies could have been similarly applied to make anthropomorphic figurines, so the exclusive application of pinching *chaînes opératoires* to make zoomorphic figurines seems to suggest the development of a "technological style" (*sensu* Lemonnier 1993; Lechtman 1975).

Later stages of the chaînes opératoires: surface engravings

There is an almost equal number of engraved and unengraved artefacts across the figurative assemblage (Table 2), which seems to affirm Sequences I and III as distinct and consciously chosen techno-artistic *chaînes opératoires*, not merely unfinished iterations of Sequences II and IV. It would be tempting to suggest that sometimes ceramicists abandoned figurines before they were "finished." Given the expedient nature of the early stages of this manufacturing sequence, it might be feasible that ceramic figurines were abandoned because craftspeople decided the figurine was not worth investing the additional time necessary to engrave it, or because they did not

have access to a tool for engraving. However, the quantity of unengraved artefacts combined with the prevalence of heavily fired but unengraved figurines seems to suggest these were not merely discarded and unfinished artefacts. Furthermore, many of these unengraved figurines are finely made and display a high degree of surface smoothing and "finishing." For instance, although badly damaged and broken, M154 is highly finished and demonstrates that considerable time and energy was spent in production, even though surface engravings were not executed.

However, if we restrict our analysis to pieces that we readily classified as either anthropomorphic or zoomorphic (thus eliminating the ambiguous "limb fragments"), about 70% are engraved. We interpret this as indicating that engravings facilitate identification of these subjects for modern viewers in their current state of fragmentation, deformation, and damage. These challenges probably lead to an overreliance on engravings as a means of identifying "art." However, the original condition of the ceramics may not have led to this reliance in the same way, and furthermore, Pavlovian artists may not have used engravings as clues to help differentiate or identify specific subjects. These biases aside, one potentially significant techno-artistic choice is the apparent tendency to engrave "pinched" zoomorphic figurines (6 examples of Sequence IV, compared to just 1 example of Sequence III). The pairing of the initially more "expedient" pinching gestures with more intensive final stages of production which employ the use of a tool suggests that temporal expediency was not always a paramount consideration.

Beyond "art": making sense of the larger assemblage

Our analysis of artefacts identified by previous scholars as "figurines" and figurine fragments demonstrated more variability and experimentation with production than had been previously recognized (e.g. Soffer and Vandiver 1994, 1997, 2005). This initial result encouraged us to expand our analysis beyond merely the most recognizable and stylistically striking pieces to catalogue the full repertoire of gestures employed to work with ceramic. Thus, we turned to the broader assemblage of worked pieces, which have been described in the past as fragments and "pellets," with the aim of gaining a better understanding of the impact of this innovation of Pavlovian art and society (Table 4).

We discovered or rediscovered more than 320 worked or formed pieces, some of which are identifiable as figurine fragments (primarily either anthropomorphic or zoomorphic limb fragments or fragments of zoomorphic torsos). We also recognized five fingerprints that had not previously been identified (one each from 1953, 1957, and 1960 excavations, and two from the 1954 excavations). Among the "pellets," we found evidence of each of the *chaînes opératoires* that we noted among the more complete figurines (discussed above). We conducted detailed analysis of 150 of the 320 newly recognised worked or formed "pellets" to identify *chaînes opératoires* (Tables 5 and 6) and noted distinct technological preferences among these less diagnostic "pellets." Nearly 30% were pinched (Sequence III), marking a 100% increase in the use of pinching gestures and techniques compared to the more

Table 4: Ceramic pellets and newly identified formed figurines from Pavlov I (1952–1962).

excavation year	total number of ceramic pellets	number of worked or formed pieces	yield rate
1952	70	1	0.014
1953	1,450	50	0.034
1954	710	44	0.062
1957	2,492	109	0.044
1960*	74	32	0.432
1961	248	26	0.105
1962	458	60	0.131
1964	31	4	0.129
total	**5,533**	**326**	**0.059**
High yield rate is because many of these pieces had been previously identified & marked with a unique ID number. However, these finds had been misplaced & these artefacts were not previously published or studied in detail.			

complete figurines discussed above. Importantly, only 5% of these newly-recognised formed pieces were engraved with a tool; again, this sharply contrasts with patterning observed in the more complete figurines, 70% of which were engraved. This ratio of engraved to non-engraved pieces among the new pieces we discovered may even be slightly inflated, as we were probably subconsciously biased towards selecting engraved pieces for more detailed technological analysis as they were more identifiable and visually striking to our modern sensibilities.

Table 5: Ceramic *chaînes opératoires* among the newly discovered pellets.

sequence I (additive)	90
sequence II (additive + engraving)	7
sequence III (pinching)	44
sequence IV (pinching + engraving)	1
material worked in less structured way	3
indeterminate *chaîne opératoire*	5
total	**150**

Table 6: Ceramic *chaînes opératoires* across broader worked assemblage at Pavlov I.

sequence I (additive)	122
sequence II (additive + engraving)	51
sequence III (pinching)	52
sequence IV (pinching + engraving)	8
material worked in less structured way	9
indeterminate *chaîne opératoire*	5
total	**247**

Discussion

The differences we observed between ceramic "art" and ceramic "pellets" may reflect contemporary approaches to the study of prehistoric art, rather than technological preferences and distinctions Pavlovian ceramicists consciously made between two types of material culture. The most readily recognizable artefacts to modern archeologists will, understandably, be those that closely ascribe to traditional expectations for how prehistoric art should look. These expectations have been established over the last century, and seem largely built around the appearance of the most famous and recognizable Paleolithic figurines made in ivory, bone and antler (for instance, the Aurignacian figurines from the Swabian Jura (Conard 2009; Hahn 1972), many of which feature engraved facial features and carefully carved iconic silhouettes. Similar pieces from Pavlov I, such as the ivory lion and mammoth statuettes (Klíma 1963), readily facilitate species and subject recognition. This modern fixation on the most visually recognizable figurines has also been highlighted by Verpoorte (2001, 16), who noted that "the reception of art is dominated by figurative thinking." These biases in the reception of Paleolithic art are reflected and reinforced by publications, which overwhelmingly focus on the most iconographically striking and aesthetically "beautiful" figurative art, giving less attention to the less identifiable and non-figurative art.

As a result, it is perhaps unsurprising that almost a century of research on Pavlovian ceramics has led to the typologies that prevail today. Finely made, additively built, and heavily fired ceramic figurines that preserve engravings are the most visually recognizable examples of this class of material culture. They are easily differentiated from the sedimentary matrix during excavation and from bone and stone during initial sorting of finds, increasing their likelihood of recognition. However, ceramic artefacts that are heavily damaged, were less finely made, or were fired at lower temperatures were more likely to be overlooked because they did not ascribe to expectations of how "art" should look, leading to biases in the categorization of this class of material culture.

Our analyses of the assemblages from Pavlov I reinforce how grouping and classifying ceramics as either "figurative art" or non-figurative "pellets" (following

Soffer 1994, 1997, 2005) limits our understanding of the range of ways Pavlovian people engaged with this innovative material. The large assemblage of artefacts that are not immediately recognisable as figurative but which preserve clear evidence of material manipulation and forming or working are rich sources of information about Pavlovian innovation and creativity, deserving more attention than they have received to date. One important addition to our knowledge of Pavlovian ceramic technologies relates to our understanding of the purported "limb fragments." Soffer and Vandiver (2005, 419) highlighted many artefacts that preserve "joints where the adding of one piece to another had occurred" which they interpret as evidence that the pieces "were worked in an additive fashion" (Soffer and Vandiver 2005, 418; also Soffer and Vandiver 1994, 167). They interpret many of these as "limb fragments" that they purport broke off from a larger figurine during the intentional "pyrotechnic" performance of ceramic explosion (following Vandiver *et al.* 1989; Soffer *et al.* 1993). While our analyses confirmed that some fragments preserve breaks or joints, demonstrating additive manufacture, we also noted rolled artefacts that look like limb fragments but that have no apparent break. One example of this, artefact #556554, found during the 1954 excavations, is a rolled and modeled fragment that might be interpreted as a leg with a pinched foot. However, there is no break at the proximal extremity where the leg could have joined with what would presumably have been a torso. This suggests it was made as an independent entity and was not part of a multi-stage, additive manufacturing sequence. The presence of artefacts like these in the "non-figurative" assemblage, combined with the prominence of "pinched" manufacturing sequences in the assemblages, overlooked by previous scholars, builds a more nuanced picture of Pavlovian ceramic technologies. The inherent flexibility of the ceramic material might have encouraged experimentation and play during production, which led to a range of ways of engaging with and manipulating wet loess paste.

The broader assemblage of ceramics artefacts from Pavlov I reveals that there was not one strict, socially normative, additive *chaîne opératoire* for making both clearly figurative statuettes and non-figurative ceramic material culture; ceramic craftspeople apparently enjoyed flexibility and freedom in production. The innovative nature of the material might have encouraged socio-technical flexibility and experimentation, as the material may not have been ascribed with the same social meaning, value, or significance of a material such as ivory. While ivory would have had more limited availability and mistakes during production would have been costly, ceramic paste was easily reworked if a mistake was made, and it was a much more renewable resource as more loessic sediment could be easily collected and mixed with water to form a paste. These technological observations encourage us to revise our understanding of Pavlovian ceramic technologies. Labelling and interpreting the less visually-striking ceramics as "non-figurative pellets" is, at best, limiting, and, more problematically, potentially misleading. These artefacts are more than just "pellets;" they provide evidence of exploration in a new material and they help build more comprehensive understanding of ceramic production at Pavlov I, which was more diverse than is apparent in the strictly figurative assemblages. These

artefacts further demonstrate that engraving was not as widespread as is suggested by the figurines, despite the relative ease with which a craftsperson could have incised the surface of a wet ceramic model. Moreover, additive manufacture was not ubiquitous; many ceramicists at Pavlov I employed pinching, pressing, and non-additive gestures and *chaîne opératoire* as they explored the possibilities of manipulating this material. We propose that this class of ceramic material culture be re-considered as an important type of artefact in its own right, rather than merely debitage or waste from the manufacture of more recognizable pieces of art.

Acknowledgements
We are grateful to Jiří Svoboda for allowing us to study the ceramic artefacts from Pavlov I. This research is funded by a Leverhulme Project Grant (2013–2016) awarded to William Davies, to investigate "Paleolithic Origins of Ceramic Technology: innovative and creative revolutions."

Résumé
Le présent article expose les premiers résultats d'un nouveau projet de recherche consacré à l'émergence des technologies de la terre cuite à travers l'Europe paléolithique. Les terres cuites du Pavlovien morave représentent à ce jour les plus anciennes manifestations des technologies de la terre cuite ; l'une des collections les plus importantes provenant du site de Pavlov I. De nouvelles analyses, effectuées à la fois sur l'art figuratif et sur la collection plus large des « pellets » de terres cuites travaillées, nous ont permis de mettre en lumière une gamme de technologies distinctes liées au travail de ce matériau innovateur. Sur base d'une approche combinant analyses macro- et microscopique, nous sommes parvenus à identifier quatre chaînes opératoires distinctes parmi les terres cuites figuratives et non figuratives mises au jour sur le site de Pavlov I dans les années 1950–1960. Il en ressort que les savoir-faire techniques associés à la fabrication des terres cuites s'avèrent être plus diversifiés que ce qui a été communément admis jusqu'ici. En particulier, l'analyse des « pellets » tend à démontrer que l'étude isolée des seules œuvres figuratives peut biaiser l'interprétation quant à l'importance de certaines techniques, telles que la gravure.

Zusammenfassung
In diesem Aufsatz werden erste Ergebnisse eines neuen Forschungsprojekts vorgestellt, das dem Auftreten von Keramik-Technologien im paläolithischen Europa gewidmet ist. Die gebrannten Tonartefakte des Pavlovien stellen die bislang frühesten Nachweise dieser Technologien dar, wobei eines der umfangreichsten Inventare am Fundplatz Pavlov I zutage gefördert wurde. Basierend auf neuen Untersuchungen der figurativen Kunst sowie des umfangreichen Inventars bearbeiteter „Pellets" rücken wir die der Bearbeitung dieses innovativen Rohmaterials zugrunde liegenden Technologien in ein neues Licht. Durch die Kombination von makro- und mikroskopischen Analysen ist es uns gelungen, unter den in den 1950er und 1960er Jahren geborgenen figurativen und nicht figurativen gebrannten Tonartefakten insgesamt vier unterschiedliche chaînes opératoires zu rekonstruieren. Damit wurde eine größere Vielfalt der Herstellungsverfahren belegt als bislang angenommen. Die Analyse der „Pellets" hat insbesondere gezeigt, dass die alleinige Untersuchung von figurativer Kunst zu verzerrten Interpretationen hinsichtlich des Stellenwerts gewisser Techniken, darunter der Gravur, führen kann.

"CERAMICS" AND PIGMENTS FROM KOSTIENKI-1 SITE: RESEARCH RESULTS AND PERSPECTIVES

Maria Zheltova[1] and Oksana Yanshina[2]

Abstract
A major role in Russian investigations of Upper Paleolithic pigment and ceramics belongs to N. D. Praslov. The cultural deposits of Kostienki-1 site yielded approximately 400 ceramics fragments of different size. The final result was the defining of a possible temperature range for firing the studied samples, from 500 to 860–940 °C. The pigments from the site of Kostienki-1 present a rich palette of colors and were used in ornamentation of dwellings and single inventory categories.

Keywords
Ceramic technologies, Gravettian, Kostienki, Russia

DOI: 10.5817/CZ.MUNI.M210-7781-2015-25

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Introduction

The questions of the earliest technologies of clay treatment and obtaining pigment and ceramics are among most urgent issues in modern Paleolithic studies. Investigations which concern these issues reveal totally new aspects of human activity in the Upper Paleolithic and, thus, make it possible to broaden our conception of the epoch and promote its value in understanding human history. The studies of pigment and ceramics have followed separate ways and were associated with various groups of sources. Renowned cave paintings of the Upper Paleolithic have played a major role in the studies of pigment production, but only recently have other spheres of pigment use become of scientific interest, such as ornamentation of dwellings and single inventory categories. The investigations conducted on the sites of Southern Moravia have yielded hundreds of ceramic items

and their fragments from Upper Paleolithic layers, and thus promoted the awareness of ceramics issues to a large degree. Ever since the discovery, artifacts of the same type have drawn scientific attention and the number of sites with the same artifacts has been growing.

A major role in Russian investigations of Upper Paleolithic pigment and ceramics belongs to N. D. Praslov and to the Kostienki-1 site, which took him many years to excavate. In cultural deposits of the site he uncovered multiple evidence of pigment use for painting household objects and various articles of bone and marlstone, as well as obvious traces of clay processing for household purposes. Praslov (1991, 1992a,b, 1997, 2005) published some results of the research in a number of papers along with the results of physical and chemical analysis of some ceramics and pigment samples. Unfortunately, the character of the artifacts, their composition and bedding conditions were not fully interpreted in his works and the research itself was initially interrupted due to the poor financing which Russian science had to face during the post-Soviet period and then by the death of the scientist himself.

According to Praslov, the Kostienki-1 site yielded approximately 400 ceramics fragments of different size (Praslov 1991). In his opinion, almost all of them were the remains of the coating of the ground part of hearth constructions. In 1988-1989 a solid stain of burnt clay of about 3–4 sq. m was recorded on the site. Praslov interpreted this stain as the remains of a clay stove similar to the one uncovered at the Dolní Věstonice site in Moravia. Many ceramics fragments had traces of little wooden twigs. Praslov also cites a common example of little lumps of burnt clay embedded in the shape of a somewhat protruding semicircle, which he believes to be the remains of a vessel made of little twigs and smeared with clay. However, not all of these observations were supported by pictures, photographs or maps and were presented only in preliminary publication.

Character of clay: Physical and chemical analyses

In support of the assumption that the lumps of clay from the Kostienki-1 site were indeed ceramics, Praslov selected some of them for physical and chemical analyses (Praslov 1992a), which were carried out by A. G. Chernyakhovsky (Institute of Geography RAS) and by B. G. Gradusov (V. V. Dokuchaev Soil Science Institute). The results of the analyses turned out to be of great interest. First, they proved that in their composition the studied clay samples were unlike the loess-like loam where they were bedded. This meant that clay raw material for making articles and smear was brought to the site from somewhere else. It is a very important observation, for other studies of the Upper Paleolithic ceramics samples claimed that their raw material was the same rocks that contained the cultural remains, that is, a raw material that was found on site (see Vandiver *et al.* 1989; Soffer *et al.* 1993; Vandiver and Vasilyev 2002).

Secondly, it was proved that there are good grounds to claim that the studied lumps of clay were exposed to thermal influence. This was indicated by:

- the data from petrographic analysis indicating the beginning of carbon compound disturbance processes and thermal changes of the clay component itself;
- x-ray-phase analysis indicating the disturbance processes of some of the rocks (chlorite, mica-hydramicaceous, etc);
- comparative analysis of thermal changes of ceramics samples and raw material, which was presumably used for the production of the former one (the similarity in chemical and substantial composition).

The final result was the defining of a possible temperature range for firing the studied samples, from 500 to 860–940 °C.

Unfortunately, the published research results do not indicate whether the samples selected for analysis were associated with the objects mentioned by Praslov when he characterized the clay articles finds from Kostienki-1 site. It is known that these samples were recovered from square O\80 which was occupied by a hearth. Another thing that remains unknown is how the samples looked and whether they had any traces of shaping or any prints on their surface. Therefore, it is difficult to interpret the published results as unambiguous evidence that ceramics technologies

Figure 1: Kostienki-4. South complex. Molded sample of white paint. Old collections.

Figure 2: Kostienki-4. South complex. Sliced baked (?) clay mass. Old collections.

were wielded by the inhabitants of the site. Considering their bedding conditions in the hearth and in its immediate vicinity, it should be noted that the samples are the remains of clay which had been brought to the site and used in constructing the hearth and the area around it. In this case the thermal changes in the samples can reflect the effects of certain ways of clay exploitation rather than intentional production of the ceramic items by way of firing.

Thus, the question about the character of clay use by the earliest inhabitants of Kostienki-1 site remains opens to discussion and requires further research. The use of clay for household purposes has already been proven. However, in order to understand whether ceramic items were produced intentionally, it is necessary to carry out an analysis of the whole collection of samples to reveal if any traces of shaping were present. It should also be noted that after Praslov's publication of the findings of ceramics in Kostienki-1, similar artifacts have been found in other sites, such as Kostienki-4 (Figure 1, 2) and Zaraysk (Soffer *et al.* 2000).

Pigments at Kostienki-1

The pigments from the site of Kostienki-1 present a rich palette of colors with red, ocher, black and white as the most common (Praslov 1992b, 1997, 2005). They were used to paint the floors of the dwellings, mammoth tusks and bones which were part of the roof of the dwelling pits, and single articles and art pieces. Praslov does not indicate any color preferences in painting the interior or the articles. At the same time, however, when reviewing the materials from the Mezinskaya site, he points to planigraphic inconsistency in the use of red and black pigments, which he correlates with ethnographic data which contrast the red and the black (Praslov 2005). These observations set serious objectives for archeologists, which require thorough planigraphic investigations and a search for patterns of pigment use.

The importance and prospectivity of such kind of survey is proved by other materials. Praslov points out that the earliest inhabitants of Kostienki-1 site used various shades of red. The reason for such a variety, on the one hand, is accounted for by instability of the technology for obtaining pigment. According to Praslov's experimental research, different duration of roasting of different ferriferous compounds, which served as the source of pigment, led to the production of shades from dark-cherry to ocher-yellowish (Praslov 1992b). But, on the other hand, the variety of colors could have a certain meaning. Besides, it should be noted that color variations in Kostienki-1 materials can be caused by chronological or cultural discontinuity of the objects preserved in a horizon. This possibility is indicated by the materials from Kostienki-4 site, where the floor of the deep dwellings of different types was covered with red pigment of various shades.

All of this raises a number of questions which are essential in understanding the peculiarities of pigment use by the inhabitants of the Kostienki-1 site. First, it is obvious that with such a rich color palette it is necessary to create its precise scale. Otherwise, it would be too difficult to even prove the fact of the color palette diversity of the site. Second, it is necessary to indicate and define all possible types

of ferriferous compounds which might have been employed by the earliest humans to obtain pigments, and then experimentally obtain samples of different shades by way of roasting of base minerals under different temperatures and conditions. The importance of such experiments consists in the fact that with their help it is possible to evaluate the earliest inhabitant's ability to control fire. Besides, it has significant meaning as far as the general technological competence of the Upper Paleolithic human is concerned, as well as the development of the research on pottery origins, as the fire-wielding skills are viewed as a most essential prerequisite for the development of ceramics production.

The presence of black pigment in the materials from the Kostienki-1 site presents an interesting question. Here it is represented by finds of two types: a cultural layer colored in black (judging from the labels, the samples were taken as a black pigment), as well as articles and mammoth bones with traces of black pigment. Unfortunately, intentional coloring of the ground in black is very difficult to prove. The roasting of ground samples in a muffle furnace less than 600 degrees for 15 minutes led to a complete removal of the black pigment, which points to the fact that the source of the latter was carbon compounds. However, it is important to note that such compounds (e.g. soot) were intentionally used by earliest humans for strengthening the color of the floors of their sites. There are complications in capturing black pigment on bones. Praslov indicated that in reality it is difficult to distinguish between a black bone colored artificially and one colored in a natural way (Praslov 1992b). Of great significance is the reconstruction of the technologies of obtaining of black pigment, as well as revealing of organic component. At the same time, it is obvious that to develop this issue further it is necessary to use the objects which have already been proven to have artificial black pigment. Thus, the problem of the search for the criteria of defining black pigment remains open.

The study of the white pigment is intricate as well. Kostienki-1 is the only site on the territory of Russia with the presence of white pigment. It was also used to color the floors of the dwelling pits and household constructions. It is interesting to

Figure 3: Kostienki-1. Second complex, layer 1. Sample of the floor alternately colored with red and white pigments.

note that white pigment was either mixed with the soil or it covered black and red parts in the form of a layer, i.e. it always presented the upper layer on the surfaces of colored parts of the floor (Figure 3). It is possible that the white pigment was used to obtain special shades of red. Praslov particularly mentions a storage pit with three thin layers of pink pigment. The layers preserved the shape of a crease on fabric or skin which made it possible to assume that the pit contained a pink-colored article of the same material. Pink pigment itself could have been obtained by way of mixing red and white pigments. When studying the white pigment the main questions remain the same as with the black pigment, i.e. the search for criteria for intentional use of white pigment and the reconstruction of the obtaining technologies.

Thus, we have a series of most interesting questions to deal with. The answer to these questions slowly but surely brings us to the possibility of reconstructing the ritual aspects of life of the earliest humans which were an inseparable part of their everyday life.

Résumé

N. D. Praslov a joué un rôle considérable dans le développement des études consacrées à la peinture et aux artéfacts en terre cuite du Paléolithique supérieur en Russie. La couche culturelle supérieure de Kostienki 1 se distingue par la présence abondante de colorants, à côté de divers objets d'art en os et en calcaire, ainsi que par l'utilisation intentionnelle de l'argile à des fins domestiques. D'après Praslov, Kostienki 1 a livré environ 400 restes d'objects en terre cuite. Une large tache de sédiment coloré a été interprétée comme vestige d´une structure de combustion similaire au « four » documenté à Dolní Věstonice. Une série d'analyses physico-chimiques sur un échantillon d'objets en terre cuite de Kostienki 1 a permis de montrer que leur composition est différente du loess sur lequel repose le site, si bien que les matières premières argileuses apportées sur le site proviennent manifestement d'un autre endroit. En outre, il a été constaté que les échantillons analysés ont été soumis à des contraintes thermiques, avec une température de chauffe estimée à 500–860 à 940 degrés Celsius. Les matériaux colorants de Kostienki 1 présentent une palette riche, dans laquelle les couleurs primaires sont le rouge, l'ocre, le noir et le blanc. Ces couleurs ont été utilisées pour la coloration du sol, de pièces artisanales et d'objets d'art. Tandis que Praslov a publié une partie des résultats de ses études, la nature des artéfacts et leur composition n'ont pas fait l'objet de descriptions exhaustives. Qui plus est, les études de Praslov ont été interrompues en raison de graves difficultés financières, propres au milieu scientifique russe en période post-soviétique, puis en raison du décès de Praslov. Nous disposons à l'heure actuelle d´une importante base de données présentant de nombreuses perspectives de recherche.

Zusammenfassung

Wegweisend für die Entwicklung von Untersuchungen zu altsteinzeitlichen Farbstoffen und Keramiken in Russland sind die Arbeiten von N.D. Praslov. In der oberen Kulturschicht von Kostienki 1 wurden zahlreiche Belege für die Verwendung sowohl von Farbstoffen als auch von Ton dokumentiert, sowie diverse aus Knochen und Kalkstein geformte Kunstobjekte geborgen. Gemäß N.D. Praslov wurden in Kostienki 1 etwa 400 Keramikobjekte unterschiedlicher Größe aufgefunden. Fast alle waren Reste des Lehmverputzes eines Ofens,

der vermutlich jenem aus Dolní Věstonice ähnlich war. Die Ergebnisse einer Reihe physikalischer und chemischer Analysen der Keramikproben aus Kostienki 1 zeigen , dass sich die Keramik in ihrer Materialzusammensetzung vom umgebenden Löss unterscheidet, d.h. der Ton wurde in die Fundstelle eingebracht. Es wurde auch festgestellt, dass das Material thermisch verändert worden war. Für den Brand wurde ein Temperaturbereich von etwa 500–860 bis maximal 940 Grad ermittelt. Die Farbmaterialien von Kostienki 1 bilden eine reichhaltige Palette mit den Primärfarben rot, ocker, schwarz und weiß. Die Farben wurden für die Einfärbung von Befunden, sowie für Handwerks- und Kunstgegenstände verwendet. Einige Ergebnisse dieser Untersuchungen wurden von N. D. Praslov veröffentlicht. Leider sind die Lagerungsbedingungen der Funde und ihre Zusammensetzung aus seinen Artikeln nicht zu ermitteln. Die Studien wurden von den schwierigen finanziellen Verhältnissen der russischen Wissenschaft in post-sowjetischer Zeit beeinträchtigt und schließlich von N. D. Praslovs Tod unterbrochen. Inzwischen wurden die Untersuchungen wieder aufgenommen und erweisen sich als sehr vielversprechend.

SOME COMPARISONS OF THE PALEOLITHIC CAVE ART BETWEEN THE URALS AND WESTERN EUROPE

Vladimir N. Shirokov

Abstract
The article compares the caves of the South Urals with those of Western European with regard to Upper Paleolithic rock paintings. Where necessary, brief comparisons are made using various parameters (placement of the ancient drawings, their topics, iconography and style). It can be concluded that the decorated caves of these two centers of Paleolithic cave art are very similar, and that the extent of the similarities cannot be explained through adopting a positios of convergence. According to the author, such similarities originated from certain periods in the Upper Paleolithic when similar natural conditions prevailed over the vast expanse of Northern Eurasia. These were favorable both for the migrations of people and for the transfer or exchange of technologies, ideas, and styles. The breakthrough of late Gravettian unity preconditioned the phenomenological affinity of Paleolithic cave art from the Atlantic Ocean to the Urals, while the roots of the Southern Ural center of Paleolithic art go back to the West European tradition.

Keywords
Paleolithic art, decorated caves, Gravettian, Upper Paleolithic, Ural, Franco-Cantabrian region

DOI: 10.5817/CZ.MUNI.M210-7781-2015-26

Introduction

In the Urals there are three caves with upper Paleolithic rock-art – Kapova, Ignatievskaya and Serpievskaya 2. With regard to the sources of the phenomenon of the upper Paleolithic pictorial ensembles of the southern Urals, O. N. Bader considered the appearance of the paintings in the Kapova Cave to have converged, and not to be dependent on the phenomenon of Western European decorated caves

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(Bader 1965). V. E. Shchelinsky does not address this issue in his publications (Shchelinskiy 1990, 1997, 2001; Schelinskiy and Shirokov 1999). V. T. Petrin suggests that the creators of the paintings in the Ignatievskaya cave originated from the Atlantic Europe caves (Petrin 1992). Z. A. Abramova identified many features that were common to the Kapova Cave and those of Western Europe. However, it is difficult to reach any clear conclusions on this matter (Abramova 1997). This article attempts to describe the decorated caves of the Urals and Western Europe and to explain their similarities. Let us briefly recall the main characteristics of the caves of Urals.

The Kapova Cave

The Kapova cave is located on the right bank of the river Belaya, approximately 250 km south of Ufa. The length of the cavity, which has three main hypsometric levels, is over 2 km. Over 50 various paintings were found in the cave in the Halls of drawings (on the upper level) and Cupola, Signs and Chaos at the middle levels, divided by a 14 m karst well. All the drawings used red paint of various shades. Black paint was used in the outline of horse image in the middle level (the article only refers to the results from the expedition of V. E. Shchelinskiy).

The repertory of the pictures included animal figures, signs in the form of different geometric shapes, zooanthropomorphic figures and undefined images. The animal paintings, including bison, rhinoceros, six or seven mammoths and four or five horses, used a realistic style. Practically all of them were represented in motion, with four legs. Four mammoths were depicted with tusks. Only two horses were located in the middle level, with other animals at the upper level. The technique and stylistic characteristics of the drawings were varied and included outlines and contour-silhouettes. The figure of the rhinoceros had an outline with a lined internal contour.

There are approximately four times many signs than animals. Different shades of ochre were used for their. Among the signs were dotted lines and a few unbroken lines and spots. The most numerous were the trapezoids with lined internal contours. These can be considered to be specific to the Kapova Cave. The signs were mainly concentrated in the middle level; in the upper level there was only one, but the largest trapeze with "ears" and a lined internal contour. The zooanthropomorphic creature was at the end of the middle level, at the height of about 3 meters above the floor. The picture was an outline, with a partially rendered human body and the head of a mammoth. The front limbs ended with the hooves of a cavicorn, with a horse's hind legs and the tail. Behind the drawing, on an overhanging wall, there was a number of unclear and poorly preserved signs.

The age of the drawings was clarified by the excavations in the middle tier of the cave, 200 meters from the entrance. A thin cultural layer was found with the remains of three fireplaces, of which two were small. There was also a larger one of about 1 m in diameter. The people who visited the cave left about 200 stone tools made from jasper, siliceous slate, limestone and sandstone. The most common tools

were retouched blades, points, and scrapers, notched tools and backed blades. An important find was a fragment from the Gravette point. Apart from the tools, there were also some decorations among the finds including four serpentine beads, of which three were of a cylindrical shape and one was flat, as well as numerous perforated clam shells, representing the remains of a necklace. The bone pieces were represented by a scraper and a borer. A lamp from the burnt clay can be considered a unique find. Small pieces of ochre found in the dig provided evidence that the paints were made there, and a small limestone block with an image that had fallen off the wall appeared to synchronise the wall paintings and the cultural layer. The figures for the radiocarbon analysis of the charcoal from the layer were: 14, 680 ± 150 BP; 13, 990 ± 130 BP; 15, 050 ± 100 BP; 16, 010 ± 100 BP (Shchelinskiy and Shirokov 1999).

The Ignatievskaya Cave

The Ignatievskaya Cave is located on the Sim River, a tributary of the Belaya. It includes over 600 meters of passages and is on average three meters wide and two meters high with a flat horizontal ceiling and four main chambers: an Entrance Hall, a Main Corridor, a Large Hall, and a Far Hall. The last two are connected by two narrow passages. The area of the floor is 1,730 m^2 and the volume of the cavity is 3,100 m^3. There are calcite and mondmilch on the walls and a ceiling in the Large and Far Halls. The paintings are located only in the Large and Far Halls, around 120 m from the entrances. In the Large Hall, pictographs were placed on vertical and sloping walls and ceilings, as well as in niches and depressions. Images are also located on a large pillar. In contrast, most pictographs in the Far Hall are painted on the ceiling, with only a few on the walls. The size of the drawings varies from approximately 1.5 centimeters for symbols to 2.3 meters for animals. The lines are between 1.0 to 5.0 centimeters wide. Two colors are used in the paintings: shades of red (iron oxide) and black (charcoal). In the Far Hall, black figures dominate. In Large Hall, red paintings are more prominent.

The images are of animals, symbols, anthropomorphs and indefinite motifs. Representations of mammoths (six or seven) and horses (four) constitute a majority of the animal images. There are also paintings of a rhinoceros-like animal, a composite animal with a camel-like body, one animal with a horse body and head, and ox horn, and a fantastic mammoth-like creature. All the animals in the Large Hall were sketched as shaded silhouettes, with minimal features depicted. Some mammoth drawings do not show a deep cervical steals and only one has tusks. A horse image is sketchily drawn without a mane or ears. Anthropomorphic images in Far Hall are represented by a black male figure and a red female figure. These anthropomorphs form a complex composition with a large figure of a rhinoceros. There is a black drawing of a phantom. A red motif in Large Hall is characterized as an aviaform. All these figures are outlines. The numerous signs include single lines and groups, dots, spirals, serpentiforms, one claviform, arrow-shaped forms, tridents, triangles, extended parallelograms, scalariforms and anchor-shaped motifs,

as well as patches of color. One ring-shaped motif looks like a rhinoceros footprint, which is unique to the Ignatievskaya cave.

Archeological excavation undertaken in the cave uncovered an Upper Paleolithic level. Its sediments contained fragments of charcoal, stone and bone artifacts, as well as small pieces of ochre, ornaments and animal bones. More than 1,300 stone tools were unearthed, mostly near the cave entrance. They were made from jasper, flint, quartzite, sandstone and limestone. Scrapers, retouched flakes and blades, burins, scaled pieces and notched denticulate forms were the moist common artifacts. There were also blades with blunted edges, including some worked at the ends. Two pendants had been made from the canine of a polar fox and a tooth of a bison. Two tiny round flat beads were made from tusks. Artifacts from the Ignatievskaya cave are very similar to those from other Uralian sites (including the decorated Kapova Cave).

Three radiocarbon dates obtained from charcoal from the Large Hall placed human activity in the Ignatievskaya cave in the Late Pleistocene: 14, 240 ± 150 uncal BP; 13, 335 ± 195 uncal BP; 10, 400 ± 485 uncal BP (Petrin 1992; Petrin and Shirokov 1991; Shchelinskij and Shirokov 1999; Shirokov and Petrin 2013). However the direct dates of a black pigment, identified by method ^{14}C AMS in the USA, appeared in the Holocene age (Steelman *et al.* 2002). In my opinion, these ^{14}C dates for paintings in the Ignatievskaya Cave are not correct (Shirokov 2006). Since mondmilch covers some art motifs located on the cave walls and culture deposits, it seems plausible that some images in Ignatievskaya cave are at least 10, 000 years old.

The Serpievskaya 2 Cave

Serpievskaya 2 Cave is situated twelve kilometers south from Ignatievskaya Cave on the Sim River. It is a typical horizontal corridor type cave. Its total length is about 200 m. The depictions here are badly damaged and represented by remnants of sub-parallel lines, spots of paint, a hut-like motif, and two badly preserved animal figures; one of which resembles a reindeer, the other the head of animal. The paintings in the depths of the cave reflect a direct influence of the Paleolithic tradition. With a high degree of probability one can consider that the motifs in Serpievskaya 2 belong to the Upper Paleolithic. Charcoal found in the Late Pleistocene layers also points to this. There are no cultural remains of the Holocene in the cave. Moreover, 50 m to the west of Serpievskaya 2, there is an Upper Paleolithic site in the grottos of Kamennoe Kol'tso.

The very bad state of preservation and almost total absence of readable depictions make interpretation difficult. One can assume that some spots of paint might be some kind of marking signs, especially in the 6th group, where two spots can be seen in the narrow part of the main corridor in front of the second hall. One can consider some depictions in the Ignatievskaya cave as having the same function. These signs probably marked out the spatial parts of the underground galleries, for the purpose of orientation, and at the same time gave a different ritual-mythological status to different parts of a cave.

Approximately 60 m from the entrance, there is a naturally sculpted formation in the shape of an animal head, resembling a feline. The "sculpture" is situated at a height of about 2.0 m above the floor and juts out 0.5 m from the right wall. Engraved motifs are found on the left side of the animal's "neck". Chaotic lines thinner than 1 mm are cut in a square about 30 × 20 cm, and there are some zigzag motives. They were inspected by archeozoologists N. Smirnov, P. Kosintsev and A. Ulitko, and in their opinion no animal could leave such traces. Only one artifact was found in the deposits - bone awl. Many very small pieces of charcoal and animal bones were also found. The faunal remains belong to the Upper Paleolithic. Materials from the cave of Serpievskaya 2 are close – in faunal content and correlation of the species - to the analogous finds from the upper horizons of Ignatievskaya cave, and characterize the final stages of development of the Upper Paleolithic faunal complex in the Southern Urals (Petrin *et al.* 1990; Kosintsev *et al.* 2011).

Collection of stone artifacts from Kapova and Ignatievskaya caves show some similarities. According to the researcher Kapova cave V. E. Shchelinskiy: *"The cultural attributes of the archeological complex sanctuary Shulgan-Tash are quite clear. This is a typical upper Paleolithic, which can be found, for example, to the West of the Urals on the East European plain. In the complex there are tools on the normal blades, well-defined microtools in General late Gravettian appearance. (...) The fact of the presence in the complex of jewelry from fossil shells of molluscs, the most famous in the Volga region and Caspian region, allows us to think about possible links with the upper Paleolithic cultural traditions of the Shulgan-Tash sanctuary in this region"* (Shchelinskiy 1997, 34). I also note that some of the signs of the stone inventory of the late upper Paleolithic in the Middle and South Urals are inherent in the industries of the late Gravettian and Epigravettian eras. This particular refers to the backed blade lets, the truncated backed bladelets and the micropoints.

Some experts believe that the Urals were not a significant barrier to the movement of people and materials at the end of the Pleistocene. S. V. Vasil'ev sees confirmation of this in European features in the complex artifacts of site Chernoozerye II in Irtysh, which appears to have dominated by the use of "*(…) debitage prismatic bladelets (...) dominate scrapers, retouched bladelets, burins, and notched tools. There are no analogues in the materials (Siberia - auth.) and a specific set of tools and ornaments made of bone. This complex has a pronounced European character; and contrasts sharply with the well-known Altai, the Yenisei and the Angara complexes" (Vasil'ev 1990, 83–84). According to Grigoriev G. P. (2001, 120–121), "The Urals (...) were not the boundary between upper Paleolithic Europe and Siberia, but an area in which (probably, at different times) carriers Siberian Paleolithic and groups of European population, had penetrated and lived there".*

Some comparisons between Ural and West-European caves

The decorated upper Paleolithic caves of the South Urals and Western Europe have a number of similarities. Drawings of mammoths and horses are the most numerous in the Kapova and Ignatievskaya caves. By the end of the 20th century, more than

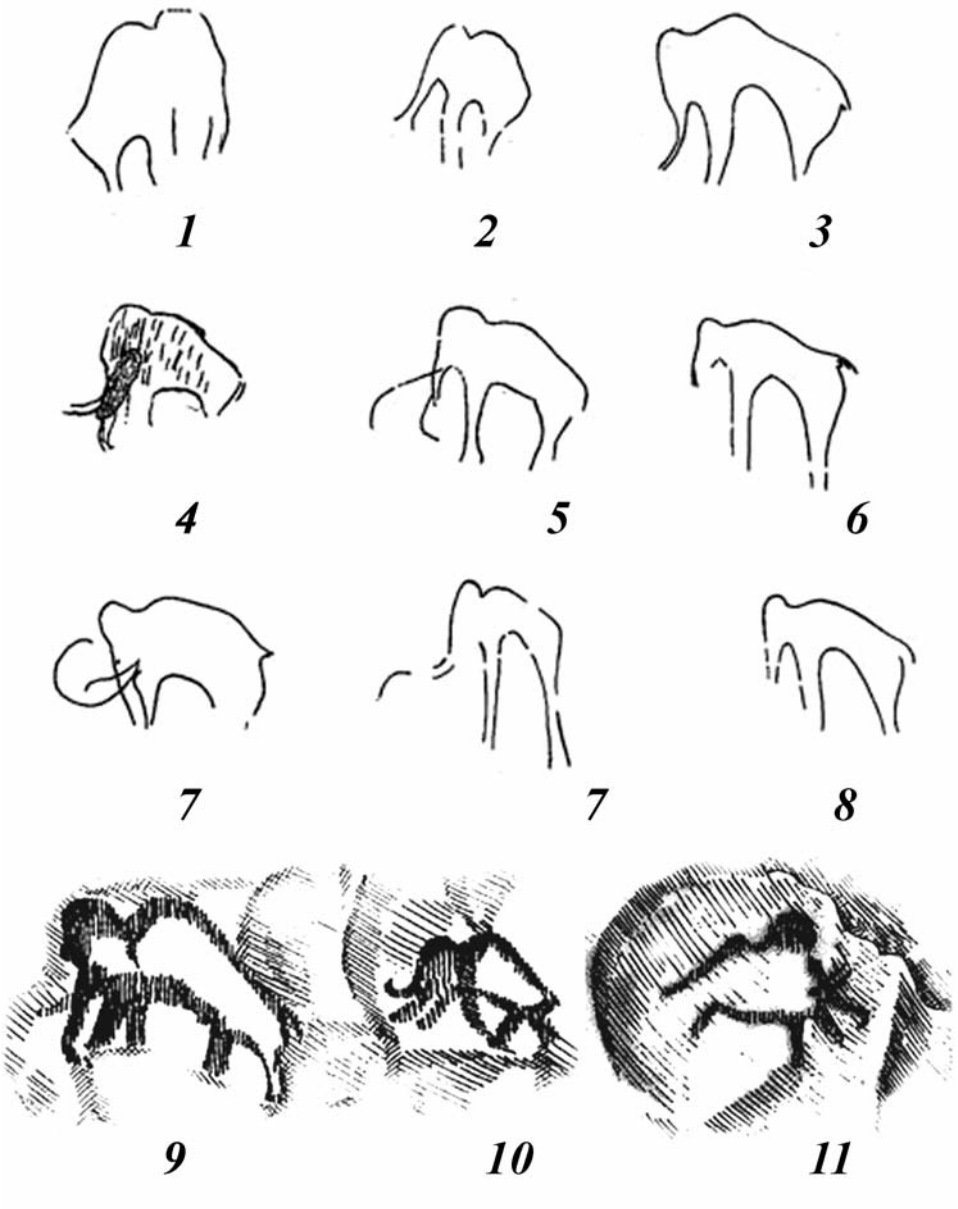

Figure 1: Images of mammoths with bellies in style of "ventral arch" from the caves:
1–2 – Chabot; 3 – Chauvet;
4 – Pech-Merle; 5 – Cougnac;
6–7 – Roucadour; 8 – La Greze;
9 – Jovelle (after Combier, Delluc, Glory, Lorblanchet);
10–12 – Kapova Cave (after Shchelinskiy).

400 Paleolithic images of mammoths, in the form of both wall art and mobile art, had been found of Eurasia. More than 40 caves with figures of mammoths are known, for the most part in Ariège, in the departments of the Lot and Dordogne, France. Drawings of mammoths are found in the Iberian region: El Castillo, Arco B and Pindal of Cantabria. These include a total of approximately 370 mammoths in the Franco-Cantabrian (Bosinski 1999) about 15 images in the Urals, in the Kapova and Ignatievskaya caves.

The art techniques used in the caves often consist of engraving, as well as finger or stick on mondmilch. Colorful drawings in red and black are also found, along

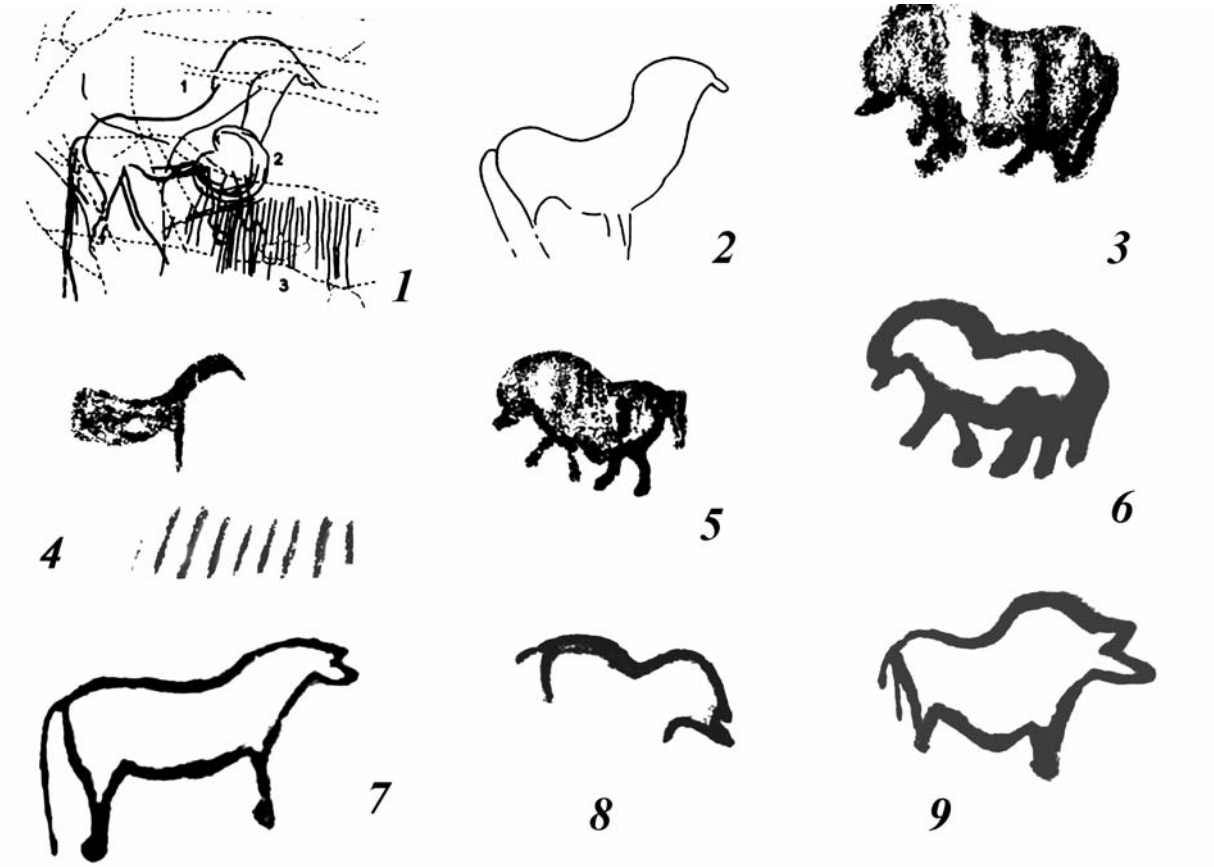

Figure 2: Depictions of horses in style of "head in a Kapor" and with a muzzle "beak of a duck": 1, 2 – Roucadour (Gravettian, after Lorblanchet); 3, 5 – Kapova Cave (afte Shchelinskiy); 6 – Kapova Cave (photo by author); 7 – Pech-Merle (Gravettian, may be Solutrean) (after Lorblanchet); 4, 8, 9 – Ignatievskaya Cave.

with some red images in El Castillo and Pindal (Spain), Arcy-sur-Cure (France) and some other places (Bosinski 1999). Detailed figures and simple condensed motives in the form typical of spinal lines or partial contours can also be found for in Les Combarelles.

The period of between 30.0–20.0 kya features numerous drawings of mammoths. All the figures are stylized, with deep lowered ass-domed skulls, often with oversized feet, and are generally attributed to the people of the Solutrean or Gravettian cultures. This period also has unusual drawings of mammoths in *Pair - non - Pair,* Arcy-sur-Cure and Chauvet. It is characterized by specific stylistic features of playback animals, with elongated legs and parabolic bellies. This way of line modeling of the abdomen is also called the "ventral arch" or "horse hoof". It is a style typical of the caves and gorges of the Ardéche (Chabot, Figuier, Le Deux Ouvertures), and of regions of the Dordogne and Perigord (Jovelle, La Grèze), and Lot (Pech-Merle, Cougnac, Roucadour) (Bahn 1997). The period of between 20.0 to 12.5 ky has many images of mammoths. There are two main types. The oldest and the most numerous are depictions with natural features in Rouffignac and Font-de-Gaume, dating back to around 18.0–14.0 ky. The drawings in the Kapova cave seemed to have appeared somewhat later. It is interesting that in the Kapova cave many mammoths retain the features of the Western European style of the preceding period. Four of them feature

massive dome-shaped heads, deep cervical steals, loose rear parts and concave bellies (ventral arches) (Figure 1). However, the reproduction of mammoths in the Kapova Cave with four legs in motion is more similar to the the Magdalenian drawings.

The second group of images in the Franco-Cantabrian area has specific forms and features, and shows every animal in different poses and movements. The motives of this group are better represented in portable engraving art (Bahn 1997). The red mammoths in the Ignatievskaya cave largely correspond to the characteristics of the second group of figures of the Franco-Cantabrian region. However, unlike them, they are extremely schematic, with tinted silhouettes for torsos. A black contour mammoth on the red panel in the Far Hall shows movement, but only two limbs are shown, and the line of the belly is almost straight.

In the caves of Western Europe there are drawings of mammoths with fantastic features. Such images are generated not by nature but by the human imagination. In the central part of the decorations in Chauvet, among the panels of lions, is inscribed an unusual little creatures with the head of a mammoth and a short trunk. There is also a figure with a long body which shows little resemblance to the trunk of a mammoth. The animal has no tail and four long limbs with rounded ends, as seen in the fantastic mammoths of Baume-Latrone. This background features an odd looking black mammoth-like creature similar to one in the Far Hall of the Ignatievskaya Cave. More than 1,000 images of horses exist on walls and in mobile art. Studying the iconography of the drawings of horses reveals important stylistic characteristics. For example, the Gravettian figures tend to have long heads, the Solutrean horses have smaller heads and the Madeleine figures of horses have a tendency towards tiny heads. On some of the shoulders of drawings of horses there are strips resembling zebra colors (for example, in Ekain). Charles Darwin noticed these among specimens of wild horses living in his time (Altuna and Altxerri 1996). It is curious that the torso of one of the red horses in the Kapova Cave is covered with black lines.

The horse was of great cultural significance to the people of the upper Paleolithic in Western Europe. The teeth and bones of horses were found in Magdalenian hearths in the deep Pyreneean caves of Labastide and Erberua. Their presence around lesions on Magdalenian sites under the open sky at Pincevent near Paris is particularly impressive, along with the remains of reindeer (Bahn Vertut 1997, 141–142). In the ancient phase of the middle period of Upper Paleolithic in Western Europe, from approximately 30.0 to 22.0 ky, members of the Gravettian - Solutrean cultures depicted horses as having rounded shapes and proportionally delicate limbs. The edges of their muzzles are heightened and their manes contain an impression of headgear in the form of hood. This morphology of the head has been called the "beak of a duck", and was regarded as characteristic of images of horses in the middle period of Upper Paleolithic. However, this technique is found still and in the Madeleine.

In the Kapova and Ignatievskaya Caves, all the horses are contoured in red and black colors. In the Kapova Cave all of them, as mentioned above, have a luxuriant mane and a narrow muzzle. They are surprisingly reminiscent of the heads of the horses in Western-European caves in the middle period of Upper Paleolithic. However, this feature is somewhat altered in the shapes of horses in the middle floor

of the Panel where the end of the muzzle is slightly sharpened up. The presence of four legs on the horses, showing movement, without showing the front hooves, is typical of Solutrean and old Magdalenian periods (Figure 2).

In the Ignatievskaya Cave, the iconography of middle period Upper Paleolithic can be seen in the the example of two horses on the black panel in the Far Hall. One of these is incomplete. The same technique can be seen in the little red horse of the Great Hall. The presence of only two limbs is a feature of the more ancient style. In Pech Merle there is a black frieze with contour figures of horses, wonderfully reminiscent of the horse on the black panel of the Ignatievskaya Cave.

The animalistic theme of both regions features similar partial playback pictures. These are animals which are drawn without heads, such as bears in Ekain (Altuna and Altxerri 1996) and the little black horse on the black panel in the Ignatievskaya Cave. Animalistic motifs only appear in the form of animal heads, as in the Serpievskaya 2 Cave and in the Grote El Castillo (Spain), where there are no less than nine (Diez and Rodriquez 2010). Numerous partial contours of animals in the Franco-Cantabrian caves are similar to the horses on the black panel of the Ignatievskaya Cave. Both have fantastic animalistic motives, among which are "the caricature" and are composed of various parts of animals. These include horses and mammoths from Mayenne-Science, mammoths from La Baume-Latrone, "antelopes" from Pech Merle (Lorblanchet 1995) and a small red mammoth, a black mammoth-like creation and an animal with the torso of a camel, and horse with horn in the Ignatievskaya Cave.

Other pictorial themes are also similar. Zoo-anthropomorphic creatures play an important role in Western European Paleolithic art. They appear in the Gravettian, but are particularly numerous in the Madeleine. Anthropomorphic creatures with the heads of bison appear in caves in Chauvet, Gabillou, Trois Frères and some others. Zoo-anthropomorphic creatures with the features of mammoths can be seen in Combarelles, Gabillou, and some others. These have a strikingly similarly composed zoo-anthropomorphic character to those in the Kapova Cave (Figure 3).

Humanoid beings from Ignatievskaya Caves are presented as so-called "stick-style" figures with male and female sexual symbolism. Such figures are not typical of the caves in France and Spain, which can be explained by regional specificity. It may be recalled that in the Kapova Cave on the West panels, the use of computer strengthening identified the profile of an anthropomorphic figure in the same "stick-style". Similar schematic sculptural forms can be seen in the Dolní Věstonice (Gravettian). Reproductions of individual parts of the human figure known as "phantoms" also appear in a similar way in Ignatievskaya, and in many caves of Western Europe (Figure 4).

Nonfigurative motives in the two areas are generally similar. Sometimes simple signs in the form of straight or wavy lines, groups of dots, lined quadrangles or "scalariforms" appear. However, in Ignatievskaya cave, claviforms can be seen which are strikingly reminiscent of some similar motifs in Western Europe. Such depictions were widespread at about the same time, as seen in the drawings in Ignatievskaya cave. These characters are mainly distributed in the French Pyrenees

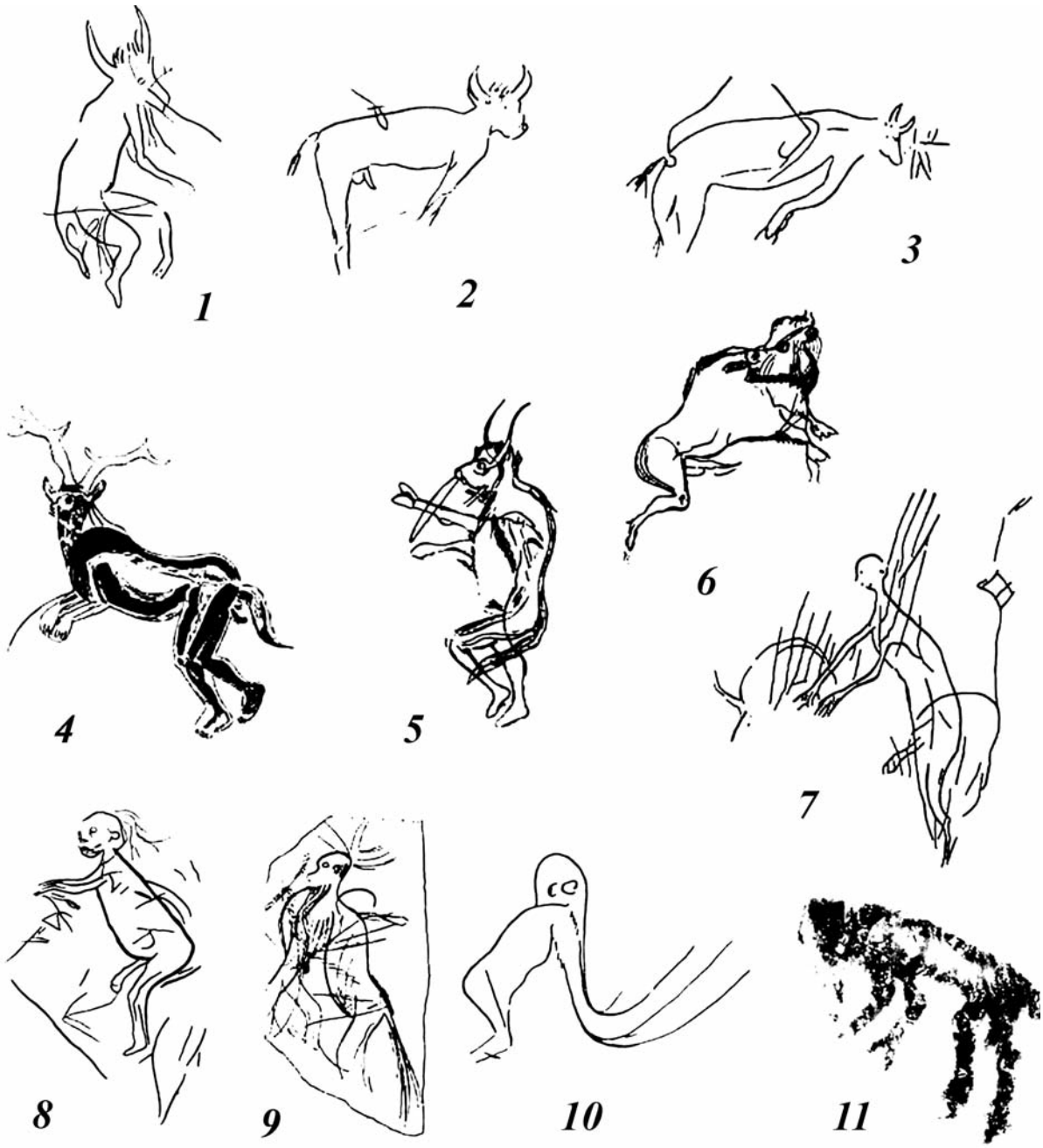

Figure 3: Image zooantropomorphous beings in cave art of Western Europe and Urals: 1–3, 10 – Gabillou; 4–6 – Les Trois Freres; 7 – Sou-Grand Lac; 8 – Saint Cirq; 9 – Espelugue; 11 – Kapova; 1–10 – after Bosinski.

and Cantabria. Similar signs appear in the form of points or arrows from the Ignatievskaya cave and, for example, in Niaux. One of the engraved signs in the Combarelles cave is reminiscent of the lined trapeze of the Kapova Cave, but without the "ears". The colorful lattice signs in the Herreria caves are very similar (Gonzáles-Pumariega 2008). In Cougnac there are spiraling spots which end in the form of a comma, which are very similar to the two signs in the Ignatievskaya Cave.

Figure 4: Image "phantoms" in cave art of Western Europe and Urals: 1 – Cougnac; 2 – Les Trois Frères; 3–5 – Marsoulas; 6 – Ignatievskaya Cave; 1–5 – after Lorblanchet.

Different types of signs in Western Europe have particular territorial and chronological distribution. This can be seen in the Urals, where the nonfigurative motifs in the Kapova and Ignatievskaya Caves are strikingly different. Thus, there is a considerable similarity between the deep decorated caves of Western Europe and those in the Urals. The first striking feature of their enormous size is their regional peculiarities. The main themes in the repertoire of the Ural caves are identical topics to those of the decorated Paleolithic caves of Western Europe. In addition, in all three caves in the Urals the basic surfaces of the walls are integrated into visual ensembles, which are very typical of the Franco-Cantabrian region.

Discussion

This can mean only one thing: in the period of Upper Paleolithic in Europe, for over 20.0 ky there was a tradition of creating and using decorated caves. It is very probable that this was the first historical religious-mythological continuum, resembling the spread of so-called world religions in the historical period. A. Leroi-Gourhan has compared the Paleolithic decorated caves to the religious temples of later epochs. The distribution of such temples of is a civilizational phenomenon, covering a vast territory and many different peoples and cultures. In our view, the decorated caves are also present a transcultural religious-mythological phenomenon of the ice age, that allows to eliminating the search for identity stone industries in the territory of the caves of the Paleolithic paintings.

According to G. Bosinski (1999, 139–166), there are decorated caves in the Urals which are about 4,000 km to the east from the Western European decorated caves, showing that *"the Ural widely variable wall art belongs to the values of the stone age Europe. They (Ural caves – aut.) are entirely within the framework of the Western European art (...). They have no parameters in Chauvet, Lascaux, or Altamira, but these are the most important caves. Of course, both the Ural caves have their own characteristics. Each cave has its own specific patterns, and it is not easy to explain this as the Kapova and Ignatievskaya caves are a large geographical distance away from each other".*

The flowering of the Paleolithic era in the form of the Gravettian culture occurred around 30.0–22.0 ky and was marked by growing technical and cultural prosperity in the Eurasian and forest steppes. According to J. Svoboda (2011, 93–97), *"…the continuous development of the Gravettian is linked with climate-friendly and stable conditions in karst areas... in the southwest of France and in Northern Spain (…) The Moravian Gravettian culminates in its earlier stage – the Pavlovien, which is also the closest to the complex societies of hunters-gatherers (...). In the younger Villendorf-Kostienkien phase, the Moravian Gravettian is already evident, with the dispersion of the population and the emergence of new centres in the Carpathian region (Pannonia) and in Eastern Europe.*

About 22.0 kya the last glacial maximum affected the whole of Europe (...) The Central European Gravettian era is associated with the herds of large mammals and more intricate floral landscapes which did not survive the process of climate change in all its complexity. There was a continuous development of large inhabited centers in Eastern Europe, far from the glaciers of Fennoscandia, in the basins of such large rivers as the Dniester, the Dnieper and the Don. A similar development could be observed further to the East, along the Angara river" (Svoboda 2011). The completion of the Gravettian era *"saw the creation of a continuous mosaic of Epigravettian cultural formations (22.0–11.0 ky.) In Ukraine and Russia the monuments of Mezin, Mezhyrich or Eliseevichi (...) continue the Gravettian tradition of figurative images, especially in regard to the realistic female characters (Eliseevichi), but the Epigravettian also reacts to certain impulses from Western Europe, where a local perspective of the female image is radically transformed to a simple but typical style with dedicated buttocks Mezin)"*

(Svoboda 2011). Perhaps it is these impulses which lead to the emergence of decorated caves in the southern Urals.

In regard to this, the findings of the Bezymyanniy Cave (Petrin and Smirnov 1977) include a collection of items made from bone, such as part of a bracelet, a three shatter oval in the cross-section of a rod made of mammoth tusk, a large cylindrical bead an awl and a stylized animal figurine of a thin plate mammoth tusk, reminiscent of a feline which is ready to jump. O. N. Bader and V. T. Petrin mapped this in general terms along with animalistic sculptures of lions originating from the Pavlov site (Bader and Petrin 1978). The radiocarbon date, obtained from the bones of an animal for this complex – 19, 240 ± 265 uncal BP, shows that they originated from a time that was close to that of the early Epigravettian sites. To the East of the Urals, bone sculpture in the *contoure decoupé* technique is not known. Large cylindrical beads, similar to those in the Kapova Cave and the Bezymyanniy Cave, have been found. To West of the Urals, the Gravettian sites often feature flat sculpture *contoure decoupé* and cylindrical beads (Pavlov, Dolní Věstonice) (Figure 5).

In the Urals at Shikaevka II, geometric products, including microlits, have been found (Petrin and Smirnov 1975). Many specialists have been inclined to see the Jangelskaya materials as part of Mesolithic culture. However, the available C14 date 18, 050 ± 95 uncal BP (Zenin 2002) provides more evidence of the Gravettian origins of this tradition. In the Pavlovian phase, similar products seem to have been used (Svoboda 2004). Geometric microlites mark an Upper Paleolithic site in a cave in Bayslantash in the southern Urals (Kotov 2004).

As well as the already known small area of territory in the Urals that features wall art, another Carpathian centre of wall art has been found. In 1978 in a cave in

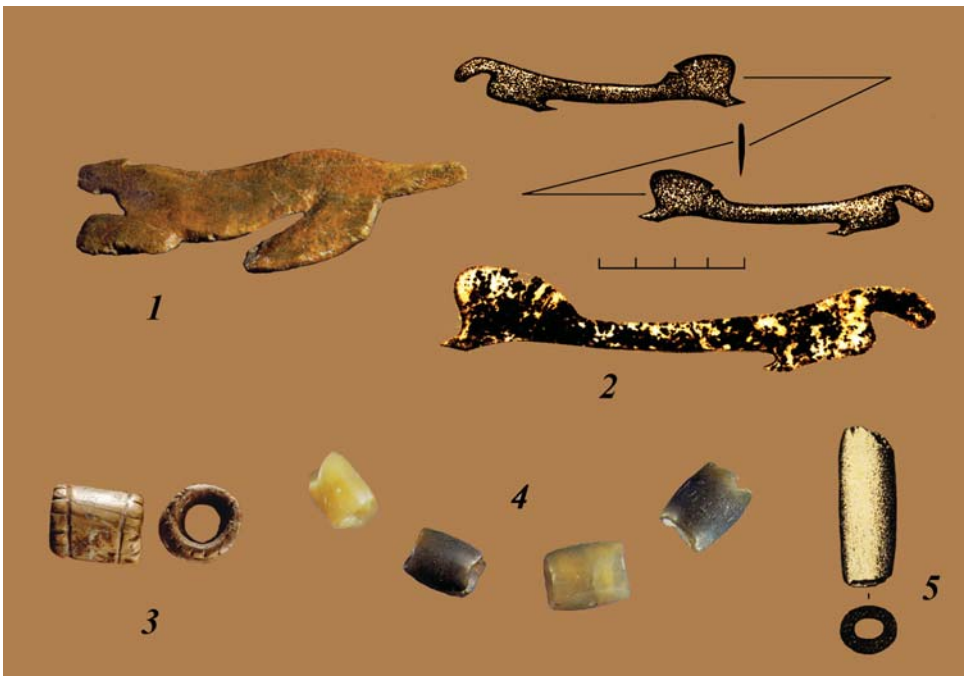

Figure 5: 1 – Pavlov;
2, 5 – Bezymyanniy Cave; 3 – Dolní Věstonice; 4 – Kapova Cave;
1–3 – after Svoboda;
2, 5 – after Petrin.

Cuciulat in northwestern Romania, figures red of horses and felines were found (Càrciumaru 1985). In 2009 Romanian cave explorers discovered images in another cave in Coliboaia. They featured the partial contours of the bodies of black animals from a very early period, resembling the style of the Gravettian culture. This finding indicates that, at the time of the upper Paleolithic in the West and East of Europe, there was a similar tradition of creating images in deep caves. Considering the above, one can assume that in certain periods of the upper Paleolithic, in the vast expanses of Northern Eurasia, favorable conditions for the movement of people, and for the transmission or exchange of technologies, ideas and styles, existed. Thus, the Paleolithic art of the caves in the Urals can be said to have its roots in the Western artistic tradition.

Résumé

L'article compare l'Oural du Sud et l'Europe de l'Ouest grottes avec des peintures murales du Paléolithique supérieur. Par nécessité brève comparaison est effectuée sur les paramètres associés à la mise en place de dessins anciens, leurs thèmes, l'iconographie et le style. Il est conclu que les deux centres grottes d'art rupestre paléolithique décorées sont très proches les uns des autres, de sorte qu'il ne peut pas être expliqué du point de vue de la convergence. Selon l'auteur, sur la base de ces similitudes, il ya certaines périodes du Paléolithique supérieur, lorsque de vastes étendues du nord de l'Eurasie existaient des conditions naturelles similaires favorables à la circulation des personnes, et pour le transfert ou l'échange de technologies, d'idées et de styles. Désagrégation l'unité gravettien tardive conduit commun phénoménologique paléolithique art parietale de l'Atlantique à l'Oural, et le Centre du Sud de l'Oural des grottes ornée paléolithique a ses origines dans la tradition de l'Europe occidentale.

Zusammenfassung

Der Artikel vergleicht jungpaläolithische Höhlen mit Wandmalereien des Süd-Ural und West-Europas. Wo es erforderlich ist, wird ein Vergleich auf der Basis verschiedener Parameter (der Platzierung der alten Zeichnungen, ihre Themen, Ikonographie und Stil) durchgeführt. Aus diesem Vergleich wird gefolgert, dass diese beiden Zentren der altsteinzeitlichen Höhlenkunst viele Ähnlichkeiten aufweisen, die nicht vom Standpunkt der Konvergenz aus erklärbar sind. Der Autor ist der Ansicht, dass diese Ähnlichkeiten aus Perioden des Jungpaläolithikums stammen, in denen im nördlichen Eurasien ähnliche natürliche Bedingungen vorherrschten, die für die Mobilität der Menschen und für die Übertragung oder den Austausch von Technologien, Ideen und Stilen günstig waren. Der Aufbruch der Einheit des Spätgravettien hat zu Gemeinsamkeiten der paläolithischen Höhlenkunst vom Atlantik bis zum Ural geführt. Das Zentrum der paläolithischen Höhlenkunst im Süd- Ural hat ihren Ursprung in der westeuropäischen Tradition.

PART IV

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DARKNESS UNDER CANDLESTICK: GLACIAL REFUGIA ON MOUNTAIN GLACIERS

Ivan Horáček, Vojen Ložek, Markéta Knitlová and Lucie Juřičková

Abstract
The paper surveys MIS3 and MIS2 records of molluscs and vertebrates from two caves in the High Tatra Mountains, situated close to the surface of the Vistulian mountain glaciers. The diversified communities with demanding elements and local endemite species appeared here undoubtedly even during the LGM. In explanation of this fact we reconsidered paleoclimatic and paleo-environmental specificities of high mountain habitats during glaciation and proposed a model suggesting the conditions enabling continuous survival of demanding forms and alpine endemites just on the surface of mountain glaciers.

Keywords
Last Glacial Maximum, biogeography, Tatra Mountains, molluscs, small vertebrates

DOI: 10.5817/CZ.MUNI.M210-7781-2015-27

The problem

The onset of current concepts of the Late Cenozoic climatic dynamics history appearing in the first third of the nineteenth century with discoveries of extensive mountain glaciation in the nearest past, soon evoked hypotheses on its impact upon communities of plants and animals. The resulting concept, which can be regarded as the *central paradigm in European historical biogeography* proposes that (a) the individual species and entire communities shifted southwards in time of glacials, (b) those of Central Europe survived in the *Mediterranean refugia*, and (c) their present ranges were recolonized by postglacial immigrations from the Mediterranean refugia. Of course, as typical of biotic phenomena, no rule is entirely valid, and this is the case with all these predictions as well.

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Molecular phylogeography, a leading approach in current historical biogeography, relied upon the central paradigm quite strongly (Taberlet *et al*. 1998; Hewitt 1999, 2000). It discovered the topic of *cryptic glacial refugia* north of the Mediterranean only by the end of the twentieth century, after refining its methodological capacities (Bilton *et al*. 1998). Since then survival of the LGM in refugia situated either in central or even the northern Europe was indicated for a number of modern European species (among others, see Brunhoff *et al*. 2003; Jaarolla and Searle 2003; Kotlik *et al*. 2006; Teacher *et al*. 2009). This topic subsequently became a mainstream subject of current studies on European historical biogeography, and even now it is instantly widely discussed and popularized in many respects (Stewart and Lister 2001; Sommer and Nadachowski 2006; Birks and Willis 2008; Bhagwat and Willis 2008; Holderegger and Thiel-Egenter 2008; Svenning *et al*. 2008; Stewart *et al*. 2010).

It should be remembered, however, that long before the explosion of general interest in the topic of cryptic refugia, paleontological studies had demonstrated that phenomenon robustly with multiple case examples (compare for example Kretzoi 1957; Ložek 1964, 1982; Frenzel 1983; Jánossy 1986; Storch 1995; Horáček and Sánchez 1984; Horáček and Ložek 1988; Horáček 2000; Stewart and Lister 2001; Sümegi and Krolopp 2002; Ložek 2006). In general, it should be remembered that, in comparison with the hypotheses generated by molecular phylogeographies, the direct fossil record provides as well as the exact localization of refugia and also contextual information (community structure, lithogenetic and archeological data etc.) which enable reconstruction of the conditions under which the refugial community survived. A continuous sequence of rich communities of small ground mammals in Dzeravá Cave, Malé Karpaty mountains (Horáček 2006), covering a period from 60.0 to 20.0 ky BP (Kaminská *et al*. 2005), or palynological records of the Vistulian woodland habitats from the inner Carpathians (Jankovská *et al*. 2002; Jankovská and Pokorný 2008), and the finding of strictly forest woodland snail species during the last glacial in the Western Carpathians (Juřičková *et al*. 2014) can serve impressive examples. Moreover, the fossil record extends the ideas on glacial refugia even in further respects. Detailed analysis of the continuous appearance of cave bears in High Alps caves (Hille and Rabeder 1986) suggest that the middle Würmian in the Alps was warmer than today (Döppes *et al*. 2011). Indirectly, this indicates that the alpine zone of European mountains provided, at least during MIS 3, suitable conditions for the survival of demanding lifeforms. The case examples further extending that hypothesis are briefly surveyed in this contribution.

The Vistualian vertebrate records from the High Tatra Mountains

The High Tatras Mountains, situated in Northern Slovakia along the border between Slovakia and Poland, represent the highest part of the Western Carpathians, a typical high alpine landscape with numerous traces of extensive glaciation during glacial periods (Figure 1). A large extent of massive mountain glaciers during the Vistulian (= Würmian) glacial, which completely infilled present-day deep valleys, was

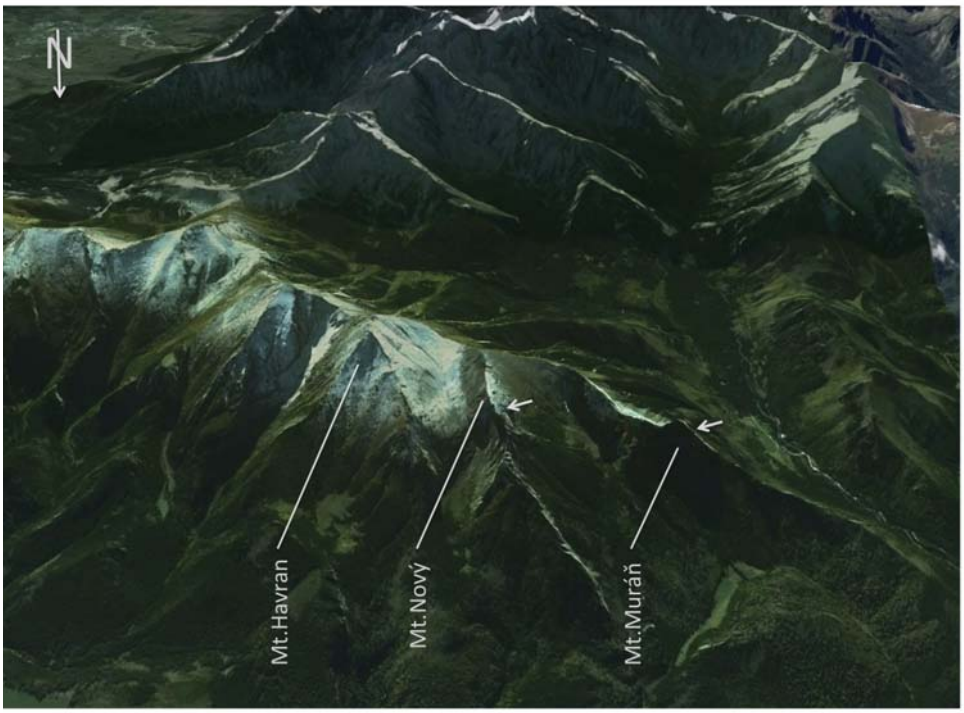

Figure 1: Geographic position and the northern view of Belanské Tatry (eastern part of the High Tatras Mountains), from Google Earth. Arrows indicate position of the discussed caves.

demonstrated in great detail (e.g. Lukniš 1973; Midriak 1983) along with the prolonged course of their postglacial deglaciation lasting to around 7.0 ky BP (Lindner *et al*. 2003). These characteristics are entirely valid also for the eastern limestone ridge of the High Tatras Mountains, Belanské Tatry (the highest peak 2,152 m), with several karstic caves, including the two which provided significant fossil records (Figure 2).

Fossil vertebrate remains from the High Tatras Mountains were first reported in a comprehensive survey "Die Höhlen der Hohen Tatra und Umgebung" by Samuel Roth (1882): a sample collected in the upper cave on Mount Nový (N III

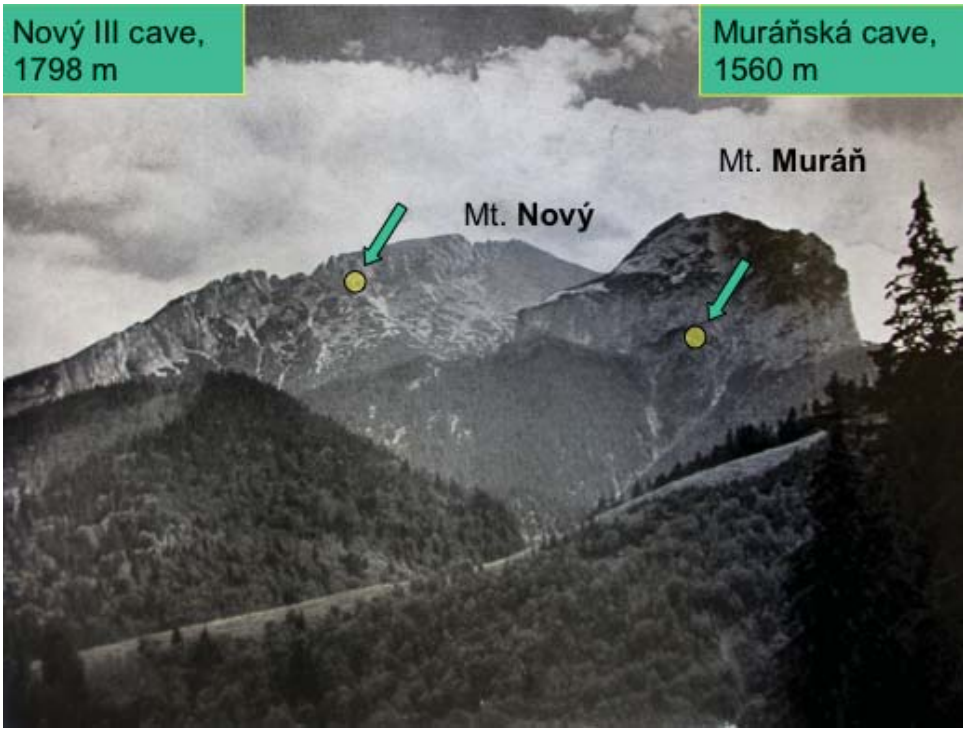

Figure 2: The western view of Mt Muráň and Mt Nový with position of the caves discussed in the text (after Sekyra 1954).

sensu Sekyra 1954; Nový I sensu Schefer 1975a; 1,798 m a.s.l.) was examined by Alfred Nehring who identified the following taxa: *Rana temporaria*, *Lagopus lagopus*, *Lagopus mutus*, *Anas crecca*, *Nyctea scandiaca*, *Sorex araneus*, *Talpa europaea*, *Lemmus lemmus*, *Dicrostonyx torquatus*, *Microtus nivalis*, *M. gregalis*, *M. oeconomus*, *M. arvalis*, *M. agrestis*, *Arvicola terrestris*, *Clethrionomys glareolus*, *Ochotona pusilla*, *Lepus timidus*, *Cricetus cricetus*, *Eptesicus serotinus*, *Mustela nivalis*, *Ursus spelaeus* and *Rangifer tarandus.* Sekyra (1954), who compiled a detailed geographical survey of the alpine karst of the High Tatras Mountains described infillings of the cave (cryogenic stone debris of a total thickness less than 95 cm) and collected a sample of bone material in which Oldřich Fejfar identified the following forms: *Rana* sp., Aves sp., *Lagopus* sp., *Sorex* sp., *Lemmus lemmus*, *Arvicola terrestris*, *Microtus arvalis*, *Microtus subterraneus*, and *Microtus oeconomus* (Sekyra 1954). Vojen Ložek excavated the site in 1972, confirmed the previous results and collected the sample surveyed in Table 1.

A particularly important contribution was undertaken by Helmuth Schaefer who collected from Nový Cave III (Nový I sensu Schaefer 1975a) a large sample of bone material, and provided also a ^{14}C datum of 30.0 ky BP obtained from a chamois skull. Unfortunately, until his death in 1976 he had published only a survey devoted to the enormously rich material of shrews (Schaefer 1975a) – more than 800 mandibles. Besides six *Sorex minutus*, three *S. minutissimus*, twelve *Neomys fodiens* and one *Crocidura leucodon*, the sample was composed of two forms: *S. araneus* (ca. 200 mandibles), which he considered a separate subspecies *S. araneus novyensis*

Table 1: List of particular taxa in individual layers of the series Muráň 3 (1–6) and samples from Nový III cave (see text for details). The numbers indicate MNI (minimum number of individuals).

MURÁŇ 3							NOVÝ III	
	6	5	4	3	1	Total	3	4
Mollusca								
Clausilia dubia		1	12	1	1	15		
Fruticicola fruticum	1	1	1	4		7		
Isognomostoma isognomostomos				1		1		
Arianta arbustorum				1		1		
Semilimax semilimax					1	1		
Chondrina clienta				1				
Vertebrata, non-Mammalia								
Pisces indet		1		1		2		
Rana cf. *temporaria*			1			1		
Lacerta cf. *vivipara*	1			6	2	9		
Ophidia (cf. *Vipera*)					1	1		
Aves, cf. *Lagopus*	1	1	1			3	2	2
Aves, Passeriformes			1	4	1	6		
Mammalia								
Myotis cf. *mystacinus*				3		3		
Vespertilio murinus	1		1	10	3	15		
Eptesicus nilssoni		1				1		
Nyctalus noctula				2	1	3		
Pipistrellus pipistrellus				1		1		
Barbastella barbastellus		1		3		4		
Plecotus auritus				2	1	3		
Talpa europaea				1		1		
Sorex araneus	1	1	6	19	11	38		1
Sorex minutus			2	11	3	16		
Sorex "arcticus"								2
Neomys fodiens				1		1		
Muscardinus avellanarius				1		1		
Sicista sp.			2	2	1	5		
Apodemus flavicollis				1		1		
Clethrionomys glareolus	1			3	3	7		
Arvicola terrestris			1	1	1	3		
Microtus nivalis mirhanreini	1	1	5	18	4	29		2
Microtus gregalis	20	4	3	1		28	10	11
Microtus arvalis	7	2	13	30	20	72	8	58
Microtus agrestis			1	4	1	6		
Microtus tatricus	1			3	4	8		
Microtus cf. *oeconomus*				1		1	3	6
Dicrostonyx gulielmi	16	3		1		20	1	3
Lemmus sp.		1		2		3	1	
Ochotona								
No ind. (Vertebrata)	50	16	37	129	57	292	25	85
No. spp. (Vertebrata)	10	10	12	26	15	30	6	8
No ind. (small ground mammals)	47	12	33	97	49	238	23	83
No. spp. (small ground mammals)	7	6	8	17	9	17	5	7

Schaefer, 1975, based on its significantly larger size, and a medium-sized form identified as *S. arcticus* (ca 400 mandibles). Despite possible doubts on the actual species identity of the latter form, the conclusions proposed by Schaefer (1975a) convincingly demonstrate that the major bulk of the enormously rich shrew assemblage from Nový Cave III is undoubtedly of the glacial (MIS 3) age. This fact is quite strange especially because the shrews are demanding insectivores dependent on a year-round stable food supply, and hence are in general for obvious reasons extremely rare in glacial communities (Horáček and Sánchez 1984; Horáček and Ložek 1988).

The fossiliferous deposits in Nový III Cave composed of cryogenic drit are of a minute thickness only and certain doubts could arise both on the time span of bone accumulation and on the representativness of the sample in regard to actual community structure. In order to exclude such doubts and reveal particular stages of structural development of local glacial communities at direct superposition we excavated in 1994 a section inside Muráňská Cave (1,560 m a.s.l.) situated in the rocky wall of the neighboring peak Muráň (Figure 1). Previously, Muráňská Cave was repeatedly reported as a rich source of subfossil and Holocene remains. The enormously rich subfossil deposit, combining an Eagle Owl nest place and thanatocenoses of fissure-dwelling bats in front of the cave entrance (Muráň I) was exavated in the 1930s and then in the 1970s by Schaefer (1935, 1974, 1975a etc.). Besides others it provided a type series of a valid local subspecies of *Microtus nivalis* – *M.n.mirhanreini* Schaefer, 1935. Muráň II, a section excavated in debris talus in front of the cave entrance, provided several layers with Early Holocene mollusc and vertebrate remains not reaching the glacial sediments (Schaefer 1975b). Sekyra (1954) excavated a 1.5 m deep section inside the cave (12 m from entrance) with sparse fragments of small mammals (*Microtus arvalis*, *Microtus oeconomus*, *Microtus subterraneus*, *Sorex* sp.) and *Ursus spelaeus* (all identified by O. Fejfar).

Our section (Muráň 3) was situated a bit deeper in the cave, about 16 m from the entrance, at the site of the supposed maximum thickness of the sediment. With total thickness of 2.5 m the section revealed a series of horizons formed by coarse limestone clastics and cryogenic drit infilled, particularly in deeper layers, with a light ochraceous eolic dust loam (Figure 3). The lithological analysis of the section indicated no traces of postsedimentary disorder and the series can be considered intact and reliable in the stratigraphical respects. Moderate size samples (ca 40 kg of fine grain fracture) were taken of each layer, transported and wet sieved with mechanical extraction of fossils.

In total about 10, 000 bone remains were analyzed providing 292 MNI (minimum number of individuals) of at least 30 species of vertebrates and 25 MNI (6 species) of molluscs. A detailed list is available from Table 1. (The sample of layer 2 disappeared during transport and, unfortunately, could not been included in further analyses.)

Two AMS radiocarbon data (based on bone tissue) are available from (i) layer 4: 13, 380 ± 90 BP = 14, 400–13, 710 BC (Poz-33601), and (ii) layer 6: 20, 430 ± 160 BP =23, 100–22, 000 BC (Poz-33602).

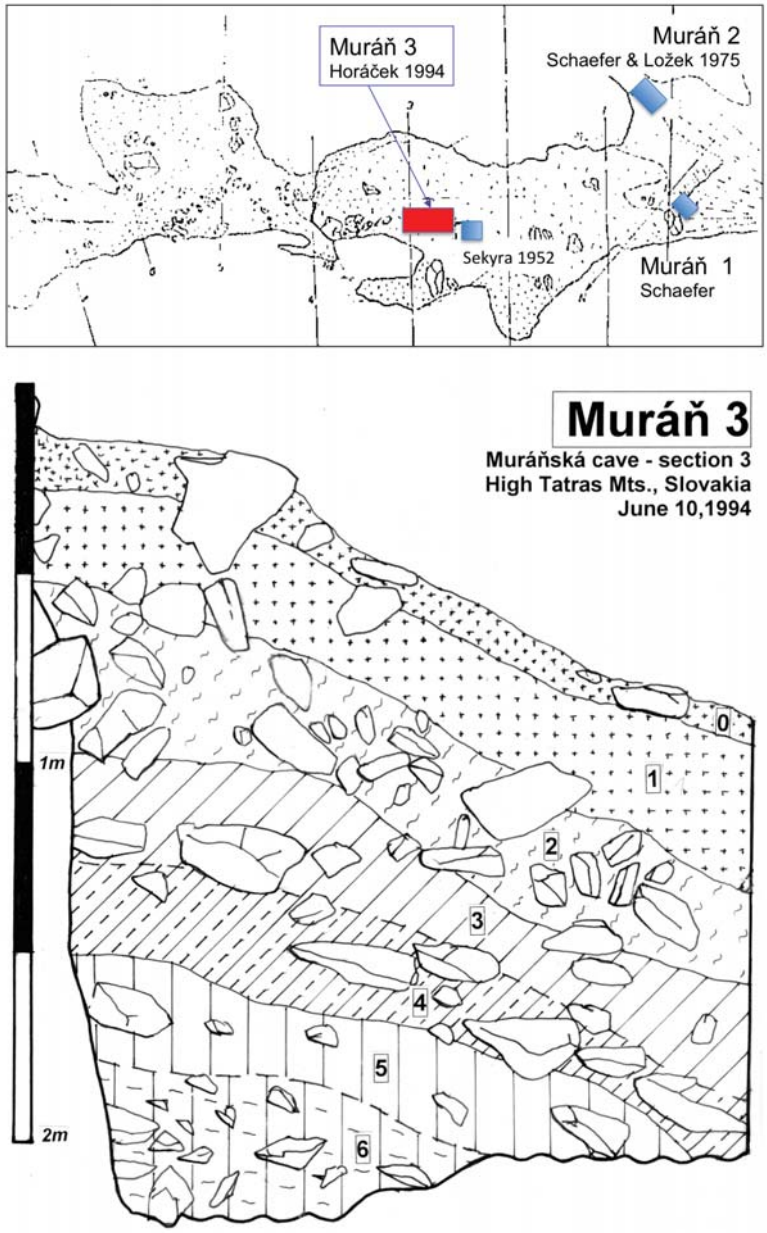

Figure 3: A sketch of the entrance part of Muráňská Cave (after Sekyra 1954) with localization of particular sections and lithological situation revealed in the section Muraň 3.
0 – blackish brown dusty loam with chamois feces, foam sinter, and boulder debris, 1 – fine-grained drit (0.5–1 cm) with infiltrations of surface dusty loam infilling spaces among massive boulder debris, 2 – a compact boulder debris, partly without any infill or with sparse blunt-grained grit, all marked by traces of intensive dripping, 3 – grayish-brown colored fine blunt-grained grit (0.5–1 cm) alternating with blurs of foam sinter, compact texture of clastics,
4 – correspoding to layer 3 by basic structural characteristics but grit is rather with sharp edges and a gray yellowish-brown loamy infill rich in dispersed grains of foam sinter (probably due to postsedimentary infiltration),
5 – light ochraceous eolic loam, fine-grained and calcareous, locally with surface corrosion of sparse clastics, almost without grit, 6 – light ochraceous eolic loam, fine-grained yet without traces of calcification, dispersed grit of limestone shards, no large boulders.

The richest assemblage (MNI 129; 21 mammalian and 6 mollusc spp.) was obtained from the layer 3: in its species composition and dominance structure it resembles the community of layer 1 (which closely resembles the present-day local communities), but it differs in having higher percentages of the forms indicating aquatic and semiaquatic habitats (*Arvicola terrestris*, *Microtus agrestis*, *Neomys fodiens*, *Sorex minutus*, *Rana temporaria*), the elements of the alpine zone including debris field uncovered by tree vegetation (*Microtus nivalis*, *Sicista* cf. *betulina*, *Microtus arvalis*, *Microtus tatricus*), and last but not least in a recedent appearance of the glacial

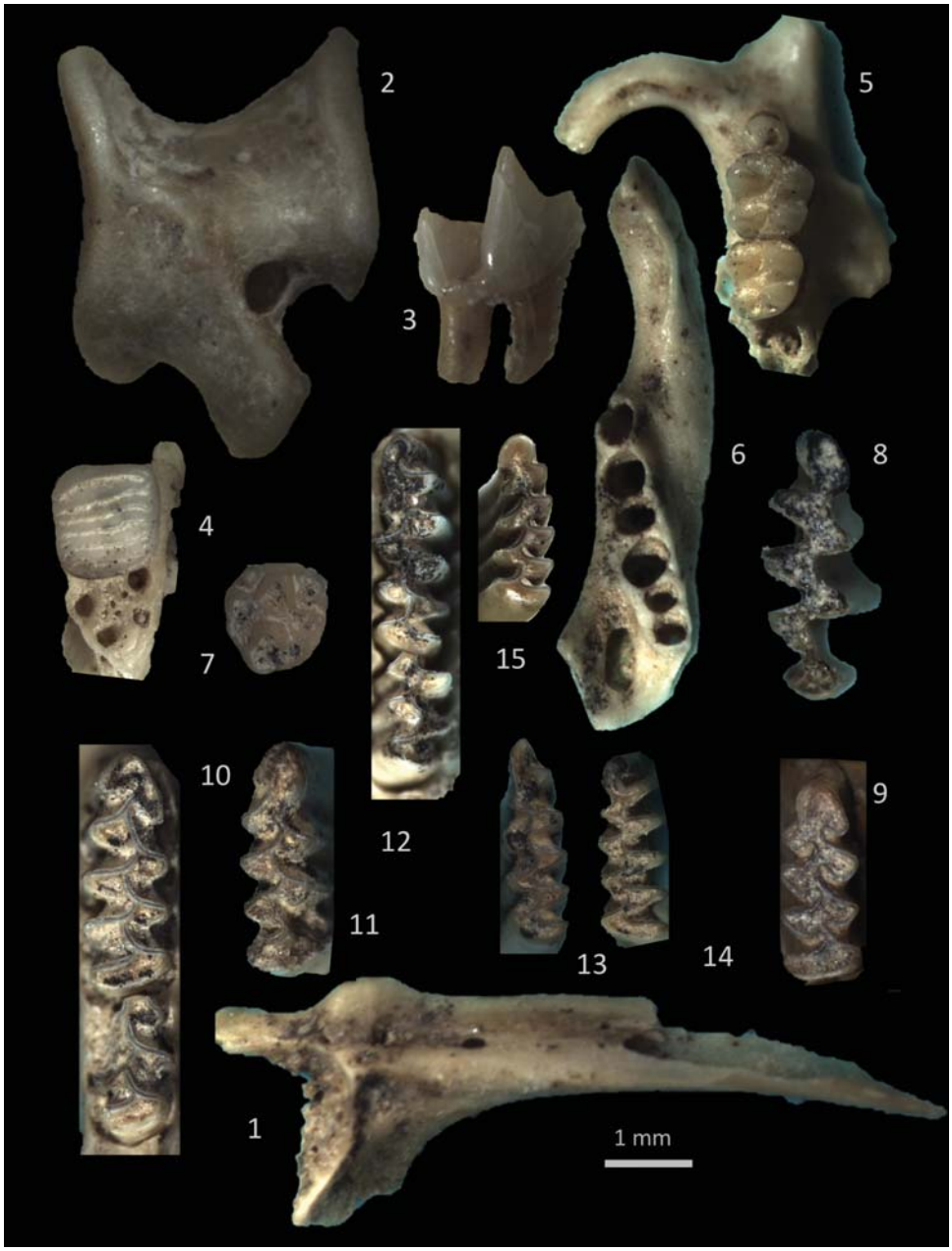

Figure 4: Vertebrate remains from Muráň 3 /layers 3 (2–3, 7, 15) and 4 (1, 5, 6.8–14): 1 – *Rana* cf. *temporaria*, ilium, 2, 3 – *Talpa europaea*, clavicle, m1, 4 – *Muscardinus avellanarius* M2, 5, 6 – *Sicista* cf. *betulina*, maxillar fragment with P4-M2, mandible, 7 – *Apodemus* cf. *flavicollis*, M2, 8 – *Arvicola terrestris*, juv. m1, 9 – *Clethrionomys glareolus*, m1, 10, 11 – *Microtus (Chionomys) nivalis mirhanreini*, m12, m1, 12 – *Microtus* cf. *arvalis*, m12, 13, 14 – *Microtus gregalis*, m1, 15 – *Microtus tatricus*, m1

elements such as *Microtus gregalis*, *Dicrostonyx* sp. and *Lemmus* sp. Such characteristics suggest a picture of proluvial deglaciation marshes in the valleys and a mosaic of semi-open habitats on slopes, which can be expected there during the earliest Holocene. Also the appearance of *Sicista* sp., *Muscardinus avellanarius* as well as the first appearances of *Apodemus flavicollis* and *Pipistrellus pipistrellus* fit the faunal characteristics of the earliest Holocene in the Slovakian Carpathians quite perfectly. In deeper layers these elements were absent, and the respective communities are

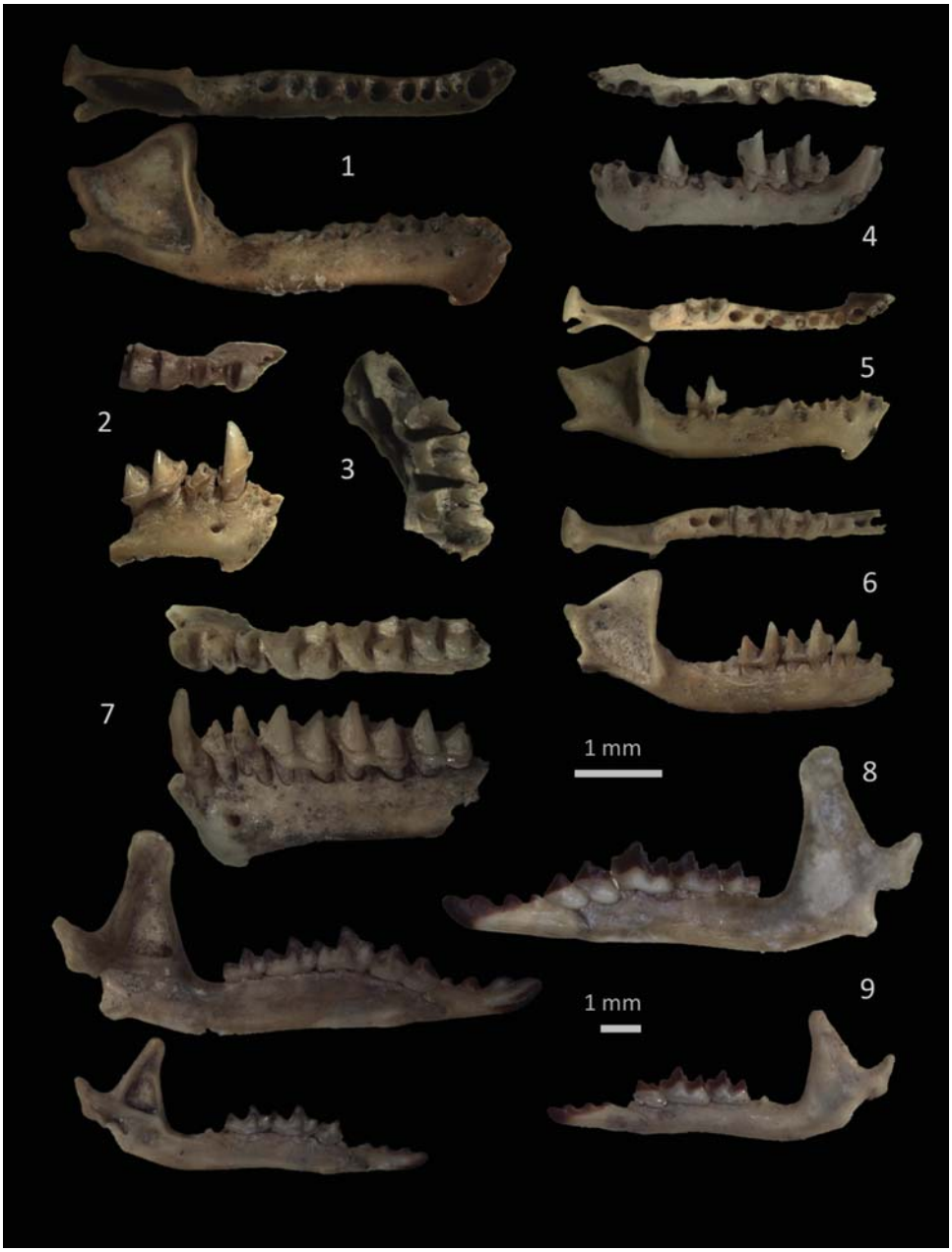

Figure 5: *Vertebrate remains* (insectivores and bats) from Muráň 3 /layer 3: 1 – *Vespertilio murinus*, md., 2 – *Vespertilio murinus*, md., a specimen with missing p2, 3 – *Plecotus auritus*, max. with P4-M2, 4 – *Barbastella barbastellus*, md. p4, m2-3, 5 – *Pipistrellus pipistrellus*, md. m3, 6 – *Myotis* cf. *mystacinus/brandtii*, md p4-m2, 7 – *Nyctalus noctula*, md c-m3, 8 – *Sorex araneus*, md., 9 – *Sorex minutus*, md.

characterized by significantly lower diversity and predominance of the open ground elements typical of glacial communities, *Microtus gregalis*, *Microtus arvalis*, *Dicrostonyx gulielmi* and *Lemmus* sp. These characteristics are particularly pronounced in the community of the deepest layer, layer 6, dated just in the time of LGM. Yet, even there the community included, though in low percentages, demanding forms such as *Sorex araneus*, *Clethrionomys glareolus* (indicating a woodland habitat) and even *Microtus tatricus*, the endemite species of alpine habitats of the Western Carpathians.

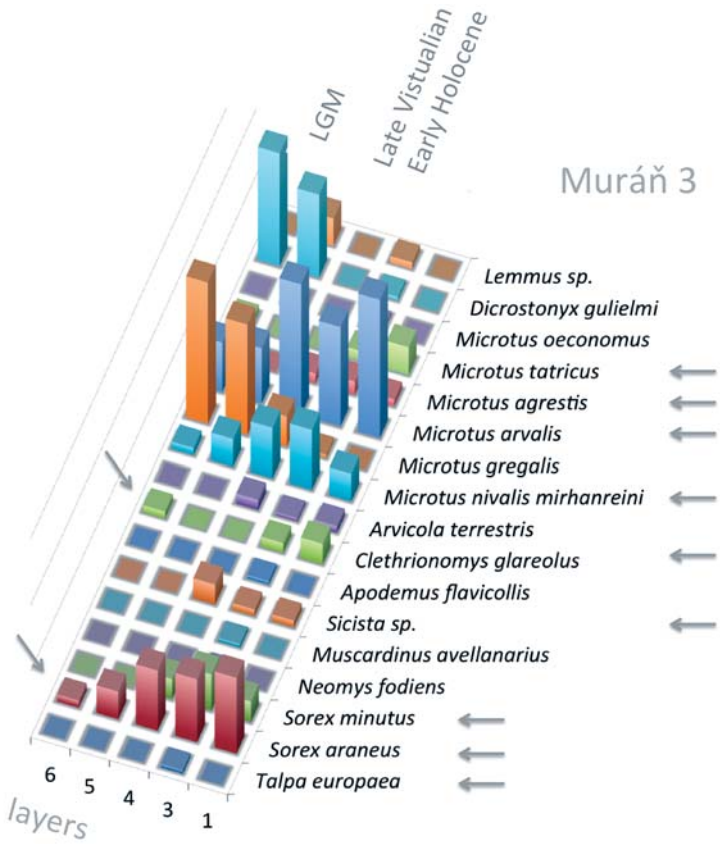

Figure 6: Percentages of particular taxa of small ground mammals in layers 1–6 of the series Muráň 3. Arrows indicate the forms not typical for glacial assemblages recorded in glacial layers of the series.

Discussion

The fossil record obtained from section 3 in Muráňská Cave demonstrated quite convincingly that not only in the time of MIS 3 (as indicated by records from Nový 3 Cave) but also in MIS 2, i.e. during the LGM, the alpine zone of the High Tatras Mountains was inhabited by a relatively rich community of small vertebrates and molluscs, including demanding endemic species (*Microtus tatricus*, *Microtus nivalis mirhanreini*) and forms indicating tree vegetation (*Clethrionomys glareolus*). The question arises: where could such a community live? The caves under study were obviously situated close to the surfaces of extensive glaciers which filled the valleys surrounding these sites (Lukniš 1973; Midriak 1983; Lindner *et al*. 2003).

The neontologic analogies (glaciers in Alps, comp. Figure 6) show for the surface of mountain glaciers the conditions clearly contradicting such a possibility. Yet, with lithogenetic intactness (supported convincingly also by ^{14}C data) the above reported fossil record is to be looked upon as quite reliable in stratigraphical respect. The implicit paleoenvironmental signal which it provides is hence to be considered robust enough to promote a search for an explanation alternative to the standard models.

In these connections, the following facts are to be taken into account:

(1) The climatic dynamics of alpine mountains today is essentially contributed to by instant relief cooling: cold air drainage into cool air pools in deep inversion valleys which perform steep thermal gradients driving extensive radiational cooling. With complete infilling of the valleys by ice masses of glaciers, the driving force promoting temporal oscillations of local thermal fluxes, typical of alpine mountains today, was not available. The thermal inversion in deep valleys forcing the cooling component of today's high mountain climate was not present. During the glacials, the high mountains, such as the High Tatras, changed their appearance from the alpine landscape of nowadays with deeply incised valleys to flat, mildly sloping plateaus with nunataks of the highest peaks.

(2) The Weichselian climate is generally regarded as rather dry in comparison to interglacial situations (Ložek 1973; Frenzel *et al*. 1992), for instance: the estimates of annual precipitation in Central Europe during LGM revealed values by 200–600 mm lower than current values (Jost *et al*. 2005).

(3) The Weichselian climate was further characterized by a greatly pronounced seasonality both in precipitation (which was concentrated to a short summer period), and in eolic dust depositional flux (the interannual variation of which amounted to around 150% in Central Europe) (Werner *et al*. 2002).

(4) The total rates of annual mineral dust deposition were two to five times greater than today in midlatitudes and up to 20 times greater than today in polar regions (Werner *et al*. 2002).

(5) The current distribution of thick loess deposits in Central Europe suggests that the deposition area of eolic sedimentation was restricted to the low altitude regions only (Fitzsimmons *et al*. 2012). Yet, more realisticaly it can be expected that the seasonal thunderstorms depositing the eolic sediments occurred throughout whole area of central Europe. Further, regarding the neontological analogies, it can be hypothesized that the role of major regional traps, both for precipitation and dust deposition, was played by mountain ranges, though much of the eolic sediments deposited in high altitude regions was obviously eroded away during later development. At the same time, it should be remembered that the eolic transport acted, for obvious reasons, as a powerful agent of long distance dispersal of germinal particles for numerous plants and invertebrates and promoted a rapid biotic colonization of the dust deposition areas (Caspers and Freund 2001).

(6) The insolation (computed from Milankovich orbital variables by Berger and Loutre 1991) at the time of the LGM was only about 5% lower than today's insolation (415 Wm^{-2} vs. 430 Wm^{-2} of 21 July insolation at 65° N (Berger and Loutre 1991)).

(7) Due to a low content of atmospheric water during glacial stages, the atmospheric albedo, the factor nowadays responsible for reflecting around 30% insolation energy, was considerably reduced. Despite decreased atmospheric capacity for absorption of the earth's surface heat radiation, the direct earth surface intake of solar radiation and, most probably also the annual net

Figure 7: Modern glacier surface of mid-European high mountains (Pasterze, Grossglocker, Alps).

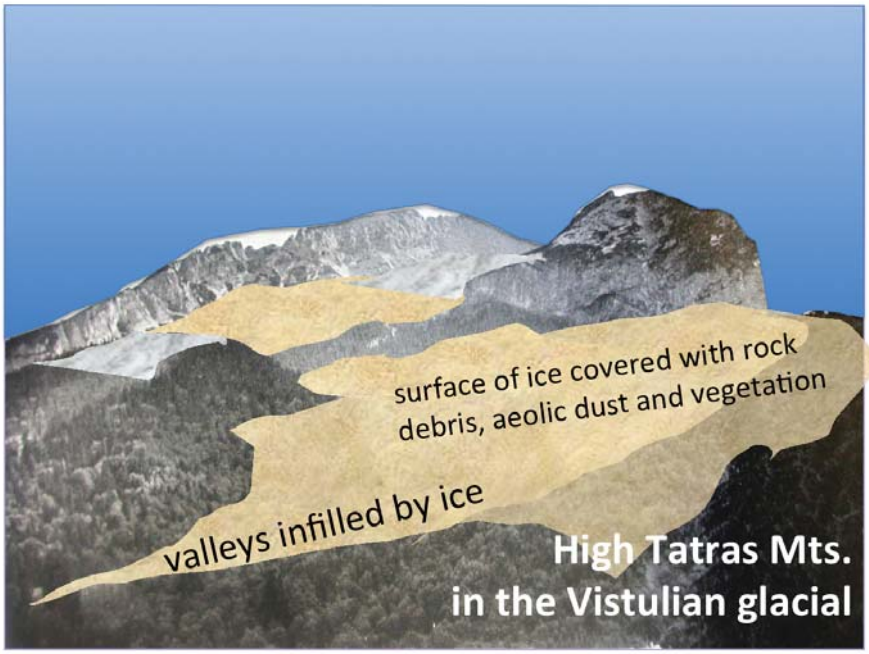

Figure 8: Visualization of assumed position and extent of local glaciers neighboring the study sites at time of LGM.

radiation balance of the earth's surface, must had been with highest probability, considerably higher than today. This conclusion supports quite well the hypothesis by Döppes *et al*. (2011) suggesting that the middle Würmian in the Alps was warmer than today. For the above surveyed reasons, we hypothesize that it holds also for other mid-European high mountains and that it could be the case, at least seasonally, even in the time of the LGM.

(8) In consequence, the mountain ice sheets were repeatedly exposed to intensive seasonal melting by which the clastic components incorporated in ice, either silt particles, large boulders and drit produced by cryogenic and insolation weathering of local rocks, appeared on its surface. Thus the glaciers, at least those situated in Central Europe, were most probably covered with a layer of rocky debris that could reach a considerable thickness and serve as an efficient trap for eolic sediments including the eolic-dispersed germinal biotic particles and invertebrates. With higher precipitation and plenty of seasonally available melting water, the mountains provided even during a glacial period much better conditions for tree vegetation and demanding taxa than the other regions. All these factors could thus produce a very specific habitat providing a high quality environment for lithophilous and heliophilous plants, invertebrates and small ground vertebrates, including insectivores. Moreover, the direct effect of the essential limiting factor responsible for disappearance of most integlacial elements – the very cold, dry and long glacial winter – could have been considerably reduced, compared with lowland regions, in this type of mountain habitats due to thick snow cover resulting of the high precipitation rate in mountain regions.

(9) In short, the above hypothesis suggests that the surfaces of mountain glaciers provided quite suitable conditions for the continuous survival of a variety of life forms either rare or missing in low altitude regions. Looking for neontological analogies for such habitats, especially the conditions characterizing high altitude regions, the Western Sayan Mountains (Chytrý *et al*. 2008; Kuneš *et al*. 2008) are to be taken in account. In particular this concerns the vegetation formations appearing on deep permafrost substrate in the areas whose climatic characteristics correspond to those expected in our model for glacial conditions of mid-European high mountains. Namely these are as follows: (N1) Subalpine tall-forb vegetation in stream valleys and on the bottoms of glacial cirques above the timberline, especially in the precipitation-rich areas with a distinctive snow accumulation, forming dense stands dominated by tall broadleaf forbs, (N2) Short-grass mountain tundra at drier, often wind-swept sites with shallow soils above the timberline in the precipitation rich areas – a patchy mosaic of short grassland and dwarf heathland of *Vaccinium myrtillus*, with frequent bryophytes and lichens, and (N3) *Betula rotundifolia-Vaccinium myrtillus-Vaccinium vitis-idaea* dwarf-shrub mountain tundra above the timberline in topographically wetter places than N2 with frequent bryophytes and lichens (see Kuneš *et al*. 2008 for details).

(10) Our hypothesis provides quite a simple explanation for an enigmatic phenomenon many times stressed in mid-European biogeography – the

enormously high amount of local endemites characterizing the extant biota of high mountain regions. The current mainstream scenarios suggest the survival of endemic forms in small local refugia in non-glaciated piedmont regions followed by recolonization of current endemic ranges in the alpine zone by extensive postglacial range shifts (Schönswetter *et al*. 2005, among others). The present explanation, suggesting no range shifts but continuous survival in current alpine ranges, responds both to minor dispersal capacities, quite typical for most of the endemic alpine forms, and surprisingly deep genetic divergences among particular local populations (compare e.g. Mráz *et al*. 2007), i.e. the facts which brought serious complications for the mainstream scenarios (comp. Schönswetter *et al*. 2005).

It should be emphasized, of course, that the present hypothesis lacks *direct* support, and – unfortunately – there is a little chance that it will ever be obtained. The large-scale erosion characterizing the postglacial history of high mountains has removed past glacier surfaces completely.

Conclusions

With aid of robust indirect evidence we demonstrated that at least in the High Tatra Mountains, the surfaces of the Vistulian glaciers were colonized by a diversified community of small vertebrates including demanding and woodland elements. Further, we proved that such conditions appeared there not only during the mild part of the Vistualian glaciation (MIS 3) but also during the time of LGM (MIS 2). We argued that the unexpected appearance of this kind of community on the surface area of the high mountain glacier necessitates reconsiderations of standard views on the glacial environment of mountain regions. Multiple paleoclimatic and paleoenvironmental evidence suggests that the surface area of the glacial ice sheet experienced conditions resembling the current conditions of semi-open habitats in the high Western Sayan Mountains, i.e. those corresponding quite well to the conditions expected for a glacial refugium. Expecting such conditions in other high mountain regions, then, in regard to the extent of glacial ice sheets in European mountains, it cannot be excluded that the most important cryptic refugia for many mid-European taxa were on the mountain glaciers themselves, and – last but not least – such regions might have attracted human interest as well.

Acknowledgements
The authors wish to thank to all colleagues who took part in field investigations and comparative studies. The study was partly supported by grant GAČR 13-08169S (Prior to the Neolithic).

Résumé
Cet article dresse un tableau du développement des stades isotopiques marins MIS3 et MIS2 à partir des séquences de mollusques et de vertrébrés de deux sites en grottes dans la chaîne des Hautes Tatras, en Slovaquie, à proximité du glacier de la glaciation de Weichsel. Notre étude démontre la présence de communautés diversifiées, caractérisées notamment par la présence d'espèces exigentes, à côté d'espèces endémiques locales, durant le Dernier Maximum Glaciaire. Pour expliquer ce phénomène, nous avons reconsidéré les spécificités propres aux habitats de haute montagne en période de glaciation. Par ailleurs, nous proposons un modèle sur les conditions nécessaires à la survie continue d'espèces exigeantes et d´espèces endémiques alpines en bordure de glaciers.

Zusammenfassung
Der Artikel gibt einen Überblick der MIS3 und MIS2 Daten der Mollusken und Wirbeltiere aus zwei Höhlen in der Hohen Tatra, die nahe der Oberfläche der Weichsel – Gletscher gelegt. Die formenreichen Gemeinschaften mit anspruchsvollen Elementen und lokalen endemischen Formen erscheinen hier unzweifelhaft auch während des LGM. Als Erklärung für diese Fakten haben wir paläoklimatische und umweltbezogene Besonderheiten dieser Hochgebirgshabitate während der Kaltphase in Betracht gezogen und haben ein Modell vorgeschlagen, welches das ständige Überleben der anspruchsvollen Arten und alpinen Endemiten an der Oberfläche des Gletschers aufgeklärt.

MORAVIA BETWEEN GRAVETTIAN AND MAGDALENIAN

Zdeňka Nerudová and Petr Neruda

Abstract
The Last Glacial Maximum (LGM) in Central Europe can be asociated with the end of Gravettian and and the onset of Magdalenian. Decreasing of number of known localities is usually interpreted, upon the global reconstruction of clima, as addaptation of humans on hard climatic conditions. The paleobiological records shows, that the local and micro-local conditions in Moravia differed from global ones and there were refugies with the milder climate.
Up to now we related 49 localities with the period of LGM and the beginning of LGT. The analysis of the relationship between the position of a locality and the surrounding landscape has revealed that we are able to distinguish at least two different settlement strategies, which might represent two techno-typological groups at the time of LGM in Moravia.

Keywords
Moravia, LGM, Epigravettian, GIS analyses, settlement dynamics

DOI: 10.5817/CZ.MUNI.M210-7781-2015-28

Among the less explored developmental phases of human society in Moravia, unlike western or southern Europe, is the period of the so-called Last Glacial Maximum (LGM)[1], which is defined on the basis of the regression of sea level

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[1] The term LGM, as far as the definition is concerned, is not very well established in the specialized literature. LGM has sometimes been correlated with the whole MIS2 period and sometimes only with a part thereof. Differences in dating are associated with selected proxy data or their correlations, which result in different dating of important climatic events captured, for example, in ice cores (GISP2, GRIP, NGRIP). These differences should be settled by a new synthesis of climatic curves (Greenland Ice Core Chronology 2005) which, however, is not yet globally used (Andersen *et al*. 2006; Rasmussen *et al*. 2006, 2008; Svensson *et al.* 2006).

(Yokoyama *et al.* 2000), or the related maximum extent of glacier ice (Clark *et al.* 2009), which occurred between 26.5 and 20/19.0 ky cal BP.[2] This period in Central Europe, from an archeological point of view, can generally be associated with the end of Gravettian in its Kostienki-Willendorf phase in around 24.0–25.0 ky cal BP and the onset of Magdalenian colonization which proceeded from western Europe through the north German lowlands as far as Moravia, where it arrived in around 17.0 ky cal BP (Neruda *et al.* 2009; Neruda 2010).

A characteristic reflection of LGM in archeological material is a considerable decrease in the number of known localities, which in Germany has even been described as depopulation of settlement territories which were not re-colonized until the onset of Magdalenian spreading from France (Terberger and Street 2002; Terberger 2013). Similarly, for the territory of Moravia a distinctly reduced number of sufficiently significant localities have also been mentioned (Valoch 1996; Svoboda *et al.* 2002; comp. Oliva 2005; Valoch 2010).

The reasons have mainly been sought in climatic conditions which considerably influenced central, western and northern Europe. During the highest phase of the Weichsel glaciation, the Czech Republic and the adjacent territories were part of a relatively narrow, about 400 km wide zone, delimited by the front of the continental glacier in the north and by the Alps in the south (extent of glaciation cf. e.g. Ehlers *et al.* 2013). This area may have served as a communication corridor in the west-east direction (Pokorný 2011) and its characteristic feature, according to global reconstructions of ecosystems in Europe, was steppe-tundra, which extended from France through south Germany, the Czech Republic, Poland, part of Austria and the Balkans as far as Russia (Figure 1). From these models it follows that the extent of tundra with low and high shrubs was considerably limited in favour of tundra with dominant herbs and grasses (Bigelow *et al.* 2003). To the north there was the area of polar deserts, which besides the British Isles also comprised a major part of Germany or north and northwest Bohemia respectively, and was significantly affected by extremely cold winds blowing not only over the Arctic Ocean but also across the adjacent lands (Miller *et al.* 2013).

However these global models are important and irreplaceable for the knowledge and reconstruction of past events and phenomena, they also may distort our interpretations and models regarding smaller territorial units, above all because they do not take into consideration local conditions, which may have been entirely different from the global ones. V. Ložek, who points out differences in geomorphology between Central Europe and the plains of northern and western Europe (Ložek 2009, 198), appeals for caution in applying the knowledge of glacial environment in north-west Europe to our territory. The mountainous regions separating Moravia and Bohemia from the adjacent northern European plains may have mitigated the influence of the aforesaid cold arctic winds (Miller *et al.* 2013) so that the ecosystem

[2] The first distinct regression of sea level and rise of glaciers occurred between about 33.0 and 29.0 ky cal BP (Yokoyama *et al*. 2000).

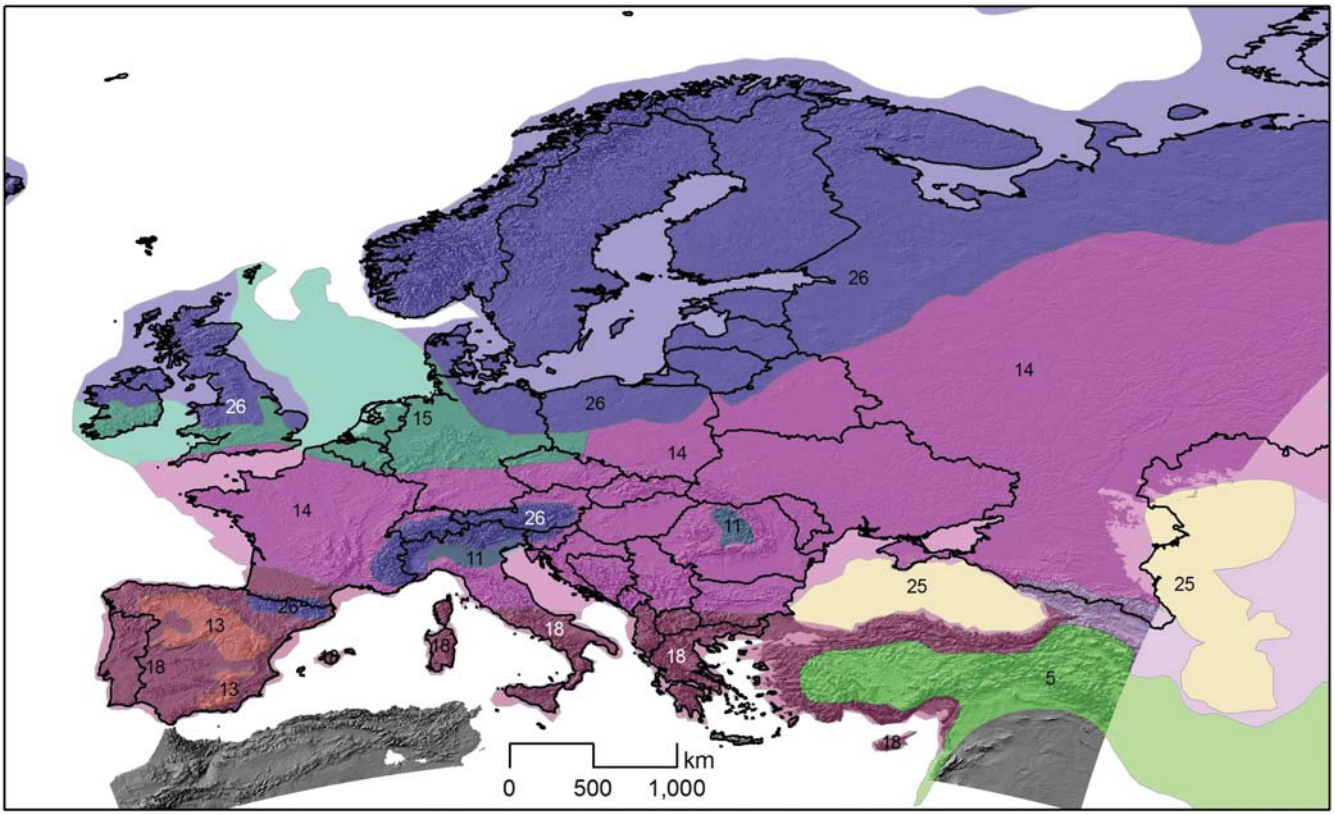

Figure 1: Vegetation zones during the LGM (hillshade made from elevation map of Europe EEA 2004, vegetation data see Ray and Adams 2001). 5 – Tropical semi-desert; 11 – Open boreal woodlands; 13 – Tundra; 14 – Steppe-tundra; 15 – Polar and alpine desert; 16 – Temperate desert; 18 – Forest steppe; 25 – Lakes and open water; 26 – Ice sheet and other permanent ice.

conditions here may have been more favorable. This could be evidenced by some delay in culmination of the glacial maximum, which on the basis of malacofauna is not dated earlier than 22.5–21.5 ky BP (Kuneš 2008; the calibration of data is unspecified). Botanical data, too, probably do not imply that at the time of glacial maximum Moravia was a land of harsh climate, rather it was characterized by cold steppe on prominent slopes, gallery forests along watercourses and dense herbal vegetation on humid habitats (the results sumarise: Pokorný 2011, 143; Svobodová 2002). The newly obtained data prove that isolated islets of trees, for example, pine, spruce, larch and juniper among others, existed in the Periglacial landscape (in the forefield of the continental glacier) during the coldest phase of the maximum glaciation as well (Kuneš 2008). The humans thus could take advantage of both open biotopes, well suited for hunting, and biotopes in river valleys or protected regions between mountain ranges, providing sufficient amounts of easily accessible wood (Kuneš 2008, 149). Such insular vegetation is also proved by malacofaunal associations (Horsák and Chytrý 2010; Ložek 2009, 2010 a, b). The analyses of fauna also indicate the existence of refuges providing living space for temperate fauna. These refuges were found, besides Western Europe, also in the Carpathians of Hungary, Slovakia and Moravia (Sommer and Nadachowski 2006).

However, reactions to changes of climate and ecosystem came to pass anyway, including in species typical of glacial climate – e.g. mammoth. An overview of

radiocarbon dating of evidence of this species in the osteological record at archeological sites in Poland shows that the population was not constant but it vanished and re-appeared again (Nadachowski *et al.* 2011). The absence of mammoth in Poland is captured in a time interval between 24.1 and 18.3 ky cal BP, which probably relates to the maximum extent of a glacier, whose front stopped 50 km from Poznań (Ehlers *et al.* 2013, 229). At the end of this period fall the finds of mammoth from Brno-Štýřice III (Nerudová *et al.* 2012), which we associate with Epigravettian and which fill in the absence of such finds in Poland in the same period (Nerudová 2015). The population fluctuations of large mammals between 24.1 and 18.3 ky cal BP may have been caused by their ethology and natural conditions (e.g. lack of water in LGM), but an important factor may also have been human behavior. Moreover, we must take into account that our knowledge is affected by the fact that the majority of osteological material is known from archeological localities and it does not reflect the real variety of game in the region under review, but rather hunting preferences.

When we take into consideration the differences between local conditions in Central Europe, then a question arises: which factor could have influenced human behavior to such an extent that it was also reflected in both material culture and subsistence strategies within the LGM period? The reasons are clear as far as Germany is concerned, above all its central and northern parts. The environment of arctic tundra, which arose here not only due to global cooling of climate, but also by the agency of cold dry arctic winds, was not suitable for typical glacial fauna, which logically found reflection in subsistence and settlement strategies of the then hunters. On the territory of Moravia, however, the reasons must have been different; it seems that the local climate and biotopes were milder but in reconstruction of Paleolithic settlement we must take into account that the landscape has changed rapidly, even in relatively small areas (Moravia). That is why local hunters had rather to deal with the mosaic-like character of the landscape and the related spectrum of game.

These changes began to occur much earlier. Gravettian hunters already had to cope with worsened conditions (cf. Figure 2). A significant temperature drop already occurred in the period of 33.0–29.0 ky cal BP, which some researchers refer to as the Local Last Glacial Maximum (LLGM) (Clark *et al.* 2009). The global climatic curve shows values similar to proper LGM (26.5–20/19.0 ky cal BP, cf. Clark *et al.* 2009). At that time the first great expansion of the continental glacier came to pass, which inevitably induced gradual changes of ecosystems as well. Based on dating and on stratigraphic position or techno-typological analysis of lithic inventories, the period between the Gravettian and Magdalenian in Moravia can be associated with 49 localities (Table 1). Similarly, for example, in Slovakia, Austria or Hungary we can also find evidence of Paleolithic people (cf. Montet-White 1994), which falls within the period of maximum extent of the continental glacier (Figure 2). Only a few among the above 49 localities in Moravia are absolutely dated and only three of them yielded sufficient amount of finds for any more extensive analyses of human behavior: Stránská skála IV, which has mainly been associated with hunting of horse (Svoboda 1991), Brno-Štýřice III where the faunal remains found are dominated by

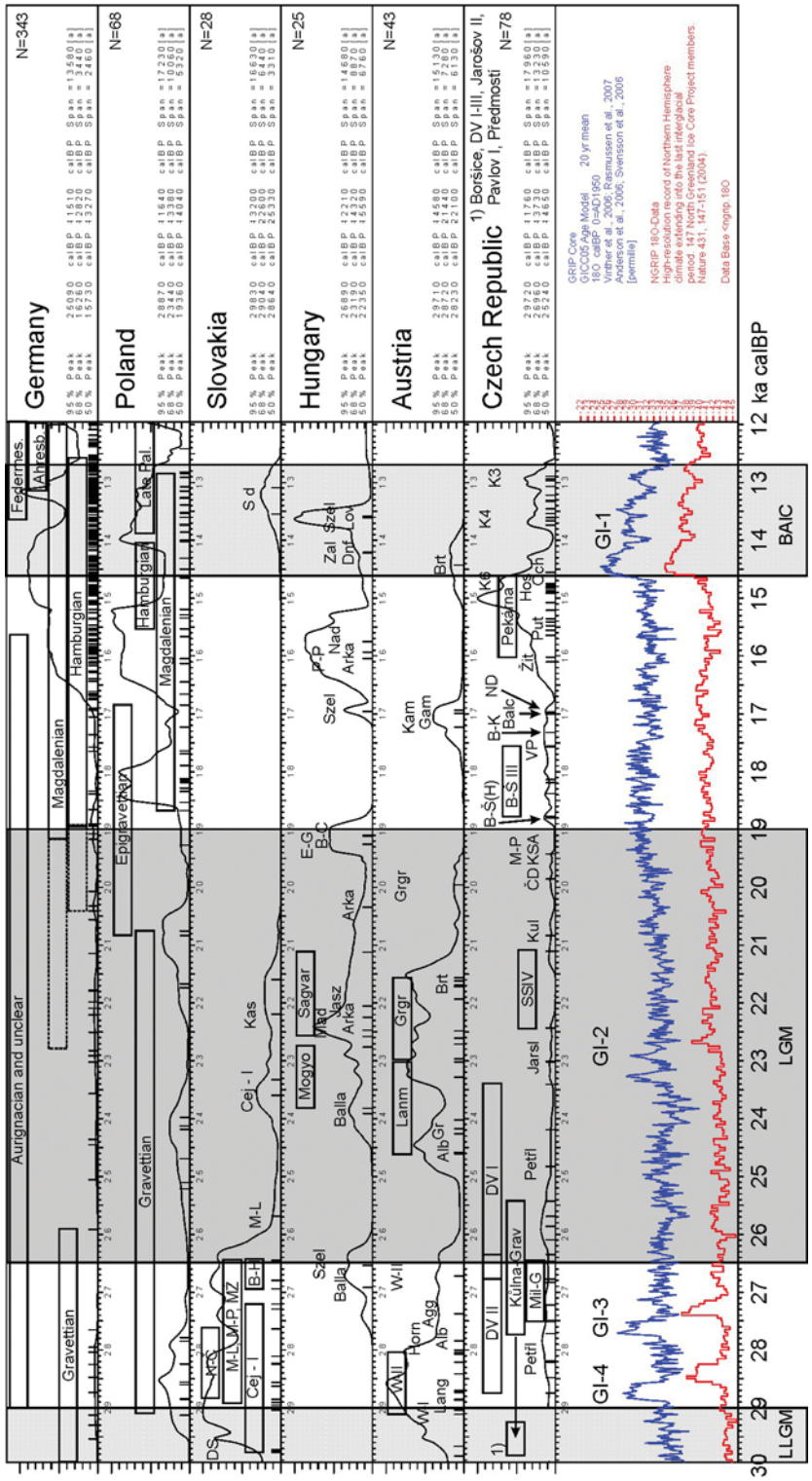

Figure 2: Calibration of radiocarbon dates for the period 30.0–12.0 ky cal BP using CalPal2007 (Weninger *et al.* 2007) and IntCal09 calibration curve (Reimer *et al.* 2009). LLGM – Local Last Glacial Maximum (Clark *et al.* 2009), LGM – Last Glacial Maximum (Clark *et al.* 2009), BAIC – Bølling-Allerød Complex (Cronin 1999). Sites (alphabetically): Czech Republic: Balc – Balcarka Cave; B-K – Brno-Kamenná St.; B-Š III – Brno-Štýřice III; B-Š(H) – Brno-Štýřice (Hospital); ČD – Čertova Díra Cave; DV – Dolní Věstonice; Hos – Hostim; Jarsl – Jaroslavice; K or Kul – Kůlna Cave, Grav. – Gravettian layer, 3, 4, 6 – layers 3, 4 and 6; Mil-G – Milovice I, sector G; M-P KSA – Mohelno-Plevovce, concentration with stones A; ND – Nová Drátenická Cave; Och – Ochozská Cave; Petřl – Petřkovice I; Put – Putim; SSIV – Stránská Skála IV; VP – Velké Pavlovice; Žit – Žitného Cave. Austria: Agg – Aggsbach; Alb – Alberndorf; Brt – Breitenbach B; Gam – Gamssulzen Cave; Gr – Grossweikersdorf, site III; Grgr – Grubgraben; Horn – Horn (Raberstrasse); Kam – Kamegg; Lang – Langenlois; Lanm – Langmannersdorf A; W – Willendorf. Hungary: Arka – Arka-Herzsanet ; Balla – Balla Cave; B-C – Budapest-Csillahegy; Dnf – Dunaföldvár; E-G – Esztergom-Gyurgyalag; Jasz – Jászfelsőszentgyörgy; Lov – Lovas; Mad – Madaras; Mogyo – Mogyorósbánya; Nad – Nadap; P-P – Pilismarót-Palret; Szel – Szeleta Cave; Zal – Zalaegerszeg. Slovakia: B-H – Banka-Horné farské role; Cej – I – Cejkov I; Kas – Kašov; M-L – Moravany-Lopata II; M-P – Moravany-Podkovica; M-Ž – Moravany-Žakovská; N-C – Nitra-Čermáň. For radiocarbon data see Radiocarbon Paleolithic Europe Database in CalPal.

mammoth (Valoch 1975; Nerudová *et al.* 2012) and newly also Mohelno-Plevovce (Škrdla *et al.* 2014). The picture indeed seems fragmentary compared with the Gravettian and Magdalenian. After the period of relatively unified Gravettian, human behavior is reflected in a heterogeneous conglomerate of industries which are referred to as Epigravettian, Epiaurignacian or Grubgrabian. Dispute has mainly been held on the meaning of carinated elements, which occur in this period as a sort of reminiscence of Aurignacian and are accepted in various ways, so that cultural classification of one and the same locality is often different. To eliminate the connotation included in the prefix epi-, which indicates a fluent development of Gravettian and Aurignacian cultures in Moravia, the industries dated absolutely after Gravettian and prior to Magdalenian (Štýřice III, Stránská skála IV, Kamenná St., Cejkov, Kašov, Grubgraben) are preferably termed Kašovian (Svoboda 2006; Svoboda and Novák 2004), which should terminologically unify the few stratified localities in the Middle Danube area and the Carpathian Basin.

For a reconstruction of settlement strategies of the period between Gravettian and Magdalenian we can use a statistically evaluable database of localities (Table 1), thanks to which it is possible to search for the relationship of people of that time to the surrounding landscape. The analysis involved localities referred to as Epigravettian or Epiaurignacian (this group also included assemblages labelled as Late Aurignacian). The above localities were still supplemented with other examples where absolute dates were obtained from contexts which have been associated with human activities – a fireplace from Kůlna Cave (Valoch 1974) or charred bones from Čertova Díra Cave (Neruda 2006), even though in these cases no lithic industry is available. For all localities attribute data were collected, focused on cultural classification and position in terrain (Table 1).[3] The cultural classification of the assemblages studied proved to be quite problematic, because individual authors prefer different criteria. For this reason, our analysis involved both the widely used cultural classification (Epigravettian or Epiaurignacian, or the problematic classification Epigravettian/Epiaurignacian respectively etc.) and the recorded presence of carinated elements as an independent variable with the aim to determine whether the resulting models will be different. Measuring the distance from individual localities to watercourses (the shortest direct distance in meters was measured) was based on the fact that during the last glaciation (Weichselian) the current river network was already more or less established in its present boundaries (Skrzypek G. *et al.* 2011). We confronted the existence of smaller streams with historical maps. The results of spatial analysis can be affected by some side factors. First of all we only dispose of a minimum of stratified and dated localities. A great deal of evidence of human presence was not found at all or was destroyed by, for example, intensive development in the built-up urban area. This mainly concerns localities from the end of the LGM and the Late Glacial (LGT) period, which are

[3] Within the heuristic part a revision of names of localities was carried out, based on present cadastral divisions. In some cases it was possible to make use of new revisions or publications which were based on the same criteria (Mlejnek 2013; Škrdla *et al.* 2012b).

Table 1: A list of analyzed sites. The site numbering corresponds to Figs. 3 and 4. EAU – Epiaurignacian, EPIG – Epigravettian, SZ – Szeletian; AUG content – presence of carinated types; MRD – major river distance (in metres); SRD small river distance (in metres); orientation: NE – north-east, E – east, S – south, SSE – south-south-east, N – north, W – west, NW – north-west; finds: LI – lithic industry, B – animal bones , H – hearth, M – malacofauna, P – pollen, C – charcoal.

no	site	character	AUG content	context	elevation a.s.l.	BRD	SWD	orientation	finds	stratigraphy	X	Y	source
1	Alojzov I - Golštýn	EAU	yes	surface	323-341	17, 500	140	NE	LI	uncertain	-562965	-1138227	Mlejnek 2013
2	Blažovice I	EAU/EPIG	yes	surface	297	11, 100	1,300	top	LI	uncertain	-585774	-1167261	Belcredi *et al*. 1989, Oliva 1987
3	Brno-Jundrov	EAU/EPIG	low	tests pits+ surf.	235-240	270	270	SE	LI,snail	uncertain	-602166	-1157987	Oliva 1991
4	Brno-Kohoutovice I	EAU	yes	surface	390	2,300	1,400	top	LI	uncertain	-603480	-1161080	Oliva 1987
5	Brno-Stránská skála IV	EPIG	low	excav.	254	3,400	3,000?	N	LI,B	loess	-593250	-1161800	Svoboda 1991
6	Brno-Štýřice III	EPIG	no	excav.	220	250	250	NE	LI,B,H,C,M	loess	-599244	-1161859	Nerudová *et al*. 2012, Valoch 1975
7	Brno-Štýřice, Hospital	EPIG	no	excav., single finds	205	80	80	E	LI,B	loess	-599090	-1161741	Škrdla *et al*. 2005
8	Brno-Štýřice, Kamenná St.	EPIG	no	excav.	210	140	140	floodplain	LI,B,H	loess	-599258	-1161744	Nerudová 2010, Skutil 1932
9	Brno-Štýřice, Polní St.	EPIG	no	excav., single finds	210	160	160	E	LI	loess	-599174	-1161801	Nerudová *et al*. 2012
10	Brno-Štýřice, Vídeňská St 849/15	EPIG	no	excav., single finds	210	270	270	E	B	loess	-599202	-1161885	Nerudová *et al*. 2012
11	Dolní Otaslavice I	EAU	yes	surface	298-306	17, 500	170	SE	LI	uncertain	-563233	-1142699	Mlejnek 2013
12	Drahanovice	EAU	yes	surface	310	12, 600	850	top	LI	uncertain	-559438	-1122892	Oliva 1987
13	Horákov IV - "Macocha"	EPIG	no	excav.+surf.	267	8,200	60	E	LI	loess	-587471	-1160025	Škrdla and Kos 1999
14	Horní Otaslavice II	EAU	low	surface	282-290	17, 600	220	top	LI	uncertain	-563366	-1143181	Mlejnek 2013
15	Jaroslavice	EPIG	yes	excav.	205	1,600	145	ESE	LI, B, M, C	loess	-630610	-1205939	Škrdla 1999
16	Karolín I	EAU	yes	surface	316	3,200	400	E	LI	uncertain	-538025	-1162497	Oliva 1987
17	Kateřinky u Opavy	EPIG	uncertain	layer	uncertain	uncertain	uncertain	uncertain	LI, B	loess	uncertain	uncertain	Svoboda 1999
18	Kožichovice	EPIG	no	layer?	uncertain	uncertain	uncertain	uncertain	LI	loess	uncertain	uncertain	Koštuřík *et al*. 1986
19	Kunovice - V úzkých	EPIG	no	surface	230-235	4,500	540	NE	LI	uncertain	-536755	-1185718	Škrdla 2005
20	Lhotka	EAU	yes	surface	330	7,600	700	top	LI	uncertain	-542297	-1163658	Oliva 1987
21	Mohelno-Plevovce, KS A (concentration 3)	EPIG	low	excav.+surf.	295	40	40	SW	LI, B	loess?	-632419	-1167170	Škrdla *et al*. 2012a
22	Mohelno-Plevovce, concentrations 1-2	EPIG	no	excav.+surf.	297	60	60	SW	LI	loess?	-632427	-1167132	Škrdla *et al*. 2012a
23	Ondratice II - Zadní Hony	EAU	yes	surface	320-360	18, 000	450	NE	LI	uncertain	-563795	-1146371	Mlejnek 2013
24	Ondratice VIII - Kopaniny	EAU	yes	surface	307-321	18, 400	200	NE	LI	uncertain	-564177	-1145814	Mlejnek 2013
25	Opava - Předměstí I (Lundwall´s Brickyard)	EPIG	yes	layer+ surf.	263	1,000	1,000	ESE	LI, B, H	uncertain	-496075	-1089000	Bayer and Stumpf 1929

no	site	character	AUG content	context	elevation a.s.l.	BRD	SWD	orientation	finds	stratigraphy	X	Y	source
26	Opava - Předměstí II (Stratil´s and Němcová´s sand pits)	EPIG	no	layer+ surf.	270	850	900	NE	LI, B	uncertain	-496530	-1088509	Bayer and Stumpf 1929
27	Opava - Předměstí III (railway station-heat house)	EPIG	low	layer+ surf.	260	760	760	NE	LI	uncertain	-496185	-1088534	Bayer and Stumpf 1929
28	Oslavany I - power station	EPIG	no	excav.	220	300	300	floodplain	LI	loess	-618230	-1166834	Oliva 2007
29	Ostrov u Macochy III	EAU	no	surface	500	7,400	50	plateau	LI	uncertain	-586177	-1139854	Valoch 2000
30	Ostrožská Nová Ves	EPIG	no	surface	180-190	3,500	1,900	W	LI	uncertain	-539499	-1187404	Oliva 1998, Škrdla 2005
31	Pístovice I	EPIG	no	surface	321	17, 400	300	SE	LI	uncertain	-575414	-1153873	Svoboda 1994
32	Pístovice II	EPIG	no	surface	370	16, 300	690	E	LI	uncertain	-577192	-1155253	Svoboda and Novák 2004 Svoboda 1994
33	Pístovice III	EPIG	no	surface	330	16, 300	430	NE	LI	uncertain	-577347	-1154353	Svoboda 1994
34	Pohořelice u Napajedel - Čtvrtky	EPIG	no	surface	225-265	1,400	411	W	LI	uncertain	-530900	-1168834	Škrdla 2005
35	Radslavice - Zelená hora	EPIG	no	excav.?	330	24, 800	100	top	LI	uncertain	-567650	-1149355	Klíma 1983
36	Seloutky I	EAU	low	surface	300-340	18, 500	245	W	LI	uncertain	-563168	-1136253	Mlejnek 2013
37	Senorady - Malá skála	EPIG	no	surface	401	4,000	200	top	LI	uncertain	-625040	-1164378	Škrdla et al. 2012b
38	Slatinice I	EAU	yes	surface	316	12, 700	490	E	LI	uncertain	-558947	-1124530	Oliva 1987
39	Sloup I - Kůlna	?	?	cave	464	7,200	300	SW	H	loess	-58624	-1138270	Valoch 1974
40	Sněhotice I	EAU	yes	surface	280-310	18, 300	260	E	LI	uncertain	-564309	-1144921	Mlejnek 2013
41	Štramberk II - Čertova Díra	?	?	cave	460	13, 300	350	S	B	uncertain	-485054	-1128706	Neruda 2006
42	Třebíč 1 (Ptáčov)	EPIG	no	excav.+surf.	390	350	200	S	LI,B	loess-like sediment	-646199	-1153050	Vokáč 2003
43	Uherské Hradiště - Mařatice Kolébky	EPIG	no	surface	250-270	2,900	800	E	LI	uncertain	-534617	-1182495	Škrdla 2005
44	Určice I	EAU/EPIG	uncertain	surface	320-338	16, 900	330	E	LI	uncertain	-562853	-1138563	Mlejnek 2013
45	Určice II	EAU	uncertain	surface	290-298	17, 000	100	E	LI	uncertain	-562844	-1137708	Mlejnek 2013
46	Vedrovice XII	EPIG	no	surface	257	7,900	1,200	SSE	LI	uncertain	-617227	-1177769	unpublished
47	Velké Pavlovice	EPIG	no	excav.	185	8,500	400	E	LI, B, M,H	loess	-586620	-1193924	Svoboda and Fišáková 1999
48	Vincencov I	SZ/EAU	yes	surface	370-385	17, 800	170	SE	LI	uncertain	-563337	-1140837	Mlejnek 2013; Svoboda and Přichystal 1987
49	Zlín-Louky	EPIG	low	excav.+surf.	225	8,700	50	NW	LI, B, P,H	loess	-524023	-1165871	Klíma 1956; Allsworth-Jones 1986

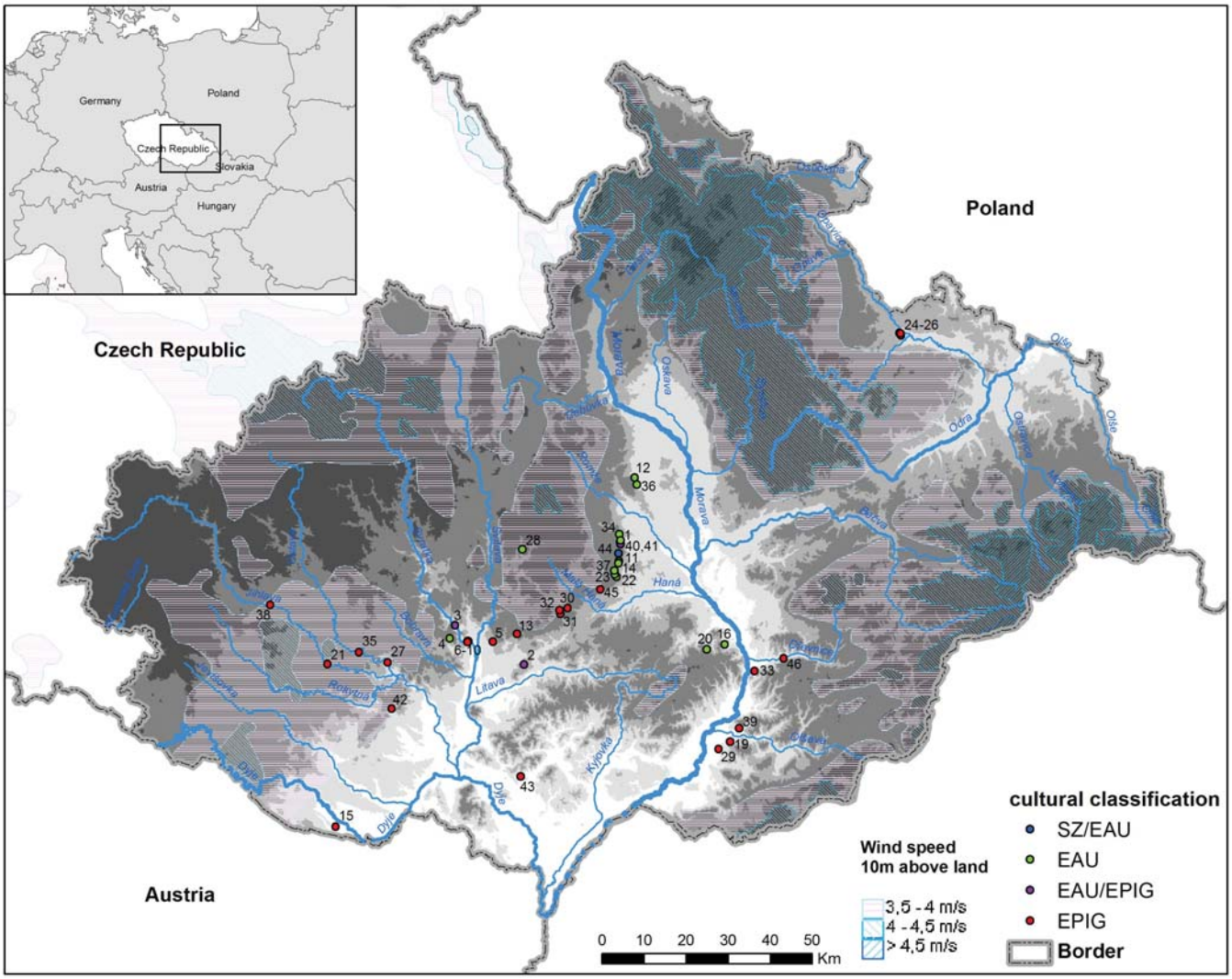

Figure 3: Moravia region with LGM sites upon their proposed cultural classification. For sites numbering see Table 1. GIS construction by P. Neruda.

often situated below a sequence of Holocene layers and are therefore disturbed (cf. Škrdla *et al.* 2008; Neruda *et al.* 2009; Nerudová *et al.* 2012). A less known aspect of spatial analysis, which has not yet really been taken into consideration and which may affect the number of known sites and their position in terrain, mainly concerns the floodplains of the major rivers (e.g. Morava, Dyje or Odra). Intensive deforestation in the Middle Ages (in the 13th century) induced a distinct increase of gradation in flatland regions with low decline. Sediments have buried the original varied floodplain of the lowland rivers and below them also are buried possible relics of prehistoric settlements (Pokorný 2011, 194). It is very possible that this process, which is captured in, for example, the Morava valley around Strážnice (Kadlec *et al.* 2009), may have secondarily influenced some localities, especially when Epigravettian sites are usually not very far away from the river and they overtop the stream at only a minimum height (cf. Brno-Štýřice or Mohelno-Plevovce).

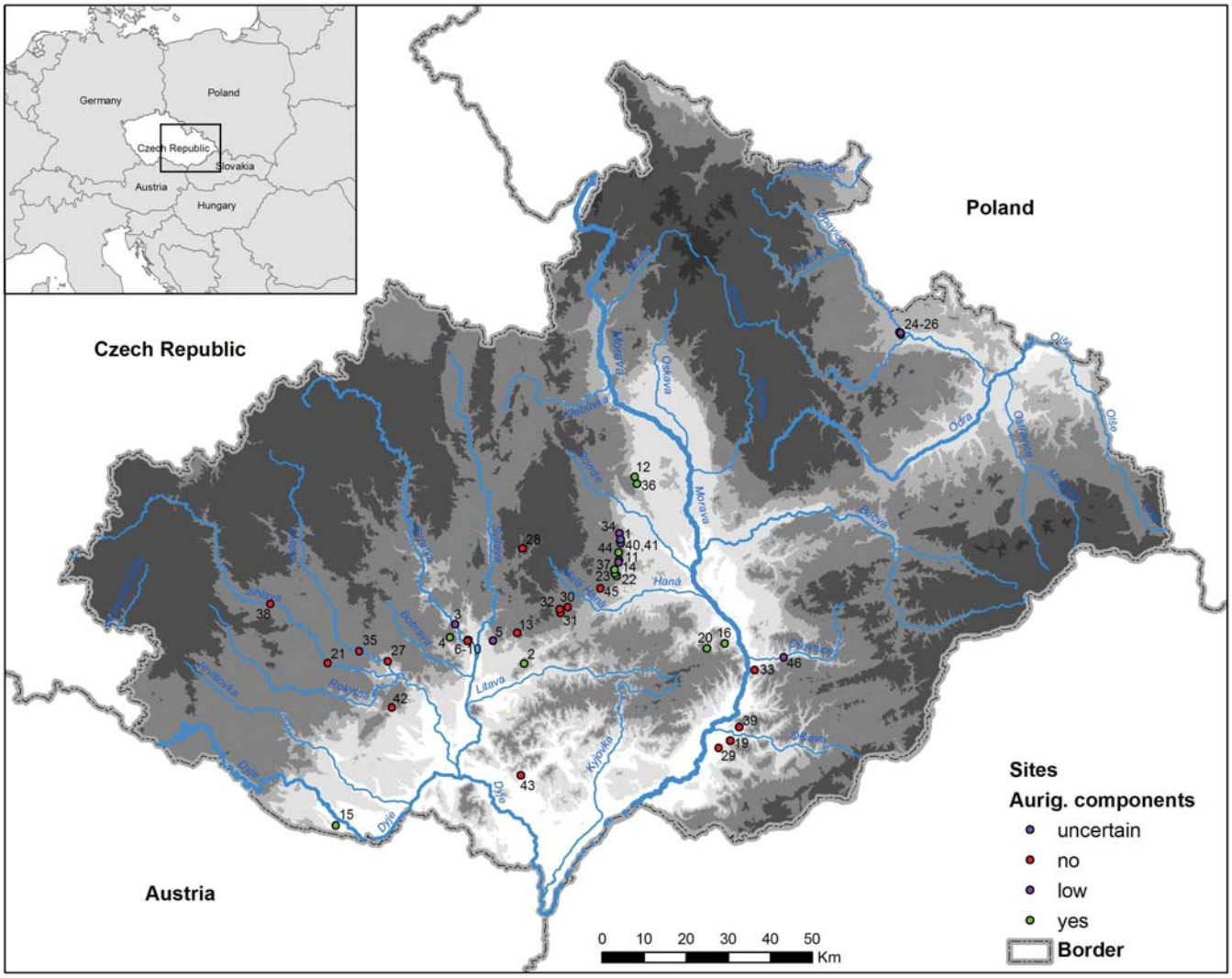

Figure 4: Moravian region with LGM sites and presence of Aurignacian type of tools. For sites numbering see Table 1. GIS construction by P. Neruda.

The localities studied form several groups within the territory of Moravia (Figure 3). The quantitatively most distinctive group is situated on the eastern slopes of the Drahany Upland with the next group lying in the Brno region on the confluence of the Svratka and Svitava Rivers. Smaller enclaves were recorded in the Opava region, in the area of the Napajedla Gate in East Moravia and on the western slopes of the Bohemian-Moravian Highlands in the Jihlava and Oslava River basin. Isolated localities were identified in South Moravia around Znojmo and Břeclav (Figure 3). From the basic overview it is evident that the localities are situated in various terrains including the valleys of both large rivers and smaller streams and even protected slopes of uplands further away from large watercourses.

An important phenomenon, which affected the character of biotope and may at least indirectly have influenced human behavior, was wind. Climate models indicate that atmospheric circulation patterns during the Paleolithic period were

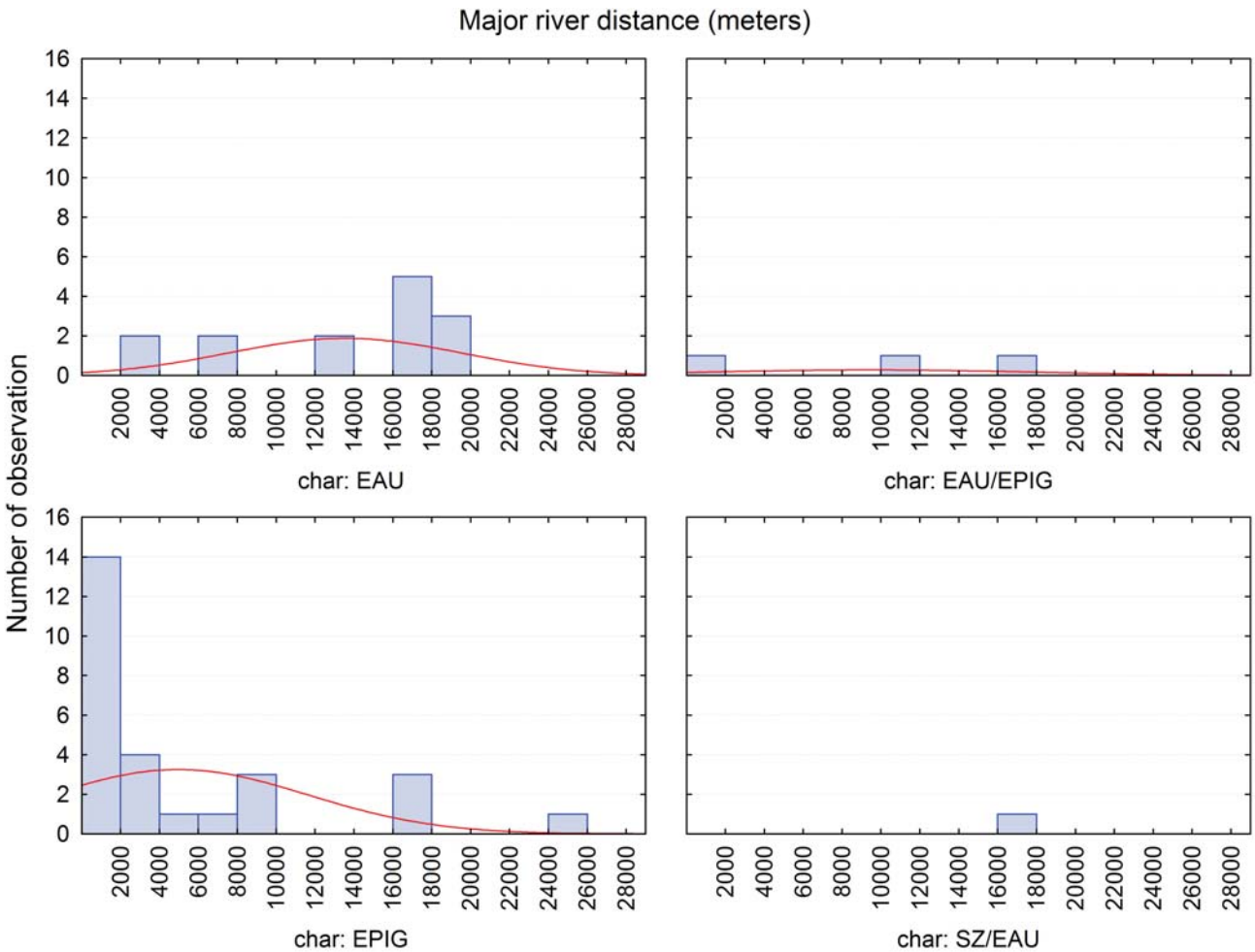

Figure 5: Histogram of distance to major rivers in comparison with cultural classification. For abbreviations see Table 1.

similar to those of today and that the positions of major baric centers governing the distribution of rain in Europe have persisted in similar positions. However, variations in atmospheric circulation over time due to expansion or shrinkage of the Scandinavian ice cap may have influenced the total amount of precipitation at the studied location as well as the ratio between rains originating from different directions (Hubberten *et al.* 2004; Skrzypek *et al.* 2011).Therefore we tried to take into consideration the position of individual localities regarding the wind flow. We used a map showing the current annual average wind speed at 10 m above the ground level. When we compare this map with the position of localities, it turns out that people have preferred regions where the influence of wind is smallest (Figure 3). An exception seems to be the Ostrov u Macochy site, which is indeed on a plateau, or some localities on the Jihlava and Oslava Rivers, which are currently situated within a zone with annual average wind speed of 3.5–4.0 m/s. In the latter sites, however, we must take into account that the river valley itself may have provided an effective protection against wind. Most of the localities examined are situated in places which in the LGM period probably were the most

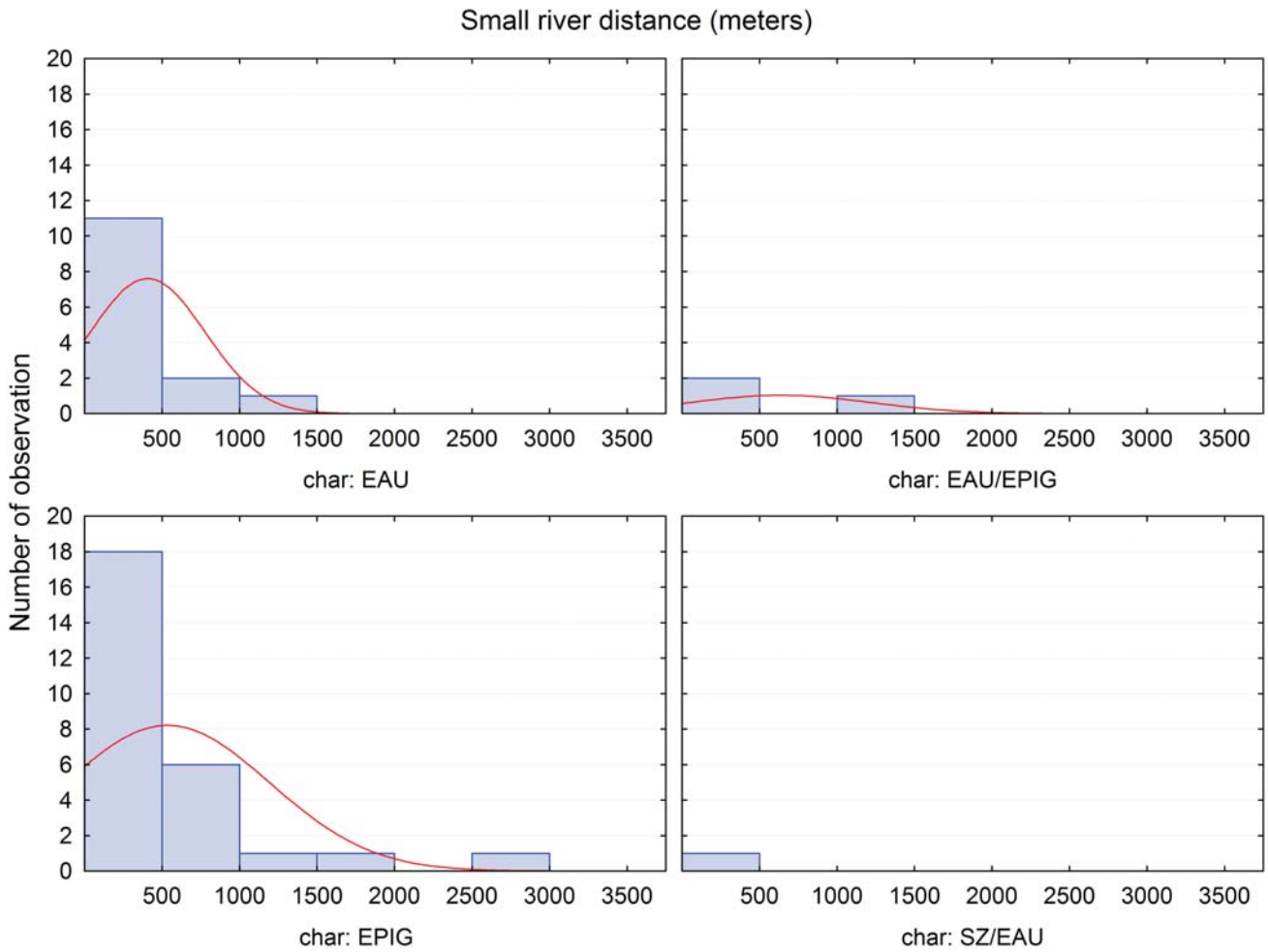

Figure 6: Histogram of distance to the nearest (small) water source in comparison with cultural classification. For abbreviations see Table 1.

favorable ones as far as the microclimatic aspect is concerned, that is, outside extreme locations and at the same time within the range of river floodplains. A group of localities on the slopes of the Drahany Upland, however, differ from this model. This would indicate that among the localities under review we are able to distinguish at least two different models of settlement strategy, which at the same time more or less correspond to distinction of industries into Epigravettian and Epiaurignacian (Figure 3), or into localities with and without carinated types (Figure 4), respectively. Epigravettian sites are rather concentrated in the neighborhood of large rivers or at least on the slopes of the main valley. Within this model we can count localities in the Napajedla Gate, the Brno and Opava regions, or those on the western slopes of the Bohemian-Moravian Highlands. Localities attributed to Late Aurignacian (Epiaurignacian) are almost entirely concentrated on the eastern slopes of the Drahany Upland. Based on the ratio of carinated elements it is evident that those sites, which exhibited none at all or only a low representation of carinated elements, rather correspond to the Epigravettian settlement model.

Table 2: The known natural conditions of excavated sites. Fauna: M – mammoth, Eq – horse, Ra – reindeer, B – aurochs, Col – woolly rhinoceros, Vul – fox, Ur – cave bear, Arv – water vole, Can – wolf.

site	fauna	others
Brno-Jundrov		tertiary shell
Brno-Stránská skála IV	M, Eq, Ra, B	stones cummulation
Brno-Štýřice III	M, Eq, Ra, Vul, Can, Col	tertiary shell, hearth
Brno-Štýřice, Kamenná St	M, Ra	
Brno-Štýřice, Polní St.		
Brno-Štýřice, Hospital	M	
Brno-Štýřice, Vídeňská St 849/15	M?	
Horákov-"Macocha"	M	
Jaroslavice	M, Ra, Eq, B, Col, Ur,	hearth
Mohelno-Plevovce KS A	Ra, Eq, Vulp, Arv	stones cummulation
Opava-Předměstí II (pískovny Stratila a B. Němcové)		hearth
Opava-Předměstí III (výtopna, nádraží)		iron meteorite
Opava-Předměstí I (Lundwall´s Brickyard)	M	
Oslavany-elektrárna	M, Eq, Col, Ra	
Sloup I-Kůlna		hearth
Štramberk II - Čertova Díra		burnt bones
Třebíč 1 (Ptáčov)	M, Ra, Eq, B	
Velké Pavlovice	M, Col, Eq	hearth?
Zlín-Louky	M	

As far as the other characteristics are concerned, the division into two groups is then evident only with analysis of the distance of individual localities from large watercourses (Table 1; Figure 5). In this case turns out that the localities which have been associated with Epigravettian (or a lower representation of carinated elements) are much closer to the river (within 2 km) than those with a higher share of carinated tools which are concentrated in the area of the Drahany Upland (more than 15 km). When we follow the shortest distance to water, then both of the groups are very similar to one another (Figures 6 and 7). Differences between sites can be found in elevations above sea level. The majority of Epigravettian localities are situated within the interval of 200–250 m a.s.l., whereas Epiaurignacian sites are found at 300–350 m a.s.l. (Figure 8). Such a difference, however, cannot be identified with regard to orientation in terrain. Epigravettian localities in Moravia are mostly oriented towards the east through to northeast (Figure 9: 12 cases in total); Epiaurignacian sites can either be oriented in the same way (7 cases) or situated on the top of an eminence (4 cases).

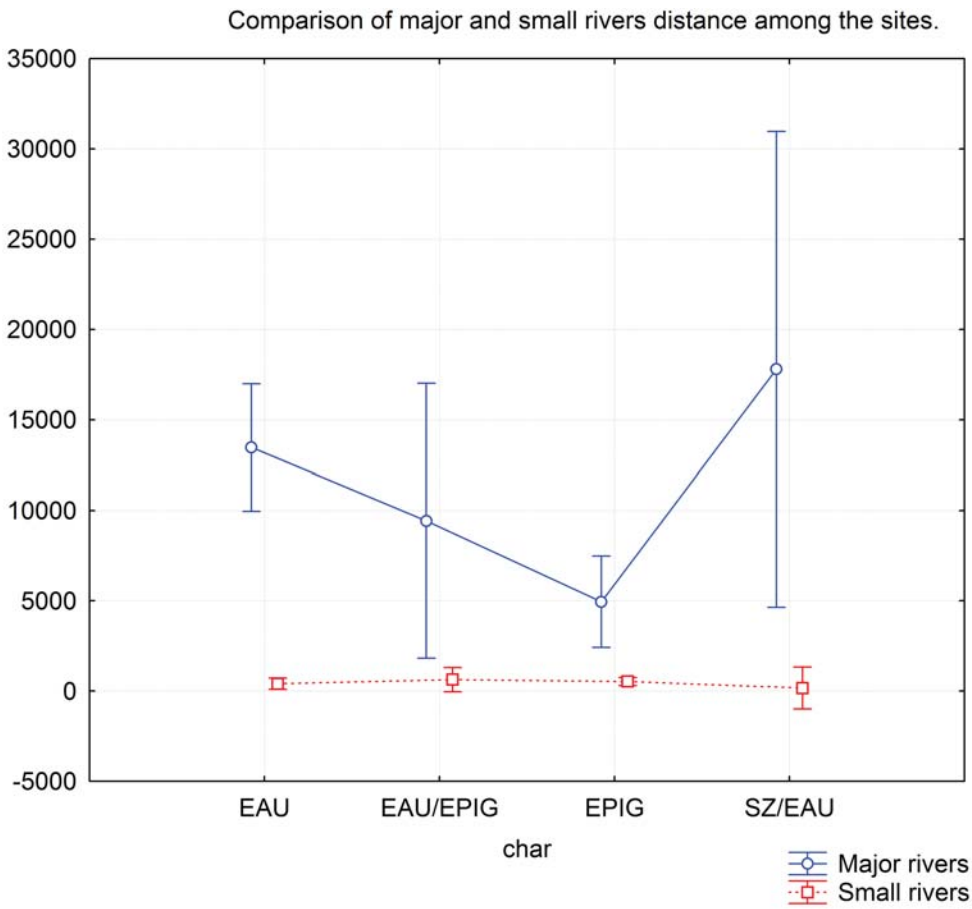

Figure 7: ANOVA comparison of major rivers distance and nearest (small) water sources histograms. For abbreviations see Table 1.

When we take into consideration the above knowledge, it seems that a real discontinuity, such as, for example, in Germany (Montet-White 1994; Terberger 2013), did not necessarily occur with settlement in Moravia. The later phase of Gravettian has already developed in a period when climate was radically changing, which gradually found response in both the surrounding ecosystem and the humans. Regions were gradually colonized, which were not earlier traditional Gravettian settlement territories (for this issue cf. Oliva 2003). Changes in the system of supply and in material culture occurred rather than depopulation. However, the data available so far do not imply that the role of mammoth (whether alimentary or symbolical) would have retreated to the background (cf. Table 2). Localities occur, specialized in hunting of other herbivores (e.g. horse at Stránská Skála IV). This phenomenon may be associated with changes of biotopes, which disintegrated into a considerably heterogeneous mosaic-like landscape. Moreover, this may have been quite arid, which some authors claim to be the crucial factor affecting the entire food chain (Horsák and Chytrý 2010, 119).

The mosaic-like character of the landscape thus also may have been reflected in settlement structure and may finally have led to disintegration of the original Gravettian techno-complex. The analysis of the relationship between the position

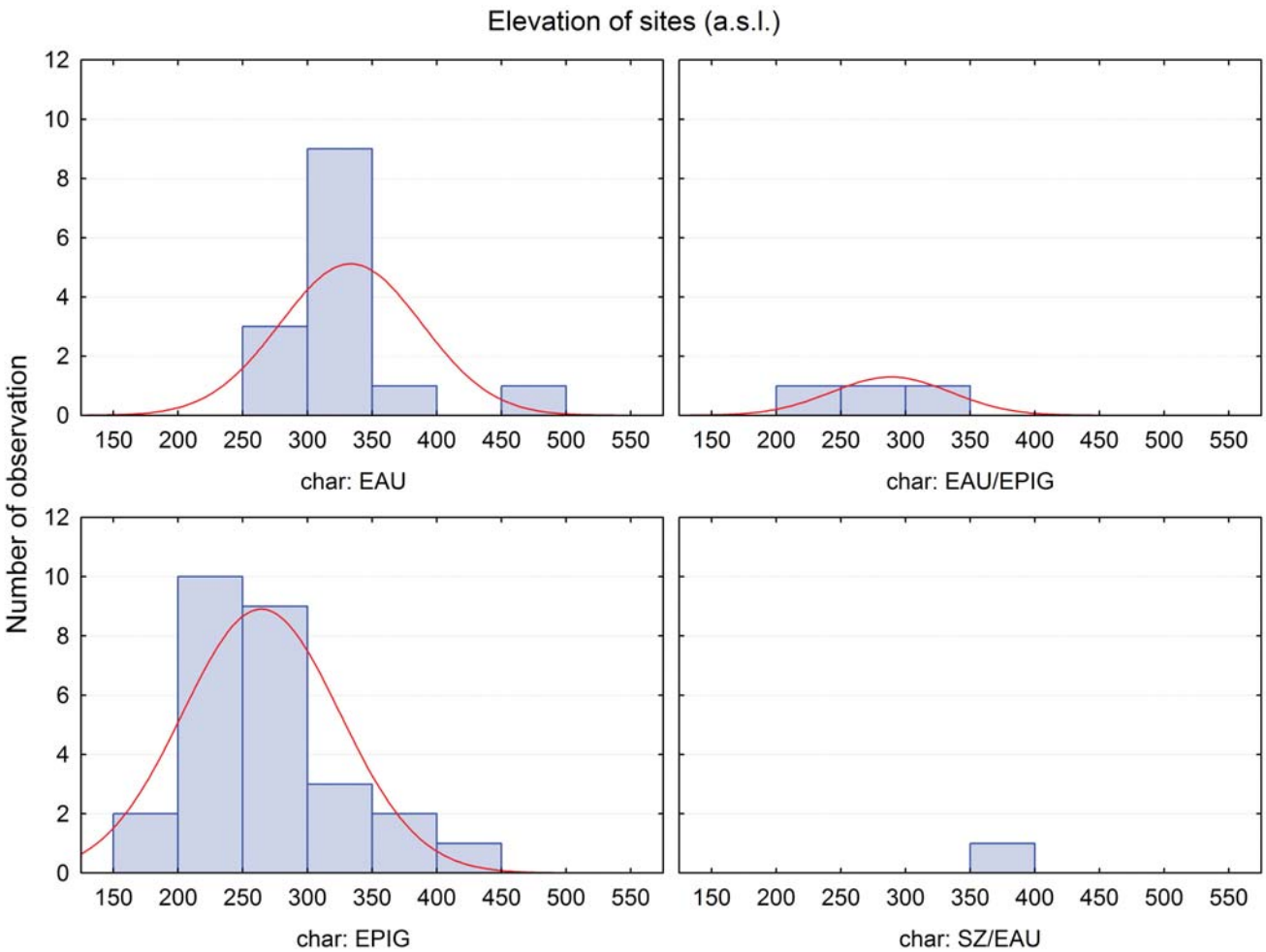

Figure 8: Histogram comparing the elevation of sites and their cultural classification.
For abbreviations see Table 1.

of a locality and the surrounding landscape has revealed that in Moravia we are able to distinguish at least two different settlement strategies, which might represent two techno-typological groups at the time of LGM in Moravia. The presence of carinated types in assemblages has to be critically assessed because these types also occur in collections classified as Epigravettian (e.g. Zlín-Louky, Opava III, Stránská Skála IV). A similar phenomenon can also be observed in Western Europe where this component of industry occurs in the Late Gravettian (Périgordian), evidently without any connection to Aurignacian, and is considered an entirely independent reappearance of a technological element, such as, for example, the adaptation to climatic changes (Djindjian and Bosselin 1994).

An important factor in connection with excavations at the Brno-Štýřice III or Mohelno-Plevovce sites is the character of interactions between the newly arriving Magdalenian hunters and the "indigenous" population. The time delay between the Epigravettian industry from Brno-Štýřice-Kamenná St. and the Magdalenian occupation of Balcarka Cave in the Moravian Karst is only about 300 years (Nerudová 2010). Any direct superposition of both these technological complexes,

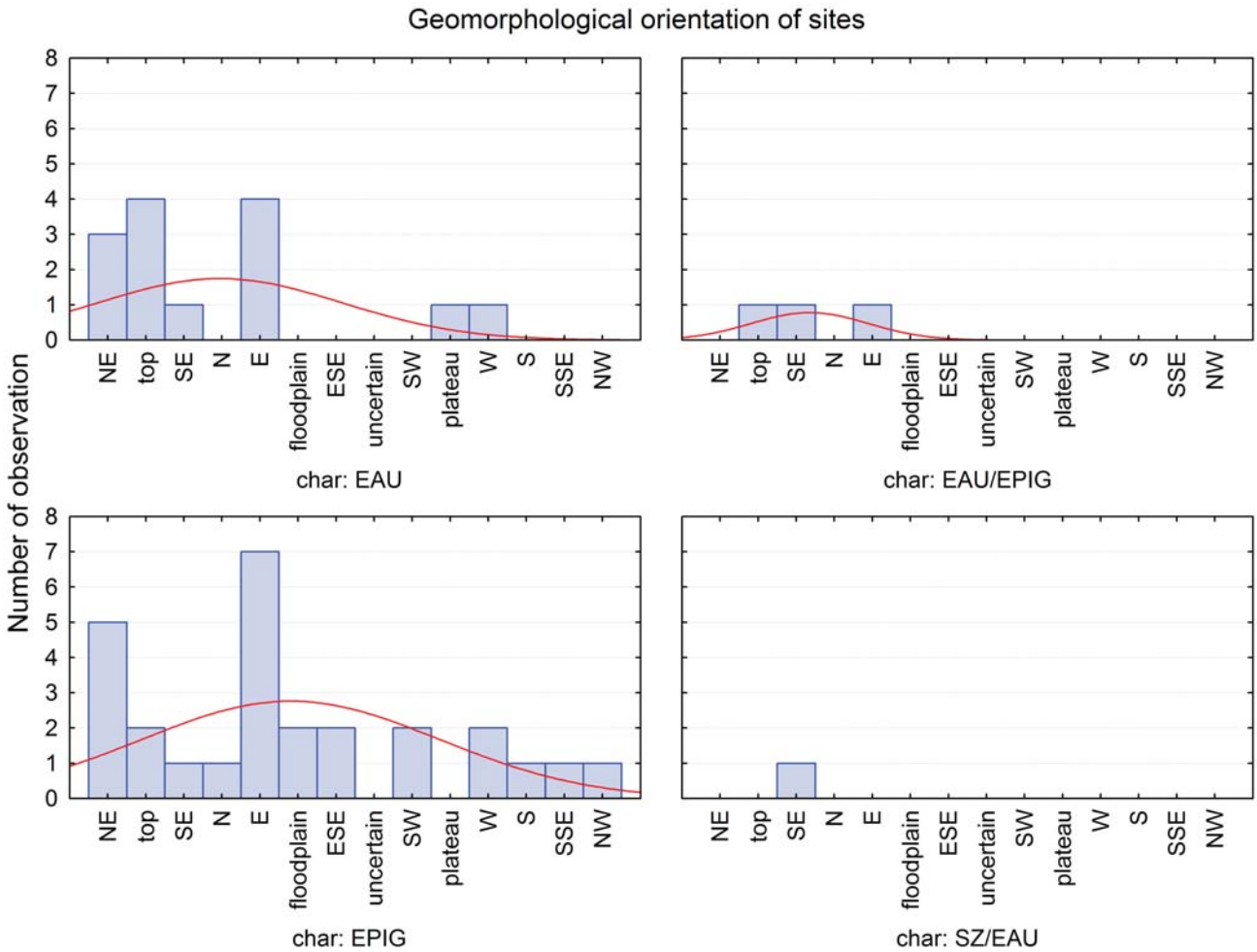

Figure 9: Histogram comparing the orientation of sites and their cultural classification.
For abbreviation see Table 1.

such as that at the Sowin site in Poland (Kussner 2010; Wiśniewski *et al.* 2012), where the situation can be classified as an evidence of two subsequent and maybe independent events, is not yet recorded in Moravia. Nevertheless, it seems likely that some interactions between the indigenous populations and Magdalenian hunters may indeed have taken place (Valoch 2010, 20). The parallel existence of two ethnic groups would explain why Magdalenians preferred a rather different terrain in Moravia (Moravian Karst), or why we can identify differences in the spectrum of game (mammoth in Brno-Štýřice and reindeer in Balcarka Cave). Differences are evident in the technology of processing of lithic raw material, above all in the process of detachment of blades (Mozola 2013).

Parallel coexistence was probably enabled thanks to different preferences which did not compete with one another. Anyway, the LGM and the Last Glacial period are still relatively little explored so that possibilities are open for new interpretations, which can considerably differ from our current concepts. However, if we want to enhance the quality of our knowledge, it will probably be necessary to find new stratified locations with well-preserved archeological and osteological material.

Résumé

La période du Dernier maximum glaciaire est définie par la baisse du niveau de la mer et l'expansion maximale du glacier continental entre 26,5–20/19 ka cal BP. Du point de vue archéologique, elle coincide, en Europe Centrale, avec la fin du Gravettien vers 24–25 ka cal. BP et l'avènement de la colonisation Magdalénienne, les changements climatiques en cours ayant dû causer une forte diminution du nombre de sites connus. Néanmoins, la géomorphologie de l'Europe Centrale diffère de celle des plaines du nord et de l'ouest. Ainsi, les conditions locales des écosystèmes, perceptibles à travers les pollens et la malacofaune, semblent plus favorables en Europe Centrale. À partir de la datation, de la position stratigraphique et/ou de l'analyse typo-technologique des assemblages lithiques, 49 sites se placent dans l'intervalle entre le Gravettien et le Magdalénien en Moravie. Ces sites (tab. 1) correspondent à plusieurs groupes régionaux implantés à proximité des larges bassins de grandes rivières, dans les vallées au cours d'eau plus petits et sur les pentes protégées des régions vallonnées plus éloignées des grands cours d'eau. L'analyse des attributs (types de site et leur implantation dans le terrain) montre que la plupart des gisements se trouvent dans les endroits favorables du point de vue microclimatique, en dehors des régions les plus exploitées. Les différents modèles d'organisation de l'habitat coïncident avec la distinction des industries de l'Epigravettien et de l'Epiaurignacien (ou Aurignacien final) (fig. 3), c'est-à-dire les sites avec ou sans outillage caréné (fig. 4). En Moravie, il est peu probable qu'il ait existé une véritable discontinuité de l'occupation comme cela fut, par exemple, le cas en Allemagne. A défaut de « dépeuplement », il faut plutôt envisager l'existence de changements dans le système de l'exploitation des sources. Une telle situation aurait permis une coexistence éventuelle entre une population Gravettienne autochtone et des nouveaux venus, représentants du Magdalénien.

Zusammenfassung

Das Letzte Glaziale Maximum (LGM) ist geprägt durch ein Absinken des Meeresspiegels und der damit zusammenhängenden maximalen Ausbreitung der kontinentalen Gletscher zwischen 26.5–20/19 ky cal BP. Archäologisch wird es in Mitteleuropa mit dem Ausklingen des Gravettien um 24–25 ky cal BP und dem Beginn der magdalenischen Kolonisierung verknüpft, wobei die Klimaveränderungen mit einer starken Abnahme der Anzahl bekannter Fundstellen einhergeht. Nichtsdestoweniger begünstigte die Geomorphologie Mitteleuropas, die sich von der in den nördlichen und westlichen Ebenen unterscheidet, die Entwicklung lokaler Ökosysteme, die sich gemäß der Pollenreste oder Malakofauna als Gunsträume darstellen. Anhand von Datierung, stratigraphischer Position und technologisch-typologischer Analyse der Steinwerkzeuge können in Mähren insgesamt 49 Fundstellen in die Zeitspanne zwischen Gravettien und Magdalénien gereiht werden, die mehrere Regionalgruppen bilden (in der Nähe weiter Beckenlandschaften großer Flüsse, in Tälern kleinerer Wasserläufe sowie auf geschützten Hängen der Hügellandschaften in größerer Entfernung von großen Wasserläufen). Die Analyse der Attribute (Charakter der Fundstelle und ihre Lage im Terrain) zeigt, dass die meisten Fundstellen in mikroklimatisch günstigen Positionen außerhalb exponierter Gebiete vorkommen. Verschiedene Modelle der Siedlungsstratigraphie spiegeln die Unterscheidung der Industrien in Epigravettien und Epiaurignacien (Abbildung 3) wider, und eventuell Fundstellen ohne und mit „carinated types" (Abbildung 4). In Mähren kam es zu keiner tatsächlichen Diskontinuität der Besiedlung, wie es z.B. in Deutschland der Fall war, und deshalb kam es eher zu Veränderungen bei der Ressourcennutzung als zu Abwanderungen. Dies würde eine eventuelle Koexistenz der autochthonen Träger des Epigravettien mit Neuankömmlingen – den Trägern des Magdalénien – ermöglichen.

TERMINAL LGM DWELLING STRUCTURE FROM MOHELNO IN THE CZECH-MORAVIAN HIGHLANDS

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Abstract
The site of Mohelno-Plevovce is situated below the water line of the Mohelno reservoir (lower part of the Dalešice pumped-storage hydroelectric power plant). During a short term excavation in September 2013, we documented a hexagonal flat stone pavement 3.0 m in diameter. Within the paved area the artifact density was relatively high. Outside the paved area the density of finds decreased rapidly, which indicates a strong barrier-effect along the pavement boundary. The industry has been dated to terminal LGM and is characterized by steeply retouched end scrapers and distinct tiny backed microliths with the closest analogy in the North Black Sea Region.

Keywords
Czech-Moravian Highlands, Mohelno, LGM, dwelling, pavement, Epigravettian, Epi-aurignacian

DOI: 10.5817/CZ.MUNI.M210-7781-2015-29

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Introduction

The site of Mohelno-Plevovce is located far from the main Moravian Gravettian communication corridor which connects the Danube River valley with the Morava River valley, the Moravian Gate and Oder River valley to the Northern European plains (Figure 1). It is situated 45 km (in a straight line) northwest of the Pavlov hills, deep in the Czech-Moravian Highlands, and connected to the Southern Moravian valleys through river basins of smaller rivers such as the Dyje, Svratka and Jihlava. Cliffs surround the site to the north-east, north and west, while the site itself is located 15–20 m above the Jihlava River. The ground is open to the south

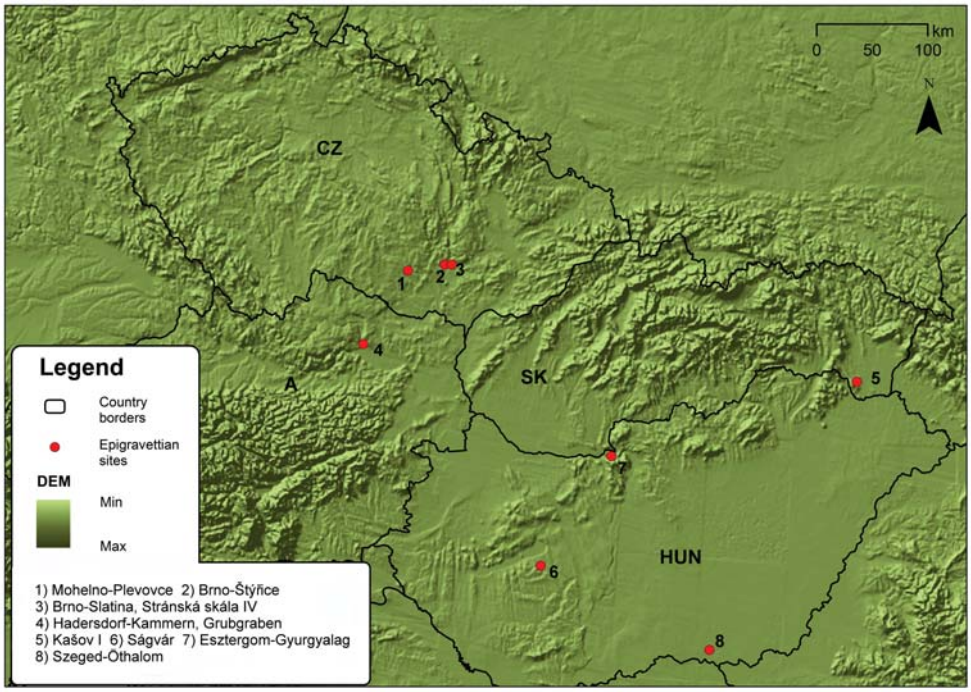


Figure 1: Map of Eastern Central Europe with location of sites mentioned in text.

(Figure 2). The microclimate of this area would have been a climatic "oasis" during the LGM. Today the site is being continuously disturbed by fluctuating water levels of the Mohelno reservoir, eroding the Quaternary sediments and disturbing the archeological material. During September 2013, the hydroelectric power plant underwent scheduled maintenance and for a period of three days the water level was at its minimum. The site was on a "dry beach", which permitted a short term salvage excavation of stone structure A.

Surface surveys and test pitting has shown this site to be polycultural. Apart from two late Paleolithic occupations, the site was also occupied during the Neolithic and Eneolithic periods (Škrdla *et al.* 2012). Three clusters of Paleolithic stone artifacts (labeled 1, 2 and 3) in intact sediments have been recovered thus far (Škrdla *et al.* 2014). Artifacts on the surface have been collected from across the site. Clusters 1 and 2 are blade-rich assemblages which are technologically and typologically similar to Epigravettian assemblages from Brno-Štýřice (Vídeňská Street and Kamenná Street; Nerudová *et al.* 2012). Although a radiocarbon date is not available as yet, it is very likely that they date to the beginning of the late glacial.

Cluster 3 is located close to the lowest water level (i.e. usually submerged). Due to the fluctuating water levels and the accompanying erosion, clusters of flat stones were exposed here. We initially identified two and subsequently a potential third structure (labeled as A, B and C). Technologically speaking, lithic cluster 3 differs markedly from clusters 1 and 2 in the flaking technique used and by the presence of steep endscrapers and diminutive microlithic tools. Thus far, we have only documented stone structure A, where we also recovered a unique lithic assemblage.

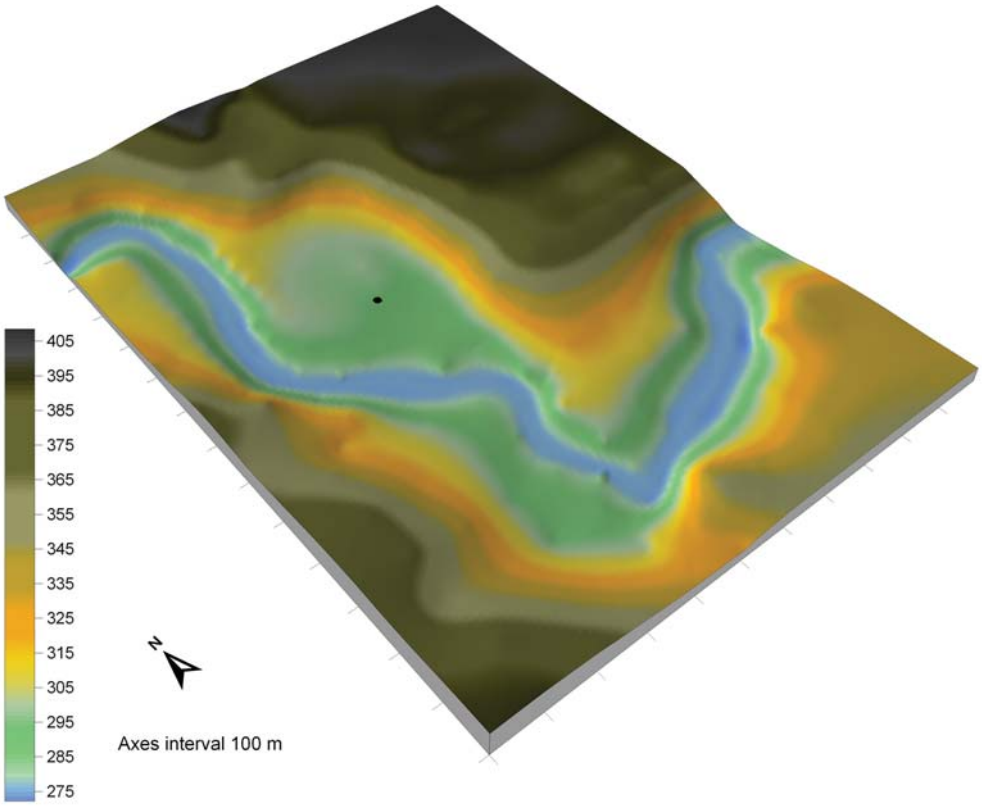


Figure 2: Mohelno-Plevovce: Location of the site within the Jihlava River valley.

On the basis of a radiocarbon date we can attribute this occupation to the terminal LGM. The results of the investigation of stone structure A are the main theme of this paper.

Stone structures

In September 2012 we noticed two areas with concentrations of flat stones on the lower part of the beach. These stones must have been exposed recently because they are not visible on photographs taken in 2011. Given that such stone features are conspicuous in colluvial sediments, we conducted a search of the surface surrounding these features and we took photographs. While clearing the surface we discovered seven stones lodged in situ. We subsequently labeled the stone structures A and B while monitoring the progressive erosion. We recorded the artifacts in the immediate vicinity of the structures separately to other surface artifacts. Given the advancing erosion and its effects on the stone structures, in September 2013, we conducted a detailed archeological investigation of stone structure A. We covered stone structure B with sediments to prevent further erosion (we are planning to excavate it during the next scheduled maintenance period in spring 2014). In October 2013, a third possible stone structure (labeled C) was discovered 18 m from stone structure B.

Research methods

The methods selected for this rescue archeology project placed particular emphasis on accurate localization of artifacts discovered during surface prospecting and wet-sieving. This data would enable us to conduct a detailed spatial analysis – key information for interpreting the stone structures. To document the stone structures, in autumn 2012 we created a 1 × 1 m square grid with relative coordinates over the area. The rescue archeology excavation in September 2013 uncovered an area of 5 × 3 m. The 1 × 1 m squares were further subdivided into sub-squares 0.5 × 0.5 m in size. Each sub-square was excavated layer by layer and all of the recovered sediment was wet-sieved using 2 mm sieves. All artifacts found during the excavation were recorded in X & Y coordinates. The recording of depth (Z coordinate) measurements was discontinued during the excavation due to time constraints and very challenging work conditions. Approximately two thirds of all artifacts do have their Z coordinate recorded; the maximum difference in Z values is 10 cm (which represents the height difference between the upper surface of the stones and the underlying sediment). All of the Z values were within the 10-cm depth interval so it is reasonable to assume that the unrecorded Z values will not affect the final interpretations.

Planigraphy

Stone structure A consisted of 40 artificially placed flat stones over an area of approximately 3 × 3 m. All stones were present in the same layer (due to stone thickness, about 10–15 cm thick) and the stones rarely penetrated into the underlying

Figure 3: View of the excavated stone structure. Documenting exposed stones in 2012 (left) and cleaned stone structure after excavation (right).

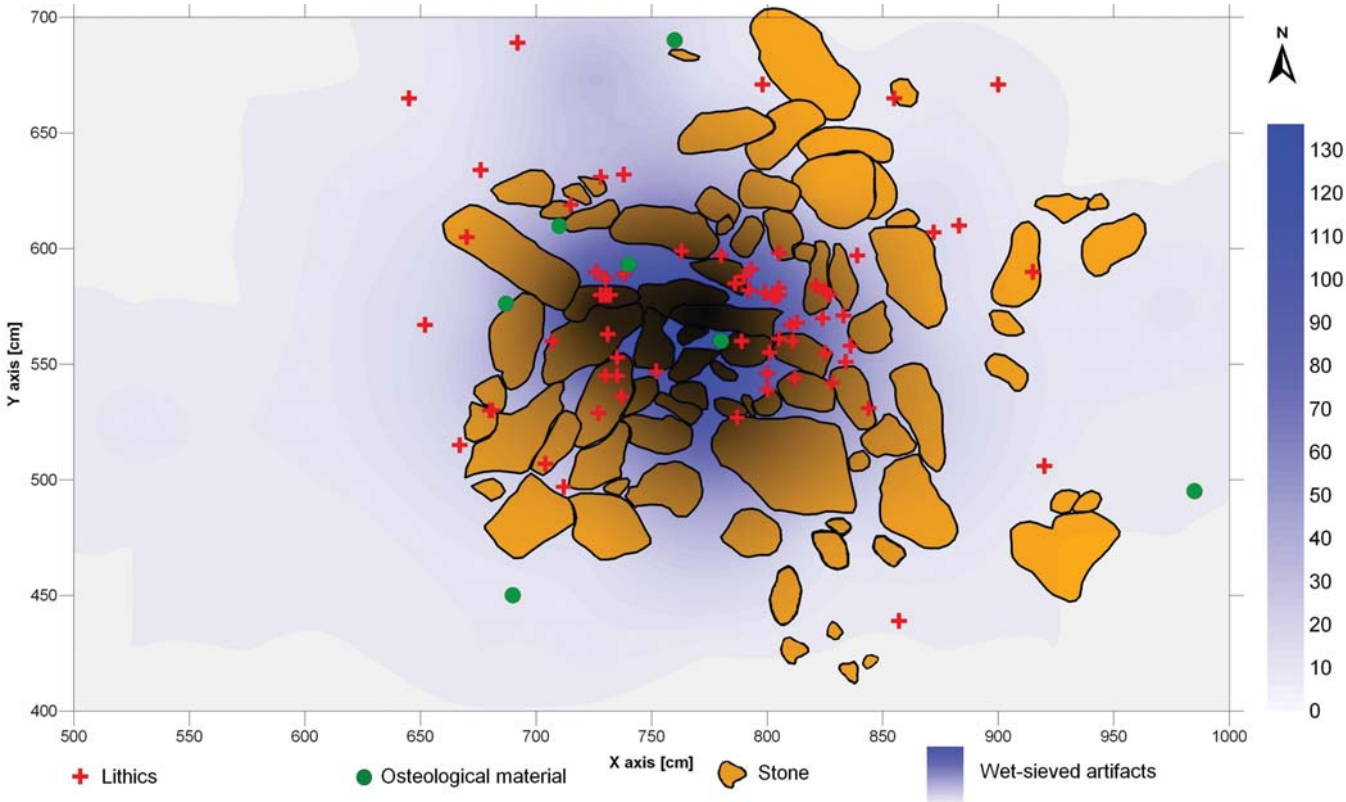


Figure 4: Mohelno-Plevovce: Flat stone structure and spatial distribution of finds.

sediment. All the stones have a similar shape and are evenly arranged so we suspect that they represent the original floor surface of the structure. The size of the stones varied from 50 × 50 cm to 5 × 5 cm, the smaller-sized ones being used to fill in gaps. Only specific shaped stones were used, giving the structure a regularized appearance. As the initial documentation suggests, the structure had a hexagonal shape (Škrdla *et al.* 2013) before the lower (southern) part of the structure was disturbed by erosion (Figure 3). The lower part of the structure was almost horizontal during the excavation and parallel to the edge of the shore. The original shape of the structure is supported by the 2012 photographs as well as the location of artifacts.

In terms of the horizontal distribution of artifacts, both in-situ and wet-sieved artifacts form a cluster roughly in the middle of the structure and the density decreases proportionately with increasing distance from the center. The density drops off markedly away from the edges of the structure, where only a very small number were found (Figures 4, 5). No hearth was discovered and charcoal is rare between and under the stones bar one exception.

The stone rock type suggests that the stones were obtained in the vicinity of the site from detrital and colluvial sediments and from terrace sediments, or directly from the Jihlava River.

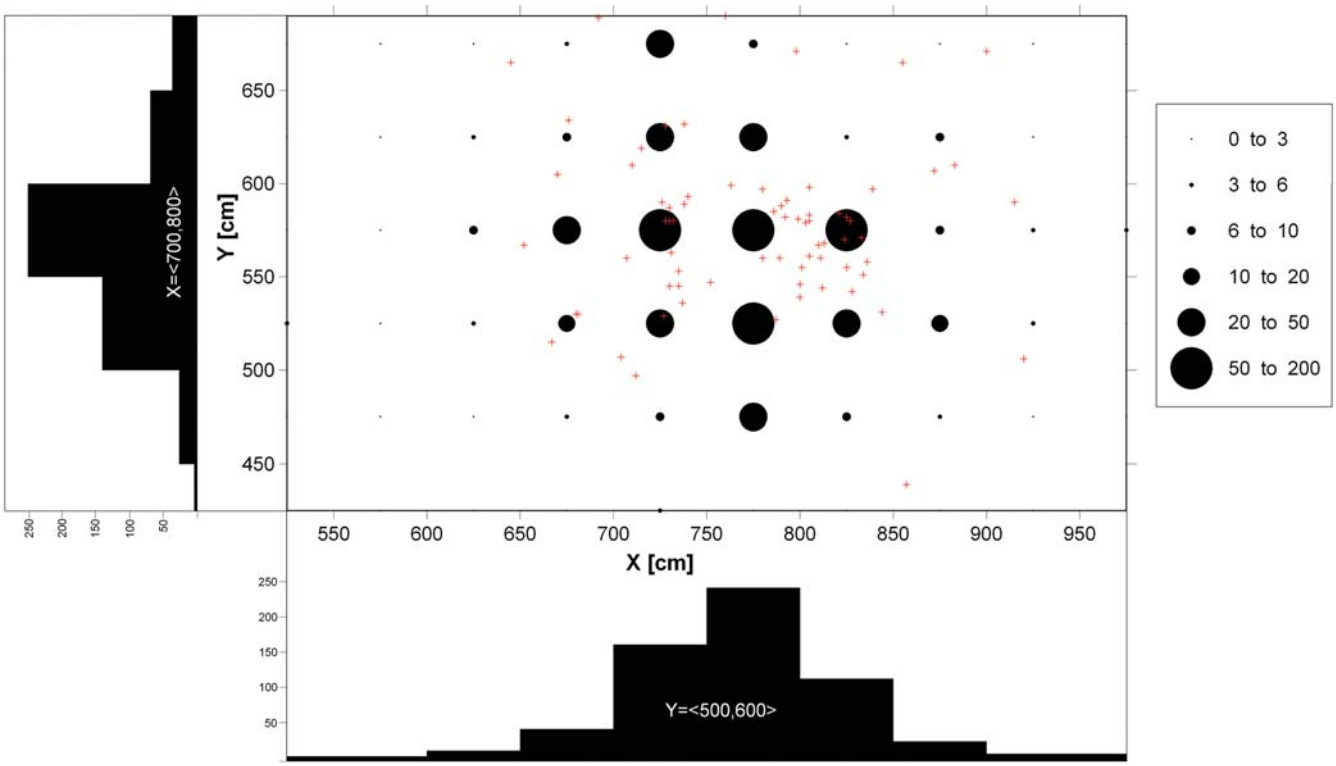


Figure 5: Mohelno-Plevovce: Barrier effect along the stone structure.

Analysis of the stratified assemblage

Ninety-one artifacts were recovered during the excavation of the stone structure. Wet-sieving has produced an additional 867 artifacts (90.5% of the total number of artifacts) resulting in a proportional increase of small pieces of debitage and very small flakes. Wet-sieving of the excavated sediment also resulted in the discovery of microliths. No microlithic pieces were detected during the excavation. The total number of artifacts is 958. No burnt artifacts were discovered.

Technology

Differences in reduction patterns between raw materials (erratic flint versus quartz and rock crystal) are evident. For quartz and rock crystal artifacts, the lithic reduction sequence was not identified due to small artefact size and poor quality of raw material. Forty-five quartz and rock crystal flakes originate from preparation of cobbles and most finished products were transported away from the site (except for one crystal blade and one crystal microblade). Examples of less efficient use of stone (in comparison to erratic chert) includes two pieces of crystal with two negative scars and five quartz/quartz crystal pebbles with one negative scar on each piece. One quartz cobble with several negative scars along its edge and additional impact scars in the center of a flat surface ("nutting stone") was designated as coarse

Table 1. Raw material spectrum.

raw material	number of pieces	percentage	notes
erratic chert	674	70.3	
rock crystal	183	19.1	1 piece is smoky quartz
quartz	79	8.2	
unspecified silicic rock	19	2.0	
reddish-brown radiolarite	3	0.4	1 piece was knapped from a pebble

industry. If we exclude the quartz crystals and crystal pebbles with "test strikes", only one single-platform (quartz) core was recorded.

Blade and microblade cores are absent. Most of the twelve core trimming elements are made from erratic chert. The small amount of core preparation debitage suggests that the cores were, by and large, brought to the site already prepared. Sixty-one pieces represent blanks, of which eight pieces are flakes and 53 pieces are blades and microblades. Blades number 8 pieces and microblades 35 pieces. The widths of blades and microblades range from 3 to 24 mm, with a mean value of 6.7 mm. The microblades are mostly complete and up to 15 mm long. Fragmented pieces include those with a broken distal end and short distal and proximal segments. Only three burin spalls were detected. There are some indicators (striking scars, indistinct striking points) for the use of soft hammer in core reduction. Platforms of target flakes and blades are plain and punctiform (the surface collection also produced two carefully facetted/abraded platforms).

Typology

Typologically speaking, there are 35 curated tools (3.6% of the total number of artifacts). Artifacts on erratic chert include 11 larger pieces and 22 microlithic tools. Figure 6: 4–6 shows three steeply retouched endscrapers made on short flakes. There are also two splintered pieces (Figure 6: 8, 9), a burin on a pointed retouched blade (Figure 6: 10), a microdenticulated borer (Figure 6: 11), a medial fragment with backing (Figure 6: 13), a distal segment of a tool on a point with backing (or a burin fragment) (Figure 6: 1) and a blade with irregular lateral retouch.

The microlithic tools were manufactured exclusively from erratic chert and they are notable for their unusually small size. They include: four asymmetric microblade points with backing (Figure 7: 1–4), three asymmetric, backed microblades (not points; Figure 7: 7, 9, 12), three backed microblades (Figure 7: 5, 6, 10), three backed proximal microblade fragments (Figure 7: 14, 16, 19), a distal segment of a laterally retouched microblade with a retouched point (Figure 7: 17), a distal segment of a backed microblade with an impact scar on the broken surface (Figure 7: 15), a distal segment of a backed microblade with ventral retouch on the opposite side (Figure

Figure 6: Mohelno-Plevovce: Selected.

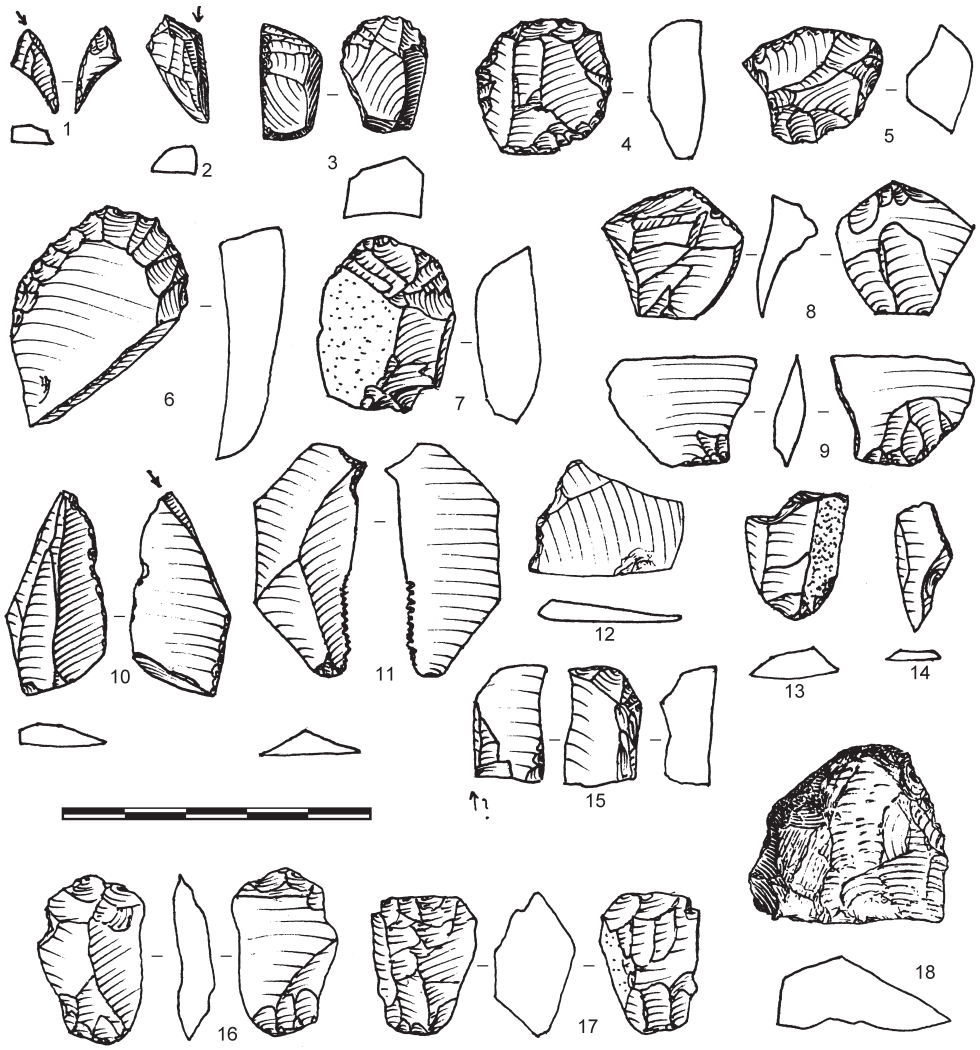
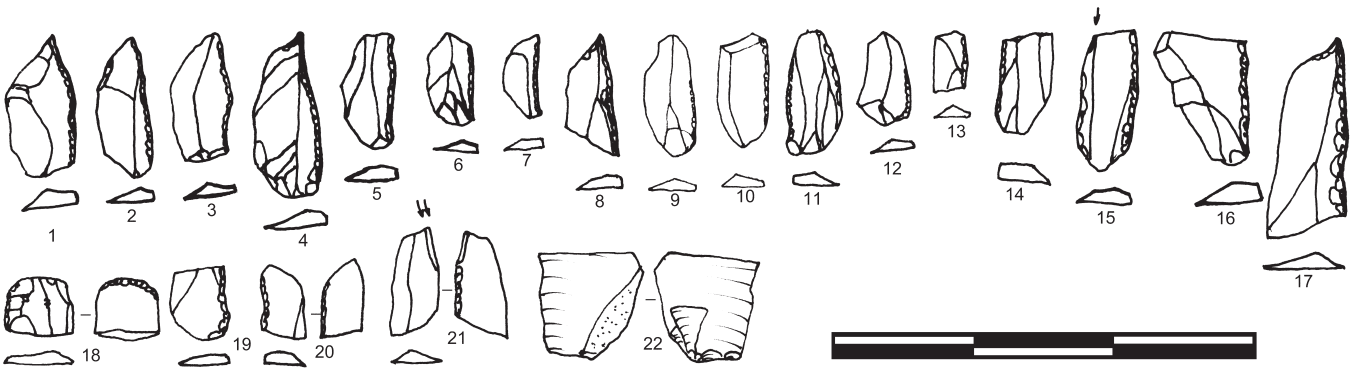


Figure 7: Mohelno-Plevovce: Microlithic implements.



7: 20), a backed microblade with dorsal retouch on the opposite side (possibly retouched to a point, which was damaged; Figure 7: 11), a distal fragment of a backed microblade and ventral "scraper-like" retouch (Figure 7: 18), a proximal fragment of a microblade with chisel-like retouch on the ventral surface (Figure 7: 22), a distal fragment of a backed microblade with borer-like modification (Figure 7: 8), a distal fragment of a backed microblade (Figure 7: 13) and a medial fragment of a retouched microblade with an impact scar on a broken surface (Figure 7: 21).

Tools manufactured from rock crystal include only a broken scraper possibly combined with a burin on the break (Figure 6: 15) and a blade fragment with fine retouch (Figure 6: 14).

Backed artifacts (19 pieces) account for over a half of all the tools (55.9%). Backing is very fine and usually located on the right lateral margin. These artifacts are often asymmetrical and sometimes pointed. Some microblades morphologically resemble flakes and the original blanks (before backing) certainly belonged to this category.

Faunal remains

The faunal remains were considerably fragmented. Identified taxonomic groups include reindeer (*Rangifer tarandus*), horse (*Equus* sp.), polar fox (*Vulpes lagopus*), vole (*Arvicola* sp.) and bone fragments of a large, horse-sized mammal. Apart from two long bone fragments of a large mammal, all the remains are teeth. Each taxonomic category is represented by one individual. Tooth fragments and long bone flakes are indicative of butchery. These animal types suggest a cold, dry steppe environment. This environment permitted animal migration into higher altitudes of the Czech-Moravian Highlands.

Raw material sources

The most common raw material type is erratic chert followed by quartz. Most of the quartz pieces are fragments of hammers. Radiolarite is rare. The most interesting raw material aspect of the collection is the high proportion of rock crystal (approximately one-quarter of the assemblage), which is unprecedented for Moravian sites of this period. The assemblage contains a mixture of good quality as well as poorer quality rock crystal, and occasionally smoky quartz. These materials have probably been procured in the catchment area of the Oslava River deeper in the highlands. Some of the poorer quality pieces may have been obtained locally.

Dating of stone structure A

Upon removing a stone at coordinates [800,500] (cf. Figure 4) we discovered a lens of humic sediment, which contained macroscopic charcoal, faunal remains and small stone flakes. This material was wet-sieved in the laboratory using a 0.5 × 0.5 mm sieve. Other material recovered during wet-sieving includes small pieces of red pigment, very small rock crystal flakes, and remains of horse, reindeer, polar fox and

vole teeth. Charcoal was sent to the University of Poznan for AMS dating resulting in a date of 16, 280 ± 80 14C BP (Poz-57891), calibrated using Calib 7.0.0. (Stuiver and Reimer 1993) and IntCal13 (Reimer et al. 2013). The resulting calibrated range is 19, 530–19, 771 cal BP (1 sigma) and 19, 441–19, 934 cal BP (2 sigma). This age estimate places the human occupation in terminal LGM, i.e. a time of sudden warming when the northern glacier began to retreat (Clark *et al.* 2009).

Surface collection

Apart from the rescue archeology excavation project, a preliminary surface inspection was also conducted and 42 artifacts were found during this search. The raw materials include erratic chert (19 pieces), silicic rock (9 pieces), rock crystal from crystals and cobbles (8 pieces) and quartz (7 pieces). One piece was burnt. Technologically speaking, the assemblage contains 3 residual cores, 3 blades (2 are medial fragments), 14 flakes, 7 tools and 16 pieces of debitage.

Tools made from erratic chert include a steeply retouched double endscraper (Figure 6: 3), a small backed microblade fragment and a burin fragment on a truncated blade (Figure 6: 2). Figure 6: 7 also depicts a steeply retouched endscraper on a short cortical flake from an unidentified silicic rock. Rock crystal artifacts also include a splintered piece (Figure 6: 16), an atypical endscraper fragment (Figure 6: 18) and an indistinct bidirectional core (Figure 6: 17).

During surface surveys of this area, a coarse industry from quartz pebbles was also recorded. This industry includes three fragments, a proximal segment of a wide flake and a large cobble with impact scars on the flat side and flake removal scars on the adjacent surfaces (damaged anvil, lightly reduced core, or a chopper?). The variability of artifacts attests to the diverse activities that took place at this site (cf. site furniture; Binford 1979).

Discussion

The diversity of raw materials suggests wide-ranging movements and high mobility of the hunter-gatherers occupying this site (Figure 10). Imported raw materials subsume an area from Southern Poland (erratic chert) to the White Carpathians or Danube River terraces, as well as local sources (weathering products, quartz) and regional raw materials (rock crystal from the highlands area). The use of rock crystal is a unique feature of this site not known from other Moravian Paleolithic sites except for the Magdalenian Žitného Cave (Valoch 1957).

The investigation of stone structure A has yielded a distinct stone industry. Blades and microblades prevail over flakes and when compared with artifacts from concentrations 1 and 2, they are narrower and less regular. Small blanks were probably obtained from large endscrapers which were likely used as cores for microblades/microflakes. Flake and blade platforms are often punctiform, plain, dihedral and linear. Indistinct striking points and indistinct lips indicate the use of soft hammers, especially soft stones. This interpretation is consistent with fine

abrasion of surfaces where flaking angle was modified. Other reduction techniques, e.g. the use of punch (some authors suggest this technique was not used until later periods; Inizan *et al*. 1999, 76) or pressure, needs to be determined by further analysis.

Salient components of stone structure A are steeply retouched endscrapers on short, thick flakes and small microlithic tools. Burins, splintered pieces and a microdenticulated borer also occur. The microlithic tools are a particularly significant feature of this assemblage. Such artifacts have not been so far discovered in any Epigravettian LGM or late glacial assemblage in Moravia. These microliths typically feature backing and were manufactured from flake-microblade blanks, which has resulted in a more elongated morphology and asymmetrical shape. The backing of the right side of the artifact is morphologically distinct. Approximately a quarter of the microliths have the morphology of a point, sometimes with modification of the distal end (i.e. the pointed end) itself. Retouched (unbacked) microlithic pieces and scraper-like or chisel-like modification of the distal or proximal ends are rarer.

The faunal remains from the excavation of stone structure A represent a cold-adapted fauna, which is consistent with an open-steppe/tundra LGM landscape. The main taxa include *Equus ferus, Rangifer tarandus, Vulpes lagopus* and *Arvicola* sp.

An important aspect of this research is finding analogies to the stone structure. Such comparisons are possible at three levels. Firstly, finding similar features, secondly, finding sites of similar antiquity, and thirdly, finding technologically-typologically similar lithic assemblages.

Similar stone structures ("pavements") are not uncommon in Upper Paleolithic sites. They have been described at Bohemian sites (Lubná II and Řevnice: Šída 2009) and an Austrian Epigravettian site (Grubgraben: Brandtner and Klíma 1995, Montet-White and Williams 1994). An accumulation of stones (there is uncertainty if it can also be interpreted as "pavement") and faunal remains were discovered at Stránská skála IV (Svoboda 1991a). Stone pavements were also uncovered at Magdalenian sites: Hostim in the Bohemian Karst (Vencl 1995), Gönnersdorf (Jöris and Terberger 2001) and Andernach-Martinsberg IV (Holzkämper 2006) in the central Rhine district. However, none of these investigated stone structures are similar to stone structure A (KSA) at Plevovce. Similarities to the other two Plevovce stone structures (KSB and KSC) are unknown at this stage because the research at the latter two has not been completed.

Three stone structures have been identified at Plevovce. KSA has a diameter of approximately 3 m. Although KSB and KSC have not been documented yet, they appear to have similar dimensions (Figure 6). KSA has been excavated in 50 × 50 cm squares. Most artifacts were recovered during wet-sieving and the largest concentration was 1.0 × 0.5 m in size at coordinates 760 × 560, where it formed an elliptical shape in a NW-SE orientation. Away from this center, the artifact density significantly decreases and the edge of the concentration forms a sharp boundary (Figure 11). This phenomenon has been labeled wall effect or barrier effect (Stapert 1991) and in the case of KSA, it is particularly distinct. It is clear that a barrier must

have been present that prevented further dispersion of the artifacts. We suspect this barrier would have been the walls of the dwelling structure. A similar situation has been observed at Grub/Kranawetberg (Nigst and Antl-Weiser 2011). An alternative explanation for this feature is an area used for sleeping – very similar structures are known from Western Greenland where they represent areas used for sleeping (Pasda 2006).

The interpretation of structures at the above-mentioned sites are based mainly on the presence of hearths and other spatial elements, e.g. pits and depressions, but not on the presence of stone structures. The absence of a hearth at Plevovce differentiates it from other known structures. Humic sediment containing charcoal was captured under only one stone and no burnt artifacts were recovered. It is evident that, compared with other known late Paleolithic dwelling structures (e.g. Grub/Kranawetberg), the Plevovce structure is different. However, dwellings without a central hearth have been documented at e.g. Le Cerisier (Jöris and Terberger 2001, 167) and Spytihněv (Škrdla *et al.* 2005, 210). The stone structure, a distinct barrier effect and the number and types of recovered artifacts leave us in no doubt that we are dealing with a dwelling structure.

Concomitant spatial features have been documented at, for example, Moravian Gravettian sites Dolní Věstonice, Pavlov and Milovice (Svoboda 1991b), the Slovakian Gravettian site of Kašov (Novák 2006) and the Austrian site Grub/Kranawetberg (Nigst and Antl-Weiser 2011). At Plevovce, the degree of preservation of the stone structures and other potential features has been adversely affected by fluctuating water levels in the reservoir; as a result, we do not have evidence of other accompanying features which may have been present, but did not survive. For example, similar structures at other sites often have large accumulations of bones that were used for supporting walls of dwelling structures (cf. Spytihněv: Škrdla *et al.* 2005). Accumulations of large bones were not found at KSA. Only seven bone fragments were found concentrated in the NW section of the feature. It is difficult to make further interpretations based on such a small sample.

There a few known sites dating to the Last Glacial Maximum (LGM) in the Carpathian Fore deep and the Carpathian Basin (Figure 8), which attests to low population density and high mobility of hunter-gatherers, who gravitated towards climatically favorable refugia, but episodically visited these territories to target local resources (cf. Verpoorte 2004). Upon examining the spread of radiocarbon dates for Moravia and neighboring territories (Slovakia, Austria, Hungary) and taking into account the techno-typological aspects of lithic industries, it is possible to subdivide them into three groups: onset of LGM, occasional sites from terminal LGM and post-LGM sites.

The first group of sites date to 23.0–21.0 ky cal BP and include Stránská skála IV in Moravia (Svoboda 1991a), Grubgraben in Austria (Montet-White and Williams 1994), Kašov I (upper layer) in Eastern Slovakia (Svoboda and Novák 2004), Sagvár in Hungary (Lengyel 2009), Mittlere Klause, Kastelhöhle-Nord and Wiesbaden-Igstadt in Germany (Terberger and Street 2003), and probably also Kraków-Spadzista C2 (Kozłowski and Sobczyk 1987) and Deszczowa Cave (Cyrek *et al.* 2000) in Poland.

The lithic industries at these sites include steeply retouched artifacts and microlithic tools. While the lithic assemblages from Stránská skála IV and Kašov are distinctly rich in blades, those from Grubgraben and Ságvár feature flake technologies.

The second group of sites date to 20.0–19.5 ky cal BP and include Mohelno-Plevovce (KSA), the Hungarian site Esztergom-Gyurgyalag (Dobosi and Kövecses-Varga 1991), probably also Szeged-Öthalom (Dobosi 1999), and maybe also the upper layer at Grubgraben (Damblon *et al.* 1996). The lithic assemblages are again distinctly rich in blades, but the microlithic component is variable.

The third group includes the Moravian site Brno-Vídeňská (Nerudová *et al.* 2012 etc.) dating to 19.0–17.0 ky cal BP and is characterized by the manufacture of long, narrow, symmetrical blades, often manufactured from bipolar cores. A typologically

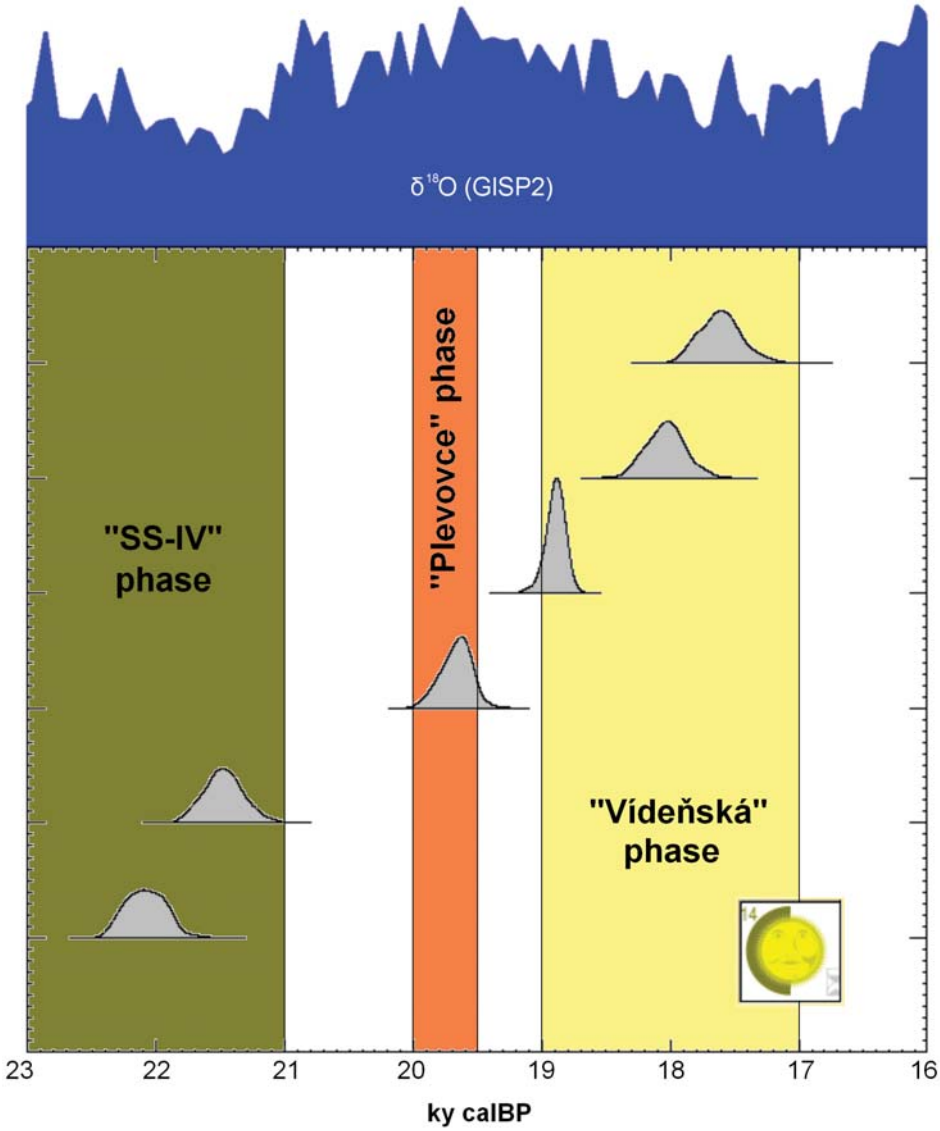


Figure 8: Overview of Moravian Epigravettian dates.

dominant component is burins with blade endscrapers and microliths represented by backed blades, as they are known from Gravettian and Magdalenian sites. Lithics from concentrations 1 and 2 at Mohelno-Plevovce also belong to this category on the basis of techno-typological analysis, but there are no dates available. Other sites in this group include several sites in Poland (Bobak *et al.* 2013), Hungary (Lengyel 2009) and Stadice I in Bohemia (Vencl 2007, 78–80).

In searching for analogous assemblages, steeply retouched endscrapers are not uncommon in other Epigravettian sites (especially during the older phase dated to 23.0–21.0 ky cal BP). Finding comparable microlithic assemblages is somewhat more difficult because such artifacts have not been recorded in the surrounding countries. This may be a factor of excavation methods (absence of wet-sieving). Similarly shaped asymmetric and point forms (but significantly larger, in comparison to the Mohelno artifacts) are known from the late Aurignacian German site Breitenbach-Schneidemühle, however this site is older at ~30.0 ky ^{14}C BP (Moreau 2012a; cf. Figure 2: 8–10). Microliths similar to Mohelno artifacts occur far to the east of Moravia on the other side of the Carpathians in the area north of the Black Sea, which was a climatic refugium, especially during the LGM (Sofer and Gamble 1990). Demidenko (2003) points out the presence of Epiaurignacian industries, which differ from industries that evolved from the Gravettian techno-complex. Examples of very similar microlithic industries include Muralovka (1,700 km east of Mohelno) on the lower Don in Russia, Anetovka I on the lower Bug in Ukraine (1,125 km east of Mohelno), and possibly also Raşcov-8 in Moldavia (960 km east of Mohelno; cf. Demidenko 2008; Demidenko and Nuznyj 2003–2004; Zwyns 2004; Croitor and Covalenco 2011).

Conclusion

Intensive surface surveys and test pitting in 2011–2013 and a follow up rescue excavation in September 2013 have permitted the documentation of two phases of human occupation at Mohelno-Plevovce in the late Upper Paleolithic period.

On the basis of the distribution of artifacts, we interpret stone structure A as the remains of a pavement floor of a dwelling structure. The associated techno-complex is characterized by steeply retouched endscrapers and unique microlithic tools with backing – diminutive, asymmetric, pointed microliths. Radiocarbon dating suggests this occupation took place during the terminal LGM and represents a rare example of recolonization of Central Europe from the Black Sea region. This occupation may be related to the upper layer at Stránská skála IV/ Grubgraben/ Sagvár/Kašov I, which is only 1000–2000 years older. It also contains steeply retouched artifacts and Svoboda also points out similarities to the Carpathian Basin and further to the east (Svoboda 2006; Svoboda and Novák 2004). As microlithic tools were not documented in this complex, we prefer to consider this as two separate phases.

We classify the occupation of Mohelno-Plevovce as Epigravettian. This period was chronologically defined as post-Gravettian and includes industries that are quite

varied (Svoboda 2006b). Oliva (1996b) classifies some surface collections (including the Stránská skála IV assemblage) as Epiaurignacian. However, these surface collections are also quite varied and with the exception of Stránská skála IV there are no associated radiometric dates. The occupation at Mohelno-Plevovce is significant because it was occupied during two subsequent phases "Plevovce" and "Vídeňská", which are technologically and typologically distinct. The first is reminiscent of Aurignacian technology, whereas the second is similar to the Gravettian. When further finds are made and more radiocarbon dates are obtained, it will be possible to test the proposed hypothesis which subdivides the Moravian Epigravettian into three separate phases.

Acknowledgement
Many thanks to ČEZ, a. s., for permission to conduct this research and for financing it.

Résumé
Le site Mohelno-Plevovce est situé sous l'actuel niveau d'eau de barrage de Mohelno (partie basse de la centrale hydraulique de Dalešice). L'arrêt temporaire de cette dernière (en septembre 2012) a permit pendant 3 jours l'abaissement du niveau d'eau. Le site, provisoirement situé sur la plage, a permit une fouille de sauvetage de la concentration lithique A. La structure de forme hexagonale, formée par des pierres plates, étendue sur 3 mètre de long a été mise au jour. Tandis que la densité des artefacts considérablement augmente à l'intérieure de celle-ci, elle reste moins importante à l'extérieure, ce que nous interprétons comme l'effet de la barrière. L'industrie lithique, datée de la fin de LGM, se caractérise par la présence des grattoirs épais, ainsi que les microlithes de petite taille et à abattage marginale, qui connaissent les analogies au Nord de la Mer Noire.

Zusammenfassung
Die Fundstelle Mohelno-Plevovce liegt unter dem Wasserspiegel der Mohelno-Talsperre (Unterteil des Pumpkraftwerks von Dalešice). Dank der Stilllegung des Pumpkraftwerks befand sich im September 2013 der Wasserspiegel der Talsperre drei Tage lang auf dem Minimalniveau. Die Fundstelle erschien also auf dem trockenen Strand, was eine kurze Rettungsgrabung der Steinstruktur A ermöglichte. Während der kurzen Untersuchung wurde eine sechsseitige Struktur dokumentiert, die aus flachen Steinen zusammengestellt war und 3 m im Durchmesser ausmachte. Während im Rahmen der Struktur die Dichte der Steine deutlich stieg, sank sie außerhalb der Struktur stark, was als Einfluss der Barriere entlang der Pflastergrenze interpretiert wird. Die Industrie, die ans Ende des LGM datiert wird, ist durch steil retuschierte Kratzer und spezifische kleine abgestumpfte Mikrolithen charakterisiert, deren nächste Analogien im Bereich nördlich des Schwarzen Meeres vorkommen.

THE SOLUTREAN UNIT OF EL CASTILLO CAVE, SPAIN

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Abstract
The multilevel sequence of El Castillo Cave contains one archeological unit attributable to the Solutrean techno-complex (unit 10). We here present a revision of the classical data and new radiocarbon dates, which allow a better understanding of the chronoarcheological place of this industry. We also present new information regarding the faunal remains and the hunting strategies based on the species present in this unit. In order to achieve this, we use the ungulates NISP and MNI represented at the site, both derived from Obermaier's original excavation data.

Keywords
Solutrean, El Castillo, faunal remains, Bifacial points

DOI: 10.5817/CZ.MUNI.M210-7781-2015-30

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Introduction

Since its discovery at the beginning of the twentieth century, the cave of El Castillo has, from a European perspective, been an important Paleolithic site that continues to be relevant in many ways. The cave's mouth opens north-east halfway up a conical hillside, overlooking the Pas river valley in Cantabria, Northern Spain. Within its long stratigraphy, ranging from the Early Mousterian (ca. 250.0 ky BP) to the Bronze Age, all major human cultural episodes are represented. Archeological works have taken place at the site on several occasions, two of which have been particularly prolific in revealing the site's importance: the work undertaken by the *Institut de Paléontologie Humaine* conducted by H. Obermaier and H. Breuil (1910/1914), and the recent excavations by V. Cabrera and F. Bernaldo de Quirós and their team (1980–present).

Figure 1: Stratigraphy of El Castillo cave.

El Castillo's sequence is composed of stratigraphic units showing human occupation interspersed with sterile units. The stratigraphic sequence is approximately 21 meters deep and, based on the study of the collections of the aforementioned excavations (Cabrera 1984), it is composed of the following archeological units (Figure 1): Late Acheulean (Units 26, 25, 24); Mousterian (Units 22 and 21); Transitional Aurignacian (Unit 18); Archaic Aurignacian (Unit 16); Gravettian (Units 14 and 12); Solutrean (Unit 10); Lower Madgalenian (Unit 8); Upper Magdalenian (Units 7 and 6); Azilian (Unit 4); Bronze Age (Unit 2); and Middle Ages (Unit 1).

Within this long stratigraphic sequence, the Solutrean level is, averaging 10 cm in depth, one of the most spatially constrained, especially from the center of the hall is, gradually thinning until completely disappearing towards the outside and the southern wall (Cabrera 1984, 279). The unit presented a series of hearths between 6 cm and 8 cm deep located towards the cave's exterior (Cabrera 1984, 68). The diameter and number of hearths is impossible to determine, not only from Obermaier's excavation documents, but also because the hearths were all completely excavated (Figure 1); this made it impossible to carry out sedimentological, geomorphological or paleoenvironmental reconstructions.

Datings

The dating of Unit 10 has always been carried out in a tentative manner. Recently, two dates were presented for this unit (Schmidt *et al.* 2012). The first of these, 16, 850 ± 220 BP (OxA-971), does not in fact belong to Unit 10, but to a bone fragment cited

by Simmer *et al.* (2008) within their date compilation list and assigned to the Upper Solutrean or Early Magdalenian, and not to a level in particular. This date was subsequently taken by Schmidt *et al.* and assigned to Unit 10. In its original publication, however, the aforementioned date was in fact linked to Level 7, Upper Magdalenian (Hedges *et al.* 1987). The second of the dates noted by Schmidt *et al.* (2012), 19, 140 ± 230 BP (GifA-98154), was obtained from a cave painting (González Sáiz 2007), specifically that of a horse from the "Panel of Hands," which is not directly linked to Unit 10. Additionally, Schmidt and colleagues omit the other date obtained for the horse figure, 16, 980 ± 180 BP (GifA-98153). Therefore, given these previous attempts at dating Unit 10 it became necessary to do so in a more reliable manner.

In 1913, Nels C. Nelson, sent by the American Museum of Natural History (AMNH) in New York, collected a number of material samples from the cave of El Castillo in order to put together a diorama of the cave at the AMNH. The samples, collected by H. Obermaier, consisted principally of various boxes containing material saved from each of the archeological units identified during the excavations then taking place, as well as rock, vegetation, etc. samples that could be of use when putting together the diorama (White 2006; Tejero *et al.* 2010). It does not seem necessary to highlight the importance of these samples given that they represent the only material reference remaining from the earliest excavations, classified according to the levels assigned by Obermaier himself. They are, therefore, of uttermost importance in the present revision.

With the aim of getting to know the site's Solutrean chronology better, in March 2011 we took a bone sample from the AMNH's collection. It was analyzed at BETA Analytic and produced a 19, 260 ± 90 BP date (BETA 242619). The date was calibrated using CALPAL 2007 HULU to 23, 026 ± 275 cal BP (Weninger *et al.* 2008).

Lithic and bone industries

The currently preserved material collection from the cave of El Castillo is scant, with barely 40 retouched pieces and 28 *débitage* remains recovered during H. Obermaier's excavations and currently stored at the National Archeological Museum of Spain in Madrid (Table 1). Besides the limited depth and delimitation of the Solutrean level, factors such as the selective recovery of material during its excavation influenced the size of the present collection; the dispersal of the collection also played an important role in its current size as the amount of material initially collected by Obermaier and Wernert was greater than what is currently preserved (Cabrera 1984, 286). In the original records list there were 158 retouched and 540 non-retouched pieces, all of which are now spread out across several national and international museums and institutions, including the Prehistory and Archeology Museum of Cantabria, the Field Museum of Chicago, private collections, etc. (Straus 1983, Cabrera 1984).

The most abundant raw material in the original collection is, as would be expected given the way the material was selected, flint (53%), followed by limestone (23.6%) and fine-grained quartzite (12.5%); quartz, sandstone and other types of

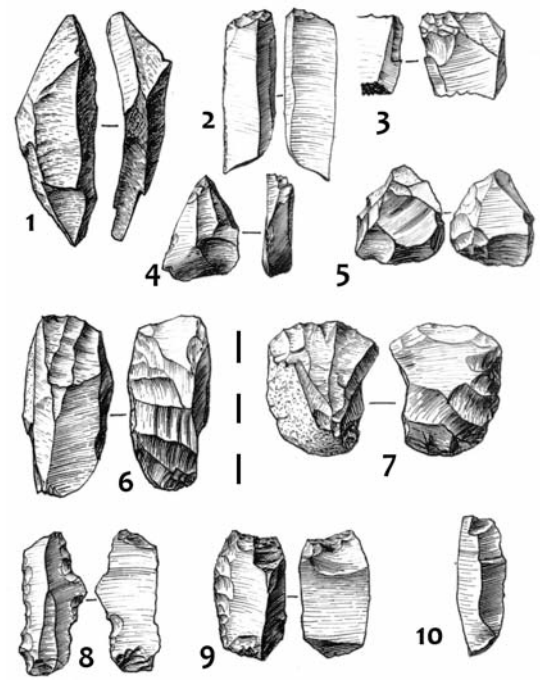

Figure 2: Pieces from Level 10 drawn by J. Boussonie: 1–5 and 10 burins; 6–7 bladelet cores; 8 denticulate; 9 sidescraper.

rocks were found as unretouched blanks. Raw material classification was not possible for the retouched pieces as no information was found in Obermaier's written notes.

From a technological point of view, little can be said about the *chaîne opératoire*, the methods and techniques employed in knapping. There are no cores in the modern collection, although there were four blades/bladelets produced from flint in the original collection.

There appear to be two great types of blanks obtained: flakes and blades. The former present previous scars that vary from centripetal to unipolar in direction. Amongst the blades, the thickest blanks were obtained from unipolar prismatic cores. The assemblage does not contain bladelets and the original assemblage records show a few narrow and long blades, which, speculatively speaking, could represent large bladelets. There is a piece, described as a burin, that could represent a bladelet core with two *débitage* surfaces, one on each of the flake's surfaces (Figure 2: 6) and another unipolar bladelet core (Figure 2: 7). In any case, the blanks obtained from this core would be short and proportionally wide bladelets.

From a typological point of view, the collection is not very diagnostic, with the exception of a small number of Solutrean-type pieces (Table 1). The *pointes à face plane* and a laurel leaf stand out from the rest of the pieces in the modern collection (Figure 3). However, in the original collection Solutrean pieces were more abundant, the majority of them being willow leaf points (Cabrera 1984, 291). The majority of the Solutrean pieces present regular parallel retouches and some were in the process of being manufactured at the time of their abandonment.

As is the case with the lithics, the bone industry at El Castillo is also very scarce. At present we have an oval-sectioned sagaie with central flattening, another in the process of manufacture and some retouchers and pieces used as chisels. However, H. Breuil's original records list was more abundant, including several sagaies, many of them incomplete or fragments from them of different kinds (curved, flat cross-sectioned) and awls made from both bone and antler.

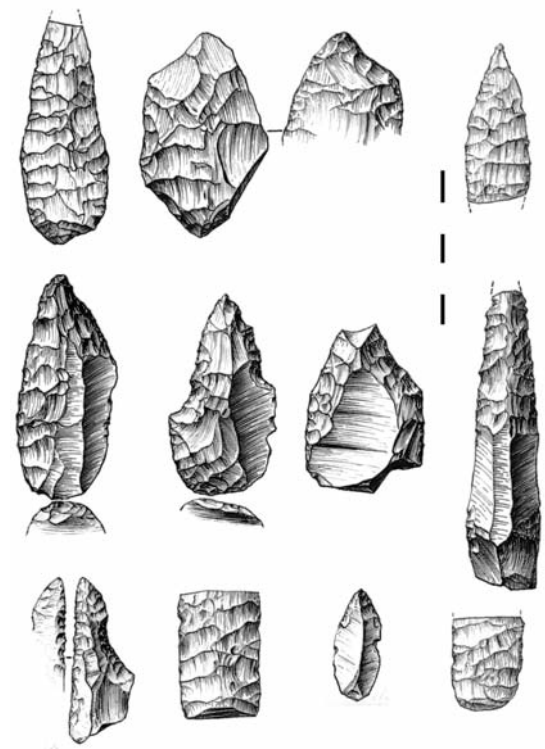

Figure 3: Solutrean pieces from Level 10 drawn by J. Boussonie.

Table 1: Typological list from El Castillo Cave's Level 10 (Cabrera 1984).

	n	%
1. endscraper on blade.	1	2.5
4. ogive endscraper.	1	2.5
14. flat nose endscraper.	1	2.5
15. core endscraper.	1	2.5
28. dihedral endscraper.	1	2.5
30. burin on angle.	2	5.0
34. burin on straight truncation.	1	2.5
61. straight truncation.	1	2.5
63. convex truncation.	1	2.5
65. piece retouched on one edge.	2	5.0
66. piece retouched on two edges.	1	2.5
67. Aurignacian blade.	1	2.5
69. *Pointe à face plane*.	9	22.5
70. Laurel leaf point.	1	2.5
74. notch.	2	5.0
75. denticulate.	8	20
76. *Pièce écaillée*.	1	2.5
77. sidescraper.	4	10
78. *Raclette*.	1	2.5
total	**40**	**100.0**

El Castillo's Solutrean fauna

The Solutrean at El Castillo is represented by an assemblage comprising more than 50 remains from Level 10. This represents the Paleolithic level with the least amount of faunal material for the whole of the site, but nonetheless it is sufficiently representative of this cultural horizon. Obermaier's list shows the presence of half a dozen ungulates and a carnivore.

The level's excavators judged horses, red deer and great bovids to be the most numerically represented species. The smaller bovids noted (goat, chamois and ibex) would appear to be less frequently represented. Therefore, based on these earliest observations, the Solutrean level at El Castillo would be characterized by the predominance of three large ungulates and the lesser presence of smaller-sized bovids.

Table 2: Species represented in Level 10 at El Castillo Cave.

	NISP	%NISP	MNI	%MNI
Equus ferus	403	67.7	17	51.5
Bos primigenius/Bison priscus	11	1.8	1	3.0
Capra pyrenaica	57	9.6	6	18.2
Rupicapra rupicapra	23	3.9	2	6.1
Cervus elaphus	99	16.6	7	21.2
Stephanorhinus hemitoechus	2		1	
Ursus sp.	4		1	
Canis lupus	2		1	
Vulpes vulpes	4		1	
Panthera leo spelea	1		1	
total	**606**		**38**	

Although some of the data obtained from the revision of the fauna coincide with the excavators' initial observations, these present some differences. In this level, a total of 606 specimens could be identified and these pertained to seven ungulate species (no roe deer was noted, a common ungulate species) and four carnivore species (bear, wolf, fox and lion, Table 2).

Horse is the best represented species followed at a distance by red deer. The relative frequency of large bovids is, however, the lowest, well below that of goats and Pyrenean mountain goats. There are no significant differences in the structure of the fauna based on the number neither of identified specimens nor in the minimum number of individuals. The only difference is the lesser overall representation of the most frequent species and, in turn, the overrepresentation of the scarcest, and both trends to be expected. Horse's predominance is a common characteristic of other Solutrean levels throughout Cantabria.

Discussion

Despite being a scarce collection composition-wise, Unit 10's cultural assignations have generated much controversy. Obermaier interpreted this assemblage as being Lower Solutrean with laurel leafs (Obermaier 1925), but in his written notes from 1928 and 1931 he classified it as Evolved Middle Solutrean (Cabrera 1984, 294). Pericot and Jordá also described it as being Lower Solutrean (Pericot 1954; Jordá 1955). Many researchers have, however, for a number of reasons, labeled it as Upper Solutrean (Corchón 1971; Straus 1975; Cabrera 1984) or Solutrean (Cabrera *et al.* 1996).

From our point of view, El Castillo's Unit 10 is not easy to assign to a particular period. From a techno-typological point of view, the assemblage is characterized by

laurel leafs, *pointes à face plane* and the presence of large flakes, which clearly brings it closer to the Middle Solutrean. However, some aspects, such as the presence of "Solutrean" retouch on tools that are not Solutrean points, or the presence of the single basal bevel sagaie with marked notches and a flat cross section with an engraved geometric sign, which is typical of the Cantabrian Upper Magdalenian, can also be considered as evidence of this assemblage's closer affinity to the Upper Solutrean (Cabrera 1984, 295).

From a chronological point of view, the dating of Unit 10 from El Castillo (19, 260± 90 BP) can be linked to other dates obtained in a number of the Solutrean levels at the site of Las Caldas (Asturias), specifically Level 9, typical Upper Solutrean: 19, 390 ± 260 BP (Ly-2424); Level 12 (ceiling), Middle Solutrean: 19, 030 ± 320 BP (Ly-2425); and Level 12 (base), Middle Solutrean: 19, 480 ± 260 BP (Ly-2426), all located in the Middle-to-Upper Solutrean transition (Jordá, Fortea and Corchón 1982; Corchón 1999).

Conclusions

The classification of El Castillo Unit 10's assemblage presents a number of issues: its complete excavation does not allow for environmental or geological reconstructions to be carried out, and the scarce number of pieces recovered from within it does not allow for a clear classification to be made. As has been suggested elsewhere (Cabrera 1984), perhaps Unit 10 represents a brief occupation episode in which knapping activities may have had a relative weight considering the characteristics of the lithic industry, which contains pieces in the process of manufacture, as well as its rather uncharacteristic bone industry (Cabrera 1984, 296).

Few dates are available for the Middle/Upper Solutrean in the Cantabrian region. The cave of Las Caldas, for which a large number of dates have been obtained, represents a frame of reference for these periods in the area. Generally speaking, in the Cantabrian region we can place the Middle Solutrean between 20.0 and 19.0 ky BP and the Upper Solutrean between 19.0 and 18.0 ky BP (Rasilla 1994). Thus, having noted this, the date obtained from El Castillo's Unit 10, 19, 260 ± 90 BP (23, 026 ± 275 cal BP), is in keeping with the Middle Solutrean levels at Las Caldas in Asturias, but also with the oldest Cantabrian Upper Solutrean, also from the Las Caldas Cave (Corchón 1999).

Having said this, it is worth noting that the lithic assemblage, from a typological point of view, suggests a Middle Solutrean affiliation, but some elements are characteristic of the Upper Solutrean, such as the Solutrean retouch on non-"Solutrean" pieces, although typical elements from this period, such as shouldered or concave base points, are missing. We therefore believe that this level could represent the final moments of the Middle Solutrean or the transition between the Middle and Upper periods, as previously noted.

Acknowledgements
This research was carried out as part of Project HAR2012-35214 of the *Subdirección General de Proyectos de Investigación, Dirección General de Investigación Científica y Técnica* of the Ministry of Economy and Competitiveness of Spain. We are grateful to Dr Pía Spry-Marqués for helping with the article's translation.

Résumé
Le site pluristratifié d´El Castillo comprend une unité stratigraphique (unit 10) attribuée au Solutréen. Nous présentons ici une série de nouvelles dates radiocarbone, en plus d'une révision des données existantes, en vue de mieux comprendre la position chrono-culturelle de l'industrie solutréenne sur ce site. Nous présentons, par ailleurs, de nouvelles données sur les restes fauniques et les stratégies de chasse, sur base des espèces animales représentées au sein de l'unité stratigraphique en question. Nous nous sommes servis des indices NISP et MNI des ongulés représentés sur le site, à partir des données originales des fouilles d'Hugo Obermaier.

Zusammenfassung
Die mehrphasige stratigraphische Sequenz der Höhle von El Castillo beinhaltet eine archäologische Schicht, die dem Technokomplex des Solutréen zuordenbar ist (Unit 10). Wir präsentieren hier eine Revision der klassischen Daten zusammen mit neuen C14-Datierungen, die ein besseres Verständnis der chronoarchäologischen Einordnung dieser Industrie erlauben. Außerdem präsentieren wir neue Informationen zu den Tierresten und den Jagdstrategien, die auf den in dieser Schichteinheit dokumentierten Tierarten basieren. Hierbei verwenden wir die NISP und MNI der Huftiere, die aus Obermaiers ursprünglichen Grabungsdaten gewonnen wurden.

HUNTER-GATHERER RESPONSES TO ABRUPT ENVIRONMENTAL CHANGE FROM THE TERMINAL PLEISTOCENE TO THE EARLY HOLOCENE IN THE LOWER AMUR REGION

Kazuki Morisaki[1] and Hiroyuki Sato[2]

Abstract
This paper presents preliminary study of the correlation between hunter-gatherer behavioral change and environmental change during the Pleistocene-Holocene transition. The reconsideration of lithic technological change on the basis of the current pottery chronology has suggested that human behavioral change surely has a connection with environmental change.

Keywords
Pleistocene-Holocene transition, environment, radiometric dates, lithic industry

DOI: 10.5817/CZ.MUNI.M210-7781-2015-31

Introduction

Recent paleoclimate studies have progressed remarkably and revealed abrupt environmental change that occurred during the Pleistocene and the Holocene. This makes it possible to investigate how humans responded to the abrupt environmental change during this transition, integrating archeological study on human behavioral change into these climate data using radiometric dates. Now, archeologists all over the world are tackling this fascinating theme (e.g. Straus *et al.* 1996; Graf and Bigelow 2011; Bousman and Vierra 2012; Bueno *et al*. 2013). East Asia is no exception to this trend (Straus *et al.* 1996; Cohen 1998; Liu and Chen 2012; Bae 2010). In particular, there are so many cultural complexes from a large number of archeological sites during the Pleistocene-Holocene transitional period in Japan (Database Committee of the Japanese Paleolithic Research Association, 2010) that past studies have focused on how humans reacted to the environmental change

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during this transition (Taniguchi and Kawaguchi 2001; Keally *et al.* 2003; Sato and Tsutsumi 2007; Sato 2008; Nakazawa *et al.* 2011; Sato *et al.* 2011; Kudo *et al.* 2011). However, in the majority of the other regions of East Asia, the successive trajectory of change of cultural complexes from the Pleistocene to the Holocene has not been established due to the scarcity of excavation and/or the other reasons. Also, in the Lower Amur region, a part of the southern part of the Russian Far East, the cultural complex assigned to the beginning of the Post-Glacial period had not been found until recently, though the Late Glacial Osipovka culture and early Holocene cultures such as the Kondon culture have widely been well known (Okladnikov 1983; Shevkomud 2005). However, a recent excavation conducted by the Japan-Russia joint research project, including us, finally found the missing link between the Pleistocene and the Holocene human culture (Uchida *et al.* 2011; Sato *et al.* 2012; Fukuda *et al.* 2014). Now the most basic condition for studying diachronic lithic technological and hunter-gatherer behavioral change over the Pleistocene-Holocene transition is satisfied. Accordingly, this paper explores the hunter-gatherer response to the Pleistocene-Holocene transition in the Lower Amur region.

The environmental background during the Pleistocene-Holocene transition

Chronozone

The time period this paper focuses on is from the terminal Pleistocene to the early Holocene, 13.0 ky ~7.0 ky ^{14}C BP (ca.15.0 ky ~7.5 ky cal BP). The chronozone during this time period has traditionally been divided into several stages in Northern Europe: Oldest Dryas, Bølling, Older Dryas, Allerød, Younger Dryas and Holocene (Figure 1-A) (Stuiver *et al.* 1995). Although there are some studies that directly adapt this staging to East Asia, the five stages are not always synchronized with results of high resolution pollen analyses there (e.g. Lake Suigetsu). Recently, paleoclimate studies on cave stalagmites in China (e.g. Hulu Cave) have also revealed millennial scale fluctuations of Asian monsoon intensity that correspond to the climatic fluctuation recorded in the Greenland ice cores (Figure 1-B) (Wang *et al.* 2001; Yuan *et al.* 2004). There are some differences between the oxygen isotope records of Northern Europe and those of China, but it should be noted that there seem to be at least three relatively distinct synchronic changes of oxygen isotope signature between the two regions (Wang *et al.* 2001): the onset of the Late Glacial warming, the Younger Dryas cold event, and the onset of Post Glacial (Holocene).

For the present, therefore, three reliable chronozones can be set within the time period focused on in this paper: the Bølling/Allerød, the Younger Dryas, and the Post Glacial. The duration of the chronozones is respectively ca. 14.7 ky ~ 12.8 ky cal BP for the Bølling/Allerød, and ca. 12.8 ky ~11.5 ky cal BP for the Younger Dryas (Wang *et al.* 2001). Some climatic fluctuations are also reported in the Holocene. The well-known 8.2 ky event (Alley *et al.* 1997) is included within the time period this paper focuses on.

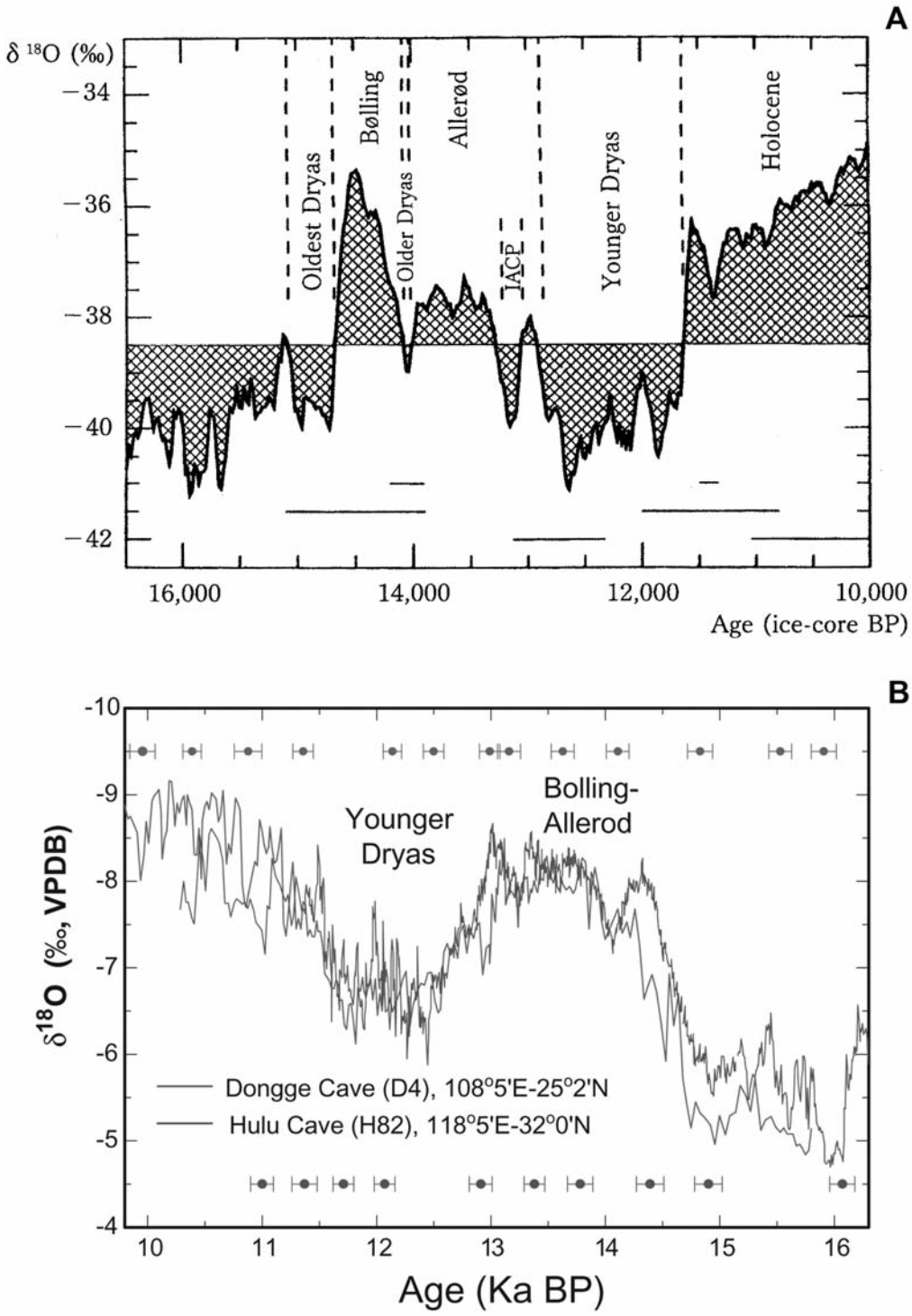

Figure 1: Oxygen isotope record and chronozone in Northern Europe (A) (Stuiver *et al.* 1995), and in East Asia (China) (B) (Yuan *et al.* 2004).

Geography

The Lower Amur region corresponds to almost the same geographical range as the Khabarovsky krai, one of the federal subjects in Russia. This region comprises the southern part of the Russian Far East with two other regions, the Primorsky krai and the Sakhalin oblast (Figure 2), and also the northern circum Japan Sea area with Hokkaido and the Korean Peninsula.

The Amur River, which starts around the Transbaikal, runs from the south-west to the north-east across the Khabarovsky krai. To the east of the Khabalovsky and Primorsky krai, the Sikhotealin Mountains run along the Japan Sea coast. The Ussly River, which starts from the southern edge of the Sikhotealin Mountains, runs northward and joins the Amur River near Khabarovsk City.

Paleoenvironment

The Lower Amur region should be considered to be a member of the northern circum Japan Sea area, since its environmental condition is different from that of Eastern Siberia. During the LGM, the Lower Amur region was covered with shrub birch-alder open forests, while tundra-steppe spread in Siberia (Takahara *et al.* 2011).

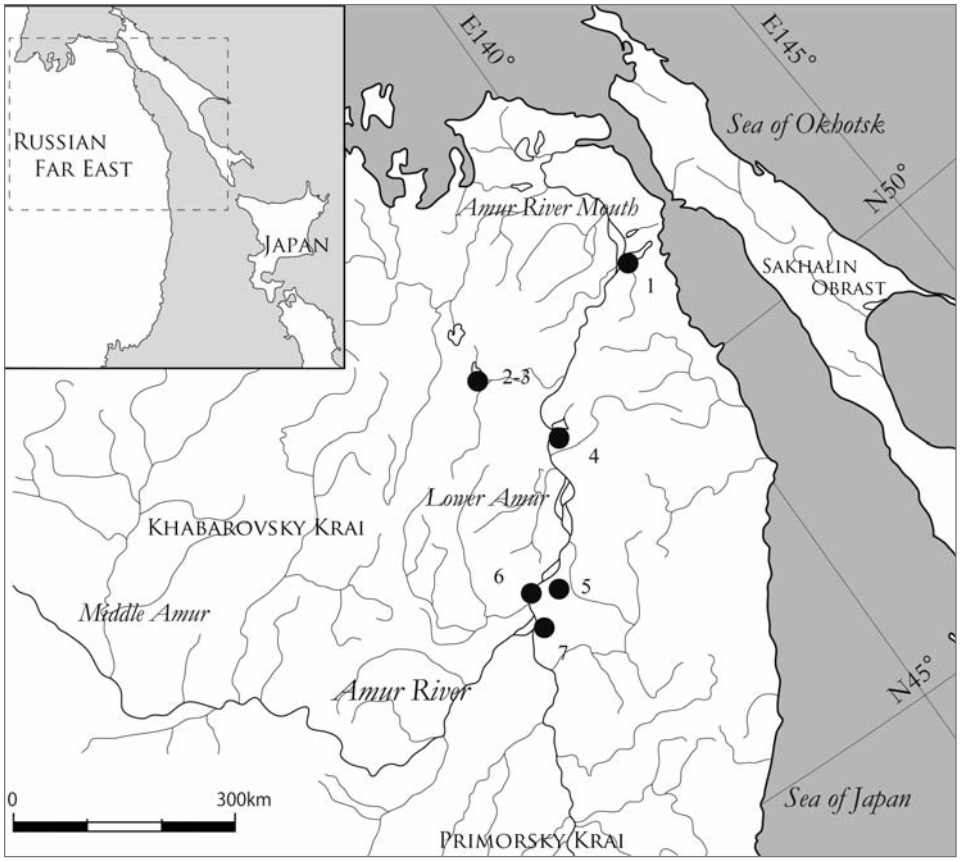

Figure 2: Archeological sites mentioned in the text: (1: Suchu Island, 2: Yamikhta, 3: Kondon-11 (post office), 4: Voznesenoka, 5: Knyaze Volkonskoe, 6: Osipovka, 7: Goncharka-1).

The recent studies of V. Bazarova (2008) clarified the following vegetation change in the Lower Amur region. As for the terminal Pleistocene, during the Bølling/Allerød chronozone, tree birch-alder forests with few coniferous species covered this area. At the end of the Late Glacial, the Younger Dryas chronozone, the Lower Amur River basin was mainly occupied by shrub birch-alder forests with tree birch and rare *Pinus pumila*, suggesting a cold environment. After the beginning of the early Holocene, climate conditions became somewhat warmer, allowing the expansion of birch-alder forests with rare larch and *Pinus pumila* in the northern part of the Lower Amur River basin. She pointed out that at the end of the Boreal period (early Holocene: 8.2–8.0 ky BP) the warm phase was followed by a short cooling event. Judging from the dates, this likely corresponds to the well-known 8.2 ky event.

Chronological study of the Neolithic period in the Lower Amur region

Research history

Past studies revealed regional characteristics of the southern part of the Russian Far East. First, almost all Neolithic pottery tradition in this region produced flat-based pottery, which is strikingly different from the round-based pottery of the neighboring regions such as Yakutia and China. This fact means the southern part of the Russian Far East formed one archeological regional unit (Onuki 1998).

Neolithic chronology was first established by A. P. Okladnikov in the 1950s (Okladnikov 1972). On the basis of the result of excavation at the Voznesenovka site in the Lower Amur, Okladnikov proposed three stages of Neolithic period from early to late: Malyshevo culture, Kondon culture and Voznesenovka culture. After that, one more complex, Mariinsk culture, which was found on Suchu Island in the Lower Amur River, was added to the chronology as a culture preceding to Malyshevo culture (Derevianko and Medvedev 2006; Derevianko and Medvedev 1996; Medvedev 2008). This chronology also offered a framework for lithic chronology. A. P. Derevianko is the first researcher to explain the diachronic change of lithic assemblage and technology in this region in the 1970s (Derevianko 1976). According to his study, lithic assemblage of the Malyshevo culture is characterized by blade technology, which decreased through the Neolithic period, but lasted until the late Neolithic period. Instead of the blade technology, bifacial tools of flake became predominant during the Voznesenovka culture. These studies were so highly comprehensive that they have long functioned as a frame of chronology.

In the 1960s, Okladnikov conducted an excavation at the Osipovka 1 site, on the basis of the information that M. Gerashimov had found a variety of lithic tools including bifaces on the right bank of the Amur River near Khabarovsk city in the 1920s, and represented the lithic assemblages recovered at Osipovka 1 site as the Paleolithic-Neolithic transitional phase, namely the Mesolithic period (Okladnikov and Derevianko 1973). Thereafter, the excavation at the Gasya site in the 1980s made it clear that the Osipovka culture contained pottery that dates back to older than 10.0 ky ^{14}C BP, some of the oldest pottery in the world. This fact revealed that the

Osipovka culture was the Initial Neolithic culture and was preceding all the cultures aforementioned. Excavations at the Khummi site added another example of the Osipovka Neolithic culture (Shevkomud 2005). Consequently, the Neolithic culture of the Lower Amur region started from the terminal Pleistocene Osipovka culture, which was followed by Mariinsk culture, Malyshevo culture, Kondon culture, and Voznesenovka culture.

Recently, a series of excavations initiated by I. Ya. Shevkomud of the Khabarovsk regional museum have revised these chronological studies. First, the order of cultural complexes was partly revised. The accumulated results of ^{14}C dating showed that Kondon culture preceded Malyshevo culture, which changed the chronological order: from the Osipovka culture, the Kondon culture, the Malyshevo culture, and to the Voznesenovka culture (Shevkomud 2005). Since there was a 3000-year hiatus between the Osipovka culture and the Kondon culture, the existence of one or more unknown cultures was expected. The Mariinsk culture, indeed, was dated to between the two cultures (Derevianko and Medvedev 1996; Medvedev 2008), but one of the two ^{14}C dates from the site corresponds to the duration of Kondon culture, and also, the characteristics of lithic tools are likely concerned with another Neolithic cultural tradition of Sakhalin Island (Morisaki 2014).

In such a situation as that described above, the Japan-Russia joint research project, including us, conducted an excavation at the Yamikhta site near the Kondon site, and found a brand-new Neolithic complex that is chronologically positioned between the Osipovka and Kondon cultures (Uchida *et al.* 2011; Fukuda *et al.* 2014).

Present chronology

Referring to the latest data, the present chronological order in the Lower Amur region is thought to be as in Figure 3 (Uchida 2011; Fukuda 2013). The list of radiocarbon dates is summarized in Table 1.

Around 13.0 ky ~10.0 ky ^{14}C BP there were the Osipovka culture occupants in the Lower Amur region at such sites as the Osipovka site, the Goncharka site, the Khummi site, the Gasha site, the Novotroitskoe site, and the Osinovaya rechka site, which contained a variety of large and small bifacial tools and a few microblades and blade tools. Between 10.0 ky and about 7.6 ky ^{14}C BP, a new culture, containing a lot of ground tools including arrowheads, chisels, drills, microblades, blade tools, and small bifacial points was found at the newly excavated Yamikhta site. Now we call the component from the site the Yamikhta culure. From 7.6 ky to about 6.0 ky ^{14}C BP there were site occupants that contained blade tools and microblades, and a few ground and bifacial tools, referred to as Kondon culture, at such sites as Kondon 11 site, Knyaze Volkonskoe 1 site, and Malaya-gavan site. The subsequent Malyshevo culture (5.5 ky ~ 4.7 ky ^{14}C BP) and the final Neolithic Voznesenovka culture (4.7 ky ~ 3.4 ky ^{14}C BP) occupants equipped with bifacial tools of flake, various flake and ground tools widely inhabited the Lower Amur River basin (Morisaki 2011, 2014).

Table 1: Radiocarbon data referred to in this paper (gleaned from Shevkomud and Kuzmin 2009).

site	archeological culture	material	lab. number	^{14}C yrs BP
Gasha, 1980	Osipovka culture	charcoal	ЛЕ-1781	12, 960 ± 120
Gasha	Osipovka culture	charcoal	GEO-1413	11, 340 ± 60
Gasha	Osipovka culture	charcoal	AA-13393	10, 875 ± 90
Khummi, 1992	Osipovka culture	charcoal	AA-13392	13, 260 ± 100
Khummi, 1992	Osipovka culture	charcoal	AA-13391	10, 375 ± 110
Khummi, 1997	Osipovka culture	charcoal	AA-23130	10, 540 ± 70
Khummi, 1998	Osipovka culture	charcoal	COAH-3826	12, 150 ± 110
Goncharka-1, layer5	Osipovka culture	charcoal	LLNL-102169	12, 500 ± 60
Goncharka-1, layer5	Osipovka culture	charcoal	AA-25437	12, 055 ± 75
Goncharka-1, layer4	Osipovka culture	charcoal	Tka-13005	11, 340 ± 110
Goncharka-1, layer3b	Osipovka culture	charcoal	LLNL-102168	10, 590 ± 60
Goncharka-1, layer3b	Osipovka culture	charcoal	Tka-13007	10, 550 ± 80
Goncharka-1, layer3b	Osipovka culture	charcoal	AA-25438	10, 280 ± 70
Goncharka-1, layer3b	Osipovka culture	charcoal	AA-25439	10, 280 ± 70
Goncharka-1, layer3b	Osipovka culture	charcoal	Gak-18981	9, 890 ± 230
Oshinovaya Rechka-15	Osipovka culture	charcoal	AA-60758	11, 365 ± 60
Oshinovaya Rechka-16	Osipovka culture	charcoal	Tka-12951	11, 140 ± 110
Oshinovaya Rechka-16	Osipovka culture	charcoal	Tka-12954	10, 760 ± 150
Yamikhta	Yamikhta culture	carbonized wood	Tka-15122	8,030 ± 40
Yamikhta	Yamikhta culture	charred residue on pottery	Tka-15157	9,520 ± 45
Yamikhta	Yamikhta culture	charred residue on pottery	Tka-15158	9,540 ± 45
Yamikhta	Yamikhta culture	charred residue on pottery	Tka-15159	9,810 ± 40
Knyaze Volkonskoe-1	Kondon culture	charcoal	Tka-14319	6,845 ± 50
Knyaze Volkonskoe-1	Kondon culture	charcoal	Tka-14320	7,655 ± 45
Knyaze Volkonskoe-1	Kondon culture	charcoal	Tka-14321	7,585 ± 50
Knyaze Volkonskoe-1	Kondon culture	charred residue on pottery	Tka-14322	7,265 ± 45
Knyaze Volkonskoe-1	Kondon culture	charcoal	IAAA-61704	6,760 ± 40
Kondon-11	Kondon culture	charcoal	ГИН-170	4,520 ± 25
Suchu Island	Malyshevo culture	charcoal	COAH-4347	6,070 ± 90
Suchu Island	Malyshevo culture	charcoal	COAH-4624	5,870 ± 45
Suchu Island	Malyshevo culture	charcoal	KCP-498	5,180 ± 100
Suchu Island	Malyshevo culture	charcoal	COAH-1123	5,170 ± 90
Suchu Island	Malyshevo culture	charcoal	SNU00-336	5,140 ± 100
Suchu Island	Malyshevo culture	charcoal	SNU00-335	5,070 ± 40
Suchu Island	Malyshevo culture	charcoal	SNU00-334	4,970 ± 40
Suchu Island	Malyshevo culture	charcoal	SNU00-333	4,950 ± 30
Suchu Island	Malyshevo culture	charcoal	SNU00-338	4,900 ± 40

site	archeological culture	material	lab. number	^{14}C yrs BP
Suchu Island	Malyshevo culture	charcoal	SNU01-363	4,820 ± 90
Suchu Island	Malyshevo culture	charcoal	SNU01-365	4,780 ± 70
Suchu Island	Malyshevo culture	charcoal	KCP-499	4,780 ± 100
Suchu Island	Malyshevo culture	charcoal	SNU00-337	4,740 ± 70
Suchu Island	Malyshevo culture	charcoal	COAH-4349	4,730 ± 100
Suchu Island	Malyshevo culture	charcoal	SNU01-366	4,680 ± 80
Suchu Island	Malyshevo culture	charcoal	COAH-1281	4,650 ± 55
Suchu Island	Malyshevo culture	charcoal	SNU00-332	4,540 ± 100
Suchu Island	Malyshevo culture	charcoal	ГИН-8292	4,470 ± 100
Suchu Island	Malyshevo culture	charcoal	COAH-1280	4,380 ± 40
Suchu Island	Malyshevo culture	charcoal	KCP-497	4,200 ± 70
Suchu Island	Malyshevo culture	charcoal	COAH-789	2,050 ± 20
Voznesenskoe	Malyshevo culture	charcoal	Bin-698	5,115 ± 160
Goly' mys	Voznesenskoe culture	charcoal	COAH-5474	3,590 ± 65
Goly' mys	Voznesenskoe culture	charcoal	AA-60754	4,070 ± 40
Goncharka-1	Voznesenskoe culture	charcoal	TKa-13006	3,610 ± 60
Kolichom-3	Voznesenskoe culture	charred residue on pottery	TKa-13238	4,820 ± 90
Kolichom-3	Voznesenskoe culture	charred residue on pottery	TKa-13237	4,680 ± 60
Kolichom-3	Voznesenskoe culture	charred residue on pottery	AA-60759	4,600 ± 40
Kolichom-3	Voznesenskoe culture	charred residue on pottery	TKa-13239	4,630 ± 90
Kolichom-3	Voznesenskoe culture	charred residue on pottery	TKa-13239	4,630 ± 90
Kolichom-3	Voznesenskoe culture	charred residue on pottery	Tka-13240	4,310 ± 60
Kolichom-3	Voznesenskoe culture	charred residue on pottery	AA-60760	4,330 ± 50
Kolichom-3	Voznesenskoe culture	charred residue on pottery	AA-60761	4,200 ± 40
Kolichom-3	Voznesenskoe culture	charred residue on pottery	AA-60762	4,250 ± 25
Kolichom-3	Voznesenskoe culture	charred residue on pottery	AA-60763	3,620 ± 25
Kolichom-3	Voznesenskoe culture	charred residue on pottery	AA-60764	3,755 ± 30
Kolichom-3	Voznesenskoe culture	charcoal	COAH-3004	3,980 ± 30
Kolichom-3	Voznesenskoe culture	charcoal	COAH-3413	3,905 ± 85
Kolichom-3	Voznesenskoe culture	charcoal	COAH-3018	3,880 ± 35
Kolichom-3	Voznesenskoe culture	charcoal	COAH-3016	3,880 ± 30
Kolichom-3	Voznesenskoe culture	charcoal	COAH-3017	3,790 ± 40
Kolichom-3	Voznesenskoe culture	charcoal	COAH-3015	3,725 ± 95
Kolichom-3	Voznesenskoe culture	charcoal	TK-958	3,520 ± 50
Kolichom-2	Voznesenskoe culture	charcoal	COAH-3015	3,725 ± 95
Kondon-11	Voznesenskoe culture	charcoal	COAH-1179	3,770 ± 30
Malyshevo	Voznesenskoe culture	charcoal	JIE-663	3,590 ± 60
Maxim Gorikii	Voznesenskoe culture	charcoal	JIE-827	3,760 ± 70

site	archeological culture	material	lab. number	^{14}C yrs BP
Novotroitskoe-12	Voznesenskoe culture	charcoal	AA-60756	6,130 ± 45
Novotroitskoe-12	Voznesenskoe culture	charcoal	Tka-13495	4,050 ± 40
Novotroitskoe-12	Voznesenskoe culture	charcoal	TKa-13490	3,650 ± 40
Novotroitskoe-12	Voznesenskoe culture	charcoal	TKa-13491	3,540 ± 40
Suchu Island	Voznesenskoe culture	charcoal	COAH-4621	4,240 ± 35
Suchu Island	Voznesenskoe culture	charcoal	ГИН-8291	4,200 ± 80
Suchu Island	Voznesenskoe culture	charcoal	COAH-4623	4,150 ± 85
Suchu Island	Voznesenskoe culture	charcoal	COAH-1657	3,950 ± 90
Suchu Island	Voznesenskoe culture	charcoal	COAH-1659	3,875 ± 60
Suchu Island	Voznesenskoe culture	charcoal	COAH-4112	3,825 ± 80
Suchu Island	Voznesenskoe culture	charcoal	COAH-4108	3,795 ± 50
Suchu Island	Voznesenskoe culture	charcoal	COAH-4110	3,735 ± 60
Suchu Island	Voznesenskoe culture	charcoal	COAH-4113	3,695 ± 65
Suchu Island	Voznesenskoe culture	charcoal	COAH-4111	3,690 ± 50
Suchu Island	Voznesenskoe culture	charcoal	COAH-4873	3,645 ± 75
Suchu Island	Voznesenskoe culture	charcoal	COAH-4114	3,620 ± 120
Suchu Island	Voznesenskoe culture	charcoal	COAH-4874	3,549 ± 65
Suchu Island	Voznesenskoe culture	charcoal	COAH-4871	3,505 ± 80
Suchu Island	Voznesenskoe culture	charcoal	COAH-4872	3,455 ± 85
Suchu Island	Voznesenskoe culture	charcoal	COAH-1658	5,455 ± 155
Staraya Kakorma	Voznesenskoe culture	charred residue on pottery	NUTA2-7571	4,410 ± 20

Technological organization analysis

Materials and method

In this paper, the Osipovka culture, the Yamikhta culture and the Kondon culture are focused on in order to investigate the diachronic change of hunter-gatherer reaction to the environmental change during the Pleistocene-Holocene transition.

The materials used in this paper mainly come from three representative complexes from those cultures in the Lower Amur region that have detailed provenience data of lithic assemblage and radiocarbon data. All data are gleaned from published excavation reports, and we supplemented them on the basis of our observation and by data from other sites. The excavation reports contained plentiful information on stone tool kit assemblage and reduction strategies.

The main focus of this paper is to investigate human behavioral response to environmental change. Therefore, we mainly discuss lithic technological organization, which reflects human behavioral strategy well, focusing on the composition of stone tool kits, tool kit diversity, reduction technique, and lithic raw material procurement. Tool kit diversity is measured by using Simpson's diversity index (D) (Bobrowsky

and Ball 1989) on retouched tools excluding unfinished or unidentified tools. Summing them up regarding all sites, and ordering them temporally, we discuss diachronic change of human behavioral response to environmental change.

The Osipovka culture

A total of more than 70 Osipovka culture sites have been found. The majority of them are mainly located on the lower terrace or hill of the upper reach of the Lower

tool types	Goncharka-1	Yamikhta	Knyaze Volkonskoe-1
blade arrowhead	0	3	6
chipped arrowhead	>10	1	1
stemmed point	+	1	0
bifacial point	>200	2	1
ground arrowhead	5	12	2
ground foliate point	1	0	0
ground chisel	0	3	0
ground drill	1	3	0
ground knife	0	0	1
ground axe	8	14	25
chipped axe	87	11	0
end scraper	11	4	6
side scraper	46	12	7
end/side scraper	0	3	0
graver	9	4	0
drill	17	8	3
scaled piece	0	1	4
pebble tool	1	10	2
tool total	440	92	58
tool richness	13	16	11
toolkit diversity (D)	0.7398	0.9003	0.7675
unfinished tool	+	13	0
blade	+	46	17
microblade	56	78	40
microblade core	+	7	12
flake	5,092	154	346
core		4	3
debitage (ground tool)		209	0
others	12	8	0
total	5,600	611	476

Table 2: Lithic assemblage and tool kit diversity Tool kit diversity is obtained by Simpson's diversity index (D)

$$D = 1 - \sum_{i=1}^{S} pi^2$$

* *S* is the total number of tool types in an assemblage. *i* is a tool type in an assemblage. *pi* indicates relative dominance (%) of species *i* in *S.*

Amur region (Figure 2). Of these, however, only a few sites have an adequate number of lithic tools and reliable radiocarbon dates were recovered from a clear geologic context. As the excavation report of the Goncharka-1 site, which provides plenty of data on lithics, flora and radiocarbon dates, was just published recently (Shevkomud and Yanshina 2012), we basically refer to it in analyzing the Osipovka lithic technology, and supplement it with data from other sites.

The Goncharka-1 site is located in a hilly area on the right bank of the Amur River, in the western suburbs of Khabarovsk city (N 48°19'45", E 134°52'15"). A total of 5,600 stone artifacts were collected from the 3b layer of this site. Charcoal from this layer is dated to 10.59 ~ 9.89 ky ^{14}C BP.

Lithic assemblage of the 3b layer of the Goncharka-1 site contains a variety of bifacial tools such as foliate points, lanceolate points, stemmed points and microblade cores on bifaces. Other artifacts include both chipped and ground axes and adzes, and tools made on flakes or bifacial thinning flakes such as arrowheads, endscrapers, sidescrapers and marginally retouched flakes. This site also has a few ground arrowheads and blade tools, but bifacial tools overwhelmingly dominate (Table 2). This is also the case at the other Osipovka culture sites (Shevkomud and Yanshina 2012; Naganuma 2010; Hashizume *et al.* 2011). Tool kit diversity is measured as 0.7398 (Table 2).

The lithic raw material of most bifacial tools is debris or angular gravel and large cobbles of dark grayish hornfels (metamorphic mudstone), making up over 80 % of the assemblage (Table 3). Some tool production is surely practiced inside the site, but not all processes are recognized. There are very few flakes with cortex. This is because angular gravel and large cobbles are not found in the vicinity of the site (Hashizume *et al.* 2011). Most bifaces and bifacial tools are thought to have been prepared at limited quarry places, and prepared bifaces were carried and retouched to produce several kinds of points, scrapers, microblades, and many other tools at each site. Bifacial thinning flakes produced in this process were also utilized for tool blanks. The site occupants produced most of the lithic assemblage by bifacial technology.

Table 3: Lithic raw material composition of the three sites

	shale, siltstone	sate, mudstone	chert, agate, jasper, chalcedony	hornfels	sandstone	tuff	others	total
Knyaze Volkonskoe-1	208	96	128	4	18	20	2	**476**
	(43.7%)	(20.2%)	(26.9%)	(0.8%)	(3.8%)	(4.2%)	(0.4%)	(100.0%)
Yamikhta	199	238	79	54	27	3	11	**611**
	(32.6%)	(39.0%)	(12.9%)	(8.8%)	(4.4%)	(0.5%)	(1.8%)	(100.0%)
Goncharka-1	—	—	563	4,911	—	385	238	**6,149***
	—	—	(9.3%)	(80.5%)	—	(6.3%)	(3.9%)	(100.0%)

* 5,600 of 6,149 is stone tools from layer 3b. The composition of lithic raw materials of debitage from layer 3b is not reported, but it is supposed to be similar to the whole proposition of lithic raw material

The Yamikhta culture

For now, just one site, the Yamikhta site, is assigned to this culture. The site is located on the lower river terrace of the upper reach of the Gorin River, a branch of the Amur River (N 51°16'01", E 136°34'35") (Figure 2). A total of 611 stone artifacts and reliable radiocarbon dates were recovered from a clear geologic context (cultural layers II and III). Charred residue on pottery and charcoal from the Yamikhta site is dated to 9.81 ky ~ 8.03 ky ^{14}C BP. Of these, 12 dates from 9.81 ~ 8.82 ky BP are likely to have been affected from marine reservoir effect, and might be 500 years on average older than the true age. Basic information about lithic technological organizational analysis is shown below, according to our excavation report (Fukuda *et al.* 2014).

The cultural component of the site consists of a relatively dense band of lithic artifacts. It contains various kinds of tools such as arrowheads, chisels, drills, foliate points, endscrapers and sidescrapers. In particular, ground arrowheads, chisels and drills are characteristics. The ground arrowhead type is quite similar to that of the Goncharka-1 site, whose ground arrowhead is very rare, though. Other than ground tools, tool blanks were made by four primary reduction techniques: blade, microblade, biface and flake reduction. Among them, blade tools are the second major tools, most of which are sidescrapers. A few blade arrowheads also first appeared at this site in the Lower Amur region. There are relatively few bifacial tools, except for chipped axes. Accordingly, ground tools are predominant at this site (Morisaki and Sato 2014) (Table 2). Tool kit diversity is measured as 0.9003 (Table 2).

Among lithic raw materials, local dark gray slate or gray mudstone dominates, which was used for producing ground tools, making up 39% of the assemblage. Most of the reduction sequence of ground tool production can be recognized inside the site. On the other hand, shale/siltstone and jasper are used for producing blade tools and microblades, though blade and microblade cores are usually prepared outside the site and carried there. Other materials including hornfels, chert, sandstone and so on occur in low frequencies (Table 3).

The site occupants produced most of the lithic assemblage by ground tool technology, and supplemented tool production with other reduction techniques.

The Kondon culture

A number of lithic artifacts of the Kondon culture were recovered from the Kondon-11 (post office) site and the Knyaze Volkonskoe-1 site, but due to problems with possible post-depositional mixing of artifacts, the Kondon-11 site was omitted from detailed analysis. Accordingly, the Knyaze Volkonskoe-1 site is discussed here. This site is located on the right bank of the Abor River, a branch of the Amur River (N 48°28'27", E 135°30'05") (Figure 2). Plenty of lithic tools, pottery and reliable radiocarbon dates were all recovered from one pit dwelling (Fukuda *et al.* 2011). Charcoal from the Knyaze Volkonskoe-1 site is dated to 7.65 ky ~ 6.76 ky ^{14}C BP.

The cultural component of the site consists mainly of blade arrowheads, sidescrapers endscrapers and microblades. Of these, blade arrowheads and

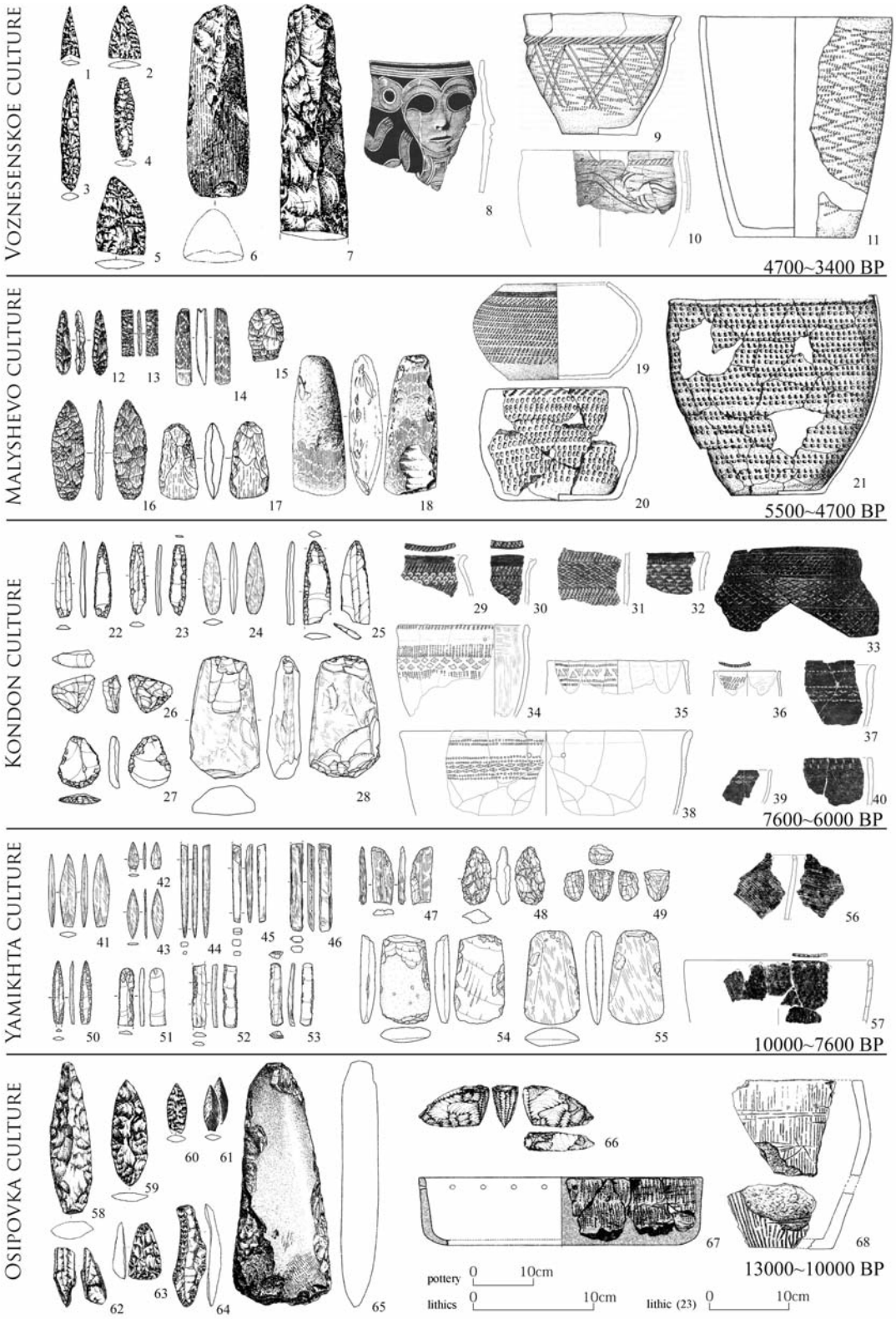

Figure 3: Neolithic cultural chronology in the Lower Amur region (this figure is made after Shevkomud and Kuzmin 2009; Uchida 2011). (1–7, 10: Kol'chom-3; 8, 11: Voznesenovka; 9, 33: Kondon-11; 12–21: Suchu Island; 22–32, 34–40: Knyaze Volkonskoe-1; 41–57: Yamikhta; 58–65, 67: Goncharka-1; 66: Oshinovaya rechka-10; 68: Gasha).

sidescrapers on blades are especially characteristic. Other tools occur in low frequency. Microblades are produced from prismatic and wedge-shaped microblade cores on small bifaces. Other than blade tools and microblades, ground axes dominate in the assemblage. A few ground arrowheads resembling those of the Yamikhta culture are recognized. Tool blanks were produced by four primary reduction techniques: blade, microblade, biface and flake reduction, but bifacial reduction and flake reduction are rare. Accordingly, blade tools and microblades are predominant at this site (Morisaki 2011; Morisaki and Sato 2014) (Table 2). Tool kit diversity is measured as 0.7675 (Table 2).

Among lithic raw materials, shale and siltstone dominate, which were used for producing blade tools and microblades, making up more than 40 % of the assemblage. Blade reduction procedure is recognized inside the site, but blade core preparing processes are not found there. Blade cores are possibly prepared outside the site, and carried into the site. Microblade reduction also utilizes small pebbles of cherts, jaspers and agates, which are thought to be collected in the vicinity of the site. Ground tools are produced from slate and mudstone (Table 3). None of these characteristics of technology reconstructed from the Knyaze Volkonskoe-1 site contradict those of the Kondon-11 site. The site occupants produced most lithic tools by blade and microblade technology, while many axes were made using ground tool technique.

Discussion

Diachronic change of lithic technological organization and hunter-gatherer behavior

The results show that most drastic change of lithic technology occurred between the Osipovka culture and the Yamikhta culture, because many bifacial tools of the Osipovka culture rapidly declined in the lithic assemblage of the Yamikhta culture. The Yamikhta culture is clearly characterized by ground tools, instead. Since the pottery technology and some lithic tool types of the two cultures are similar, observed change seems not to be caused simply by human immigration or cultural diffusion.

It is well known that large bifaces generally serve as core tools and also as knives and/or projectile points (Kelly 1988). Actually, several types of tools are made on bifaces at the Goncharka-1 site and at the other Osipovka culture sites. Moreover, a lot of tools made on bifacial thinning flakes are also identified there (Naganuma 2010). Bifaces serve also as microblade core blanks. These facts all indicate that the Osipovka hunter-gatherers placed great importance on a bifacial reduction strategy, functional flexibility or versatility, all of which met a wide variety of needs and reduced various risks in their subsistence activities, and made it possible for them to move across a wide foraging area.

On the other hand, it is evident that the Yamikhta lithic technology, which is characterized by ground tool technology, does not aim at economical reduction of lithic raw materials, and is therefore unsuitable for highly mobile subsistence. Blade and microblade reductions supplemented it, but tools produced through the

reduction processes never dominate among the lithic assemblage. Also, compared with the Goncharka-1 site occupants, the increase in tool kit diversity of the Yamikhta site occupants suggests a decline in their mobility frequency (Shott 1986). These facts tell us that the Yamikhta hunter-gatherers rather aimed at somewhat broad-based resource exploitation within smaller foraging territory than during the previous stage.

During the Kondon cultural stage, hunter-gatherers seem to have produced blade tools and microblades again frequently, instead of ground tools. Blade tools and microblades were provided by carrying both cores, which reduced the amount of procurement time and made it possible to increase time for hunting or other food-finding activities. Hunter-gatherers equipped with these reduction techniques are supposed to have focused on highly mobile subsistence.

Correlation between human behavior and environmental change

It should be noted that the aforementioned lithic technological and human behavioral change generally correspond with temporal environmental change during the Pleistocene-Holocene transition. The radiocarbon date of the Osipovka culture (Table 1) is calibrated to ca. 16.0 ky ~12.0 ky cal BP on the basis of the Oxical 4.2.3 using IntCal 13 calibration curve (Bronk Ramsey 2013; Reimer *et al.* 2013). This date almost corresponds to the Late Glacial. The 3b layer of the Goncharka-1 site might pertain to the Younger Dryas. Calibrated dates obtained from the Yamikhta culture, which range from 10.7 to 8.7 ky cal BP, is assigned to the beginning of the Post-Glacial period. Calibrated dates of the Knyaze Volkonskoe-1 site, 8.60 ky ~ 7.68 ky cal BP, possibly correspond to the Holocene climatic oscillation, 8.2 ky event, although this is still uncertain.

As shown in studies of flora, there is abrupt vegetation change caused by climatic fluctuation from the terminal Pleistocene to the Holocene in the Lower Amur region. If this is correct, the drastic technological and behavioral change between the Osipovka culture and the Yamikhta culture was caused by this abrupt environmental change. The decline of the risk-buffering strategy of lithic tool production and shift to a more sedentary lifestyle from the Osipovka to the Yamikhta might have been a result of climatic stability and amelioration after the Younger Dryas. Moreover, since the backlash to the more mobile subsistence during the Knyaze Volkonskoe-1 seems to have something to do with the climatic deterioration caused by the 8.2 ky event, further investigation is needed. After the Malyshevo cultural stage, however, lithic assemblage consisted of a wide variety of flake tools, bifacial tools on flakes, and ground tools such as axes. The change during the Kondon culture seems to have been a temporal phenomenon.

Concluding remarks

This paper has tried to investigate the correlation between hunter-gatherer behavioral change and environmental change during the Pleistocene-Holocene

transition. Analysis in this paper on lithic technological change according to the current chronology has suggested that human behavioral change surely has a connection with environmental change. At present, this is just a preliminary study because there are still a few archeological materials to be analyzed. We hope future expeditions and investigations will test the results shown here and clarify the detailed causal relationship between them.

Acknowledgements
We are deeply grateful to Mr. Kazunori Uchida and Dr. Dai Kunikita for helping us prepare this paper. This work was supported by Grant-in-Aid for Scientific Research (A), Grant Number 23251014.

Résumé
Cet article explore la question de l'adaptation des chasseurs-cueilleurs aux changements environnementaux de la transition Pléistocène-Holocène dans la région du bas Amour. Une fouille récemment conduite sous la direction conjointe d'un projet russo-japonais a finalement découvert le « chainon-manquant » entre les cultures humaines de l'Holocène et du Pléistocène. Aujourd'hui, les conditions indispensables à l'étude diachronique des changements de comportement des populations de chasseurs-cueilleurs de la transition Pléistocène-Holocène sont désormais satisfaites. Le matériel analysé dans cet article provient des sites archéologiques des cultures Osipovka, Yamikhta et Kondon. Dans un premier temps, nous avons d'abord étudié la technologie lithique qui reflète les stratégies adaptatives des groupes humains en nous focalisant sur la composition et la diversité des tool-kits, le débitage et l'approvisionnement en matière première, enfin dans un second temps, nous avons corrélé ces informations avec les changements environnementaux. Les résultats montrent que les changements les plus clairs perceptibles à travers la technologie lithique sont intervenus entre la culture Osipovka et la culture Yamikhta. En effet, la technologie bifaciale de la culture Osipovka décline rapidement dans les assemblages postérieurs de la culture Yamikhta qui est davantage caractérisée par des outils polis. Pendant la phase culturelle suivante du Kondon, les outils sur lames et lamelles dominent à nouveau. Ces éléments montrent l'importance de la portabilité du tool-kit et de la stratégie d'amortissement des risques qui ont décrus de l'Osipovka au Yamikhta pour à nouveau se développer durant le Kondon. Si l'on considère la correspondance des changements intervenus dans la technologie lithique et dans l'environnement, le déclin de la stratégie d'amortissement des risques et l'adoption d'un mode de vie plus sédentaire entre l'Osipovka et le Yamikhta pourraient avoir résulté d'une phase de stabilité et d'amélioration climatique après le Dryas récent. Le retour brutal à un mode de subsistance plus mobile durant la phase du Kondon pourrait être lié à la détérioration climatique brutale causée par l'évènement de 8,2 Ka.

Zusammenfassung
Dieser Beitrag untersucht die Reaktion von Jägern und Sammlern auf Umweltveränderungen während des Überganges Pleistozän/Holozän in der unteren Amur-Region. Eine neue Ausgrabung, die von einem japanisch-russischen Forschungsprojekt durchgeführt wurde, fand schließlich das Bindeglied zwischen pleistozänen und holozänen menschlichen Kulturen, das in früheren Studien vermisst wurde. Nun ist die Grund-

bedingung für die Untersuchung diachroner Verhaltensveränderungen von Jägern und Sammlern über die Pleistozän/Holozän – Grenze hinweg erfüllt. Die in dieser Arbeit analysierten Materialien sind archäologische Fundstellen der Osipovka Kultur, der Yamikhta Kultur und der Kondon Kultur. Wir haben zuerst den Aufbau der Steintechnologie, die die menschlichen Verhaltensstrategien widerspiegelt untersucht, indem wir uns zunächst auf die Zusammensetzung der Geräteensembles, die Diversität der Geräteensembles, die Abbautechnik und die Rohmaterialbeschaffung konzentriert haben und als zweiten Schritt alles mit den Umweltveränderungen korrelliert haben. Diese Ergebnisse zeigen, dass ein klarer technologischer Wandel zwischen der Osipovka Kultur und der Yamikhta Kultur stattgefunden hat, weil die Strategie des bifazialen Abbaus, wie sie in der Osipovka Kultur vorkommt, in der nachfolgenden Yamikhta Kultur abnimmt, welche durch geschliffene Geräte charakterisiert ist. Während der nächsten Stufe, der Kondon Kultur, dominierten wieder Klingengeräte und Mikroklingen. Das zeigt, dass die Bedeutung der Risiko-absicherung und der Transportierbarkeit der Geräteensembles von der Osipovka zur Yamikhta Kultur abnahm und schließlich in der Kondon Kultur wieder anstieg. Zieht man den Zusammenhang zwischen dem technologischen Wandel der Steinindustrie und den Umweltveränderungen in Betracht, so mag die Abnahme der Risikoabsicherung und der Übergang zu einem mehr sesshaften Lebensstil von der Osipovka zur Yamikhta Kultur das Ergebnis klimatischer Stabilität und Verbesserung nach der jüngeren Dryas gewesen sein. Die Gegenbewegung zu einer mehr mobilen Subsistenz während der Kondon Kultur könnte mit der abrupten Klimaverschlechterung verursacht durch das 8.2 Ka. Ereignis in Beziehung stehen.

MESOLITHIC PEOPLE FROM CRIMEA

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Abstract
The materials for our study were represented by three skeletons from Murzak-koba I and II and Fatma-koba dated to the Upper Paleolithic-Mesolithic period. The skeletal remains, both cranial and postcranial parts, were standardly measured and selected indexes describing shape and proportion of individual body parts were estimated. The intravital stature of all individuals was high, the cranial shape was heterogenous and their extremities proportion resembles the mid-continental adaptive human type. Various pathological traces, such as periodontitis and periostitis were observed.

Keywords
Crimean hominids, skeletal anthropology, paleopathology, Murzak-koba, Fatma-koba

DOI: 10.5817/CZ.MUNI.M210-7781-2015-32

Introduction

The earliest known finds of Crimean hominids include fragmentary skeletons from Kiik-koba apparently belonging to (pre-Wurmian) Neanderthal men, a twin burial from Murzak-koba, which is dated back to Upper Paleolithic-Mesolithic, and a skeleton from Fatma-koba belonging to the Upper Paleolithic-Mesolithic age (according to Debets – to "the early time of Neolithic age") (Debets 1948).

A skeleton of an adult from Kiik-Koba is very fragmented and essentially represented only by a skeleton of hands and feet. A paleoanthropological study performed by G. A. Bonch-Osmolovsky showed considerable massiveness of the skeleton characteristic of known classical Neanderthal forms. Unfortunately, these remains do not give us any other information. At the same time, this find may be

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considered a strange one – the burial contains complete skeletons of hands and feet and lacks all other bones, including a skull.

That is why we are mostly interested in finds belonging to slightly later ages – those from Murzak-koba and Fatma-koba. In 1927, during excavations in the cave of Fatma-koba, G. A. Bonch-Osmolovsky found a skeleton of a male, whose age was estimated as about 40 years. The main characteristics of the skull were: a low face, deep horizontal profiling, a high nose bridge, a sharp protrusion above the line of facial profile, and wide nasal bones slightly narrowed in the middle. The skull is characterized by a mesognathic profile – not alveolar, but a general one, which may be to an extent considered as an archaic feature. However, in G. F. Debets' opinion, the combination of the skull features demonstrates greater remoteness of the Fatma-koba man from the Neanderthal type (Debets 1948). Therefore, we may conclude that there could hardly be any evolutionary relationship between Neanderthal men (in particular, as represented by the man from Kiik-Koba) and the people of Fatma-koba type.

A stronger resemblance in skull morphology was observed between the Fatma-koba skull and skulls from the grotto of Murzak-koba. In 1935, while performing excavations in Murzak-koba, S. N. Bibikov found a twin burial. The anthropological study was performed by V. E. Zhirov (1940). The biological age of the buried individuals was estimated as 20–23 years (now there is a specified estimate – 23–26 years) and 45 years, respectively. It was concluded that the first skeleton belonged to a young female, and the second one to a male. This conclusion is still considered as the correct one, though some authors suggested that the sexual identity of the first skeleton had been determined incorrectly. Thus, G. F. Debets wrote: "*...The female skeleton turned out to be very similar to the one from Fatma-koba. In this connection I even had a suspicion concerning my determination of the latter's sex. Therefore, I inspected a left nameless bone from Fatma-koba for the second time… After all, it has rather a male structure, though it is not very pronounced. Resemblance in the structure of both skulls saves us the trouble of more detailed characterization of the female skull from Murzak-koba, which would be a repetition of the one given above for the Fatma-koba skull*" (Debets 1948). Our study of skeletons from Fatma-koba and Murzak-koba, performed in 2004–2005, has also implanted doubts concerning the correctness of the conclusion that the young individual from Murzak-koba was a female. Therefore, we gave a specimen for DNA sex determination and it confirmed the correctness of its primary attribution. The female skull was large (skull cavity volume – 1,534 cm^3), mesocranic, low-faced, moderately prognatic, high, with straight forehead and low orbits. The male skull was dolichocranic, high, with a very wide, high, orthognathic face, a low, inclined forehead, very developed superciliary arches, and very low orbits. The skulls resemble the late Cro-Magnon type (Brno-Předmostí) (Debets 1948). The postcranial skeletons were earlier studied according to a minimal program, mainly with a view to calculating intravital body length.

Materials and methods

Within the framework of craniological processing we performed a standard procedure for determination of individuals' sex and age in accordance with

methodic recommendations of Russian anthropologists. Sex and age were determined on the basis of special scales for obliteration of skull sutures and degree of dental attrition (Alekseyev and Debets 1964). We applied a standard technique of craniometric measurements and recording of descriptive features (Alekseyev and Debets 1964). A categorical estimation of feature values was taken from rubrications contained in the same guidance.

Measuring of postcranial skeleton bones was performed according to the standard osteometric program with several additions. A method used for particular measurements of skeleton bones was based on rules described in V. P. Alekseyev's *Osteometriya* (1966). In order to describe muscular relief we used a scheme introduced by V. N. Fedosova (1986) with our additions. Description of bone features was based on schemes proposed in V. P. Alekseyev's *Osteometriya* (1966).

The materials for our study were represented by three skeletons from Murzak-koba I and II and Fatma-koba, which are kept in the Museum of Anthropology and Ethnography of the Russian Academy of Sciences (Kunstkamera) in Saint Petersburg.

Results and discussion

Craniological study

Table 1: Craniological characteristics.

no.	features	Murzak-koba I	Murzak-koba II	Fatma-koba
1	length	191	198	189
8	breadth	145	140	137
17	height	145	–	151
5	skull base length	100	–	109
9	breadth frontal mimimum	105	97	94
10	breadth frontal maximum	119	113	110
11	skull base breadth	131	–	126
12	nape breadth	113	–	111
29	forehead horde	119	122	112
30	cranial horde	117	123	127
31	nape horde	103	103	108
26	forehead arch	138	138	125
27	cranial arch	130	140	142
28	nape arch	123	122	127
7	cranial opening length	39	–	35
16	cranial opening breadth	32	–	30
45	cheekbone diameter	142	142 (?)	142
40	face base length	101	107 (?)	112

no.	features	Murzak-koba I	Murzak-koba II	Fatma-koba
48	upper facial height	67	77	68
43	upper facial breadth	112	113	112
46	middle facial breadth	104	107	102
60	alveolar arch length	56	58	53
61	alveolar arch breadth	63	67	67
55	nose height	50	54	49
54	nose breadth	25	28	26
51	orbit breadth from MF	45	47	45
52	orbit height	30	28	30
77	nose-molar angle	1440	1380	1430
<zm	zygomaxillar angle	1280	1250	1340
SC	symotic breadth	8	11	11
SS	symotic height	2.6	5	5.5
MC	maxillofrontal breadth	–	–	22
MS	maxillofrontal height	–	–	9
	canine fossa depth (on the right)	–	2	2.5
	jugal bone bend height (according to Wu) (on the right)	–	15	59
	jugal bone breadth (according to Wu) (on the right)	–	14	64

Table 2: Indexes of craniofacial characteristics.

no.	index	Murzak-koba I	Murzak-koba II	Fatma-koba
8/1	skull index	75.9	70.7	72.5
17/1	height-length index	75.9	–	79.9
17/8	height-breadth index	100.0	–	110.2
29/26	forehead curvature index	86.2	88.4	89.6
30/27	cranial curvature index	90.0	87.8	89.4
31/28	nape curvature index	83.7	84.4	85.0
9/8	cross forehead index	72.4	69.3	68.6
12/8	cross nape index	77.9	–	81.0
48/17	vertical cranial facial index	46.2	–	45.0
45/8	cross cranial facial index	97.9	101.4	103.6
9/45	frontomolar index	73.9	68.3	66.2
40/5	face profile index	101.0	–	102.7
48/45	upper facial index	47.2	54.2	47.9
48/46	upper middle facial index	64.4	72.0	66.7
54/55	nose index	50.0	51.9	53.1
52/51	orbit index	66.7	59.6	66.7
Ss/Sc	symotic index	31.3	45.5	50.0

Brainpan description

When looking from above, a brainpan has a pentagonal shape – the largest breadth of the skull is shifted backwards and falls on the back third. Frontal and especially parietal protuberances are quite developed. It is their development that determines the pentagonal shape of the brainpan. The male skulls may be described as elongated and comparatively narrow – dolichocranial. The female skull from Murzak-koba is mesocranial. The longitudinal height index is high and testifies to hypsicrania. According to the transversal height index, it falls within the category of acrocranial skulls. Both indices suggest that the skulls are comparatively high.

The forehead of the female skull from Murzak-koba is straight and (visually) quite wide, and those of the male skulls are backward-sloping and medium-wide. The absolute dimensions of minimal and maximal forehead breadth belong to the category of medium and large ones. According to the transverse frontal index, the skull from Murzak-koba I is megasemic (with wide forehead) and the male skulls from Murzak-koba II and Fatma-koba are mesosemic (medium-wide). The frontomolar index of the female skull is medium and that of the male ones is small. Based on the comparatively low frontal bone curve index, we can conclude that it is quite curved. Parietal protuberances are high. The comparatively low parietal bone curve index suggests their curvature has a small radius. The nape is wide.

Facial skeleton description

The facial part of the Murzak-koba I and Fatma-koba skulls is wide and comparatively low, and eurienic (low face index) – according to the upper facial index – and that of the Murzak-koba II skull is mesenic. Horizontal profiling angles are medium and small, i.e. the face is quite well profiled, especially in the area of the maxilla alveolar ridge. Face prognathism is also confirmed by the face protrusion index (Flower index). The craniocephalic vertical index is close to the minimum for *Homo sapiens*, i.e. there is a tendency for a combination of low face and medium-high brainpan. On the other hand, the craniocephalic transverse index is very high, which testifies to a combination of wide face and comparatively narrow brainpan.

Orbits are low and comparatively wide (chameconic). In absolute dimensions the nose is not high and comparatively wide (chamerinic), which is also confirmed by the nasal index. The symotic index is high, which suggests a considerable nasal bridge height. The zygomaxillar area is of medium massiveness. The lower edge of the piriform aperture is anthropina, i.e. its lateral edges pass into the lower edge, having a sharp shape.

We also performed a comparative analysis of a number of metric features with the use of the multidimensional method of main components. For this analysis we used the following features: longitudinal (1) and transversal (8) diameters; minimal forehead breadth (9); frontal (29), parietal (30) and occipital (31) chords; cheekbone diameter (45); upper height (48) and breadth (43) of facial skeleton; nose height (55) and breadth (54). The comparative analysis included only the male skulls from

Murzak-koba II, Fatma-koba and Upper-Paleolithic *Homo sapiens* from Europe. The two main components describe about 45 percent of variation. Results of the analysis may be seen in Figure 1.

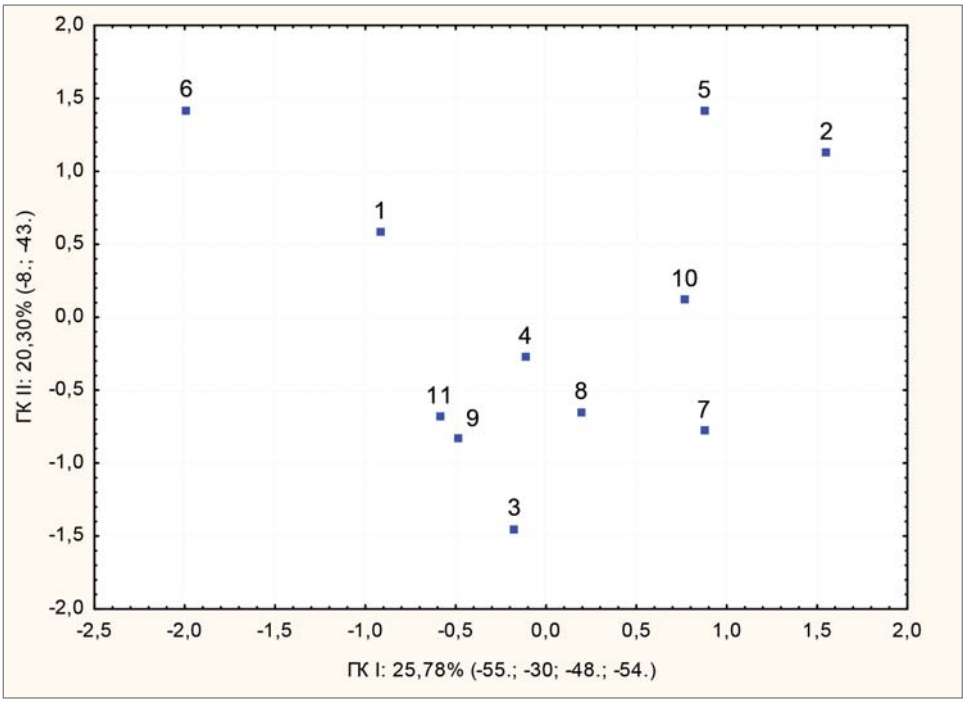

Figure 1: Spatial arrangement of skulls in main components (ГК) I and II
Legend. 1 – Murzak-koba II; 2 – Fatma-koba; 3 – Cro-Magnon I; 4 – Solutré II; 5 – Solutré IV; 6 – Comb-Cappel; 7 – Oberkassel; 8 – Předmostí III; 9 – Předmostí IX; 10 – Mladeč I; 11 – Sungir I.

The first main component describes the increase of upper facial breadth and decrease of parietal chord, upper facial height and nose breadth and height. The second component is indicative of the increase of occipital chord and decrease of transverse diameter and upper facial breadth. The figure shows that the Murzak-koba II skull is distinguished by a comparatively narrow, but high face, high and wide nose, large occipital chord and small transverse diameter. Close to these characteristics is the skull from Comb-Cappel. The skull from Fatma-koba is opposite to that, according to the first component, i.e. it has a comparatively wide and low face with small transverse diameter. It is evident that the two males from Crimea have different craniotypes. While the first is more similar to the Comb-Cappel type, the second is close to a specimen from Solutré IV.

Postcranial study

We performed fuller measuring of postcranial skeletons. However, now the collection lacks long bones of the skeleton from Fatma-koba. Therefore we could calculate some indices of extremity proportions on the basis of data concerning length of the bones cited in the work of G. F. Debets (1948). Then, we calculated indices of extremity proportions and bone massiveness (except for Fatma-koba). Some results are shown in Tables 3 and 4.

↑ Figure 4: The fullface and profile of skull of Fatma-koba

↑ Figure 2: The fullface and profile of skull of Murzak-koba 1

← Figure 3: The fullface and profile of skull of Murzak-koba 2

Table 3: Indices of extremity proportions.

index/burial	side	Fatma-koba	Murzak-koba 1	Murzak-koba 2
intermembral	right left	– 68.07*	– 70.80	– –
brachial-femoral	right left	– 72.29*	69.16 71.44	72.28 –
radio-tibial	right left	– 63.10*	– 69.97	– –
radio-brachial	right left	– 74.25*	78.185 76.83	78.41 –
pedidian-femoral	right left	– 85.07*	– 78.44	– –
clavicular-brachial	right left	– –	46.62 45.57	44.57 ?? –
shoulder breadth (cm)		–	35.38	39.04 ??
pelvis breadth (cm)		29.40	28.60	–
pelvic index		79.25	69.93	–
stature according to Dupertuis and Hadden		173.2*	167.8	182.8

* data according to G.F. Debets or calculated on the basis of some long bone sizes, according to G.F. Debets (Debets 1948); ?? – approximate measurement; the result is not lower than the actual one (i.e. shoulder breadth could be a little bit more).

Table 4: Massiveness indices of extremity bones.

index/burial	side	Murzak-koba, 1	Murzak-koba, 2
Clavicula	right left	24.14 24.14 ?	– –
Humerus	right left	19.11 18.66	21.10 19.46
Radius	right left	16.70 17.00	15.03 –
Ulna	right left	16.45 16.31	16.73 –
Femur	right left	19.60 19.78	21.19 –
Tibia	right left	– 20.40	– –

Thus, inter-membral indices of individuals from Murzak-koba 1 and Fatma-koba are very close to each other and belong to medium values for modern man, which suggests the average correlation of extremity length. For the individual from Fatma-koba, this index is a little lower than the average one, i.e. we can speak about quite elongated legs. Brachial-femoral indices are obtained for all three individuals. For the individual from Murzak-koba 1, this index suggests comparatively medium-

long or quite increased femoral section as compared to shoulder size. For other skeletons this correlation reflects considerably elongated shoulder as compared to femur. The correlation of forearm and shoulder of both individuals from Murzak-koba is very similar and indicative of a medium or slightly elongated forearm. The individual from Fatma-koba has a different correlation – with a shortened forearm. At the same time we may recognize a very elongated shin as compared to femur. This result also corresponds to the value of the radio-tibial index. The individual from Murzak-koba 1, by contrast, has a shortened shin (or elongated femur).

The supposed shoulder breadth of the male from Murzak-koba 2 is quite wide, while that of the first individual is medium (considerable for females and medium, but quite allowable for a young male). In terms of pelvis breadth, the individuals from Murzak-koba 1 and Fatma-koba are very similar, but the pelvis breadth of the male from Fatma-koba is a little (almost 1 cm) wider. However, the first of the above-mentioned individuals has a very low pelvis, ilium wings are not so unfolded and iliac and ischial bones are short. In this context, the pelvis of the male from Murzak-koba 2 is more "masculine." The height of his right hip bone (including iliac and ischial bones separately) is the greatest. However, we should note that the male from Fatma-koba has much longer pubic bones and wider ilium wings than the "female" from Murzak-koba 1. At the same time, "she" has larger cotyloid cavities, and "her" pubic symphysis is 49.5 cm, i.e. higher than that of the "male."

Thus, according to extremity proportion indices, we may suppose that all three individuals belong to a mid-continent adaptive type. Meanwhile, the male from Fatma-koba is distinguished by an elongated medial section of a leg – a shin, which is more characteristic of people of a tropical adaptive type. However, the radio-brachial index of the man from Fatma-koba does not correspond to this type.

The intravital body length was determined according to the Dupertuis and Hadden formulae for femoral bones (Alekseyev 1966). The male from Murzak-koba turned out to be tall – almost 183 cm. The intravital body length of the individuals from Murzak-koba 1 (if it was a male) and Fatma-koba may be estimated as average and just above average: 171.8 and 173.2 cm, respectively. If the individual from Murzak-koba 1 is a female, then – according to the formula for female skeletons – her stature turns out to be 167.8 cm, which is quite tall for women.

Unfortunately, it was impossible to estimate bone massiveness of the skeleton from Fatma-koba and the analysis was done only for those from Murzak-koba. Almost all the bones of the individual from Murzak-koba 1 are of medium massiveness. Humeri are a little more gracile and radii are a little more massive than the average for humans. Moreover, we should note that the left shin bone is aciniform (the right is absent). The humerus and cubitus of the second individual are of medium massiveness, the available right radius is gracile, and the only right femur is massive and better fastened in the upper part of the diaphysis.

In general, the muscular relief of both individuals is developed moderately and almost equally. Differences mainly concern femoral bones. The male from Murzak-koba II has more pronounced femur relief, especially the *linea aspera*, inter-trochanteric crest and epicondyles. However, this is probably connected with a

difference in their age. The first individual (female) was 23–26, and the second (male) was about 45 years old. We should note that the humeri of the young woman from Murzak-koba 1 have much more developed deltoid roughness, while on the male's humeri it is almost invisible.

It is hard to imagine rough labor of Mesolithic people in the low-hill terrain. Most probably, they subsisted on hunting, fishing and gathering. Much energy was apparently expended in traveling across hills and mountains, crossing cold mountain rivers and transporting spoils, tools and weapons. The probable load on shoulder joints accounts for quite good development of collarbone relief on both individuals, as well as crests of greater and lesser tubercles of humeri – i.e. relief of muscles ensuring force movements and static loads on shoulder joints. Perhaps, it is also implied by considerable deformation of the lumbar vertebrae of the adult male from Murzak-koba.

Paleopathological study

In 2004, the authors of this work had a chance to visit the grotto of Murzak-koba, to range hills and mountains and cross an "icy" river near the grotto, which is now much shallower than it was in ancient times. Almost the same conditions were

Figure 5: The left brush with a trauma (Murzak-koba 1).

observed near Fatma-koba. The analysis of pathologies of skeletons from Murzak-koba and Fatma-koba first revealed porosis of various structures in end sections of long bones, sometimes vertebrae, and some areas of hip bones. This could be caused by poor diet, lack of some substances (maybe vitamins), and infections. Another noticeable manifestation of diseases was some *periostitis* on various bones (including some sections of collarbones, humeri, cubits, radii; on leg bones *periostitis* is more expressed). Infections and frequent traumas, plus a need to cross very cold water, provoked inter alia inflammatory processes in periosteum.

The main skull pathologies are: fine-meshed porosis (of *cribra* type) of superciliary arches, tympanal parts of temporal bones, malar bones, sometimes parietal bones, occipital squama and some other structures. The male from Murzak-koba II shows porosis and tumor of tympanal plates of temporal bones and size reduction of external auditory canals. Apparently, this implies ear infection and a decrease of this man's hearing. And this disease could be caused by the need to dive into cold water, as well as winter winds, etc. In other words, here we have the consequences of adaptation to occasional cold stress.

We should also note that the individual from Murzak-koba 2 has *periodontosis* with a cavern from a probable cyst above the left upper first premolar. The male from Fatma-koba has very worn teeth and small enamel *hypoplasia* on cutting and canine teeth.

And, finally, we have to describe after effects of a trauma or, perhaps, some ritual actions on the skeleton of the young woman from Murzak-koba. It seems that nail bones of both her hands were cut during her life. Adhesion was accompanied by an inflammatory process. As a result, the distal surface of medial phalanges shows some *porotic hyperostosis*. This trauma was described in detail by D. G. Rokhlin (Rokhlin 1965).

Conclusions

In terms of craniology, the Mesolithic males from Crimea are heterogeneous. While the man from Murzak-koba is similar to the Comb-Cappel variant, the Fatma-koba variant is closer to the finds from Solutré. Based on the indices of extremity proportions, we may suppose that all three individuals belonged to a mid-continent adaptive type. Intravital stature of the individuals was quite high. In general, the muscular relief of both individuals from Murzak-koba is developed moderately and almost equally. The analysis of pathologies of skeletons from Murzak-koba and Fatma-koba first revealed porosis of various structures in end sections of long bones, sometimes vertebrae, and some areas of hip bones. It seems that the woman from Murzak-koba had her nail bones of both hands cut during her life.

Acknowledgements
The authors of this study would like to thank employees from the anthropology section of the Museum of Anthropology and Ethnography of the Russian Academy of Sciences (Kunstkamera) in Saint Petersburg and, personally, Vera Ivanovna Seleznyova, a curator, who helped us. We also thank Jiří Svoboda for this great opportunity to publish our study in his monograph and congratulate him from the bottom of our hearts.

Résumé
Les découvertes de Murzak-Koba et de Fatma-Koba (fin du Paléolithique supérieur – Mésolithique) suscitent beaucoup d'intérêt. En 1927, lors des fouilles de G. A. Bontch Osmolovsky, un squelette masculin a été découvert dans la grotte Fatma-Koba. Les traits caractéristiques du crâne sont une face basse et verticale , une racine du nez haute, les os du nez avancés au-dessus du profil, larges et légèrement rétrécis dans la partie médiane. Le crâne est caractérisé par la mésognathie qui n'est pas alvéolaire, mais totale considérée comme un caractère archaïque. On observe des ressemblances dans la morphologie du crâne (selon les critères métriques a descriptifs) entre le crâne de Fatma-Koba et ceux de la grotte Murzak-Koba. En 1935, lors des fouilles de S. N. Bibikov, une double inhumation a été découverte dans la grotte Murzak-Koba. Nous avons examiné les crânes et nous avons trouvé des traits de ressemblance entre les découvertes de la Crimée et les spécimens du Paléolithique supérieur – le Solutréen et Předmostí. En outre, on a conduit une vaste recherche ostéologique. Les indices des proportions des membres peuvent indiquer un type adaptatif moyen-continental pour tous les trois spécimens. Le tibia allongé de l'homme de Fatma-Koba est plus typique des personnes du type adaptatif tropical. Cependant, l'indice de radius-humérus de l'homme de Fatma-Koba ne correspond pas à ce type adaptatif. L'analyse de la pathologie osseuse des squelettes de Murzak-Koba et Fatma-Koba a révélé de l'ostéoporose sur les os longs, les vertèbres, et sur certaines parties des os pelviens. Cela peut être causé par des carences alimentaires ou un déficit en éléments nutritifs (par ex. Un manque de vitamines), ou des infections.

Zusammenfassung
Von großem Interesse sind die Funde vom Ende des Jungpaläolithikums – der Mittelsteinzeit aus Mursak-koba und Fatma-koba. Im Jahr 1927 wurde bei den Ausgrabungen in der Höhle Fatma-koba von G. A. Bontsch-Osmolowskij das Skelett eines Mannes entdeckt. Die Hauptcharakteristiken des Schädels waren die folgenden: niedriges Gesicht, starke horizontale Profilierung, hohe Nasenwurzel, heftiger Vorsprung der Nasenbeine über der Profillinie des Gesichts, breite und im mittleren Teil schwach eingeengte Nasenbeine. Eine Besonderheit des Schädels ist Mesognatie – wobei nicht alveolar, sondern auf den Kiefer bezogen – das man in einem bestimmten Maß für ein archaisches Merkmal halten kann. Größere Ähnlichkeit wird in der Morphologie des Schädels, sowohl nach den Messmerkmalen, als auch nach den umschreibenden Merkmalen zwischen dem Schädel aus Fatma-koba und den Schädeln aus der Grotte Mursak-koba beobachtet. Im Jahr 1935 wurde im Laufe der Ausgrabungen der Grotte Mursak-koba von S. N. Bibikow die Doppelbestattung aufgedeckt. Von uns wurde die kraniologische Untersuchung durchgeführt, die die Ähnlichkeit der Funde aus der Krim mit jungpaläolithischen Beispielen wie Solutrée und Předmosti an den Tag brachte. Außerdem wurde eine umfangreiche osteologische Untersuchung durchgeführt. Nach den Indices der Proportionen der Gliedmaßen kann man bei allen drei Individuen den zentraleuropäisch angepassten Typ vermuten. Dabei hebt sich der Mann aus Fatma-koba durch einen verlängerten

Unterschenkel ab, was eher für die Menschen des tropisch angepassten Typs charakteristischer ist. Jedoch entspricht der Speiche-Schulterindex des Menschen aus Fatma-koba diesem Typ nicht. Die Analyse der Pathologien der Skelette aus Mursak-koba und Fatma-koba hat in erster Linie Osteoporose verschiedener Strukturen am Ende der Langknochen, manchmal der Wirbel und einiger Regionen der Hüftbeine an den Tag gebracht. Gründe dafür könnten die Ärmlichkeit der Nahrungsration, der Mangel irgendwelcher Stoffe, vielleicht der Vitamine, sowie Infektionen sein.

BETWEEN NORTH, WEST AND SOUTH: WESTPHALIAN MESOLITHIC RESEARCH DURING THE LAST DECADE

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Abstract
In recent years, new insights into the Mesolithic in Westphalia have been gained. The Early Mesolithic human remains of the Blätterhöhle in Hagen should especially be mentioned as they even attracted international attention. Additionally, a first stratigraphic sequence containing hearth remains and lithic assemblages of the Early to Late Mesolithic age has been excavated there. Further new sites and radiometric investigations on single finds suggest varying influences from northern and southern as well as western regions on the Westphalian Mesolithic. Several sites, which are assigned to the long blade industries or the Belloisien due to the distinct blade technology and simple microlithic projectile points, represent the initial stage of the Westphalian Mesolithic.

Keywords
Mesolithic, Germany, settlement strategy, microlithic projectile points, stratigraphy

DOI: 10.5817/CZ.MUNI.M210-7781-2015-33

Geographic setting

Westphalia represents the eastern part of the German federal state of North Rhine-Westphalia.

It consists of different types of landscapes (Figure 1). To the north, the *Münsterland* plain, the so-called Muenster or Westphalian Embayment, forms the southern part of the North European Plain, which mainly consists of sandy soils and where several larger rivers are located. To the south, the *Lippe* River runs east to west, and further to the north-east the *Ems* River drains to the north-west. During the Drenthe glaciation around 160.0 ky the entire *Münsterland* was covered by ice, while the prior Elster glaciation only reached its north-eastern part (Skupin *et al.* 2003).

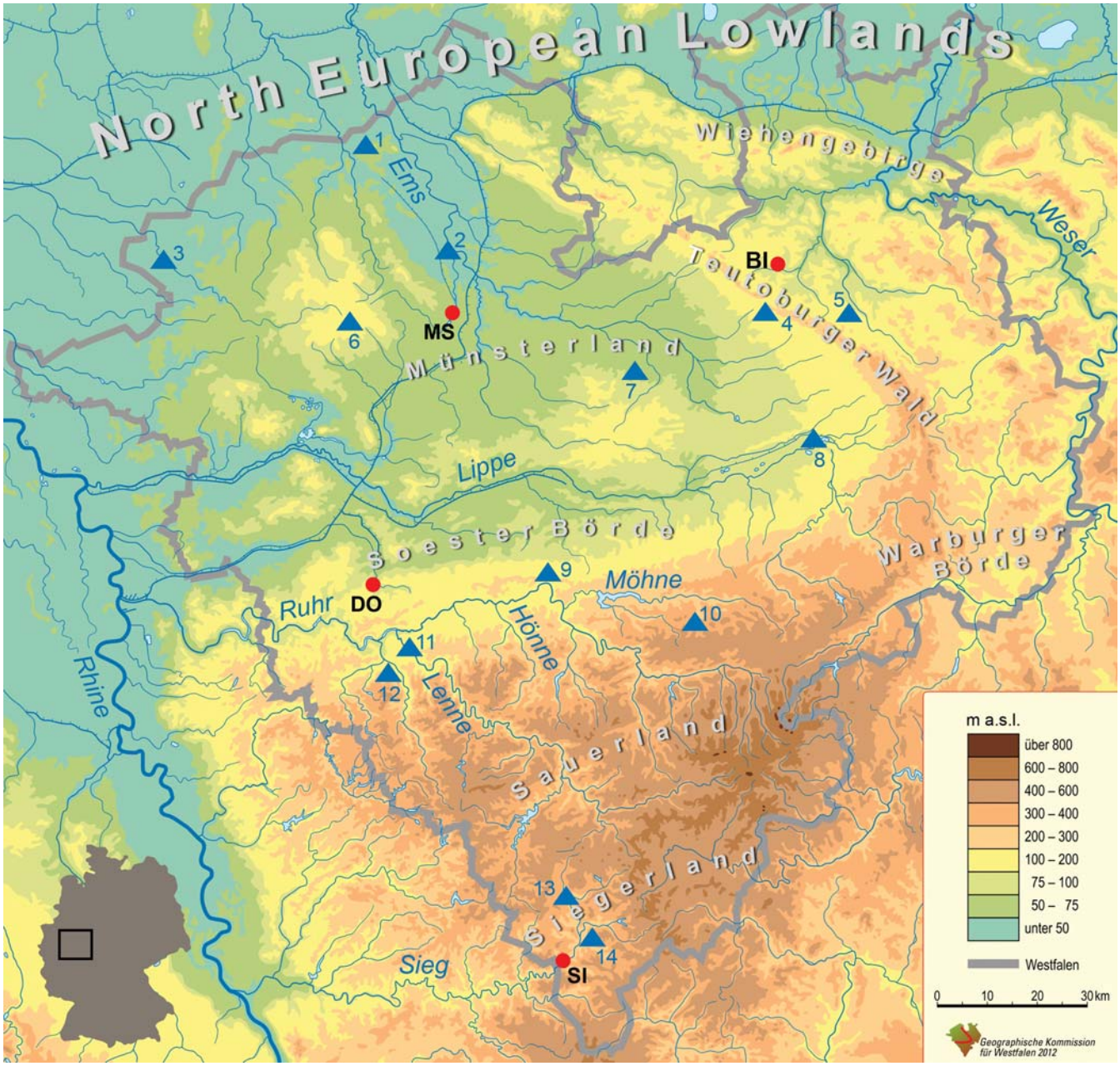


Figure 1: Westphalia consists of different landscapes: its northern regions are part of the North European Lowland, while the eastern and southern regions consist of upland landscapes. – Sites mentioned in the text: 1 Wettringen; 2 Greven, Schencking; 3 Vreden; 4 Oerlinghausen, Bokel Fenn II; 5 Lage, Retlager Quellen; 6 Nottuln, Uphoven; 7 Oelde, Weitkamp; 8 Paderborn, Sande; 9 Werl, Büderich; 10 Warstein, Bilsteinhöhle; 11 Hagen, Blätterhöhle; 12 Hagen, Rieger Busch; 13 Kreuztal; 14 Netphen, Dreis-Tiefenbach. – MS Münster; BI Bielefeld; Do Dortmund; SI Siegen. Map by A. Müller/LWL.

Mainly the younger glaciation left a large amount of erratic boulders and incorporated to moraine sediments the Baltic or North European flint as well, which has usually been used for the production of lithic artifacts. To the east the Muenster Embayment is surrounded by the mountain ranges of the *Teutoburger Wald* and the *Wiehengebirge* and the *Lippe* uplands in between. The *Teutoburger Wald* and the *Wiehengebirge* rise up to elevations of 440 m and 320 m a.s.l. respectively. The northbound Weser River, which cuts through the *Wiehengebirge* at Porta Westfalica, forms the eastern border between Westphalia and Lower Saxony. To the south, the sandy Münsterland changes to the *Soester Börde*, where fertile loess soils appear. In this area, as well as in the *Warburger Börde*, which is located to the east at the border with Hesse, the earliest Neolithic settlements (LBK and Rössen) of Westphalia have been found.

Further south the *Sauerland* mountain area representing the eastern part of the Rhenish shield with many deeply incised valleys is located. After the confluence with the river *Möhne* to the east and several other rivers coming from the south-east at the northern margins of the *Sauerland* the *Ruhr* runs east to west. The highest elevations of the *Sauerland* (max. 843 m a.s.l.) are located to the east, in the so-called *Rothaargebirge*. Further to the south there are still elevations rising to heights from 500 m up to 650 m a.s.l. In the northern *Sauerland* three Devonian *Massenkalk* areas consisting of lime or dolomite outcrops are located (another one is situated further south). These areas and the Upper Permian (*Zechstein*) outcrops around Marsberg at the border with Hesse to the east contain numerous caves. The southern *Sauerland* changes to the *Siegerland*, where the westbound *Sieg* River serves as the major drainage. In the *Siegerland* there are hills at heights of some 600 m a.s.l. and Tertiary volcano remnants, which are much more frequent further south in the *Westerwald* uplands of northern Rhineland-Palatinate. To the north-east of the Siegerland the *Wittgensteiner Land* – a fertile basin – is located. While in the mountain areas and wide ranges of the *Münsterland* only scattered villages and hardly any cities can be found, western Westphalia forms part of the *Ruhrgebiet* agglomeration.

Outline of the Westphalian Mesolithic

Introduction

Ever since their discovery in the *Kleine Feldhofer Grotte* in the *Neandert(h)al* valley close to Westphalia in 1856, the caves in the *Sauerland*, especially those in the river *Hönne* valley around Balve, have come into the focus of pioneer prehistoric researches. Despite the larger caves being mostly empty due to the production of natural fertilizer since the 1830s, famous researchers like Hermann Schaaffhausen and Rudolf Virchow were still able to excavate and collect lithic artifacts and animal remains, generally dating back to the Middle Paleolithic or Late Pleistocene (Günther 1988).

Even though some of the caves and Paleolithic open-air sites had been excavated during the following century, the Paleolithic and Mesolithic periods were of only

limited concern to the official prehistoric research in Westphalia. Consequently Mesolithic excavations were largely carried out by amateurs. From 1929 to 1931, for example, Late Mesolithic material was excavated at the famous *Retlager Quellen* in the *Teutoburger Wald* near Detmold (eastern Westphalia). Afterwards these finds enabled the reconstruction of habitation structures or huts, which often even up to now, symbolize the construction of Mesolithic huts. Recently it has been figured out that not only Mesolithic remains, but also those of the Iron Age, have been excavated there. Hence, it remains highly questionable how reliable the reconstruction of Mesolithic huts at this site actually is (Pollmann 2006).

During the following decades Paleolithic and Mesolithic research in Westphalia remained a "private" domain; nevertheless, it was often carried out with permission of the Archeological Heritage Service lacking personnel capacities. However, the Mesolithic research was mainly confined to the collection of lithic artefacts on surface sites. Even up to the 1990s only a few Mesolithic excavations took place in Westphalia, which hardly provided any further additional information; the pre-Neolithic periods were still out of the focus of the "official" Westphalian Archeology. For instance, the third volume of a popular overview edited by Klaus Günther about the Pleistocene, Paleolithic, and Mesolithic in Westphalia has not been published, despite the availability of finalized manuscripts.

Since the turn of the millennium, the situation has slightly changed. For example, some coincidental Mesolithic discoveries during prehistoric settlement excavations in the *Münsterland* have been scientifically examined. In particular, the Early Mesolithic excavation at Oelde-Weitkamp (see below) has to be mentioned, as for the first time in Westphalia a Mesolithic open-air site revealed burnt macro botanic and faunal remains. In 2004, finds from the *Blätterhöhle* in Hagen, especially Early Mesolithic human remains, came into focus (see below). In the following years the finds were increased by the discovery of several fireplaces and numerous lithic finds in a stratigraphic superposition, which was uncovered in the abri-like situation of the cave's entrance. Unfortunately financial support for continuing the research at this significant site in 2014 has not been secured.

In 2011, an open-air site with preserved, unburnt animal remains was accidentally uncovered on intensively ploughed farmland near Werl-Büderich in the southern part of the *Soester Börde*. Eventually it turned out to be one of the oldest Mesolithic find spots located in the North European Plain (see below). Thanks to the financial support of the responsible ministry in Dusseldorf (Dr. Thomas Otten), and in cooperation with the *Klaus-Tschira-Labor für physikalische Altersbestimmung* in Mannheim (Dr. Bernd Kromer and Dr. Wilfried Rosendahl), an AMS-dating project for Final Paleolithic and Mesolithic finds originating from Westphalia has been set up and revealed several interesting results (Baales *et al*. 2013a; Stapel *et al*. 2013). Our current knowledge of the Westphalian Paleolithic and Mesolithic has recently been presented in a new popular scientific volume (Baales *et al*. 2013c). The results published there will – as far as the Mesolithic is concerned – be summarized in the following (all calibrated ages here are given by using www.calpal-online.de).

The Earliest Mesolithic: A long blade tradition?

During the past decade a few sites within the Muenster Embayment still demonstrating a Final Paleolithic technological tradition were found (Stapel 2010; Baales *et al*. 2013c, 161–163). Unfortunately no organic material was preserved, which could have been radiometrically dated, therefore their chronological position (Figure 2) is based on mere techno-typological arguments. The most striking

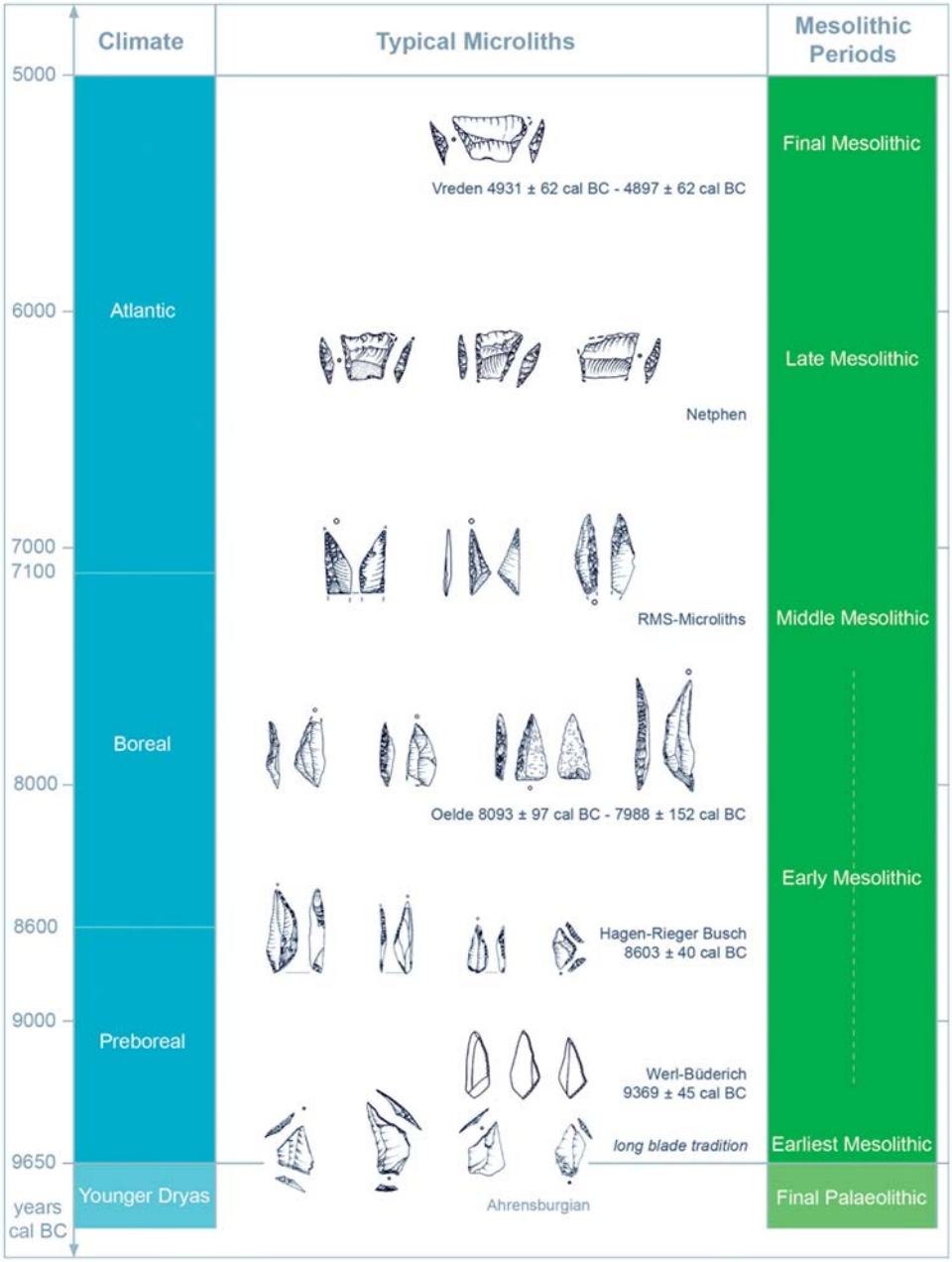


Figure 2: Chronological outline of the Westphalian Mesolithic based on a few radiocarbon dated sites and distinct microlithic inventories. Drawings by P. Altevers and A. Müller/LWL.

characteristics of the assemblages (Figure 3) are the presence of several long blades and large, partly bipolar extracted blade cores showing numerous negatives, which demonstrate the serial production of large blades. Beside these technological arguments the fact that the assemblages consist only of simple microliths and/or base retouched Zonhoven points, whereas Ahrensburgian tanged points are missing, is furthermore of great importance.

These observations link the sites to the Late Pleistocene-Early Holocene long blade or *Belloisien* assemblages mainly of Southern England and Northwestern France; however, in many cases their chronostratigraphic position is quite vague (Barton 1998; Valentin 2008, 173 ff.). Particularly large and broad blades with distinctive battered edges (bruised blades or *lames mâchurées*; Figure 4), which are a characteristic of the above-mentioned north-western European sites, have so far only been found at one Westphalian site (Wettringen). This lithic inventory is quite similar to the one from Nørregård VI in Denmark, where comparable *lames mâchurées* (and furthermore flint core and flake axes) are present (Sørensen and Sternke 2004).

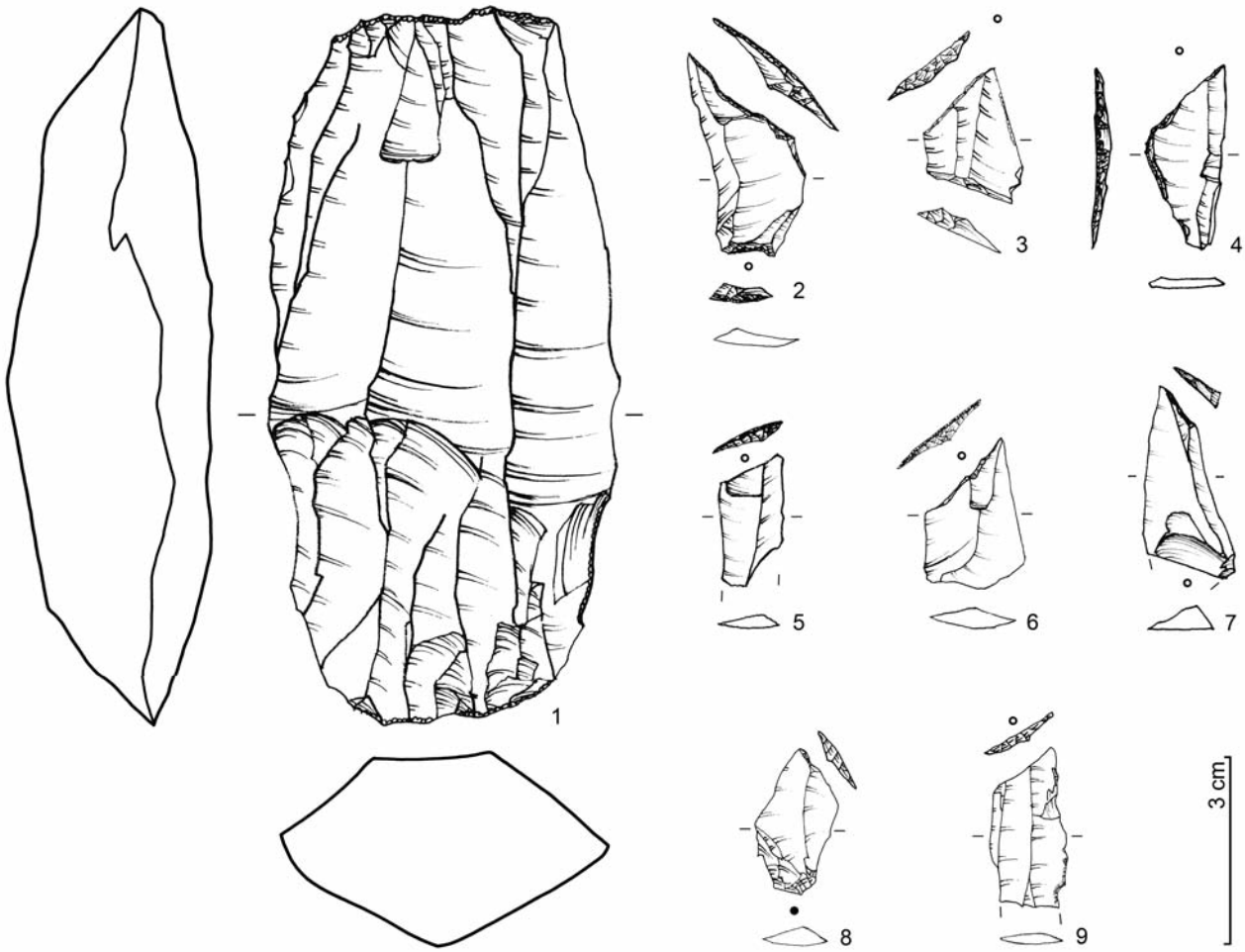


Figure 3: Westerkappeln-Brennesch, long blade assemblage. – 1 large blade core; 2–9 several simple microliths; all made of Baltic flint. Drawings by K. Koana and M. Kloss/LWL.

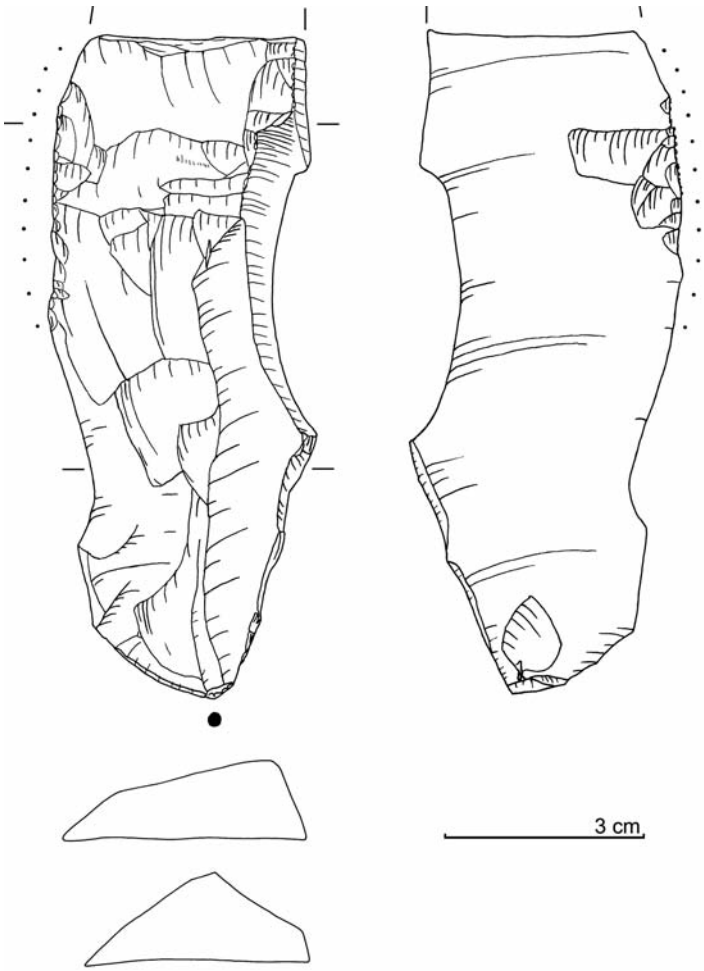


Figure 4: Wettringen, long blade assemblage. – lame mâchurée, Baltic flint. Drawings by M. Kloss and B. Stapel/LWL.

Lithic assemblages from the north-west European Lowlands obviously demonstrating a Final Paleolithic blade technology alongside simple microliths or Zonhoven points have in several cases already been classified, yet without containing tanged points. In spite of that, in most cases these assemblages have been attributed to the Ahrensburgian. For instance, sites such as Duisburg-Kaiserberg (Tromnau 1982), Höfer near Celle (Veil 1987) or Gramsbergen (Johansen and Stapert 2000) in the northern part of the Netherlands have all been attributed to an "Ahrensburgian without tanged points." However, concerning these northern and central European sites of the long blade tradition there are reliable arguments at hand to demonstrate that they date to the first centuries of the Preboreal. Hence, they represent an Early Mesolithic without geometric microliths (Sørensen and Sternke 2004, 104–106).

Comparable assemblages like Übach-Palenberg in the Lower Rhine valley are believed to date to this earliest Holocene period (Jöris and Thissen 1997). Even the neighboring site of Bedburg-Königshoven still reveals a Final Paleolithic blade technology accompanied by simple microliths, which reveal a most probable origin in the long blade tradition. Here, a typical Holocene fauna composed of red and roe deer (*Cervus elaphus* and *Capreolus capreolus*), aurochs (*Bos primigenius*) and wild boar (*Sus scrofa*) (accompanied by horse; *Equus ferus*) was found and dated to 9.1 ky cal BC (Street 1998, 1999). Very similar is Potsdam-Schlaatz in Brandenbourg, which might have served as a hunting and slaughter spot and which is only slightly older (9.45 ky cal BC; Benecke 2002).

To conclude, during the Early Preboreal human communities representing the Earliest Mesolithic of the north-west European Lowlands continued to use a Final Paleolithic (Ahrensburgian) lithic techno-typological tradition but otherwise seem to have adapted themselves to radically changing environmental conditions. The few lithic artifacts of the long blade tradition that have been found in the northern part of the *Münsterland* are believed to fit in this scenario. So far there is a lack of finds from the Westphalian uplands to the south, dating back to this striking period.

Early Mesolithic: northern influences

The oldest scientifically dated Mesolithic assemblage of North Rhine-Westphalia was excavated near Werl-Buerderich in 2011, during an archeological project prior

to road construction work (Heinen 2013; Baales and Heinen 2012; Heinen and Baales in: Baales *et al*. 2013c, 182–185). Even though the partly destroyed site is located in the before-mentioned fertile *Soester Börde* on constantly ploughed farmland, the Early Mesolithic open-air location was preserved some 70 cm beneath the surface within a small depression. The fact that in addition to lithic artifacts animal remains such as bones, teeth and a red deer antler fragment have been preserved in calcareous, silty sediments is of special interest. Since the discovery in Bedburg-Königshoven, this has only been the second time ever that unburnt animal remains definitely attributed to an Early Mesolithic open-air site have been uncovered in North Rhine-Westphalia.

Due to the preserved find distribution encountered in an area of some 30 m² the remaining site can be separated into two activity zones: most animal remains and lithic artifacts were located in the eastern part, an expanse of around 15 m². All of the microliths and microburins were found alongside with a distinct concentration of burnt small animal remains, which hint at the existence of a hearth, in the western part of the site. The existence of both microliths and microburins (which cannot be in any case refitted) indicates that arrows had been repaired at this spot. Whilst no obvious concentration of burnt finds and therefore no evidence of a hearth were found in the eastern part, in the surroundings further fireplaces might have existed. Presumably, the eastern zone is just part of a dump area of a much larger settlement site, which has unfortunately not been preserved, due to erosion and the former construction of a small channel adjacent to the site.

The remaining 188 lithic artifacts mainly (83%) consist of the easily accessible Baltic flint, which had been transferred to the region by the Drenthian glaciation. This raw material can be collected easily in the *Soester Börde*; however, as larger flint nodules usually show numerous frost cracks and therefore tend to shatter irregularly when knapped, mainly small, compact nodules were used for the lithic production. Several of these manuports and small exhausted cores have been found at the site. As the size of the usable raw material limited the size of the flint artifacts, all blanks like flakes, blades and bladelets are rather small.

In contrast to that, the biggest artifact – a wide flake of 8 cm in length – consists of siliceous slate (black lydite). A total of 16.5% of the lithic inventory (only one flake is made of a fine-grained quartzite) consists of this raw material, which can be found in primary outcrops in the adjacent *Sauerland* (some 20 km distance) or as pebbles within river gravels (e.g. *Ruhr*, 6 km distance). This pattern at least demonstrates the migration of the Büderich hunter-gatherer group from the southern uplands into the *Soester Börde* area.

The above-mentioned large lydite flake has a heavily battered edge that may have resulted from working on organic material. Due to the generally bad preservation of the bones' surfaces, no cut marks are visible. The just partially preserved skeletal fragments, however, reveal in some cases oblique facets, which are generally a typical feature when green bones were smashed to gain bone marrow. Mostly the remains of red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), a few fragments of wild boar (*Sus scrofa*) and red fox (*Vulpes vulpes*), which would be more usual

Figure 5: Werl-Büderich, Early Mesolithic. – 1, 2 simple microlithis. 3–5 scalene triangles. Photo by M. Heinen/Frechen.

representatives of the Early Holocene fauna. Five of the lithics have been identified as microliths, all made of Baltic flint (Figure 5). This small assemblage is composed of two simple microliths and three irregularly shaped scalene triangles.

Looking for comparisons, one has to take a closer look at the well-known site Friesack 4 in Brandenbourg, where Bernhard Gramsch has excavated an important Preboreal to Boreal stratigraphy located in the northern German Lowlands. Here, numerous Early Mesolithic lithic assemblages have been found in superposition. The composition of finds from stratum 10 (recently assigned as Complex I) reveals predominantly simple microliths accompanied by mainly scalene and fewer isosceles triangles (Gramsch 1987, 82; 2002, 65; *cf.* Gehlen 2009, 373), and therefore bears a resemblance to the small microlithic assemblage from Werl-Büderich. The Friesack inventory, however, seems to be slightly younger than Werl-Büderich, as it is dated to around 9.10 ky cal BC. Due to the lack of collagen none of the bones from Werl-Büderich could be dated, yet a charcoal fragment of a deciduous tree (identified by Ursula Tegtmeier from Cologne University) has been successfully radiocarbon dated to 9,923 ± 33 BP (MAMS 15941). This piece of charcoal was found within the above-mentioned latent fireplace in the western part of the excavation and is therefore assumed to stem from the Mesolithic settlement activities. Henceforth, Werl-Büderich is, with its age of 9.30 ky cal BC, one of the oldest dated Mesolithic assemblages in Germany, or rather in the whole of the north-west European Lowlands.

Amidst the 10 cm Mesolithic find layer in Werl-Büderich, a small, flattened spherical bead, which has a diameter of only 3.5 mm and a regular central perforation (Figure 6, 1), has been found during wet screening of the sediment (Baales *et al.* 2013b). It is made of a pure, yellow silicon oxide mineral, which has been analyzed at the Muenster University Mineralogical Institute. Although it cannot be definitely ruled out that the bead represents an intrusion into the Mesolithic find layer, this unique find is very likely to be of Early Mesolithic age (actually, a protohistoric pit house was found close to the site, but in this context no such beads are known so far; pers. comm. Vera Brieske, Muenster). As the bead was probably sewn on clothes, it involuntarily leads to similarities with leather moccasins decorated with glass beads of North American natives of the nineteenth century.

Figure 6: Werl-Büderich (1) and Hagen, Blätterhöhle (2), Early Mesolithc. – Two small beads. Photo by S. Brentführer/LWL.

On the basis of an analysis of organic single finds, influences from the North European Lowlands on the Early Mesolithic Westphalian Embayment have become traceable. Some decades ago, a moose antler mattock-head (Figure 7) was found in a sandpit near Paderborn-Sande in eastern Westphalia. Such implements are characteristic of the early

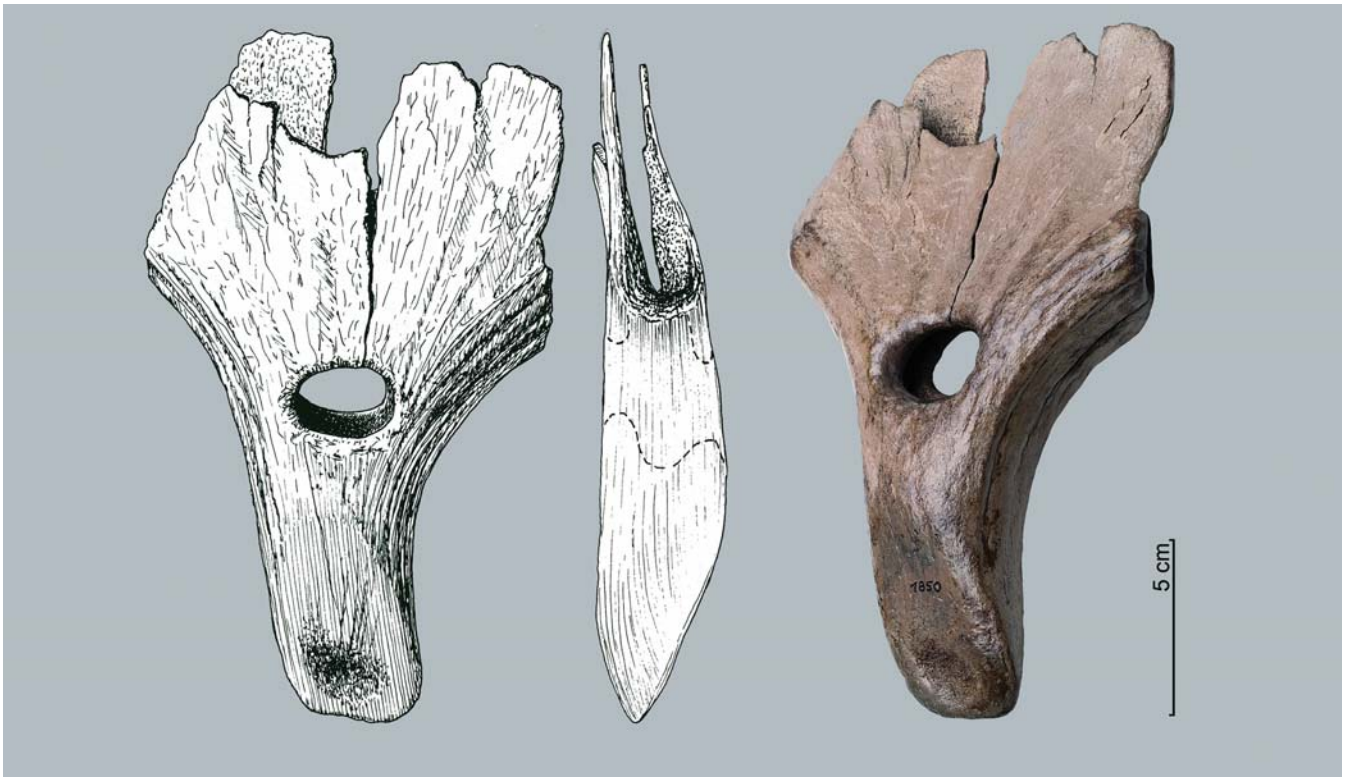


Figure 7: Paderborn-Sande, Early Mesolithic. – Distinct implements of the northern Mesolithic are moose antler mattock-heads like this one dated to 9.0 ky cal BC. Photo by S. Brentführer and A. Müller/LWL and LWL Bielefeld.

Mesolithic Maglemosian (Preboreal to Early Boreal; Pratsch 2006, 53). The find from Paderborn-Sande has an elongated, carefully shaped working edge and the perforation, which is found diagonally to the longer axis of the antler, has been driven obliquely through the proximal part of the palmated area. The age of this implement is AMS-dated to the second half of the Preboreal to some 9.0 ky cal BC (MAMS 14119: 9,591 ± 30 BP; B. Stapel *et al*. 2013). This single item in particular already hints at Nordic influences on the Westphalian Embayment Early Mesolithic.

Furthermore, from time to time slender bone points, which are common for the Maglemosian but were presumably in use for the first time during the Younger Dryas (Cziesla and Pettitt 2003), appear in the course of sub-aquatic sand dredging within the Westphalian Embayment (Baales *et al*. 2013c, 200; Figure 8). The shapes of the usually found points, which were common in varying proportions during the whole northern European Early Mesolithic (*cf.* Gramsch 2011), are the following:

– bone points with slight or deep notches
– bone points with small barbs

Recently, the age of a basal bone point fragment from the Schencking sandpit near Greven has been dated to 9,402 ± 32 BP (MAMS 18465; 8,687 ± 41 cal BC) and therefore to the late Preboreal-early Boreal transition (Stapel and Schlösser 2014). This fragment represents a bone point with small, merely indicated barbs similar to those that appeared, for instance, in the Early Mesolithic of Friesack (Gramsch 2011, 23 u. Abb. 9, 28).

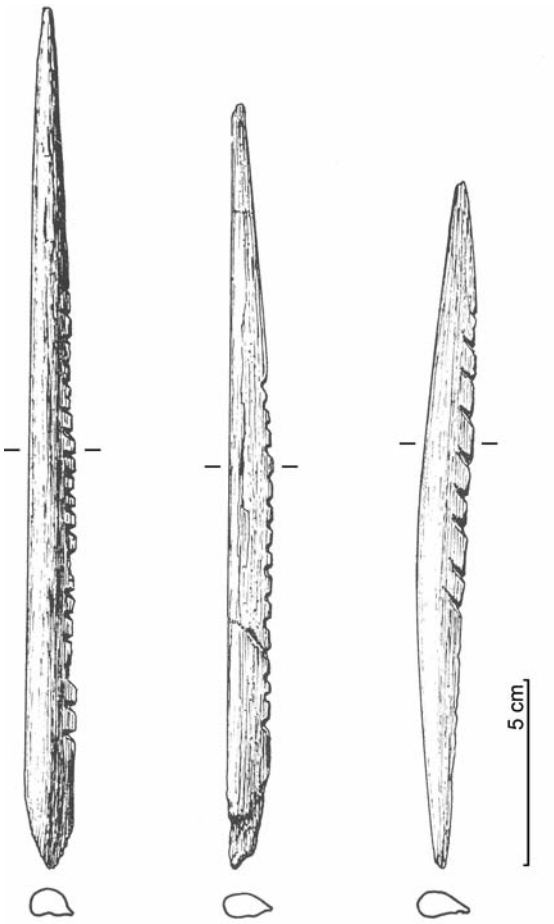


Figure 8: Paderborn-Sande, Early Mesolithic. – Slender bone points found during dredging in old Lippe sediments. With courtesy of LWL Bielefeld.

Early and Middle Mesolithic: southern and western influences – and northern ones!

Although we can assume that the whole Central European uplands were used intensively during the Mesolithic because of hundreds of open-air sites, there have been hardly any modern excavations conducted in that region. Only the abri excavations conducted by Klaus Grote during the 1980s (Grote 1994) in the Göttinger Forest (Lower Saxony) adjacent to the northern edge of the upland area and the excavations initiated by Jiří A. Svoboda (Svoboda *et al.* 2007, 2013) in the sandstone area of northern Bohemia allow deeper insights into Mesolithic life and chronology within the northern upland area of Central Europe.

Therefore, of special interest for Early to Late Mesolithic settlement in the upland areas of (not only) Westphalia is the *Blätterhöhle* in Hagen close to the northern border with the *Sauerland*. Since 2004, Late Neolithic but also Early Mesolithic human remains have been found in that small and narrow cave (Orschiedt *et al.* 2010, 2012a,b; in: Baales *et al.* 2013c, 175–180; a human skull cap found a long time ago in a further *Sauerland* cave, the *Balver Höhle*, could recently likewise be dated to the Early Mesolithic: GrA-19538, 9,160 ± 50 BP). The lower layer of the *Blätterhöhle* disturbed by rodent activity contained the remains of a minimum of five Mesolithic individuals, including two children. According to the dating on seven of the human bones, all dates cluster between 9.30 ky and 9.50 ky ^{14}C BP and can therefore be attributed to the Preboreal (Orschiedt *et al.* 2012b; Bollongino *et al.* 2013). An additional small human cranial fragment, which revealed an age of 9,700 ± 30 BP (KIA 45012; 9,210 ± 29 cal BC), proved to be the earliest Mesolithic find at the site and is probably one of the oldest postglacial human remains in Central Europe (Orschiedt *et al.* 2012b). Stratigraphically associated but in a slightly higher level, three boar skulls without canines and without mandibles were found. According to direct dating they seem to be a few hundred years younger but are in a spatial context with the human remains (Orschiedt *et al.* 2012b). Although affected by bioturbation, the Preboreal human remains and the boar skulls might represent a ritual deposition. The closest parallels for this situation are the Preboreal human remains from Grotte Margaux and Abri des Autours in southern Belgium (Cauwe 1998; Polet and Cauwe 2002), which might reveal a special treatment of human remains during the Preboreal, at least for western Europe (Orschiedt in prep.).

The area in front of the *Blätterhöhle*, which has been identified as a former rock shelter, has been excavated since 2006 and is of great importance, especially concerning the Early to Late Mesolithic chronology of Westphalia. Initially, the entrance appeared to have been only a small hole, whereas recent excavations

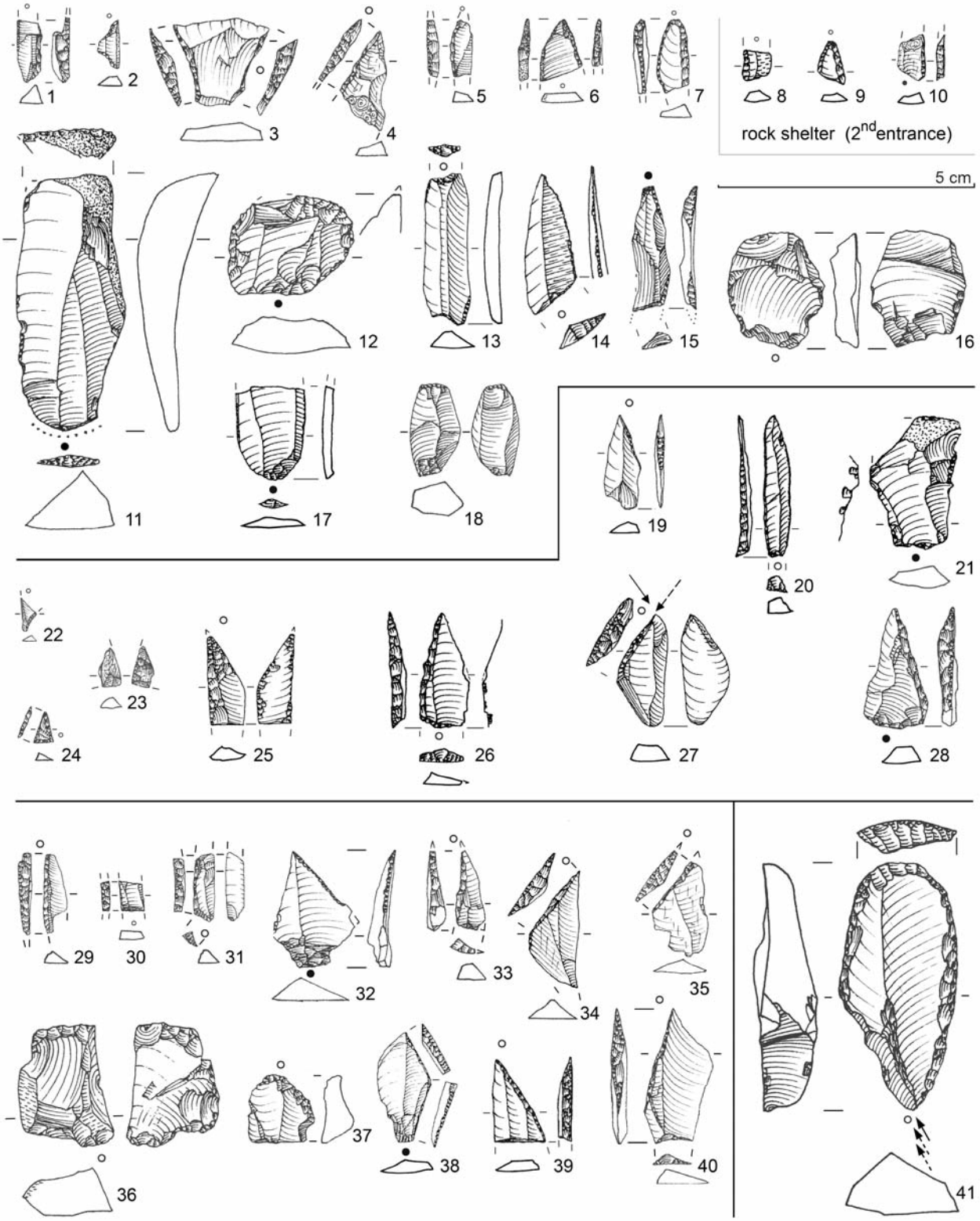
revealed that originally this entrance area was much larger and subsequently had been buried by debris from rock shelter erosion. Below a debris layer of 1.5 m, sediments containing Mesolithic finds have been excavated. High concentrations of charcoal hinted at the existence of former fireplaces, generally located at different parts of the site. By radiocarbon dating they can be related to the following periods:

1st Fireplace:	8.90–8.50 ky cal BC
2nd Fireplace:	7.50–7.20 ky cal BC (probably of multiple uses)
3rd Fireplace:	around 7.40–7.20 ky cal BC
4th Fireplace:	7.60–7.50 ky cal BC

Surrounding the fireplaces, several lithic artifacts, as well as animal remains (and even human remains), were uncovered. The microlithic spectra (Figure 9) correspond to the chronological periods as demonstrated by the fireplaces, which in conclusion represents the first Early to Middle Mesolithic sequence discovered at a single Westphalian site. The Late Mesolithic artifacts, stratigraphically associated with the late Middle Mesolithic find horizon and found further above, have up to now not been associated with any features like fireplaces. The sequence excavated so far covers the second half of the Preboreal, the middle and late Boreal, and probably the early Atlantic. Up to now, there have been no finds from the rock shelter area of the *Blätterhöhle* dating to the Early Boreal.

Simple and irregular, triangular microliths, which remind us of the Werl-Büderich inventory, and a large segment can be assigned to the Preboreal. The majority of the finds date into the late Boreal (the Middle Mesolithic) and represent a main occupation period of this site as already indicated by most of the dated fireplaces. The microlithic spectrum consists of simple end-retouched points, scalene triangles, broad base-retouched micro-points and backed bladelets. Of special interest are two fragments of bifacial retouched microliths (Figure 9-23, 25) proving close relations to the Rhine-Meuse-Schelde Culture (RMS), which usually existed in the region west of the Rhine and the Moselle. The *Blätterhöhle* microliths are two of only a few RMS lithics (Figure 10) found east of the Rhine and in Westphalia, proving westerly influences on the Westphalian Mesolithic (Baales *et al*. 2013c, 217–218; *cf.* Heinen 2005). The rivers Lippe and Ruhr running east to west seem to have facilitated the expansion of the distinctive RMS tradition to the east during the Late Boreal to Early Atlantic.

Another find from the *Blätterhöhle* Mesolithic horizons should be mentioned: a small bead with a diameter of only 4.6 mm made of a quartzite material (Figure 6, 2). Around the central perforation, there are four smaller ones (diameter of 0.6 mm) forming a square (Baales *et al*. 2013b). Furthermore, about ten perforated stone objects of various sizes have been found in the area of the former rock shelter mostly made out of limestone, including some perforated fossils. Probably these objects were used as pendants, while the small bead made out of quartzite or sandstone is, however, too small to be worn as part of a necklace. Presumably this piece was sewn on the clothing and like the pendants was lost during settling beneath the *Blätterhöhle* rock shelter.


rock shelter (2nd entrance)
5 cm

Whilst in layer 13 of the *Jägerhaus Höhle* in south-western Germany dating to the late Preboreal broad base-retouched micro-points characteristic of the Beuronian A already appear (Gehlen 2009, 373; *cf.* Heinen 2005, 154 ff.), no such microliths have yet appeared in Westphalia (and further north). Initially, this tradition began to expand north during the following Boreal, however without gaining comparable importance to southern and western Europe (*cf.* Gehlen 2009).

Bearing that in mind, it is interesting to note how many broad base-retouched micro-points appear in the Early Mesolithic lithic assemblage from Hagen *Rieger Busch* on the northern edge of the *Sauerland*, which has been radiometrically dated to the Late Preboreal (Schneid in: Baales *et al.* 2013c, 186–188; Stapel *et al.* 2013). The small inventory together with charcoals was excavated in the 1980s by amateurs and has been preserved ever since. In the course of a thesis at the University of Cologne, Nele Schneid has recently analyzed the lithic inventory. Ulrike Tegtmeier determined some charcoals (some of them turned out to represent recent intrusions) as willow, which were dated in Mannheim to around 8.60 ky cal BC (9,333 ± 36 BP; MAMS 14 123). Consequently the lithic artifacts most certainly belong to the final Preboreal.

Due to the presence of several broad base-retouched micro-points alongside triangles, a slight influence from western and southern regions on at least the southern region of the Westphalian Embayment becomes traceable. As the assemblage includes four slender lanceolate points of the kind that also appeared in Friesack during the Late Preboreal (Gehlen 2009, 367) it reveals that in the Hagen *Rieger Busch* microlithic inventory different influences are represented.

Subsequently, the evolution of Mesolithic assemblages of the greater part of Westphalia was mainly influenced by adjacent southern and western regions. Due to the absence of "absolutely" dated sites influences from the north-west European Lowlands are only hardly assessable, however, rarely possible at least by judging some typological characeristics of lithic assemblages. As an example, the presence of several core and flake axes (as around Tecklenburg in Eastern Westphalia: Wienkämper 2000; in: Baales *et al.* 2013c, 189–191) hints that they most certainly did existed. This will also be demonstrated in the following for the site of Oelde-Weitkamp located 60 km north-east of Hagen. There, from 2002 to 2004, archeological excavations took place, during which four Early Mesolithic find concentrations were uncovered (Stapel 2008). One of these find concentrations seems to have developed through multiple occupations, which, by AMS-measuring a charred hazelnut shell, could be dated to 8.0 ky cal BC (Arndt 2012). The microlithic spectrum consists of simple points, base-retouched micro-points, different triangles, and the aforementioned lanceolate points, which are regarded as a characteristic of the north-eastern part of the North German Lowlands (Gehlen

← ← Figure 9: Hagen Blätterhöhle, diagnostic Early to Late Mesolithic lithics excavated within the rock shelter. – 1–7, 11–18 Late Mesolithic. – 8–10 presumably Late Mesolithic. – 19–28 Middle Mesolithic. – 29–40 Early Mesolithic. – 41 Late Upper or Final Paleolithic (stray find). DFG project Blätterhöhle, drawings by B. Gehlen.

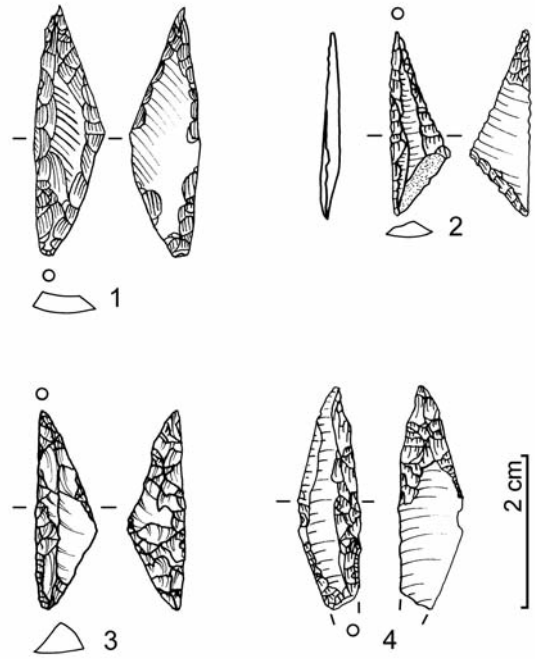


Figure 10: A few of the RMS microliths found within the Münsterland. – 1 Heiden-Nordick; 2–4 Olfen-Kökelsum. With courtesy of LWL Muenster.

Figure 11: Kreuztal, Early Mesolithic. – Small Baltic flint core with an engraved checkered pattern. Photo by H. Menne/LWL.

2009, 377). Their presence in Oelde-Weitkamp demonstrates the continuing northern influences on the Westphalian microlithic during the Boreal.

One of the Oelde concentrations is of further interest as it contains a distinct accumulation of burnt finds, and therefore indicates the existence of a former fireplace likewise dated to some 8.0 ky cal BC. At this hearth for the first time at a Westphalian Mesolithic open-air site it was possible to determine charred hazelnut shells and raspberry kernels as well as several calcinated animal remains of red deer, roe deer, wild boar and hare (Stapel 2008; Baales *et al*. 2013c, 192–195).

The majority of the Westphalian Mesolithic locations are attributed to its early periods (Early and Middle Mesolithic). In the last few decades in nearly every Westphalian region new surface sites have been discovered. That resulted in a high concentration of sites in some areas. One example of this is the *Siegerland* located south of the *Sauerland* where during the last four decades an amateur discovered several dozen mainly Early Mesolithic surface sites (Kleinfeller 1994). Recently, at one of these sites near Kreuztal he collected a small flint core, which is quite exceptional for the Westphalian Mesolithic, as it exhibits a small checkered pattern (Figure 11) engraved on its yellowish cretaceous crust remnants (Baales and Koch 2013). The intention of that kind of "decoration/art" and other similar examples (not only of Mesolithic age) has not yet been satisfyingly revealed.

The fact that the Mesolithic lithic assemblages in the *Siegerland* do not only consist of the predominant siliceous slate of regional origin but also of exogenous Baltic flint (a linear distance of a minimum of 70 km) has to be pointed out, as it indicates regular contact between groups from the *Siegerland* and the Westphalian Embayment during the Mesolithic. Furthermore, a few artifacts are manufactured of chalcedony (a Tertiary silex) or quartzite and therefore suggest occasional contact with the Rhineland in the west. It can be assumed that the westbound river *Sieg* may have functioned as the exchange route.

Late and Final Mesolithic – prevailing south-western and northern influences

Whilst there is a lot of evidence on the Early Mesolithic in Westphalia, the early Atlantic Mesolithic is hardly verified. The reason for this difference cannot yet be satisfyingly explained. For example, just a few years ago the first Late Mesolithic lithic scatter – including several broad trapezes and transverse arrowheads made of siliceous slate and (rarely) of Baltic flint – was uncovered in the *Siegerland* (Baales and Koch 2010, 2013; in: Baales *et al*. 2013c, 214–216). In the *Sauerland* the situation is quite similar as only a small collection of highly patinated Baltic flint artifacts from the *Bilsteinhöhle*, containing trapezoidal microliths, excavated during the late nineteenth century can be attributed to the Late Mesolithic finds (Baales 2007).

The area around Detmold and Bielefeld in East Westphalia, where not only the aforementioned *Retlager Quellen* with its Late Mesolithic lithic assemblage but several more sites exist, is rated as one of the most important regions of Late Mesolithic sites (Pollmann 2006; Banghard and Gehlen in: Baales *et al*. 2013c, 207–213). Besides the problematic habitation structures from the *Retlager Quellen*,

similar discoveries were made in the sandy soil of the *Senne* near Bielefeld during the 1920s/30s. Preserved charcoal remains of one of those hut remains at Bokel Fenn II (Banghard 2007) have recently been analyzed and dated. Nevertheless, the estimated age of 4.30 ky cal BC (5,407 ± 29 BP; MAMS 14892) is quite recent and might be problematic for proving evidence for a Final Mesolithic occupation of that area.

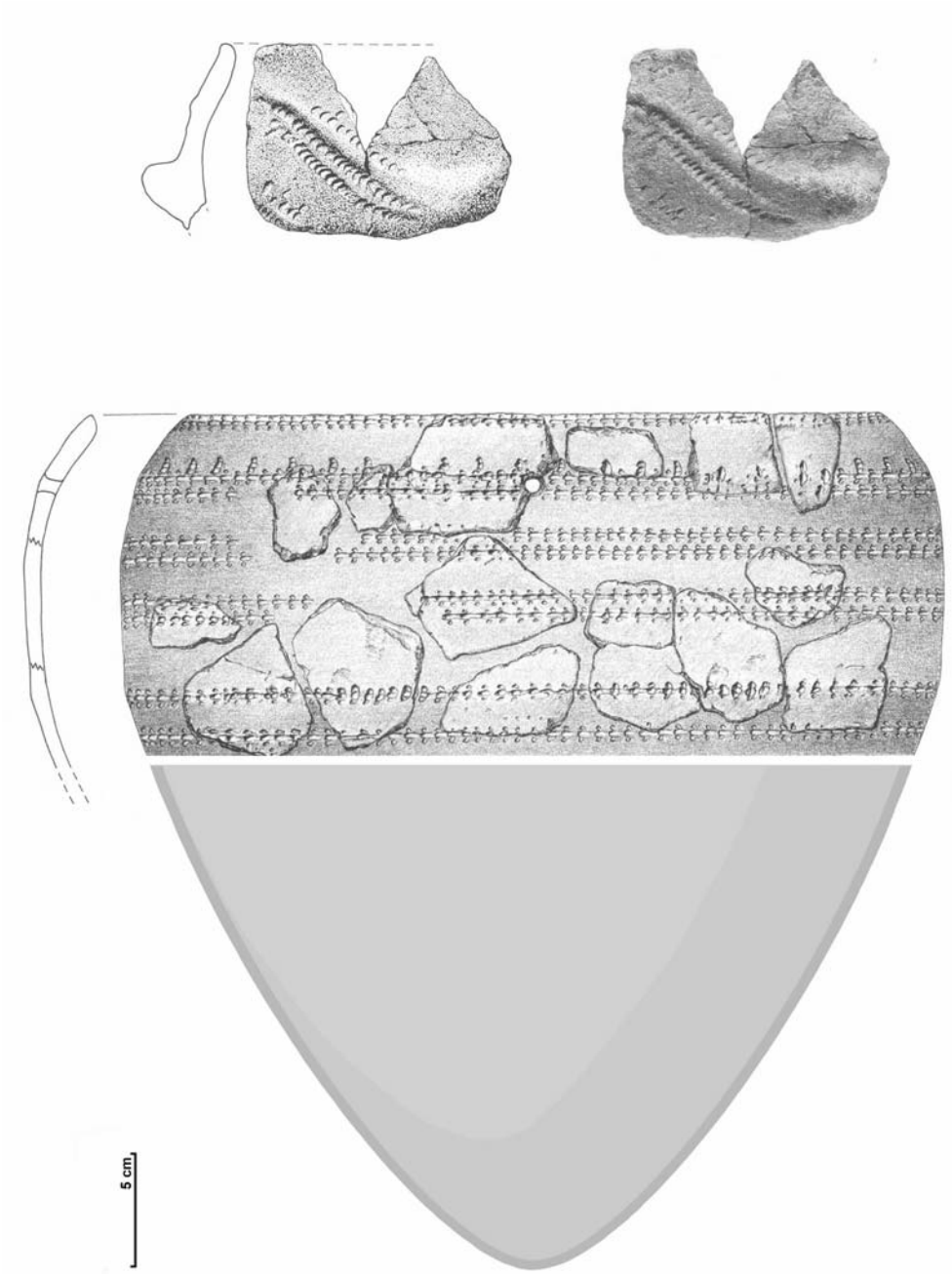


Figure 12: La Hoguette ceramics found in Westphalia. – Hiddenhausen, Schweicheln-Bermbeck (eastern Westphalia, top) and Anröchte (Soester Börde, base). With courtesy of LWL.

An intensely discussed topic is the relationship between Late Mesolithic and Early Neolithic communities in a region like the Westphalian Embayment, where new finds and datings enabled a preliminary conclusion to be drawn.

In the north-west of the Westphalian Embayment the unfortunately disturbed Vreden site provided a small inventory of lithic artifacts (containing a broad trapeze and two simple microliths; Baales *et al.* 2013c, 219–221). The ^{14}C-Analysis of charred hazelnut shells dates this assemblage to around 5.0 ky cal BC (GrA 21396: 4,897 ± 62 BP; GrA 22941: 4,931 ± 62 BP) and proves that at least the western *Münsterland* was still inhabited by Final Mesolithic communities, while not much further south, in the fertile *Börde* areas of Soest and Warburg, agricultural groups (*Linearbandkeramik* and the following Rössen Culture) had already settled since the late sixth century BC. Furthermore, even the presence of the initial or Proto-Neolithic ceramic groups of *La Hoguette* (Figure 12) and Limburg have been attested by a few characteristic ceramic sherds found in the *Soester Börde* and eastern Westphalia (Knoche 2012; Baales *et al.* 2013c, 225–227). Still indistinctive, however, are the regions (as possibly the upland and/or sandy regions of Westphalia) that those communities primarily inhabited.

The Final Mesolithic groups from Ertebølle (Hartz 2010; Klassen 2004) and Swifterband (Raemaekers 1999) are known to have inhabited territories north and north-west of Westphalia. They verify a continuation of the Mesolithic *lifestyle* in coastal regions of the Baltic and North Sea, at least for the most of the fifth century BC.

In the Westphalian Embayment several so-called T-shaped red deer antler mattocks have been found in alluvial deposits. In particular, a collection of those items uncovered in *Lippe* sediments decades ago and stored in the Werne local museum is known. In Central Europe those T-shaped axes are implements characteristic of both the Final Mesolithic and the Early Neolithic to the Michelsberg Culture. Some of those items have recently been dated in Mannheim (Stapel *et al.* 2013):

lab. no.	site	^{14}C BO	cal BC
MAMS 14745	Werne 86/2274	6,027 ± 24	4,921 ± 44
MAMS 11799	Greven-Schencking	6,005 ± 30	4,898 ± 42
MAMS 11809	Marl-Sickingmühle	5,708 ± 22	4,545 ± 30
MAMS 11812	Hamm	5,602 ± 27	4,422 ± 36
MAMS 14120	Werne 86/2227b	4,809 ± 31	3,593 ± 47

Most finds can therefore be interpreted as being of Neolithic origin, bearing the *Lippe* valley find area and its close vicinity to the early Neolithic settlement regions in mind. Only the second oldest (4,898 ± 42 cal BC) of the recently dated items found in a sandpit in Greven-Schencking near the upper *Ems* and therefore uncovered in the sandy northern part of the Westphalian Embayment can be plausibly assigned to an indigenous Final Mesolithic occupation.

In the same sandpit the scapula of an aurochs (*Bos primigenius*) was found in 2013, which turned out to be a great surprise. Three discs had been cut out of the

flat part of the bone (Figure 14). Similar finds are known from a Final Mesolithic context (younger Ertebølle) in southern Scandinavia (Petersen 1984, 14–15, Figure 13; Andersen 1998, 36–38, Figure 19, 20a; Klassen 2004, 126–128). The successful radiocarbon dating to some 4,345 cal BC (5,488 ± 24 BP; MAMS 18466) confirmed that attribution (Stapel and Schlösser 2014). In this context, the fact that fragments of Swifterband ceramics were found at the Upper Neolithic sites of Rosendahl-Osterwick in the western part of the Westphalian Embayment (Knoche 2008, 148) is quite interesting. These extraordinary finds in the Westphalian Embayment demonstrate once more that the (predominately) coastal Ertebølle and Swifterband inhabitants had regular contact with the southern and south-eastern hinterland, as – the other way round – Neolithic finds in an Ertebølle or Swifterband context already proved a long time ago (e.g. Klassen 2004).

At the same time the sandy northern Westphalian Embayment's affiliation to a "terminal Mesolithic territory" becomes obvious today. Therefore the Final Mesolithic occupation episode recently dated at the *Senne* site Bokel Fenn II (see above) becomes more likely. Additionally, the Neolithic site Nottuln-Uphoven, which is located in an island-like loess area located within the northern Westphalian Embayment and was inhabited by Rössen, Bischheim and Michelsberg groups during the fifth century BCE (Knoche 2008; Groer and Bußmann 2010), provides evidence of the regional propinquity of Final Mesolithic and fully Neolithic groups in northern Westphalia (Stapel and Schlösser 2014). As in other regions of Central Europe, the "Mesolithic way of life" in the whole of Westphalia presumably ended during the early fourth century BCE. This is proved by the increased appearance of later Neolithic sites (Michelsberg and Funnel Beaker Culture) in low mountain ranges as in the Westphalian Embayment respectively.

Nevertheless, that impression could be at least partly incorrect. In 2013, mtDNA and isotopic (C/N) analyses of the Late Neolithic and Mesolithic human remains from the *Blätterhöhle* in Hagen were published (Bollongino *et al*. 2013). This

Figure 13: Greven, Schencking, Final Mesolithic. – T-shaped red deer antler mattock found within the Westphalian Embayment and dated to 5.0 ky cal BC.
Photo by S. Brentführer/LWL.

Figure 14: Greven, Schenking, Final Mesolithic. – Aurochs scapula with disk-shaped cut-outs well known from younger Ertebølle contexts. Photo by S. Brentführer/LWL.

attracted some public attention as the study revealed that during the fourth millennium BCE some of the human individuals dated to the Late Neolithic had regularly subsisted on freshwater fish and large quantities of meat. Yet, their mitochondrial haplogroup U is characteristic of pre-Neolithic hunter and gatherer communities of Central Europe (and is also substantiated for the Early Mesolithic human remains from the *Blätterhöhle*). Alongside that haplogroup U, other haplogroups (mostly H) were detected on further Late Neolithic human remains from that cave; their nutrition had definitely been exclusively terrestrial. These results describe two human groups – one only represented by haplogroup U, the other with a typical mix of haplogroup H, U and others – showing different dietary habits. Both ways of living seem to have been present at the same time and have therefore – quoting the *Science* study – resulted in "parallel societies."

Could this be explained by the possibility that during the Late Neolithic direct descendants of regional Mesolithic groups still stayed in the lower *Lenne* and middle *Ruhr* area around Hagen without adapting to the "Neolithic way of life" and possibly filling an ecological niche, unoccupied by the "Neolithic" people? However, the deposition of their dead alongside each other within the same narrow chamber of the *Blätterhöhle* implies comparable ritual practices of the two groups. The interaction of those groups, whose existence has been assumed before, is still unknown in detail. Ethnographic studies on modern hunter-gatherer communities living side by side with farmers or herders prove such an interaction as not uncommon (Bollongino *et al*. 2013), and this might be a scenario not implausible for at least some parts of Europe.

Conclusion

As in later prehistoric periods, Mesolithic Westphalia absorbed different influences of adjacent northern, southern as well as western regions. This is not only proved by the presence of characteristic microliths, but recently also by distinct organic artifacts. This knowledge leads to further interesting questions, which, despite the strained financial situation of archeology in North Rhine-Westphalia, should be pursued.

Acknowledgements
We would like to thank the editors very much for inviting us to participate in this Festschrift dedicated to our dear colleague Jiří. It is a pleasure for us to do so! Furthermore, we have to thank Desiree Hammerschmidt most sincerely for her valuable help with the English.

Résumé
De nouvelles découvertes en contexte Mésolithique ont été réalisées en Westphalie au cours des dernières années. Il faut mentionner en particulier les restes humains du Mésolithique ancien de la grotte de Blätterhöhle à Hagen qui ont suscité un intérêt international. En outre, et pour la première fois, une séquence stratigraphique comportant des vestiges de foyers et des séries lithiques couvrant l'ensemble du Mésolithique ancien, moyen et final a été mise en évidence dans ce même site. D'autres nouveaux sites, ainsi que des analyses radiométriques menées sur des découvertes isolées semblent indiquer que le Mésolithique de la Wesphalie a été tour à tour influencé par celui des régions septentrionales et méridionales ainsi que celui des zones occidentales. Plusieurs sites, attribués aux Long Blade Assemblages, ou Belloisien, en raison de leur évidente technologie laminaire et de la présence d'armatures microlithiques simples, représentent la première phase du Mésolithique de Westphalie.

Zusammenfassung
In den letzten Jahren konnten vermehrt neue Erkenntnisse zum Mesolithikum in Westfalen gewonnen werden. Hierbei erregten vor allem die Ergebnisse der Blätterhöhle in Hagen, nicht zuletzt aufgrund ihrer frühmesolithischen Menschenreste, besondere Aufmerksamkeit. Hier konnte darüber hinaus erstmals in Westfalen an einem Ort eine Abfolge früh- bis spätmesolithischer Funde und auch Befunde freigelegt werden. Darüber hinaus sind weitere Fundplätze bzw. Einzelfunde neu entdeckt und auch datiert worden, so dass u.a. die wechselnden Einflüsse aus nördlichen und eher südlichen sowie westlichen Richtungen auf die mesolithische Entwicklung in Westfalen verdeutlicht wird. An den Beginn der Entwicklung gehören dabei einige neu entdeckte Fundinventare, die aufgrund ihrer großen Klingen und einfachen Mikrolithen den nordwesteuropäischen long blade-Industrien bzw. dem Belloisien an die Seite zu stellen sind.

ON THE TRAIL OF THE ELKS: FINDS FROM THE PREBOREAL IN SOUTHERN SWEDEN

Lars Larsson

Abstract
The Preboreal is a period that is still relatively poorly known as regards its archeological cultures. At the transition between the Pleistocene and the Holocene there are finds from Northern Germany indicating the presence of the Late Paleolithic Ahrensburg culture with a clear focus on reindeer hunting, but at the same time there are Danish finds reflecting an orientation to elk hunting, with an unclear cultural affiliation. Clear evidence of a material culture characteristic of the Maglemose culture does not appear until the middle part of the Preboreal. Dated finds suggest that reindeer existed throughout the chronozone, contemporary with other game such as horse and elk. Elk is observed through finds of deposits of parts of elk bodies which differ from later ways of treating game animals. These have been interpreted as being linked to ritual activities. A couple of finds of metapodials from Skåne may be a consequence of the same patterns of deposition. Finds of elk antler mattock heads and leister points have also been observed. The former in particular have a special position as characteristic of an early Maglemose culture. The leister points can be followed back to the Late Paleolithic, and it is still uncertain when elk antler mattock heads began to appear.

Keywords
Pleistocene – Holocene transition, Maglemose culture, elk, reindeer, chronozone, Sweden

DOI: 10.5817/CZ.MUNI.M210-7781-2015-34

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Introduction

The Preboreal chronozone is a period about which little is known in comparison with other stages of the Mesolithic in Southern Scandinavia. The extreme rises in temperature that mark its introduction were followed by distinct fluctuations in

temperature (Björck *et al*. 1997; van der Plicht *et al*. 2004; Rasmussen *et al*. 2006; Kobashi *et al*. 2008). Rapid climate changes along with regional climate gradients cause difficulties in comparing radiometric datings (Blockley *et al*. 2007). An improved climate during the period meant that the tundra-like landscape from the Younger Dryas changed, at first to a light steppe landscape with grass and herbs. Clusters of birch, willow, sallow and aspen occurred. An early stage of the chronozone led to the formation of forest-like stocks of juniper. A few centuries later birch too underwent a vigorous spread, and after a few more centuries there was also an invasion of pine into the bright birch forests. Towards the end of the period hazel appeared as well. On good soils it even formed pure hazel woods.

In some former studies the transition from the Late Paleolithic to the Early Mesolithic has been presented as a quite abrupt change from a society mainly based on reindeer hunting to hunting of a new boreal fauna (Benecke 2004). The question is whether this matches the information we have today about the period.

The transition from Late Pleistocene to Holocene is reasonably well dated to 9.5 ky cal BC. This transition has also been regarded as some kind of basis for the cultural transition between the Late Paleolithic and the Mesolithic. The first real questioning of the contemporaneousness between the climatic and cultural changes was a result of the dates presented from the Northwestern German site of Stellmoor, viewed as the eponymous site for the Ahrensburg culture. The dates provided a value close to about 9,500 cal BC (Fischer and Tauber 1987). In contrast, the earliest well dated sites with a "typical" Mesolithic material culture are dated to about 9.0 ky cal BC (Dark 1998; Mellars 1998; Gramsch 2002). Other sites with artifacts attributed to the earliest Maglemose Culture give values of 9.0–8.0 ky cal BC (Fischer 1996; Brinch Petersen 2009).

Even if there are some problems with the calibration of the radiocarbon scale during the period in question (Baales *et al*. 2002; Cziesla and Petit 2003), this is probably not the only reason for the lacuna between the latest expression of a Late Paleolithic material culture and the earliest Maglemose Culture.

The find situation of faunal remains

We have to be aware that the faunal finds from the Late Pleistocene and Early Holocene may cause great problems concerning how representative they are in describing the cultural as well as environmental situation. From a number of radiocarbon dates of different mammal finds in Southern Scandinavia we have reasonably good information about some animals during the period in question (Liljegren and Ekström 1996; Larsson *et al*. 2002; Aaris-Sørensen *et al*. 2007; Aaris-Sørensen 2009). Skeletal parts of reindeer, especially antlers, have been found in a number of wetlands during drainage and peat cutting (Liljegren 1975). More than 40 finds from Southern Sweden have been dated (Liljegren and Ekström 1996).

The majority of dates are related to what should be regarded as the first half of the Preboreal. The situation is the same in Denmark (Aaris-Sørensen *et al*. 2007) and the east Baltic region (Ukkonen *et al*. 2006). However, this does not indicate unreservedly

that reindeer were more numerous during the early Preboreal than earlier. Drainage and especially peat cutting might not have included the lowermost layers of bogs. The vegetation around small lakes might have increased in the early Holocene and therefore attracted animals to the lakeshores for longer periods than before. The filling in of organic material started already in the early Preboreal. Therefore, more animals might have become stuck in the mud, died and been preserved.

The numerous finds of reindeer, mainly antlers and skulls, in bogs are in most cases due to the fact that these skeletal parts are easily recognized as exotic. One has to be aware that skulls with antlers have been easier to identify and retrieve than crania with shed antlers. Therefore winter bulls and early summer cows are probably underrepresented (Aaris-Sørensen *et al.* 2007, Figure 5).

The question is how long reindeer was a part of the fauna after the glaciation stage in Southern Scandinavia. In Southernmost Sweden there is a dating of an antler that gave the value 9,090 ± 90 BP, OxA-2793 (Hedges *et al.* 1995). This would mean that reindeer existed during significant parts of the Preboreal. Similar datings also occur from Denmark (Aaris-Sørensen *et al.* 2007; Aaris-Sørensen 2009). The existence of newborn as well as young calves testifies that Southern Scandinavia was a calving ground during the Preboreal (Aaris-Sørensen *et al.* 2007).

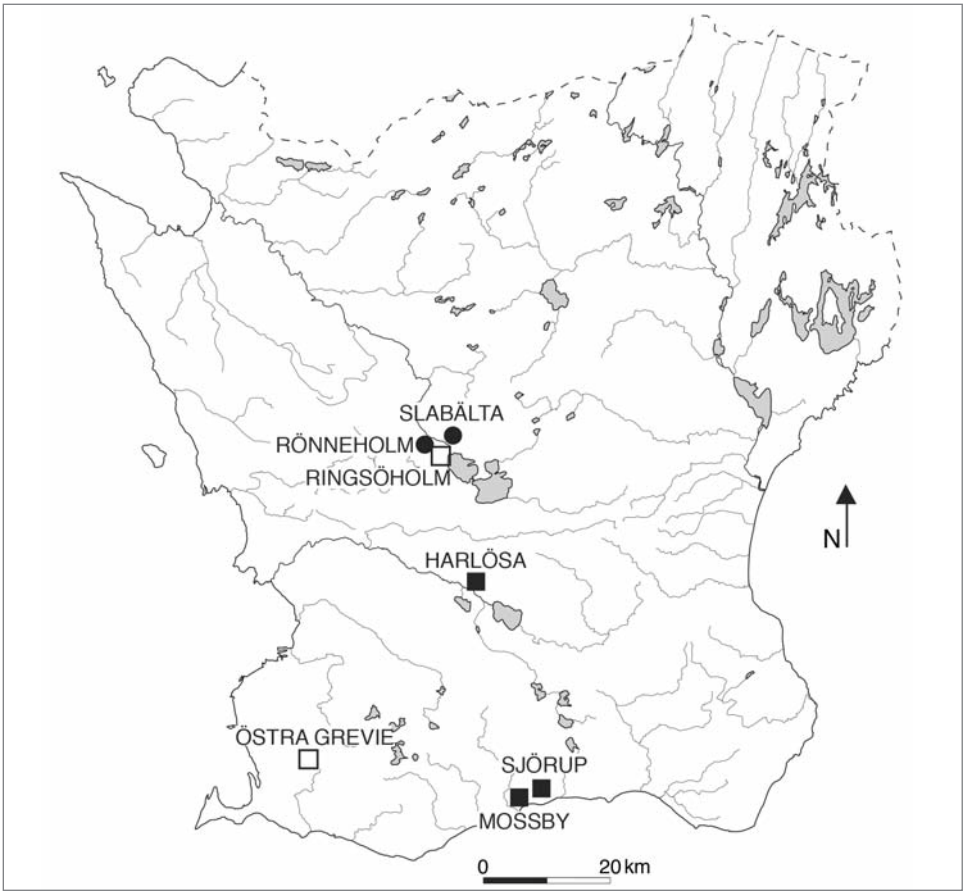

Figure 1: Scania, Southernmost Sweden, with the sites of finds mentioned in the text. Legend: open square: deposition of elk bones, filled square: elk antler mattock adzes, filled circle: leister points.

The horse has been dated to the Younger Dryas in Southernmost Sweden (Larsson *et al*. 2002) and to the Preboreal in Denmark (Aaris-Sørensen 2009). The reason the number of finds from wild horse is so small might be that the bones are not easy to identify. If, for example, skulls were found during peat digging, they would have been familiar to local rural people and might be regarded as horse carcasses recently buried because of natural death or due to diseases. So the finds of wild horse are no doubt be heavily underrepresented.

The museum stores of Southernmost Sweden contain a number of elk finds (Liljegren 1975). Unfortunately these finds have not been dated with the same intensity as the reindeer. In Southern Sweden elk appeared during a rather early part of the Allerød, and a small number of dates show their presence during the Younger Dryas and Preboreal (Liljegren and Ekström 1996; Larsson *et al*. 2002). It is uncertain whether the elk survived all through the Younger Dryas or reinvaded at the start of the Holocene.

Judging by their present behavior, reindeer as well as elk can be acclimatized to a range of different environments from forested regions to open tundra. Elk and reindeer are not viewed as direct competitors since they prefer different food (Bowyer *et al*. 2003). Elk move within the same region during a yearly cycle. Horse and elk are more stable resources than reindeer, which was probably an important but seasonal resource. Horse and elk should therefore be much more reliable for hunting, with an occasional surplus derived from mass killing of migrating herds of reindeer.

Elk bone depositions

Since the elk has a very limited pattern of movement during the year, besides which it moves in small flocks, hunting this quarry requires a different strategy from hunting more pronounced herd animals such as reindeer and horse.

From the Preboreal we have three Danish find sites revealing an interesting pattern of deposition of skeletal parts of elk. Significant parts of elk bodies were deposited together after the animals had been slaughtered. The finds near the shore of the kettle hole at Lundby on Zealand (Møller Hansen and Buck Pedersen 2006) from the Pleistocene/Holocene transition, or the remains from Skottemark dated to the Preboreal (Fischer 1996), might indicate that using small lakes or ponds as traps was of special importance for elk-hunting during the period in question. However, the small lakes usable for chasing and trapping large animals became overgrown during the early Holocene. That particular method of hunting thus disappeared.

That these small lakes were being filled in with organic litter during an early stage of the Holocene made them extremely dangerous for animals to cross, which might also have been a factor making these wetlands especially attractive to human hunters. Moreover, it ought to have been easier to hunt elk in this kind of environment since it prefers vegetation in water.

The finds at Lundby contain five concentrations of bones representing one to three individuals that are dated to the early Preboreal (Møller Hansen and Buck

Pedersen 2006; Leduc 2014) (Table 1). The bones at Skottemark include six individuals and the finds at Favbro two elks. The animals at the latter two sites were killed in the winter half of the year (Møhl 1978). At the site in Skottemark there were also finds of flint tools and several leister points, while just a few flakes were discovered at one of the concentrations in Lundby (Fischer 1996; Møller Hansen and Buck Pedersen 2006).

We do not know whether these kinds of elk depositions were a common phenomenon or not. The three finds indicate that they might be rather frequent. Recent digging by farmers might easily neglect this kind of find locations, as they look like "another heap of bones". They might be destroyed by deep ploughing of former wetlands and totally disintegrated even by a small reduction of the water table.

The absence of metapodials is particularly stressed in the case of Skottemark, and they are under-represented in the finds from Lundby (Møhl 1978; Leduc 2014). It is suggested that they were removed to be used as raw material for tool manufacture. In this connection, a couple of finds from Southernmost Sweden are of interest. A somewhat similar type of deposition is indicated at the Ringsjöholm site in the bog Rönneholms Mosse, central Scania (Sjöström 1998) (Figure 1 and 2). A spit of sand partly parallel to the former lakeshore formed the basis for a Late Boreal-Early Atlantic settlement. The spit turned out to cover a layer of calcareous *gyttja* that was formed during the Preboreal. An assemblage of three metatarsal bones of elk in close proximity was found in this layer. All the bones were cut at the proximal end in order to remove the marrow. One bone shows clear evidence of cut marks. Two of the bones probably originate from the same full-grown bull and the third from a cow (personal information from Dr. Ola Magnell). That they belong to a late part of the Preboreal is proved by the radiocarbon dates from two bones (Table 1). In the same layer a small number of artifacts were found, including a flint core axe (Sjöström 1998).

A second find comes from Östra Grevie in Southwestern Scania (Wilhelmsson 2008) (Figure 1). The bones were noticed during digging to lay cables at the edge of a kettle hole. There were four extremity bones, probably from a young individual. Cut marks were noticed on one bone. A radiocarbon dating has given a value in the

Figure 2: Elk metapodials from Ringsjöholm, central Scania.

late Preboreal (Table 1). A worked flint was registered near the find. Here we have two finds of precisely the bones that are absent from the Danish finds. In both cases there are slaughtering marks but no traces of any continued use of these bones.

As for the finds from Lundby, Skottemark and Favbro, different suggestions have been put forward to explain these accumulations of bones. Møhl is clear in his perception of these as the result of activities with a ritual element, an interpretation that is not supported by all who have examined the finds from Lundby (Møhl 1978; Møller Hansen *et al*. 2004).

The best way to preserve raw material such as metapodials for future use would have been to place them in water so that they would not dry out and crack. This would support a purely rational reason for depositing these finds for future use. Corresponding accumulations of metapodials also occur later in the Mesolithic (Larsson 1983). It should be borne in mind, however, that there need not always be a distinction between function and ritual in hunter-gatherer societies (Ingold 2000). Depictions of elks from this time show that this quarry had a special position in people's conceptions (Kabacinski *et al*. 2011). Deposits of metapodials are in themselves a consequence of the more widespread deposits of elk bones. As we see from the radiometric datings, deposits of elk bones occur throughout the Preboreal.

Table 1. Dates of elk bone deposits.

site	lab. no.	date
Lundby 2	AAR-5469	9,950 ± 75
Lundby 1	AAR-5470	9,930 ± 70
Lundby 3	AAR-5471	9,860 ± 70
Skottemark	K-2075	9,400 ± 140
Ringsjöholm	LuS 10784	9,145 ± 40
Ringsjöholm	LuS 10785	9,110 ± 35
Östra Grevie	LuS 7733	9,035 ± 55

Elk antler mattock head adzes

There is considerable uncertainty about the form taken by Southern Scandinavian settlements in the early Preboreal. With the exception of Lundby, there is no find location dated to this period. Based on typology, some find sites with artifacts belonging to the Ahrensburg culture have been interpreted as belonging to the Preboreal (Johansen and Stapert 1999). The Årup site in Northeastern Scania (Nilsson and Hanlon 2006), with flint material including indications of opposed-platform single-faced cores as well as early Mesolithic types of microliths, has been regarded, for the same reason, as belonging to a stage of the epi-Ahrensburgian (Brinch Petersen 2009).

The suggestion that Lundby belonged to the Maglemose culture is based on the fact that the elk antler mattock head adze found in Lundby later occurs in distinct

complexes dated to the Maglemose culture (Møller Hansen and Buck Pedersen 2006). But this argument can hardly be considered certain.

The finds from Lundby really challenge the definition of the Maglemose culture (Møller Hansen *et al*. 2004; Møller Hansen and Buck Pedersen 2006). The elk antler mattock head adze is well known from early Mesolithic sites such as Star Carr (Clark 1954) and Friesack (Pratsch 1995). In Scandinavia it is known from a number of stray finds (Andersen 1976, 1977). In Friesack the type appears in the middle and late Preboreal layers (Pratsch 1995).

That the Preboreal is the time of existence of this axe type in Southern Sweden is indicated by the dates of three examples from Southernmost Sweden. They are all bog finds. Two are found in adjacent parishes, Västra Nöbbelöv (Mossby) and Sjörup (Salomonsson 1962) (Figure 3). They are dated to the Preboreal (Table 2). That the axe type existed throughout a longer time is indicated by a date from a find in Harlösa, in central Scania, Southern Sweden. This find has been dated by pollen analysis to an early part of the Preboreal (Tillander 1962). In the close vicinity of the find, flint artifacts similar to those from the Bromme culture were found (Salomonsson 1962). However, a sample from the mattock head adze provided Preboreal date (Table 2). It may be added that this form of adze also occurs in other parts of Continental Europe. A find from Paderborn-Sande, Germany, has been dated to the Preboreal/Boreal transition (Stapel *et al*. 2012) (Table 2).

The relationship between sea and land in the Preboreal was significantly different from that of today. Considerable parts of the Southern Baltic consisted of land, which must have facilitated close contacts for both humans and fauna with northern Continental Europe. This also means that the coastal settlements are now at the bottom of the sea. Settlement must have been intensive, as we see from the many settlement site finds from the west coast of Sweden, where eustatic uplift raised them high above the present shoreline (Kindgren 1996). Two of the dated mattock head adzes, from Mossby and Sjörup, were found close to the present coast, which probably means that they were used by people who lived in the coastal zone as it was then.

Even if the type appears in an early Mesolithic context, it could very well have been invented in an otherwise Late Paleolithic assemblage. As long as the organic material from the Preboreal is very scanty we do not really know what is typical of a Late Paleolithic origin or a new Early Mesolithic innovation.

Elk mattock heads adzes seem to disappear in Southern Scandinavia at the transition to the Boreal chronozone. It is highly likely, however, that the form continued to be used in other parts of Scandinavia. Some support for this assumption comes from finds in Norway and the Swedish part of Southern Norrland where this form of adze is documented (Mikkelsen and Høeg 1977). A find from Singsån in Jämtland has been dated to 6,720 ± 85 BP (5,756–5,484 cal BC) (LuA 5693). This indicates that it was a form of tool that belonged to the Late Mesolithic material culture in this area. An explanation for the lack of finds during significant spans of time may be that the majority of Mesolithic settlement sites in Central and Northern Sweden have no organic material preserved. On the other hand, similar adze forms of elk antler also occur in the Neolithic in Central Sweden (Salomonsson 1962).

Table 2. Dates from elk antler mattock head adzes.

site	lab. no.	date
Lundby 1	AAR-5470	9,930 ± 70
Harlösa	LuS 6535	9,600 ± 65
Mossby	LuS 6536	9,300 ± 60
Sjörup	LuS 6534	9,170 ± 60
Paderborn-Sande	MAMS 14119	8,993 ± 116

Leister points

Metapodials of elk were good raw material for making leister points. For several years archeological surveys have been conducted during peat cutting in Rönneholms Mosse in central Scania, Southernmost Sweden. Apart from settlement site remains (Larsson and Sjöström 2011), a considerable number of leister prongs have been

Table 3. Dates from leister prongs.

site	lab. no.	date
Bodal	AAR-6868	9,660 ± 75
Skottemark	OaX-4864	9,570 ± 100
Skottemark	OaX-5528	9,310 ± 90
Slabälta 2	Ua-46486	9,546 ± 76
Rönneholm RFP 1469	Ua-46878	9,208 ± 55
Rönneholm RPF 985	Ua-46481	9,054 ± 47

Figure 3: Elk antler mattock head adzes from Mossby (left), Sjörup and Harlösa.

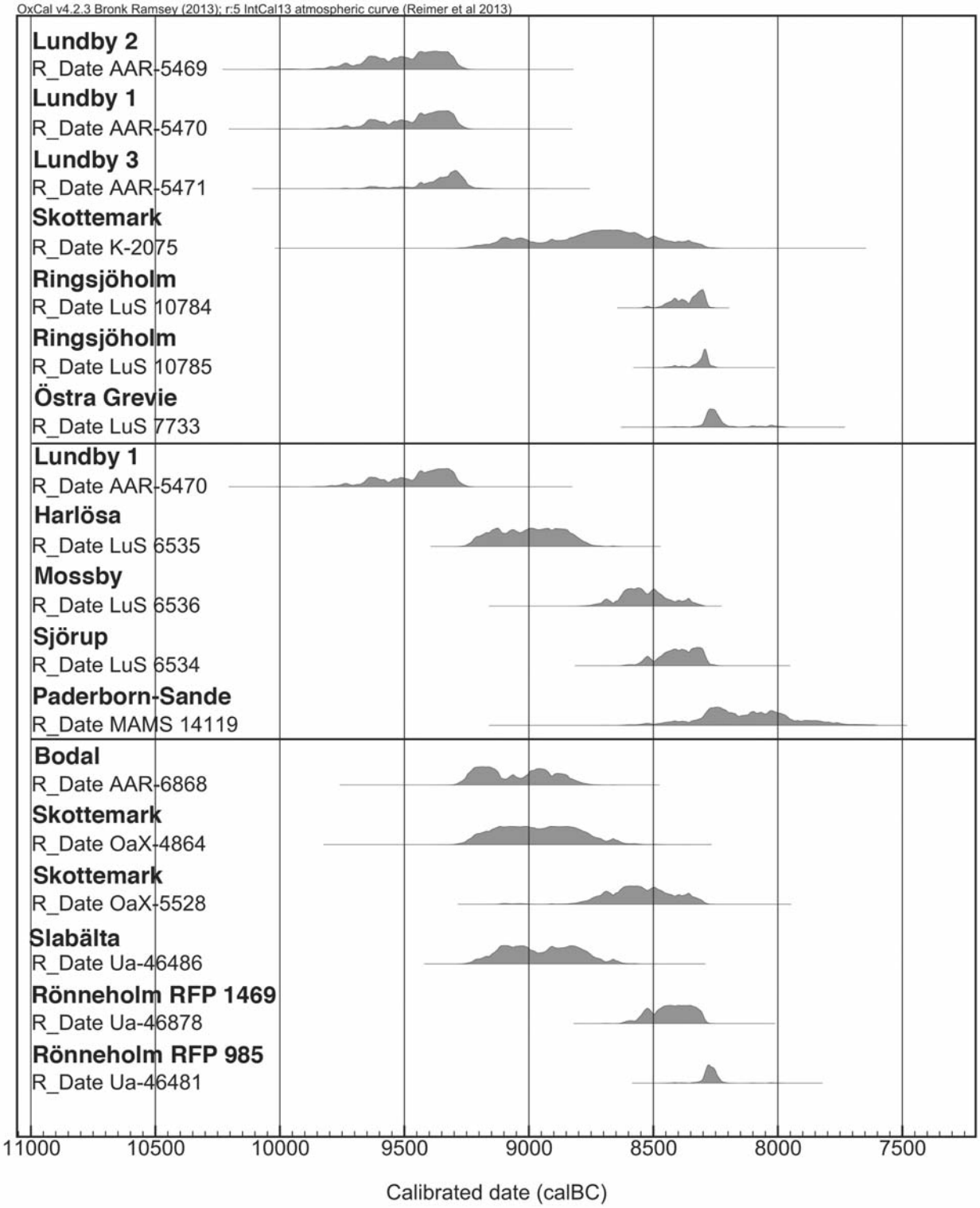

Figure 4: The calibrated radiocarbon dates.

found. When people used leisters the points stuck in the mud at the bottom, and the entire leister or the points broke off and stayed there. Through a large dating effort it has been shown that a couple of these belong to the Preboreal. Yet another stray find at Slabälta from the adjacent bog of Ageröds Mosse has been dated to the same period (Table 3). These leister prongs have small barbs cut into them or have one edge denticulated (Figure 5). They are very similar to two leister points from Skottemark and yet another Danish find also dated to the Preboreal (Fischer 1996, Figure 3, 2011, Figure 3b) (Table 3). They correspond well in form to finds in northern Continental Europe (Cziesla 2004; Gramsch 2011). This form, which has been viewed as a typical tool from the Maglemose Culture, can be traced far back into late glacial times (Cziesla 2004).

The find circumstances indicate that leister prongs were used for fishing.

Figure 5: Leister prongs from Rönneholm and Slabälta (right).

Final comments

The elk antler mattock head from Lundby really challenges the definition of the Maglemose. Even if the type appears in an early Holocene context, it could very well have been invented in an otherwise Late Paleolithic assemblage. As long as the organic material from the Preboreal is very scanty we do not really know what is typical Late Paleolithic or Early Mesolithic.

Due to influences from the south, new inventions in lithic technology were introduced. The so-called epi-Ahrensburgian sites and the long-blade tradition in the continental south are examples of this change that started during an early but not the earliest part of the Preboreal (Johansen and Stapert 2000; Sørensen and Sternke 2004; Terberger 2004). In the middle part of the Preboreal the change shaped a lithic material culture as well as a mixture of bone and antler tools that we regard as typical Maglemose culture. During the early Preboreal hunting included the main herding animals such as reindeer and horse, with the addition of more localized species such as elk. We do not have to expect a radical change of new groups but more of an input of new ideas based upon a flow of contacts.

Résumé

Le Préboréal est une période qui est encore relativement mal connue du point de vue de ses cultures archéologiques. A la transition entre Pléistocène et Holocène, il existe des découvertes du nord de l'Allemagne qui indiquent la présence d'une culture du Paléolithique final (Arhensbourgien) clairement orientée sur la chasse du Renne. Cependant, durant la même phase, il existe des découvertes danoises, d'attribution culturelle incertaine, qui indiquent l'existence de groupes dont la chasse est orientée sur l'Elan. Les premières traces claires de la culture maglemoisienne n'apparaissent pas avant le milieu du Préboréal. Les découvertes datées suggèrent que le Renne a toujours existé dans cette chronozone et fut contemporain d'autres gibiers comme le Cheval ou l'Elan. Les restes d'Elan identifiés se présentent sous la forme des dépôts de parties anatomiques du corps de l'animal ce qui diffère des manières plus tardives de traiter le gibier. Cela fut interprété comme de possibles activités rituelles. La découverte de deux métapodes à

Skåne correspond peut-être au même genre de dépôt. La présence de pointes barbelées (Leister points) et de têtes de pioche en bois d'Elan a également été observée. Ces dernières sont particulièrement caractéristiques du Maglemoisien ancien. Les pointes barbelées (Leister points) remontent, elles, au Paléolithique final tandis que la période d'apparition des têtes de pioche en bois d'Elan est encore incertaine

Zusammenfassung

Bei dem Präboreal handelt es sich um eine Periode, deren kulturelle Verhältnisse bis heute in nur verhältnismäßig geringem Umfang bekannt sind. Aus der Zeit des Übergangs zwischen dem Pleistozän und dem Holozän gibt es Funde aus Norddeutschland, welche die Anwesenheit der spätpaläolithischen Ahrensburger Kultur mit einer eindeutigen Ausrichtung auf die Rentierjagd anzeigen. Gleichzeitig sind aus Dänemark Funde bekannt geworden, welche eine Ausrichtung auf die Elchjagd anzeigen, deren kulturelle Zuordnung aber unklar bleibt. Eindeutige Belege für die charakteristische materielle Kultur der Maglemosekultur treten dagegen nicht vor der Mitte des Präboreals auf. Fest datierte Funde zeigen dabei an, dass das Rentier höchstwahrscheinlich während dieser gesamten Chronozone gleichzeitig mit anderen Wildarten wie Pferd und Elch aufgetreten ist.

Der Elch tritt in dieser Phase in Form von Funden von Deponierungen einzelner Körperteile des Elchs besonders hervor, die sich von der später üblichen Form der Behandlung von Jagdwild unterscheiden. Dieses Phänomen wurde dabei oft im Zusammenhang mit rituellen Handlungen gesehen. Einige Funde aus Schonen von Metapodien des Elchs können hier als Resultat gleichartiger Deponierungsmuster verstanden werden. Auch die Funde von Elchgeweihhacken und Knochenspitzen aus Elchgeweih sind hier bemerkenswert. Vor allem die Geweihhacken besitzen eine besondere Bedeutung als charakteristische Fundgruppe der frühen Maglemosekultur. Die Knochenspitzen können bis in das Spätpaläolithikum zurückverfolgt werden, bei den Elchgeweihhacken ist der Zeitpunkt ihres Auftretens derzeit noch unbekannt.

PART V

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PTAHANCH: DER PRIESTER DES DUAU – DES PATRONS DER ÄGYPTISCHEN AUGENÄRZTE

Břetislav Vachala

Meinem lieben Freund Jiří Svoboda
mit Erinnerungen an Abusir und Dolní Věstonice …

Zusammenfassung
Eine gut erhaltene Kalksteinstele in Form einer Scheintür befindet sich in der Privatsammlung Alió im spanischen Alicante. Ihre Maße betragen 84 × 71 × 24 cm. Wir datieren dieses Monument in die Zeit der ausgehenden 12. und beginnenden 13. Dynastie (um 1800–1750 v. Chr.). Inhaber der Stele sind nicht näher bekannte Ptahanch, wab-Priester des Gottes Duau, der als Schutzer der Augenärzte gilt, und sein Sohn Ipepi mit dem Titel eines Schreibers. Der genannte Titel des Ptahanch ist anderswo nicht belegt.

Schlüsselwörte
Altägyptische Stele, 12./13. Dynastie, Ptahanch: wab-Priester des Gottes Duau, Duau als Patron der Augenärzte

DOI: 10.5817/CZ.MUNI.M210-7781-2015-35

In der Privatsammlung Alió im spanischen Alicante (und mein Dank geht jetzt an meinen Freund Jorge L. Alió, Professor der Augenheilkunde) befindet sich in Form einer Scheintür eine gut erhaltene Kalksteinstele, die dem Priester Ptahanch und seinem Sohn, dem Schreiber Ipepi gehört (Abb. 1, 2). Ihrer Herkunft nach sei sie von "deutschen Forschern im Valley of the Nobles während des Baus des Suezkanals" (also 1859–1869; Farag 2003, 141–143) gefunden worden. Eine Zeit lang befand sie sich in einer ungenannten Privatsammlung in Chicago, nach deren Aufteilung sie Anfang der 1990er Jahre in die Galerie Nefertiti in Zürich gelangte. Ihre nächste Station war die Galerie Félix e Hijo Antigũedades y Arqueología Clásica ("Antigũedades Clásicas Adriano") in Sevilla. Am 28. 12. 2004 kaufte sie Jorge Alió für seine Sammlung (Alio, Singh und Dua 2008, 487 + Cover illustration [No. 4]; Vachala 2012, 110–112).

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Abb.1: Die Stele des Priesters Ptahanch.(Sammlung Alió, Alicante). Foto von Jorge L. Alió.

Die Maße des ursprünglich rot bemalten Kalksteinmonuments, das aus der eigentlichen Stele, aus dem oberem Sturzbalken und zwei Seitenpfeilern besteht, betragen 84 (Höhe) × 71 (Breite) × 24 (Dicke) cm. Die sorgfältig ausgeführte Inschrift (Nr. 1–13) und die Speisetischszene sind in versenktem Relief angebracht. Der mit Inschrift versehene Teil der eigentlichen Stele (Inschrift Nr. 5–13) wird beiderseits und oben von einem Rundstab mit charakteristischen Zickzacklinien und darüber noch von einem gebogenen Gesims begrenzt.

Die Speisetischszene zeigt links den wab-Priester des Gottes Duau, Ptahanch, der auf einem Stuhl mit niedriger Lehne und stilisierten Löwenbeinen vor einem Tisch mit zehn Opferbroten sitzt. Ptahanch trägt eine schulterlange Perücke, ist in einen kurzen, eng anliegenden Schurz mit betontem Zipfel gekleidet, seinen Hals

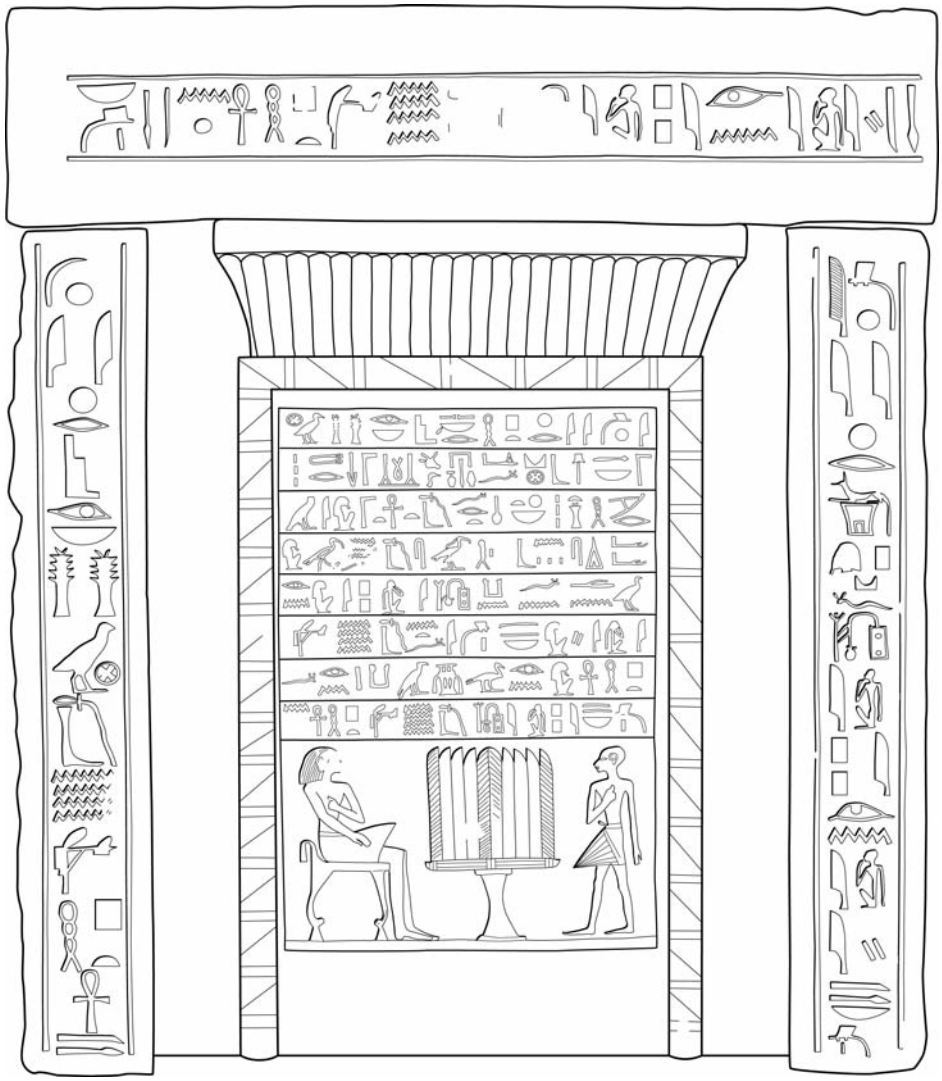

Abb. 2: Umzeichnung der Stele. Abbildung Břetislav Vachala und Jolana Malátková.

umschmiegt ein breites Halsband, und Arme und Beine tragen Schmuckbänder. Seine rechte Hand mit ausgestreckten Fingern liegt am rechten Oberschenkel an, während er die Linke mit geballter Faust vor der Brust angewinkelt hat. Im rechten Teil der Szene sehen wir den Schreiber Ipepi stehen, dessen rechte Hand zur Faust geballt die Brust berührt, während die Linke am Körper anliegt. Er trägt kurze Haare und einen kurzen, bis ans Knie reichenden Plisseeschurz mit vorstehendem Zipfel.

Die Inschrift auf der linken Hälfte von Sturzbalken (Nr. 1) und letzter Zeile der eigentlichen Stele (Nr. 12) verläuft waagerecht, die auf dem linken Seitenpfeiler (Nr. 3) hingegen senkrecht; in allen drei Fällen verläuft die Schrift von rechts nach links. Jeweils spiegelbildlich dazu ist die Inschrift auf der rechten Sturzbalkenhälfte

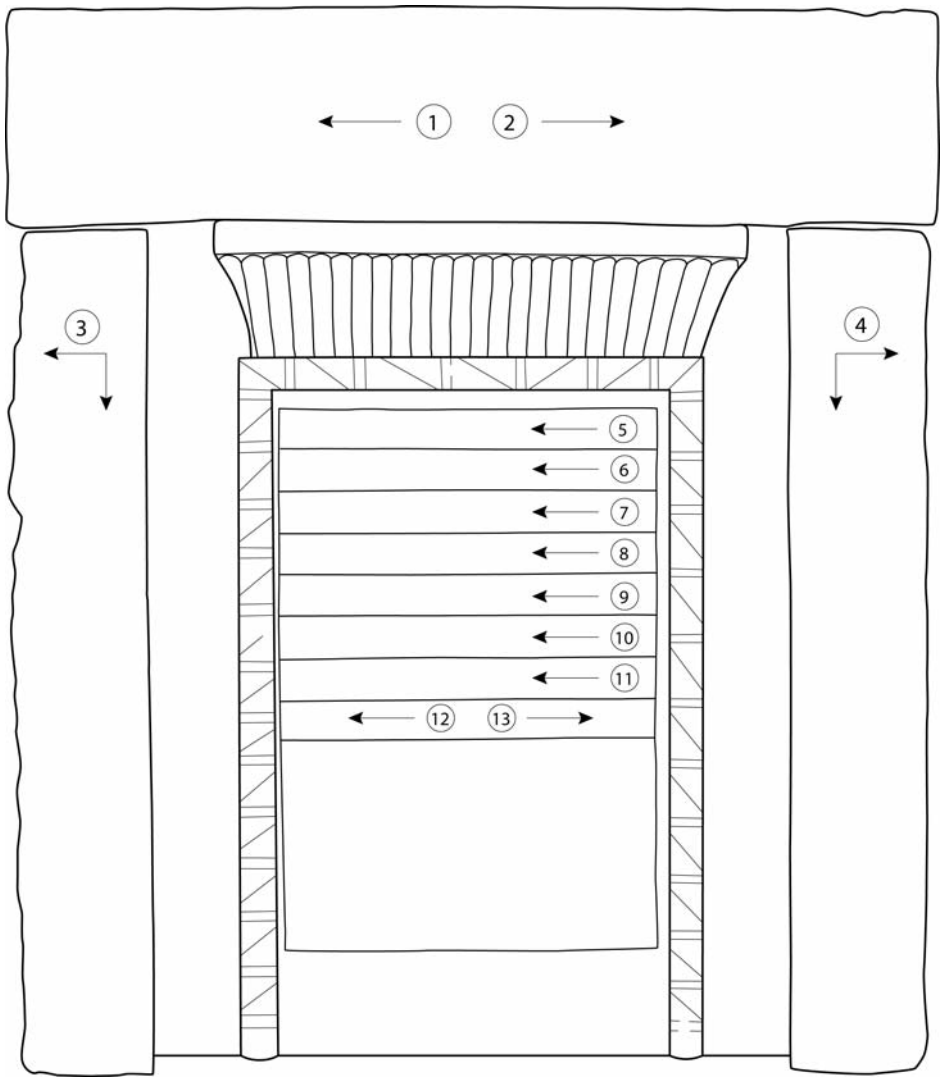

Abb. 3: Inschriftenverlauf auf der Stele. Abbildung Břetislav Vachala und Jolana Malátková.

(Nr. 2), der rechten Hälfte der letzten Zeile der eigentlichen Stele (Nr. 13) und dem rechten Seitenpfeiler (Nr. 4) angeordnet. Die Inschrift der eigentlichen Stele (Nr. 5–11) verläuft in waagerechten Zeilen von rechts nach links (s. das Schema auf Abb. 3). Ihre Übersetzung lautet:

1. "Der *wab*-Priester des Duau Ptahanch (Ranke 1935, 138.20), gerechtfertigt (Doxey 1998, 91–93), der Ehrwürdige (Doxey 1998, 100–102).
2. Der Schreiber Ipepi (Ranke 1935, 24.7), geboren (Obsomer 1993, 180–192, 199) von Iij (Ranke 1935, 7.15), gerechtfertigt.
3. Versorgt (Doxey 1998, 94–100) bei Osiris, dem Herrn von Djedu, der *wab*-Priester des Duau Ptahanch, gerechtfertigt.
4. Versorgt bei Anubis, dem, welcher auf seinem Berg ist, der Schreiber Ipepi, geboren von Iij, gerechtfertigt, der Ehrwürdige.

5. Versorgt bei Ptah-Sokar-Osiris, dem Herrn von Djedu,
6. dem Großen Gott, dem Herrn von Abydos. Möge er geben ein Totenopfer an Brot, Bier, Ochsen, Vögeln, Salbgefäßen, Leinenstoffen, Weihrauch,
7. Ölen und allen schönen und reinen Sachen, von denen der Gott lebt!
8. Die Arme sollen geben, die Wasserfülle soll reinigen, Thot
9. soll opfern dem Ka des Schreibers Ipepi, geboren von
10. Iij, des Gerechtfertigen, des Ehrwürdigen! Sein Vater, der wab-Priester des Duau
11. Ptahanch, geboren von Satchentiuka (Ranke 1935, nicht angeführt), hat dies für ihn getan (= ließ diese Stele für ihn anfertigen).
12. Der *wab*-Priester des Duau Ptahanch.
13. Der Schreiber Ipepi, gerechtfertigt, der Ehrwürdige. ”

Inhaber der Stele sind also Ptahanch und sein Sohn Ipepi. Beide Protagonisten werden auf der Stele viermal erwähnt. Dreimal erwähnt wird auch der Name von Ipepis Mutter (und Ptahanchs Ehefrau) Iij und einmal kommt der Name von Ptahanchs Mutter (und Ipepis Großmutter väterlicherseits) Satchentiuka vor. Der nicht näher bekannte Ptahanch ist Träger eines – soweit mir bekannt – anderswo nicht belegten Titels eines *wab*-Priesters des Gottes Duau “der Morgendliche” (Otto 1975, 1147; Leitz 2002, 506–507), der als Schutzherr der Augenärzte gilt (Grdseloff 1942, 207–217; zu R 60 [Erweiterte Zeichenliste: Hannig 1997, 1158]: Collombert 2010, 115, 128; Evans 2011, 107 ["royal placenta"]). Die bislang bekannten Titel und Epitheta, in denen der Name dieses Gottes vorkommt, stammen aus dem Alten Reich:

– “assistant of Duau” (Jones 2000, I, 351–352.1308),
– “*hm-ntr*-priest of Duau” (Jones 2000, II, 585.2142),
– “beloved of *Dw3w of ʿnw*” (Jones 2000, I, 443.1654),
– “servant of (the god) Duau (?)” (Jones 2000, II, 594.2177), und aus dem Mittleren Reich:
– “Priest of Duau in Stretching the Cord” (Ward 1982, 113.942).

Ptahanchs Sohn trug lediglich den Titel eines Schreibers (Piacentini 2001, 190–191).

Während wir nicht sicher sein können, ob die Stele tatsächlich aus der Thebais (Ilin-Tomich 2012, 69–84) stammt (dem Valley of the Nobles), stehen wir bei ihrer Datierung auf festerem Boden: die Form der Stele und die Art ihrer Fertigung (man vergleiche die Stelen Kairo CG 20460: Arafa 2009, 15; Wien Inv.-Nr. 105: Satzinger 1994, 22), ikonographische und philologische Aspekte bzw. die Erwähnung von Ptah-Sokar-Osiris (Z. 5) weisen in die Zeit der ausgehenden 12. und beginnenden 13. Dynastie. Auf jeden Fall aber verdient unsere Stele die entsprechende Aufmerksamkeit, wie übrigens auch weitere Stelen des Mittleren Reiches, die sich über verschiedene Sammlungen verstreut finden und laufend veröffentlicht werden (jüngst z.B. Baligh 2008, 169–184; Awad 2010, 19–38; Stefanović 2010, 207–215; Vachala 2011, 107–111); Abdel-Raziq 2013, 275–281).

Summary

This paper reports on the false door limestone stela of Ptahankh (in the private Alió Collection in Alicante, Spain). Its dimensions are 84 × 71 × 24 cm. The stela dates from the end of the 12th or beginning of the 13th Dynasty (c. 1,800–1,750 BCE). Its owners are the so far unknown Ptahankh, the wab-priest of Dewaw, and his son the scribe Ipepi. The title ”wab-priest of Dewaw“, the god of oculists, does not appear in any other document.

Résumé

Ptahankh – prêtre de Dewaw , patron des oculistes dans l’Egypte ancienne. Cet article présente la publication de la fausse-porte stèle en calcaire de Ptahankh (collection privée Alió à Alicante, Espagne). Ces dimensions sont de 84 × 71 × 24 cm. La stèle date de la fin de la 12ème ou 13ème Dynastie (c.a. 1,800–1,750 BCE). Ses propriétaires jusqu’à maintenant inconnus étaient Ptahankh, le prêtre-wab de Dewaw et son fils le scribe Ipepi. Le titre de « prêtre-wab de Dewaw », dieu des oculistes n’apparait dans aucun autre document.

THE OLDEST MYTHOLOGICAL RUN IN EGYPTIAN WESTERN DESERT? ON THE POSSIBLE ORIGINS OF THE *SED* FEAST IN ANCIENT EGYPT

Miroslav Bárta

Abstract
The subject of this brief study is a representation of a running man dating back to the sixth millennium BCE. This unique iconographic motif was discovered in a rock shelter in Wadi Sura in the Gilf Kebir mountain range located deep in the Egyptian Western Desert. Based on the formal analysis of the scene, the possibility of its relationship with the much later Ancient Egyptian iconography of a running Egyptian king during the sed festival of the renewal of magical forces of the pharaoh is considered and discussed.

Keywords
Iconography, Wadi Sura, Gilf Kebir, Egypt, running king, renewal ritual

DOI: 10.5817/CZ.MUNI.M210-7781-2015-36

Introduction

Jiří Svoboda, whom we used to call in Egypt *Doctor George*, has always been a good companion to have with both in the field and in the evenings. This small piece of discussion is meant as a look back to the year 2008 when we travelled together in the depth of the Western Desert and visited, among other sites, the famous Wadi Sura cave discovered by the renowned desert explorer Láslo Almásy in 1933 (Almásy 1998) (Figure 1).

Wadi Sura cave and *sed* feast origins

Wadi Sura cave is much more than just a shelter which has managed to preserve remains of its original decoration despite increasing tourism in the last three decades. Inside it, mostly painted in red pigment, survive scant remains of original

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Figure :1 Cave of the Swimmers in Gilf Kebir, Egypt (M. Bárta).

:

scenes which are characterized by the occurrence of small figures formally resembling swimmers. Hence also the original name of the cave (Figure 2).

At present, it is beyond any means to reconstruct the original decoration program of the site. One of the most intriguing scene fragments, isolated in the left part of the cave, depicts a figure about 12 cm high (likely a male) oriented to the left (Figure 3). It features a red painted body with stretched-out arms and widely spread legs. The impression is that it catches a person in the moment of intensive running. The figure wears on its head a cone-like shaped artifact formally resembling the

Figure 2: Figures of 'swimmers' in the Cave of the Swimmers (M. Bárta).

crown of Upper Egypt (Rhotert 1952, 55 and pl. XXIX, 5). The figure holds what resembles an adze in its right hand. On its right knee is fastened a double band and the left knee is decorated with two hanging strips of cloth. The scene as such seems to be unique in the context of surrounding art of the north-east of Africa. This is notably the case with most of the scenes from Wadi Sura (Le Quellec, de Flers and de Flers 2005).

Despite the suggested date for the Wadi Sura rock art (sixth millenium BCE), the representation of this running man has much later formal parallels and virtually all

Figure 3: Running male figure in the Cave of the Swimmers (M. Frouz).

of them originate from Egypt (for Wadi Sura dating, see Kuper and Kröpelin 2006). It was already H. Rhotert, in his publication of Wadi Sura cave art, who considered the scene to be very close to what Egyptologists recognize as a prototypic *sed*-feast scene, as performed by much later ancient Egyptian kings (Rhotert 1952, 55).

With regard to Ancient Egypt, there is unbiased evidence for *sed* feast representations starting in the late Predynastic period (from 3,300 BCE onwards). The oldest explicit evidence seems to be a fragment of a mace head associated with King Scorpion (Hornung and Staehelin 1974, 16; Hornung and Staehelin 2006, 13;

Serrano 2002, 51 and fig. 18). The second oldest indication of a *sed* feast is associated with King Narmer, the first king of the First Dynasty. The king is represented by a white baboon, "Big White One", who on religious level, according to Egyptian concept, symbolized the passed-away king. The available evidence indicates that the white baboon, the "Big White One", is to be associated with the early attestations of the *sed* ritual (Hornung and Staehelin 2006, 13). One of the early attestations of the baboon's importance in the early version of the *sed* feast features on the seal of Den dating to the First Dynasty (Figure 4). On the right of the composition the running king is rendered dressed in a short kilt, with a flail over his left shoulder and with a White Upper Egyptian crown on his head. He is running towards a seated baboon who is offering him a cup with a drink of some kind. The left part of the composition shows again a running king in a similar attitude but wearing the Lower Egyptian red crown. The king is leaping behind a running bull, likely Apis (Decker 1987, 40, fig. 10). This particular scene may attest to very close relationship between the ruling and passed-away king and to magical rejuvenation of physical forces of the king.

Next to the running performance, another distinctive feature of the ritual may be the White crown which became during late Predynastic period the emblematic symbol of Upper Egypt. The earliest attestation of the White crown (and possibly of the *sed* feast as well) in the territory of the Nile valley originates perhaps from Naqada I period (Ciałowicz 1997). It is followed by an incense burner from the Lower Nubian site of Qustul, south of Abu Simbel, Cemetery L, Tomb L 24 (Williams 1986, pls. 34 and 38) and from Gharb Aswan (Hendricks and Gatto 2009).

The origin of the *sed* feast role and significance may be an ancient ceremony during which the newly appointed chieftain/king had to perform a ritual run during which he – on a symbolical level – hurried around a sacred area that symbolized the world he was to rule. By this performance the king became the true ruler of his world (Hornung and Staehelin 1974, 43). Wilkinson calls the scene characteristically "encompassing the field" – the ritual of territorial claim (Wilkinson 1999, 212–215). Runs as such always played a significant role in Egyptian symbolism and rituals (the specific run of the king during the *sed* festival: Decker 1987, 32–41, in general then

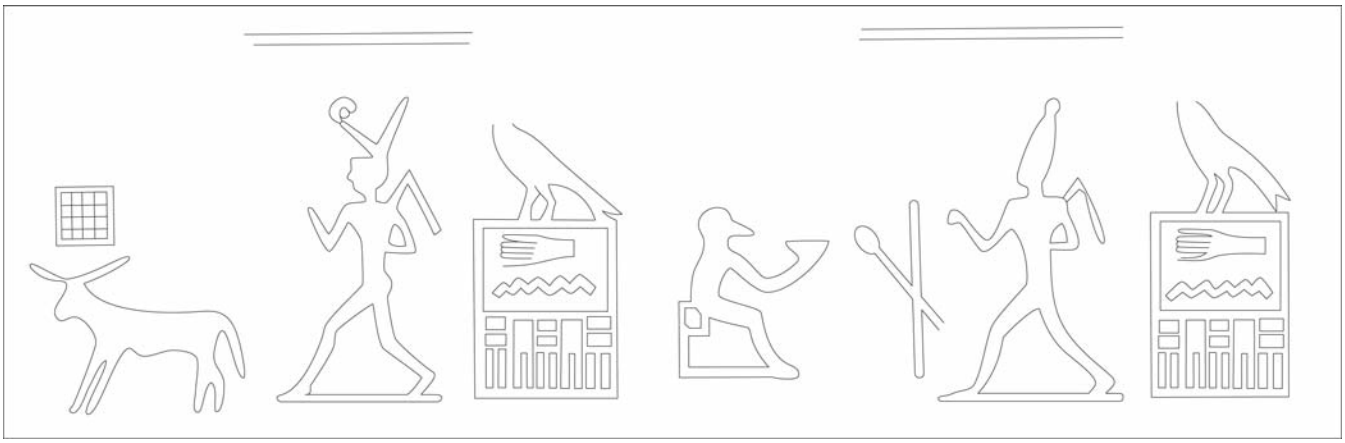

Figure 4: Running king Den, First Dynasty, ca 2950 BC (L. Vařeková).

see 68–74). Based on several authors, the ritual run may be considered the most characteristic feature of the whole ritual (Kees 1912, 142–200; Helck 1954, 411; Hornung and Staehelin 1974, 43; Munro 1961, 66).

Yet, despite the emphasis laid on the magical renewal of the ruler's forces, the structure of the *sed* feast was very complicated and comprised many ritual activities, not only the ritual run performance. These rites included foundation and construction scenes, the counting of cattle, veneration of the king by his subjects or interaction of the king and the gods (Hornung and Staehelin 2006, 91–95; Kaiser 1971, 87–105; Martin 1984, 785–786; Serrano 2002, 44–46).

It has also been shown that the *sed* feast was not limited to the life-time of the ruler. Its importance extended in the hereafter, as the perpetuation of the qualities and extraordinary forces of the passed-away king was a subject of primary importance especially after the physical death (Friedman 1995; Hornung and Staehelin 2006, 41 ff.). This also explains why so many attestations of the feast in relief originate from mortuary temples and, from the Twelfth Dynasty on, they become prominent in temples dedicated to different gods, which indicates that this is not a historical event (Hornung and Staehelin 2006, 51). The feast kept its importance and virtually unchanged structure through the next three millennia, down to the Roman period, as many attestations of the feast indicate (Hornung and Staehelin 2006, 13–32).

Returning to the surviving scene from Wadi Sura cave, we can observe some close formal resemblances between the running figure and much later attestation of the *sed*-feast run known from Ancient Egypt. These are the specific and characteristic attitude of the person represented, the leaping momentum, the specific insignia held in hands and, last but not least, the characteristic "cone-shaped" hat worn on the head (resembling the White crown of Upper Egypt) that make this iconographic composition so attractive.

Discussion

The impression of unusual parallelism may be even more compelling when looking at Early Dynastic and early Old Kingdom *sed*-feast scenes of the running kings of Den (mid-First Dynasty, about 2,950 BCE) and Netjerykhet Djoser (early Third Dynasty, about 2,700 BCE) (Friedman 1995, 3, fig. 2b and 33, fig. 19c) (Figure 5). Yet, despite all formal resemblances, we will never be sure about the degree of internal similarities between the compared scenes from Gilf Kebir and the Nile valley. One of the basic lessons to be taken from archeology is that, despite identical or comparable forms resulting from specific human behavior, their internal meaning may be (or not) worlds apart.

But still, on a hypothetical level and with regard to other evidence which could not be discussed in this context there seems to have existed a cultural and intellectual link connecting the areas of Gilf Kebir and the Nile valley (for details see Bárta 2011, with bibliography; for opposing and prevailing opinion comp. Förster and Kuper, 2013; Zboray 2013). We may thus consider this individual and the isolated scene

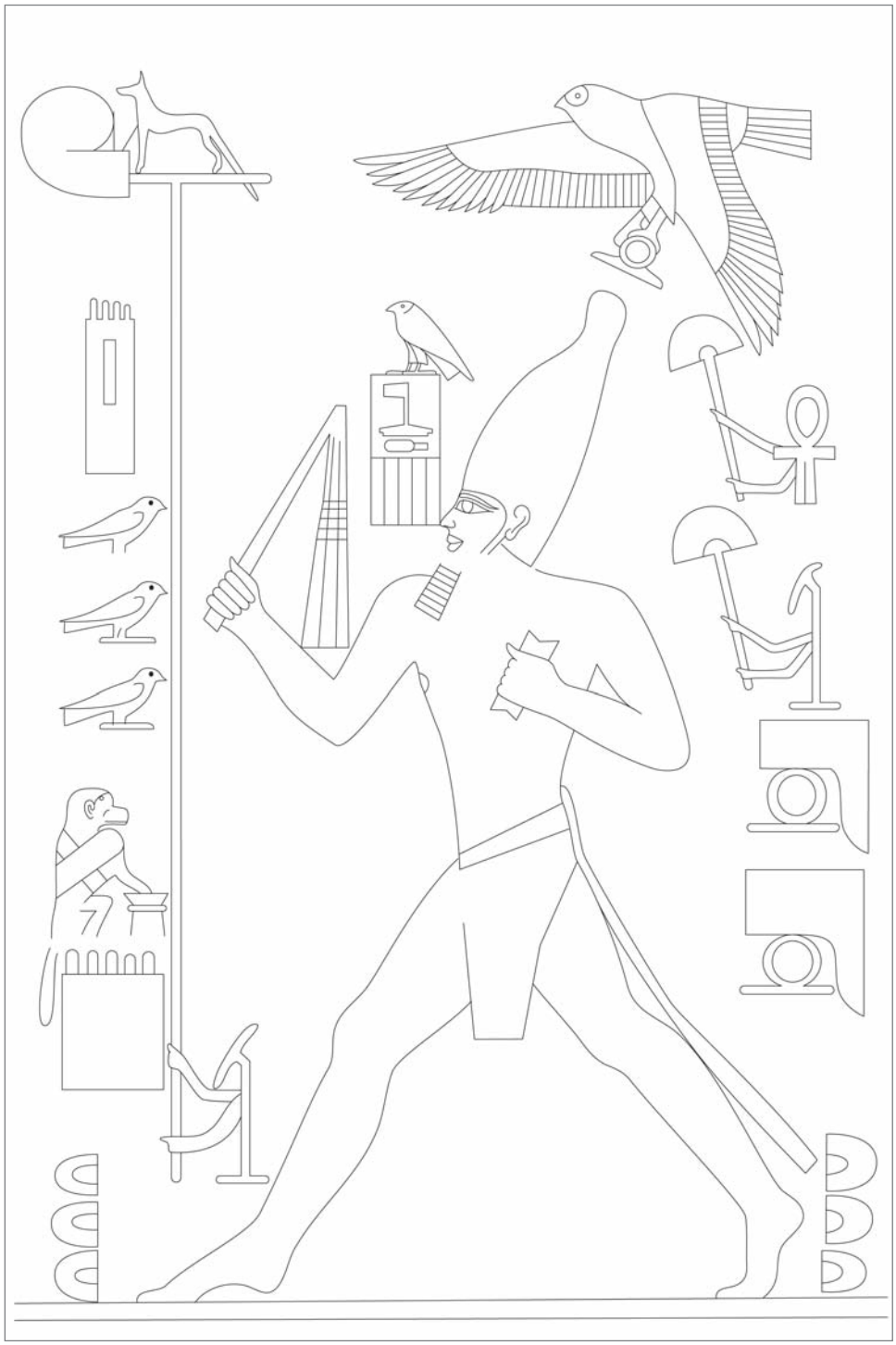

Figure 5: King Netjerykhet Djoser, Third Dynasty, Saqqara, ca 2650 BC (L. Vařeková).

surviving deep in the Western Desert as another indirect attestation to the possibility that quite a few intellectual concepts known to characterize much later civilization in the Nile valley were designed, at least in their basic outlines, not in the Nile valley itself but in a very different place, the Gilf Kebir area of the Western Desert. The creators of these concepts would have been relatively simple pastoral populations of the sixth millennium BCE which were forced, due to rapid climate deterioration, to withdraw to the Nile valley and who contributed to the emergence of one of the earliest civilizations of the world (for the climate change and the withdrawal of local populations from the Western Desert during the 6–4 mill. BCE see Kuper and Kröpelin 2006). Within this early framework, however, there would have been no kings but local chieftains at best, who could, if our hypothesis is correct, use the act of public physical exercise of "fitness" as a legitimization tool to gain and/or maintain control over the local population.

Acknowledgement
This study was supported by the Grant Agency of the Czech Republic, Grant no. P405/11/1873.

Résumé
L'objet de cette brève étude est une représentation d'un homme qui coure datant du VIème millénaire avant J.C. Ce motif iconographique unique a été découvert dans un abri sous-roche dans le Wadi Sura, dans la région des montages de Gilf Kebir localisées profondément dans le désert occidental égyptien. En se basant sur l'analyse formelle de la scène, on peut proposer et discuter la possibilité de sa relation avec une iconographie beaucoup plus récente de l'Egypte ancienne montrant un roi égyptien courant à l'occasion de la Fête-Sed du renouvellement des forces magiques du pharaon.

Zusammenfassung
Gegenstand dieser kurzen Untersuchung ist die Darstellung eines laufenden Mannes, die in das 6. Jahrtausend v. Chr. datiert. Dieses einzigartige ikonografische Motiv wurde unter einem Felsvorsprung im Wadi Sura im Gebirgszug des Gilf Kebir in der westlichen Wüste Ägyptens entdeckt. Ausgehend von einer formalen Analyse der dargestellten Szene wird die Möglichkeit erwogen und diskutiert, dass es einen Zusammenhang gibt zu der viel späteren altägyptischen Ikonografie eines laufenden ägyptischen Königs anlässlich des Sedfests , das der Erneuerung der magischen Macht des Pharaos diente.

SIMULATING ARCHEOLOGICAL MODELS: PERSPECTIVES IN PROTOHISTORY

Balázs Komoróczy and Marek Vlach

All models are wrong but some are useful.
G. E. P. Box and W. E. Deming[1]

Abstract
The process of model building is one of the fundamental means of scientific reasoning and assessment of theoretical constructs. Most of the theoretical models in social sciences (specifically in archeology) are formulated through the basic descriptive means of common language. Developments in IT during the last decades and its accessibility have made available various computing methods in archeological research. The paper aims to outline basic features of the method called agent-based modeling (ABM), which allows the building of digital models to simulate artificial societies or other studied complex phenomena of archeological interest. Such models may reveal the behavior of featured systemic components and their influence on system dynamics (e.g. population dynamics or emergence of system properties of social structure). Generally the aim of the described method is the study of systemic micro-level properties and their output in macro-scale pattern generation (structural behavior). Finally, the paper outlines the most recent applications of this method to study society and its trajectories of development within the Roman Period in the Middle Danube region.

Keywords
Methodology, agent based modelling, complex systems, non-linear dynamics, Protohistory

DOI: 10.5817/CZ.MUNI.M210-7781-2015-37

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[1] The quotation is usually ascribed to both authors (cp. Box 1979, 202; Box and Draper 1987, 424).

Introduction

Models are universal means of understanding and describing the complex reality of the physical and abstract (psychic) world. The process of modeling is necessary due to the profound complexity of some questions. Therefore the process is a fundamental instrument of scientific knowledge (Pelánek 2011, 15 ff.). The main feature of every model is reduced complexity and abstraction of the modeled subject in order to realize and describe its basic structuring relations (Gilbert and Troitzsch 2009, 2), for example, the implications of mathematics applied to the study of the nature of historical processes led to the emergence of a specialized field of study (cp. Turchin 2008; Turchin *et al.* 2006)[2]. In natural sciences such models are often defined through differential equations (e.g. relation between temperature and humidity in effect on evaporation or crystallization-temperature dependency, or nowadays highly advanced weather forecast modeling). Humanities scholarship, including archeology, builds its models on basis analyses, syntheses and interpretation of its sources of information, which are often not specific (mainly from a quantitative perspective) due to the character of its sources of information (Neustupný 2007a, 54 ff.). The very beginning of an approach towards archeological information requires the previous existence of a so-called preliminary model, which would provide necessary theoretical groundwork for archeological reasoning (Neustupný 2010, 27 ff.). Archeology uses models ordinarily for the basic formulation of structures and processes through the common language. During the process of modeling the dynamics of archeological sources, lost through the archeological transformations (Neustupný 1986, 544–548) can be reanimated.

Complex systems and non-linear dynamics

The principal presumptions for digital modeling originated some decades ago in the emergence of the theory of systems (also known as the general theory of systems). Its author, Ludwig von Bertalanffy (1950, 1968; Boulding 1956), postulated the theory on the basis of researches in botany, but its principles are strikingly universal and applicable within the wide range of scientific disciplines. The approach considers the complex realities of the physical world (and its properties) to be systems consisting of interconnected compartments (subsystems), which express properties other than only those apparent in its individual subsystems without centralized control. The later theoretical development in the 1980s led to emergence of so-called complexity or complex theory (cp. Beekman and Baden 2005, 3; Ottino 2003; Mitchell 2009; Pelánek 2011, 21 ff.). A complex system, amongst other characteristic properties, exhibits non-linear behavior (non-linear dynamics, Figure 1), which may make study

[2] The new subdiscipline was named cliodynamics (after the mythological Greek muse Kleió representing subject of history) and aims to study historical processes through applied mathematics, mainly using ABM.

of its development trajectories ungraspable solely on the basis of individual inhibited parts (Epstein 1999, 53; Manson 2001). The basic principle can be asserted succinctly through the maxim of the Greek philosopher Aristotle, "*the whole is more than sum of its parts*". The theory of systems is close to holistic approach principles, which presumes structuring of the systems into infinite divisible components, which are systems on their own. The holistic approach in archeology requires incorporation of comprehensive investigation of all aspects of past human societies (Demarrais 2013). A complex system cannot be considered and studied outside its environment, which shapes its structural properties. In many considerations the human mind tends to follow generally a linear form of dynamics; however, the activity of aggregations of individual different system components results in profoundly non-linear behavior dynamics. Through this conception the theory of complexity (or complex systems; cp. Bentley and Maschner 2007) defines itself against the traditional Newtonian logic of analyses (Beekman and Baden 2005, 2), which presumes sufficient understanding of studied phenomena via reduction of the studied system into individual components and analyses of their separate components and properties. Most recently there has been accentuated a shift from "complex" systems towards "non-linear" systems, which conveniently underlines the vitality of the dynamic principle of complex systems. On the basis of their fundamental nature they are most of the time in a state of non-equilibrium around which they oscillate (White *et al.* 1984, 8 ff; Beekman and Baden 2005; Pelánek 2011, 41 ff). The state of a system is almost constantly shaped through various feedback effects (positive and negative), which reflect mutual relations within the systemic variables and though which the system is self-organized (Pelánek 2011, 41 ff). Previous theoretical research in the domain of complex systems often included chaos theory and determinism (Manson 2001, 407). However, the dynamics of system behavior is based on system properties and change throughout time is not purely stochastic. Perhaps the most illustrative example of a complex system is the human brain[3]. The actual state of research recognizes fundamental principles of information transmission between neurons, but the study of individual hubs would not lead to understanding of such concepts as abstract reasoning, which is emergent property of collective action of individual cells (Barceló 2009, 142 ff.). Mathematical representation of such complex features plays a vital role in modeling processes of artificial intelligence implementing principles of neural networks. These concepts find a surprisingly wide range of application in the process of archeological reasoning. In archeology the complexity approach has found its place mostly within the processual paradigm (Clarke 1968, 1972; Flannery 1968). A human society can also be regarded as a profoundly complex system (a kind of living "organism") (Renfrew 2013), while its behavior manifests non-linear dynamics with specific emergences of social evolution in various aspects and scale (cp. Epstein 1999; Silverman and Bryden 2007).

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[3] The enormous complexity of such a system appropriately underlines the maxim, "*If the brain was so simple we could understand it, we would be so simple we couldn't*" (Pugh 1978, 154).

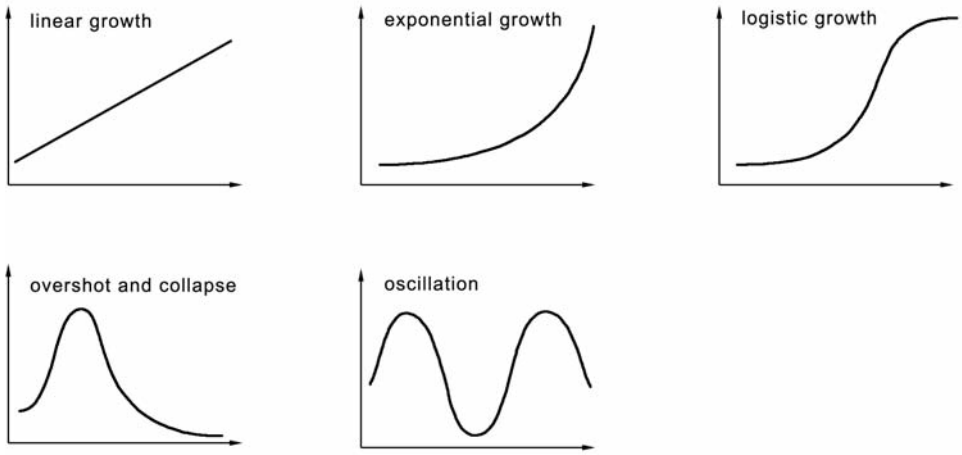

Figure 1: The most frequent functions used for description of system dynamics (after Pelánek 2011, Figure 6.4).

Agent-based modeling and simulation

The quantity of significant scientific knowledge acquired through the analysis of systemic dynamics and its complexity may be mediated using a methodological framework called agent based modeling (also agent based simulations or multi-agent simulations, referred to below as ABM). For a detailed description and definition of the methodology there exists a large quantity of dedicated papers with further references and examples (e.g. Doran 1970; Axelrod 1997a, b; Bonabeau 2002; Dornan 2002; Billari *et al*. 2006; Castle-Crooks 2006; Gilbert 2008; Chan *et al.* 2010; Macal and North 2010; Pelánek 2011, 80–81). The method belongs to a group of applied computing simulations. New ways of tackling scientific problems soon found application within archeological analyses of theoretical models. Versatility of method implementation ranges through natural sciences (e.g. chemistry, physics, economics or biology), where it helps to understand structural features of processes such as the complexity of physical emergences (e.g. snowflake shapes), market development, supply chain optimization or impacts various organism behaviors on environmental conditions (Parker *et al.* 2003; Bousquet and Le Page 2004). The method of ABM enabled new ways of scientific research among others also in demography (cp. Billari and Prskawetz 2003). The method was first formulated and used in social sciences (Epstein 1999), where it mediated more thorough insight into various complex social phenomena of human populations such as the dynamic behavior of crowds, principles of cooperation and competition (Axelrod 1997a, b; Burstev and Turchin 2006), the emergence of altruism or spatial segregation of minorities (Schelling 1969, 1971).

The main principle of the ABM is the use of so-called agents, autonomous digital entities with predefined (programmed) properties and principles of behavior (set of trigger-threshold and other reactions for resolution to interactions among the agents and the respective model environment, cp. Epstein and Axtell 1996; Epstein 1999; Dornan 2002), which generate dynamics and activity in the studied systems.

Their complex behavior creates emergent properties which could not be expected only on the basis of study of individual agent entities. The agents can represent various kinds of modeled structure from individual atoms to complex entities such as human beings within individual based social simulations. Complex interactions among agents and environment through the iterative simulation phases (steps) change properties of the actors. Some agent design approaches also include the possibility of learning during the course of simulation, which may change the behavior of a system considerably. Through the process of simulating models various hypothetical scenarios of interest can be tested. One of fundamental methodological presupposition lies in observation of emergent properties coming from system dynamics on micro level (from aggregated individuals) leading to the higher macro level structures (complexity of society). Such an approach is usually noted as bottom-up (cp. Epstein and Axtell 1996; Billari et al. 2006, 5 ff.), which stands opposite to a top-down (stepwise design) modeling approach, where the hierarchical structure of the created model is implemented at the beginning. The difference corresponds in antagonism between an individualist/"rational actor" and a structuralist/institutional (non-discursive practice) approach towards the model design (O'Sullivan and Mordechai 2000; Beekman 2005, 55 ff.). Application of the so-called rational-thinking agent in models is closely linked with questions of agent cognition (Zhang *et al.* 1992) and consequent decision making processes, which create agent behavior. However such abilities are suitable in specific types of model (individual-oriented) and their application depends on the nature of the modeled phenomena (Doran 1999)[4]. Understanding of fundamental features of studied complex system inevitably requires an appropriate level of complexity reduction (Dornan 2002, 217), usually referred as the rule of KISS ("Keep it simple, stupid" or "Keep it short and simple"; Axelrod 1997b, 6). This implies that large and robust models do not necessarily produce better understanding of a studied system, what is most important is the selection and design of the vital featuring structures of a system.

Spatially explicit ABM can deal with questions of spatial distribution, however the fundamental methodological features of ABM are in certain ways distinct from the conception of geographic information systems (GIS; cp. Gimblett 2002; Castle-Crooks 2006), where analyses are generally conceived through singular steps, which do not allow the study of temporal dynamics. On the other hand, GIS implementation in the process of model building or spatial analyses of its results is crucial in the case of models with an environment of explicit spatial representation. ABM comprising reduced complexity of human actors often includes features from artificial intelligence, however, on the basis of featuring questions on a level expected to be sufficient for the understanding of the modeled complex systems of a society

[4] E.g. Complexity reduction in some models results in the aggregation of human actors into household units, which represent the basic level of agent entities and whose activity is an outcome of collective decission making (cp. Janssen 2009; Kohler *et al*. 2005; Mayer *et al*. 2006).

as a whole in order to uncover the structuring phenomena leading to qualitative change of the system.

The methods of AMB (mainly its concepts of environment) partially come from the digital computation method called cellular automata (CA; generally on the topic, see Wolfram 1984, 1994; Hagselmann and Flache 1998). During its beginnings in the 1960s the development of IT did not allow implementation of robust models. Despite these limitations and using simple sets of rules the CA models led towards remarkably complex spatial patterns (e.g. Chan *et al.* 2010, Figure 2). The founder of the methodological framework, J. von Neumann[5] (1966), developed its fundamental principles through the concept of self-reproduction of simple individual "automatons". Spatial framework consisted of a regular grid, where each cell iteratively acts on basis of preset rules and consideration of its neighborhood and responds accordingly within each simulation step. Perhaps the most famous is a CA called the Game of Life (cp. Flake 2000; Berlekamp *et al.* 2003). Earlier versions of the famous Sugarscape model were also based on a grid environment of CA conception (Epstein and Axtell 1996; Axtell *et al.* 1996). The last decades have witnessed unprecedented development of IT and sufficient computational capacities are widely accessible for everyone. Due to the numbers of applications in various scientific disciplines there is a distinctly wide range of implementations of various forms and solutions. Some ABM projects are designed to comprise thousands (or even hundreds of thousands) of individual cognitive agents, which proportionally requires substantial computational capacities. An examples is the robust models constructed for testing scenarios of the threat of bioterrorism in the form of smallpox epidemics (Burke *et al.* 2006; Ferguson *et al.* 2003; Epstein 2009) involve sometimes even millions of individually-acting human agents (cp. del Valle *et al.* 2006).

ABM in archeology has been applied since the beginning of the implementation of computer modeling in social sciences and has mediated new perspectives on fundamental complexity issues such as social evolution, the development of hierarchical social organization or the emergence of wealth inequity. Amongst the well-known applications of ABM is the project called Artificial Anasazi, which was designed to explore digitally role of various exo- and endogenous factors (environmental change) to population dynamics in the case of the archeologically well documented Anasazi culture of pre-Columbian North America in the Long House Valley (Arizona, USA). The environment of the model was represented by spatial distribution of arable soil quality and the human agents were represented by households performing agriculture and mutually interacting with the environment (Dean *et al.* 1999; Axtell *et al.* 2002; Kohler *et al.* 2005; Janssen 2009)[6]. On the basis of anthropological, archeological and demographical data there has been series of

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[5] Together with Slanisław Ulam they have also developed the very popular statistical mechanism Monte Carlo, widely used in simulations and complex system probability outcomes.

[6] The project of settlement ecodynamics similarly deals with the ecodynamics of the settlement activities and the impact of subsistence requirements on environmental conditions in the region of Mesa Verde (Colorado, USA) (Varien *et al.* 2007).

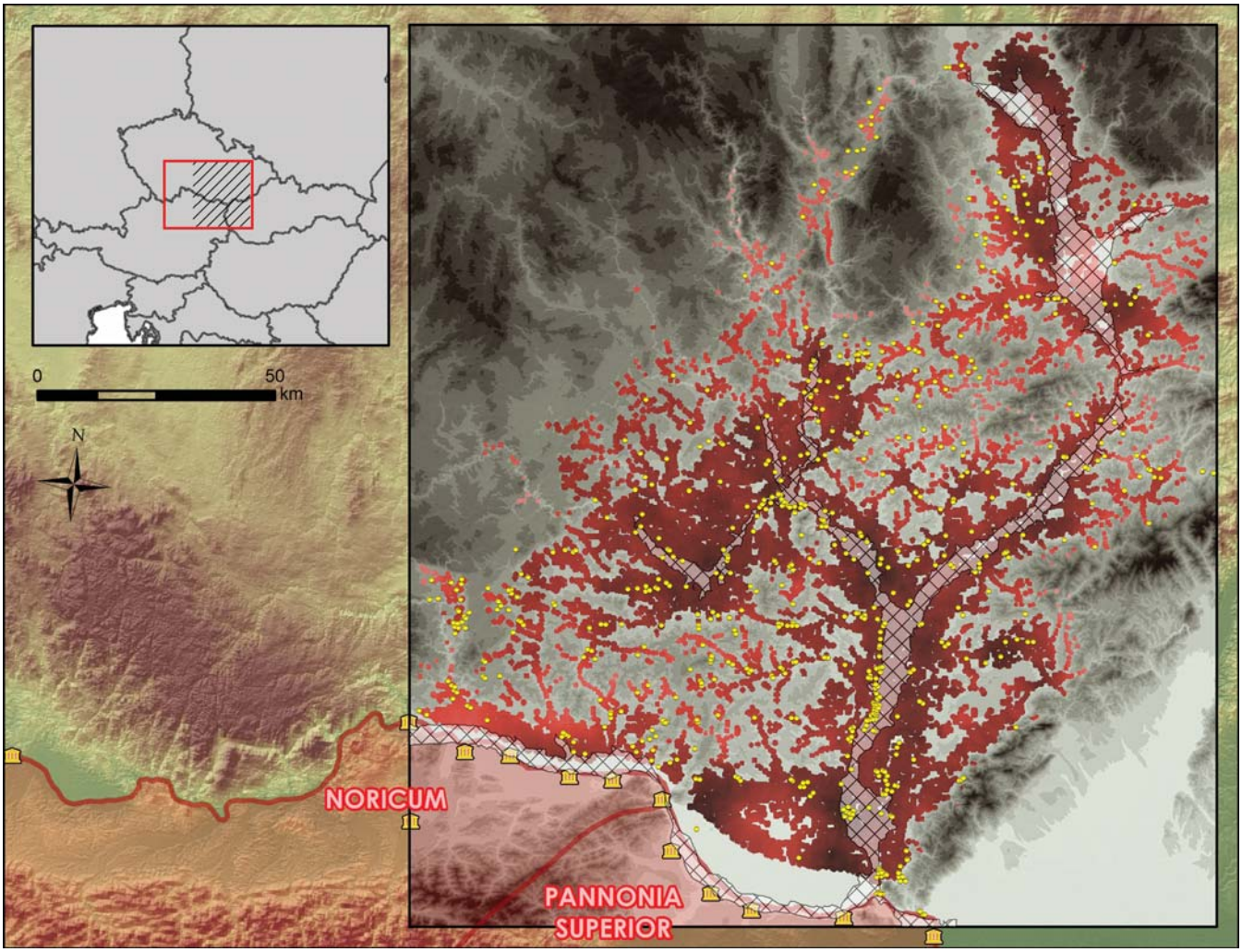

Figure 2: Example of simulated spatial distributions of the local population densities (red shaded areas) and all observed archeological evidences (yellow dots) of the ABM (modeled environment conceived in grayscale relief) of the Germanic settlement structure (after Vlach, in press)

various models tackling questions of social development (Doran *et al.* 1994) or subsistence and population growth of, hunter-gatherer societies (Barceló et al. 2008; Barton *et al.* 2011) or their spatial distribution in the Lower Paleolithic (Romanowska 2013). The emergent features of social complexity were studied in a Bronze Age settlement system in Mesopotamia (Wilkinson *et al.* 2007; for more applications in social simulation and environmental dynamics cp. Christiansen and Altaweel 2005, 2006; Johnson *et al.* 2005). Other implementations include a study of the expansion dynamics of Neolithic subsistence strategies in Europe (Lemmen *et al.* 2011), evaluation of spatial relations dynamics of the Antonine itineraries (Graham 2006), simulation of patronage and civil violence in Roman society (Graham 2009), analyses of costs and outputs of Hallstatt salt mining (Kowarik *et al.* 2010), the development of social and wealth inequality in Bronze Age society (Bentley *et al.* 2005) or the emergence of complex organization and hierarchical structuring in human society (Turchin and Gavrilets 2009). Another interestingly

conceived project theoretically explored the causes of the Byzantine loss at the battle of Manzikert in 1071 on the basis of modeled conditions of the march and provisioning of the Byzantine army through Anatolia and validating theories of combat readiness on arrival at the battlefield. Every soldier was represented by a single agent (with estimates of the army size of hundreds of thousands of individuals), comprising large sets of variables and decision hierarchy. The whole robust model was run on a couple of interconnected supercomputers using techniques of parallel computing (Craenen *et al*. 2010).

One of the vital features of the model building process compels one to specify and concretize model input data on a certain level of reduced complexity. The process inevitably leads to revelation of pertinent gaps in the archeological data and archeological theoretical models (Kowarik 2012, 238–239). The process of model building requires input data from corresponding information sources (natural and social sciences), which may provide background for sufficient estimates or "proxy" data for building ABMs. However, for many issues (or subsystems) in archeology there are no simple quantifiable variables and numbers of featured variables have to be devised on the basis of other analogous contexts through results from other scientific disciplines (e.g. ethnology or experimental archeology) or implemented through dimensionless coefficients (transition rates).

Nowadays there are numbers of ABM solutions according various forms, license conditions (open source, freeware or proprietary), requirements (procedural or object-oriented programming language, computational capacities) and productivity based on overall conception and design of intended model. Apparently the easiest way is by use of toolkits (SWARM, MASON, OBEUS, Repast, AnyLogic or NetLogo), which provide users with modeling interface, environment and other settings and tools (cp. Macal and North 2010, 158 ff.; Castle and Crooks 2006, 26–35, table 2, 3). One of the most widely used toolkits, NetLogo, disposes of a large variety of built-in properties, and a procedural programming language called Logo (Willenski 1999; Sklar 2007). However its major disadvantage is use of procedural programming language instead of object oriented. There are significant possibilities of modeling also for unexperienced researchers and teachers interested in modeling system dynamics.

Perspectives in modeling of theoretical issues of central European Protohistory

Application of advanced computational approaches towards the study of structure and complexity of systems has been closely connected with the emergence of the processual paradigm in western Anglo-Saxon archeology (Beekman 2005). Systemic approaches and the implementation of digital modeling and simulations have gradually influenced more scientific researchers. The archeology of protohistorical periods within central Europe (especially post-socialist states) has been theoretically oriented mainly on traditional methodological means of culture-historical paradigm (Neustupný 2007b, 20), but for some time the shift towards other theoretical

questions (Neustupný 1986) and wider implementation of computational techniques has been apparent (e.g. Macháček 1997). Recently there has been the first implementation of ABM in Protohistory (e.g. Cimler *et al*. 2012; Vlach in press). Within the activities of the Center for the Roman Period and Great Migration Period of the Institute of Archeology of the Brno Academy of Sciences, there are numbers of subjects. Most of the research is of the Roman military presence in the Germanic territories of the central Danube region (e.g. Tejral 1997, 1999; Komoróczy 2009; Komoróczy and Vlach 2010), Germanic society and its settlement structure, social stratification, subsistence strategies and recognition of fundamental historical processes within the studied structures.

ABM of artificial societies in archeology is widely used for the study of settlement dynamics, subsistence and the impact of human activities on the surrounding environmental conditions. It is our long-term intention to assemble representative sets of input data (however, the actual state of research in this area is still rather insufficient) for modeling within formal and spatial scale of one community, corresponding to one archeological residential component. In this concept agents represent individual community members and based on theoretical models they behave according to the set of rules within the fundamental subsistence frame of contemporary economics. Due to the archeological record there is no evidence of significant qualitative change or development within the local subsistence strategies or the Germanic settlement structure during the Roman period, whilst our attention is directed to quantitative aspect of the subsistence strategies of the local population. Furthermore it is possible to simulate expected long-term anthropogenic impact on the modeled environmental conditions, the study system stability and sensitivity considering temporary climatic disturbances. The Germanic community model is largely based on consumption/production estimates based on extensive survey projects relevant to the studied system (cp. Dreslerová 1995, 1996, 2008). The modeled society is structured into family/household units and the individual agents possess derived biological properties (life expectancy etc.). A set of profound behavior rules dictates mostly reproductive cycle, food provisioning and basic artifact production activities. The environment of the model is based on simplified features of the real spatial context containing information on geomorphology, soil-type and expected land-cover. Based on estimations of nutrition demands consumption is calculated and actual needs of individual agents result in agricultural activities, production of artifacts and gathering raw materials. The food production subsystem consists mostly of growing crops and is complemented by herding. Also pottery and metalworking is incorporated, while the processes generate costs and waste. Theoretical study of quantitative and qualitative aspect of the accretion and spatial distribution of waste has importance for evaluation of the excavated archeological record (cp. Neustupný 2007a, 66 ff.). The modeled society also develops through the time based on exo- and endogamic principles. Social relations within the modeled community are expected to be predominantly cooperative, but also questions of wealth distribution may be theoretically tested. However, the settlement context of the central Danube

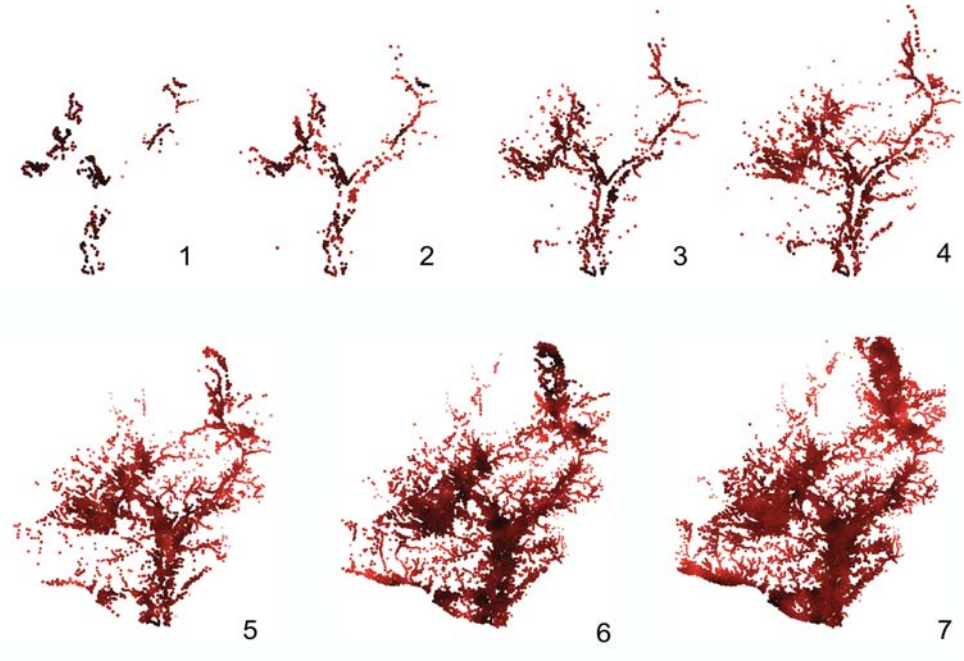

Figure 3: Simulated development of the local population densities (red shaded areas) of the Germanic settlement structure in 20-year stages (after Vlach in press).

region generally shows little evidence of social stratification, in opposition to the burial grounds (Komoróczy and Vlach 2011). Hence the profile of the modeled population can be transformed during the simulation into the corresponding record of modeled burial grounds, which can be tested against data from archeological records (cp. Binford 1971; Brown 1971, 1995).

Moving up in the scale of formal and spatial scope of studied questions, there is also undeniable potential in modeling and simulation of the development of the overall settlement structure of the Germanic tribes of the central Danube in Moravia, Lower Austria and part of Slovakia west of the Lesser Carpathians, which are spatially closely interconnected. The first generation of such modeling has put the main interest on demographic conditions (Vlach in press), which is a vital step for understanding overall the studied context (Chamberlain 2006, 2009; Renfrew 2009; Zimmerman *et al.* 2009). Devised estimates of population size and distribution provide the background framework for numerous issues such as critique of figures known from contemporary literary sources, estimates of possible surpluses of Germanic subsistence strategies (evaluation of "purchasing power") and calculations of trans-frontier trade forms (models) and volumes, emergence of production centers and trade network (fine gray ware from the Late Roman period; iron production; Roman imported goods etc.), characteristics of internal and external conflict within the chiefdom social organization (cp. Fried 1967; Carneiro 1970; Service 1971; Earle 1987; Beliaev *et al.* 2001; Steuer 2006) of the barbarian world (e.g. emergence of tribal unions) and study of the Roman-Germanic military conflicts (especially during the Marcomannic wars). Available archeological information from the first two centuries CE generally show rather scarce traces of settlement activities during the first century CE (Tejral 1977, 2009) and substantial

growth tendency towards the second half of the second century CE, where the settlement structure covers large areas of the lowland areas up to 300 meters above sea level (cp. Droberjar 1997). So far we are missing quantitative theoretical models describing demographic processes, and development of the local and global population density during the given time. Demographic calculations and estimates may also enlighten persisting questions of the form, dynamics and proportion of immigration in various periods and causal depopulation of other neighboring regions. The ABM of basic spatial and demographical aspects of the Germanic settlement structure consists of the geographical environment and agents representing individual settlements and burial grounds. The components were modeled based on theoretical models (Neustupný 1994, 2010, 150 ff), archeological data (e.g. Stuchlík 2002) and archeological demography (cp. Renfrew 2009) and population dynamics (also abstraction of general background data from results of community modeling). Decision making processes took into account spatial distributions of "suitability" for residential activities based on archeological prediction (e. g. Goláň 2003; Vachůtová and Vlach 2010) based on known archeological evidence from the region. Naturally, aspects such as a top-down decision making of upper social organization (chieftain) levels or the influence of religious beliefs might have had importance in the development of the settlement structure and other features of the society, although such aspects are incorporable with difficulty requiring specification of qualitative and quantitative of its principles and functioning. Preliminary estimates based on results of minimum and maximum simulation settings (above all the ranges and averages of households per community, area required for subsistence, intrinsic population growth and immigration) rather vaguely range between 100, 000 and 220, 000 inhabitants within the modeled region, while "reasonable" estimates oscillate around 160, 000 (140, 000–180, 000) with 0.3 persons per square km of global population density (Figure 2, 3). Generally comparable estimates are expected for population sizes in Bohemia during certain periods of Protohistory (Waldhauser 2001, 23; Salač 2006, 42; 2008, 54) or other comparable regions of contemporary Europe (Zimmerman et al. 2009). Hopefully further research on the topic and above all more published representative data from the archeological record from Germanic settlements will help to refine input data of the model and provide background for meaningful results.

Other possibilities of application of the ABM lie within the topic of the Roman military invasions in the barbarian territories (e.g. Tejral 1999; Komoróczy 2009). Dynamics and structure here contain specific theoretical issues. Logistics and organization of the military campaigns inevitably involve full consideration of a wide array of aspects, among others mainly the local geopolitical conditions and communication parameters (passability) of invaded regions (Komoróczy and Vlach 2010). Perhaps the most important issue for the Roman military leadership during the army's presence in any non-provincial territory was the provisioning and security of supply lines. The Roman army required many types of products and commodities for its operability, but 95% of its volume consisted of food, animal fodder and wood, either as construction timber or firewood (Roth 1999). Foraging

was frequently performed in order to provide necessary supplies in many contexts of Roman military campaigns. The practice of requisitioning and pillaging of food supplies on occupied territories was also the Roman practice since Republican times, however the economic context of the Germanic territories could have hardly provide sufficient and continuous food surpluses to cover such requirements. Estimating only a limited size of Roman forces, consumption would result in vast quantities (cp. Roth 1999; Kehne 2008). Given the high importance of river-borne transport routes, which comprises the highest transportable volumes, the whole impacted region of operation within the central Danube should have been secured with anchorages on the main back-bone rivers, the Morava and Dyje (Thaya). On the basis of the stated theoretical framework it is possible to generate a dynamic model for simulation of the consumption and supply chain of the Roman army on the barbarian territories incorporating various means of transport and Roman military strategies.

Conclusions

ABM represents an application of computation techniques in archeology with undeniably significant potential. Perspectives of the application of complexity theory and methodological means to construct models (agent-based modeling) underline possible implications for the study of some theoretical issues of scientific research in archeology. The process of model building on the basis of theoretical concepts itself reveals gaps in our data. Within the archeological record we lack data for some processes which must be supplemented with estimates. Simple outlined examples of applied methods of ABM show a wide range of possible benefits for testing and validating archeological theoretical models of Protohistory in the Middle Danube region.

Acknowledgement
The paper was created within the framework of the project of internal support of international cooperation of the Academy of Sciences CZ, reg. no. M300011201 “The Roman temporary camps in Moravia and Lower Austria; interdisciplinary research – standard methodology – new historical interpretation”.

Résumé
La création de modèles est un des moyens fondamentaux du raisonnement scientifique et de l’évaluation des constructions théoriques. La plupart des modèles théoriques en sciences humaines (ou directement en archéologie) sont formulés à travers les moyens descriptifs de base du langage commun. Le développement et l’accessibilité des technologies de l’information et de la communication (IT) durant ces dernières décennies ont permis d’appliquer les méthodes de calcul informatiques aux recherches archéologiques. L’objectif de cet article est d’exposer les grandes lignes de la méthode dite de modélisation à base d’agents (ABM) qui permet de construire et tester des modèles numériques de sociétés artificielles ou encore d’étudier des phénomènes complexes intéressant l’archéologie. De tels modèles peuvent éclairer le comportement des

composantes caractéristiques d'un système et leur influence sur les dynamiques du système (par exemple la dynamique de population ou l'émergence des propriétés de système des structures sociales).En général, le but de la méthode décrite est d'étudier les propriétés systémiques de micro-niveau et leur résultat sur la génération de modèle à l'échelle macro (comportement structurel). L'application la plus récente de cette méthode prend ses racines dans l'archéologie domestique.

Zusammenfassung
ABM repräsentiert eine Applikation der Computertechnik in der Archäologie mit unbestreitbar großem Potential. Die Perspektiven der Anwendung der Komplexitätstheorie und methodologischer Ansätze bei der Modellerstellung (agentenbasierte Modellierung) unterstreichen die Möglichkeiten ihrer Anwendung beim Studium einiger theoretischer Fragen der archäologischen Forschung. Der auf theoretischen Prinzipen beruhende Prozess der Modellerstellung bringt Lücken in unseren Daten zum Vorschein. Im archäologischen Fundgut fehlen genaue Daten über einige Prozesse, die mit Einschätzungen ersetzt werden müssen. Einige einfach umrissene Beispiele von angewandten ABM-Methoden zeigen eine breite Skala von möglichen Vorteilen für die Überprüfung und Bewertung archäologischer theoretischer Modelle der Frühgeschichte im Mitteldonaugebiet.

THE MYSTERY OF THE SIEMONIA SKULL (POLAND): FROM THE PALEOLITHIC TO THE MIDDLE AGES

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Abstract
In this paper, we present the most recent results of dating and anthropological findings related to the cranium from the site of Siemonia, near Będzin in Silesia (Poland). The Siemonia human skull was found accidentally by workers in 1955 in quarried sand. Until recently, the Siemonia skull was considered the oldest find of an anatomically modern human from Poland. Unfortunately, the results of the dating of the cranial bone using the AMS method indicated that the individual to whom the skull belonged derived from the Holocene epoch and not, as was previously assumed, from the Upper Paleolithic period. The calibration, showing the calendar age indicates that the skull belonged to a man from the twelfth or thirteenth century. The morphology of the Siemonia skull is typical for the Homo sapiens crania. However, this skull exhibits high grades of robusticity characters expression and thick bones of the cranial vaults, thus overall the skull is massive.

Keywords
Silesia, Poland, anthropology, cranium morphology, *Homo sapiens*

DOI: 10.5817/CZ.MUNI.M210-7781-2015-38

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Introduction

One of the most important areas of research in the last few decades in Central Europe is the attempt to date more accurately human remains which are or have been connected with the Aurignacian culture (Wild *et al.* 2005). Some of the results obtained, such as the dating of relics excavated in Moravia, confirm earlier speculations (Svoboda *et al.* 2002), while some of them, e.g. the human remains from Vogelherd, have forced earlier views to be changed (Conard *et al.* 2004).

The most frequent reasons why earlier inaccuracies or even mistakes occurred were the impossibility of applying the methods of absolute dating, different – compared with today – standards of excavation work and control of stratigraphy, and the research paradigm based on the dating of human remains on the basis of the context, e.g. stone artifacts or faunal remains. Until recently, an important place among Pleistocene human finds within the territory of Poland was held by the skull from Siemonia, near Będzin in Silesia (Poland). It was considered the oldest find of an anatomically modern human from Poland (Stęślicka 1960a, b). However, it should be noted that archeologists have had reservations about this discovery from the very beginning, mainly due to the unclear stratigraphic context (e.g. Kozłowski 1964, 91; Kozłowski and Kozłowski 1996, 119). In this work, we present the most recent results of determination of age and anthropological findings related to the Siemonia cranium.

The "Paleolithic" human skull from Siemonia

The Siemonia human skull was found accidentally by workers in March 1955 at the sandpit in Siemonia (site No 56) near Będzin in Silesia (in southern Poland) (Figure 1). The skull was found in sand which had been transported to a mine – i.e. far from the place of its excavation. The Siemonia site is located in the western part of the Śląsko-Krakowska Upland. The relief of this land is varied through the presence of hills composed of limestone, marl and dolomite rocks. The valleys in this area are filled mainly with glacial deposits from the Middle and Late Pleistocene periods and with Holocene fluvial deposits (Biernat 1957). The excavation site of the cranium was located in the Jaworznik River valley where sandy deposits were exploited on an industrial scale until the beginning of the 1960s. Subsequently, this area was reclaimed and the former bed of the Jaworznik exploitation field was flooded to make a series of reservoirs. Pursuant to the documentation (Zieliński 1960, *Figure* 1), the excavation site of the skull may be located by the southern bank of one of the reservoirs (Abłamowicz 2007, Table 1, Figure 2). The skull was found in sand transported from the area of the sandpit (Stęślicka 1960a, b). Unfortunately the original position of this skull is not precisely known, thus reconstruction of the accurate stratigraphic position of this skull was not possible. Therefore, the exact place of its original location was not determined and only the general area from which it could have come was indicated. It was the southern slope of the Jaworznik excavation that was exploited at that time. Zieliński, a geologist who analyzed the stratigraphy of the excavation, suggested that the sandy deposits date back to the Middle Pleistocene. Another geologist, A. Jahn, who examined the Siemonia site, related the roof of the sandy series in Siemonia to the Aurignacian interstadial of the last glacial period (interstadial of Rixdorf, Göttweig or interstadial-Würm I-II, see Woldstedt 1962). Earlier, Jahn dated the deposits in Pyskowice back to the same period; these deposits – similar to the ones in Siemonia – were the source of remains of the Pleistocene fauna.

In one of the first publications concerning the Siemonia site, data about the bones of the following mammals which were also excavated in the sand pit was

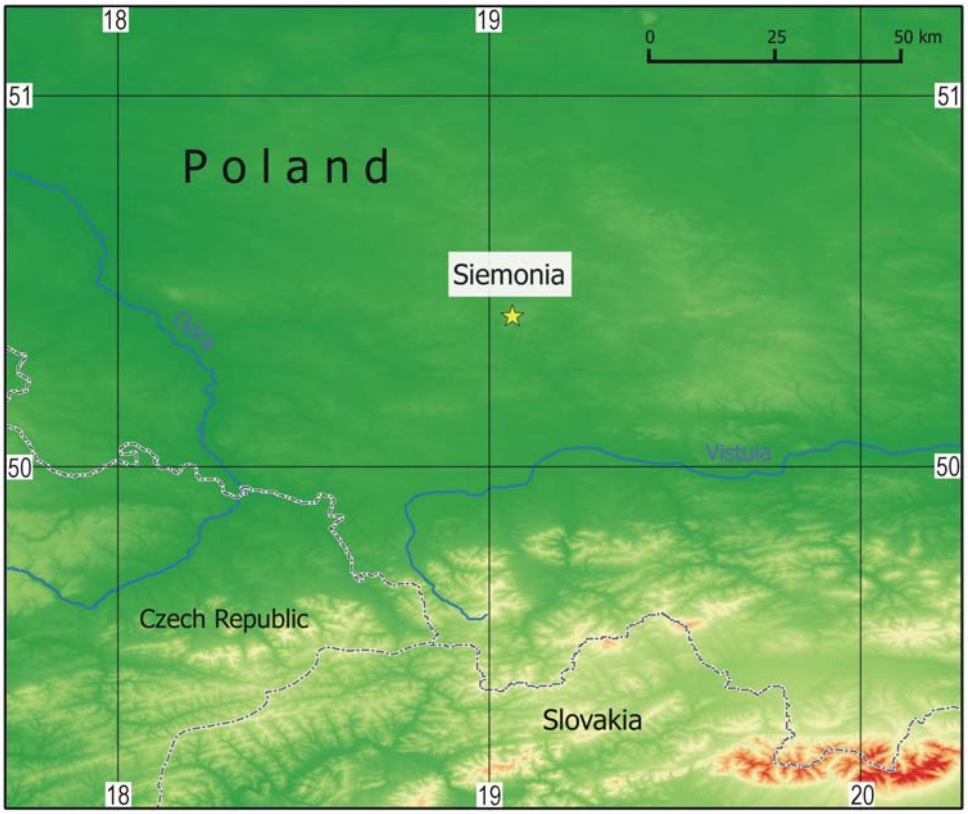

Figure 1: Location of the Siemonia site (Southern Poland).

included: mammoth, rhinoceros, horse, and boar (Stęślicka 1960b). This collection of bones was gathered by the sand pit workers. The stratigraphic position of the bones was not determined. They probably came from different places of the excavated area. The bone remains were assessed by Ryziewicz, a paleozoologist (the University of Wrocław). Although the bones did not have any determined stratigraphic position, they were used as an argument in favor of earlier dating of the series of sandy layers. Pursuant to the researchers, the presence of the bones of mammals from the Late Pleistocene period indicated that they date back to the interstadial of Rixdorf (Stęślicka 1960a, b). Dating the deposits in Siemonia to the Late Pleistocene period was the grounds for assigning an analogous age to the skull, which was an isolated find. The Siemonia skull was examined in detail by an anthropologist, Wanda Stęślicka (Stęślicka 1960b). She described this cranium as belonging to the *Homo sapiens fossilis* and recognized this specimen as the oldest known human cranial remains found in Poland at that time. According to Stęślicka (1960b), the Siemonia skull exhibited the greatest morphological similarity to the Late Pleistocene human remains excavated in Moravia, including the human remains from Předmostí and Mladeč (Stęślicka 1960b).

Main purpose and methods

Taking into account the information concerning the Siemonia skull presented above and the fact that the skull indicates a morphology specific for *Homo sapiens*, we wanted to know whether the Siemonia skull belonged to a Late Pleistocene *Homo sapiens* individual or to modern *Homo sapiens*. Thus, the main purpose of this study was to establish the age of the Siemonia skull using the radiocarbon accelerator (AMS) dating method. An appropriate sample including the bone fragment (2.49 grams; 28.0 mm × 16.7 mm), of the Siemonia skull was analyzed in the Research Laboratory for Archeology and the History of Art (Oxford OX1 3QY). To remove contaminants from the bone sample the acid/base/acid (ABA) method was used. Gelatinization and ultrafiltration were also used to select original organic molecules. According to Bronk Ramsey and his colleagues, such methods are effective at removing more recent contamination in old bones and obtaining appropriate precision in age determination (Bronk Ramsey *et al*. 2004a, b). The re-examination of this find was related to the realization of the research project concerning the existence of Paleolithic *Homo sapiens* in the region of the Upper Silesia (Southern Poland).

Additionally, the description of the qualitative and quantitative traits of the Siemonia skull by Stęślicka (1960b) was analyzed and supplemented by new information concerning the morphology of this skull. The grades of some cranial superstructures development (including the supraorbital ridge, the profile of the infraglabellar notch, the sagittal keeling, the occipital crest and the nuchal lines) were assessed according to the Lahr (1996) scoring system. The internal cranial structures (e.g., frontal sinuses) were examined using X-ray. Several exocranial measurements were taken from the Siemonia skull using a standard spreading and sliding caliper (to the nearest 0.5 mm) and a digital coordinate caliper (to the nearest 0.01 mm). The values of the angles (in degrees) were calculated based on trigonometric functions using appropriate measurements as described by Howells (1973). An attempt to extract the DNA from the left fragment of the temporal bone of the Siemonia skull was conducted by H. Witas (from the Medical University of Lodz, Poland) to obtain some information concerning the mtDNA type of this specimen. Unfortunately, the external surface of the Siemonia cranium was coated with resin substantiation to conserve the bones and thus the attempt to extract the DNA from the bone fragment failed.

Material: The state of preservation of the Siemonia skull

Of the whole Siemonia cranium, only the neurocranium is preserved, along with a small part of the left nasal bone, without the base. Of the neurocranium, the preserved elements comprise the frontal bone, right and left parietal bones, the occipital bone (in the case of the lower part of this bone only the posterior margin of the foramen magnum is preserved), the left temporal bone (with mastoid process and with a damaged external acoustic opening), and some portion of the sphenoid

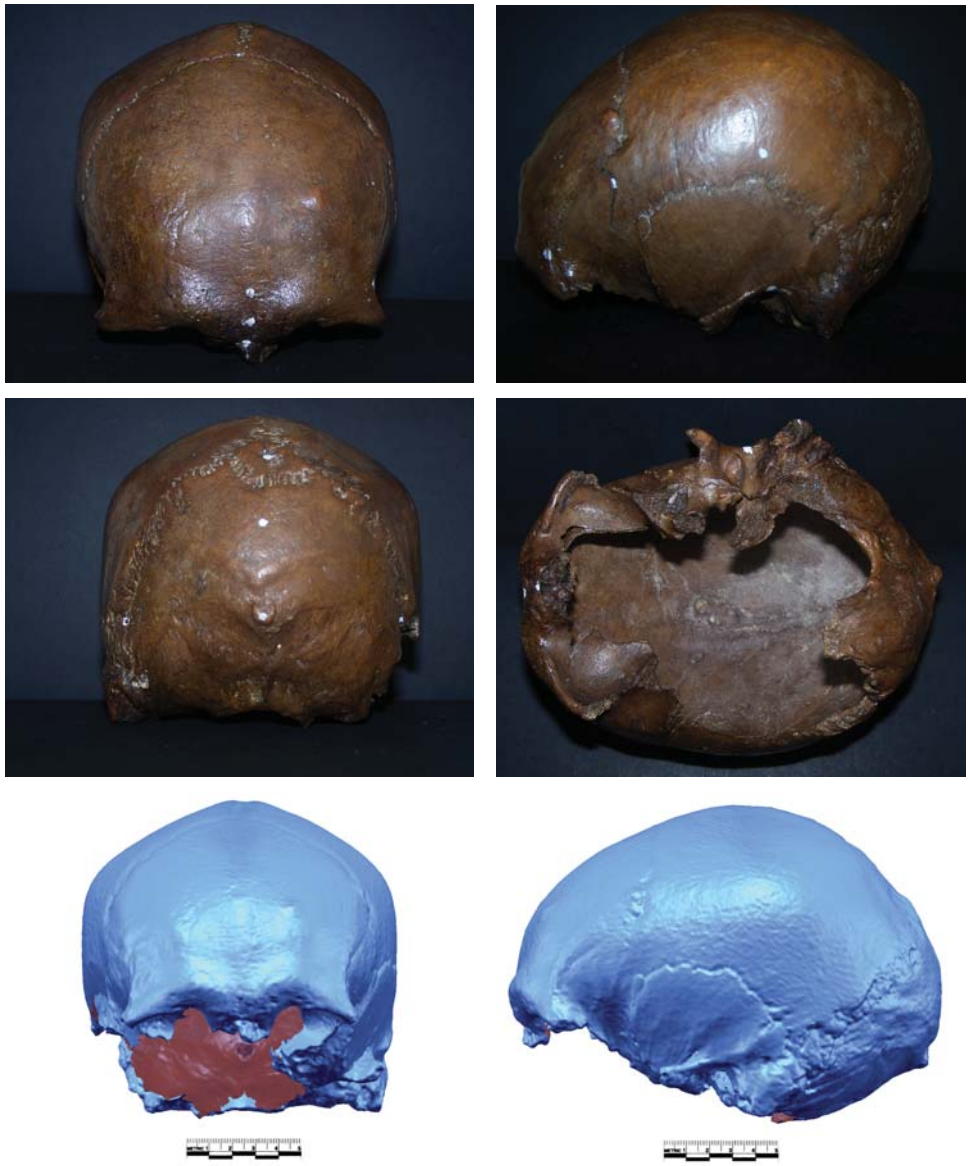

Figure 2: The Siemonia skull: (a) anterior view, (b) lateral view – left side, (c) posterior view, (d) inferior view, (e) and (f) 3D scanning of anterior and lateral side. Photo: by W. Nowaczewska, scanning by M. Mackiewicz.

bones (the parts of the greater wings) (Stęślicka 1960b) (see Figure 2a–f). Although Stęślicka (1960b, 7) suggested that the lack of the base of the cranium was the result of cannibalistic practices, there were no traces of intentional human influence (mechanical) on the shape of the margins of the vaults bones or on the external surfaces of the bones to indicate that the Siemonia specimen was a victim of cannibalism (see for comparison Bello *et al.*, 2011).

Results

The results of radiocarbon dating

The results of the dating of the Siemonia cranial bone using the AMS method indicated that the individual to whom the skull belonged derived from the Holocene epoch and not, as was previously assumed, from the Upper Paleolithic period. The Siemonia skull was dated at 819 years ± 25 (OxA-25147). The results of the calibration using the OxCal computer program (v4.1.7) of C. Bronk Ramsey and the INTCAL09 dataset (Reimer *et al.* 2009) enabled the Siemonia cranium to be dated between the twelfth century and the second half of the thirteenth century (Figure 3).

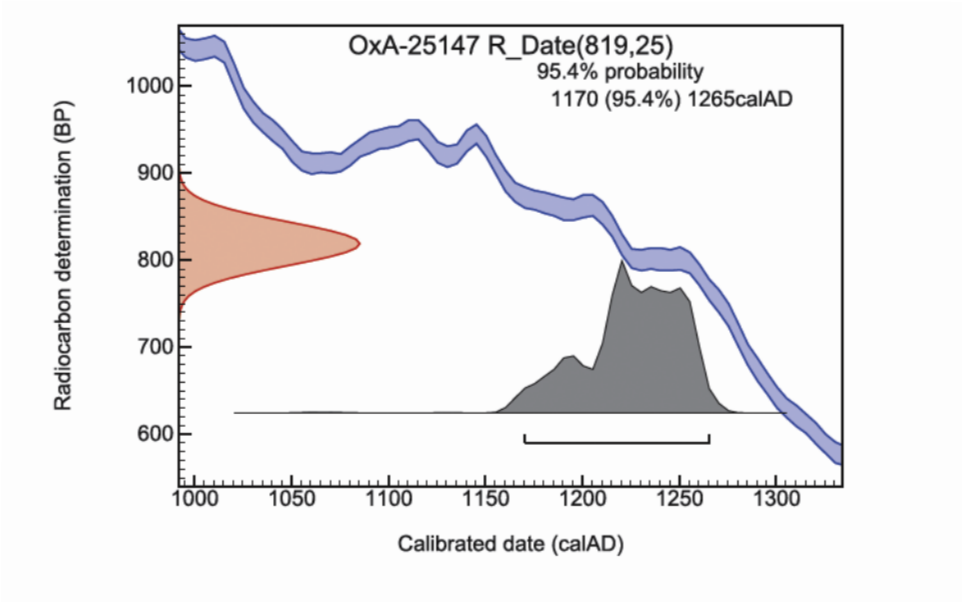

Figure 3: The calibration plot showing the calendar age ranges of the Siemonia skull using INTCAL09.

The assessment of sex and age

According to Stęślicka (1960b), the Siemonia cranium belonged to an adult male. She described this specimen as a male skull based mainly on its overall large size, including the thickness of the cranial bones (see Stęślicka 1960b, Table 3, p. 16), the high degree of development of the supraorbital region of the frontal bone and the high degree of the nuchal lines expression. In the present study, the authors' assessment of the sex of the individual from Siemonia was based on the "Workshop method" (Workshop of European Anthropologist, 1980) which also indicated that it was male skull. The age at the time of death was estimated by Stęślicka (1960b) using observation of the state of closure of the cranial sutures. Most of the sutures were clearly visible and at the beginning of the process of fusion, giving an estimated age of 20–25 years. Although this method of age assessment has recently been

considered very controversial because of the large sexual and inter-populational differences in the rates of suture closure (see e.g., White and Folkens 2000) we should remember that there were no teeth and no other skeletal remains (postcrania), thereby rendering it impossible to employ other age assessment methods.

The qualitative traits of the Siemonia cranium

The Siemonia cranium exhibits some superstructures with high grades of development, indicating that this cranium is relatively massive. The following grades of expression of the some qualitative traits are visible (assessed according to Lahr 1996 scales) in this skull: the third grade of the sagittal keeling expression, the third grade of the supraorbital ridges expression (the prominent superciliary arches), the salient region of the lateral portion (trigone) of the supraorbital part of the frontal bone; the third grade of the shape of the profile of the infraglabellar notch, the third grade of the occipital crest expression (clearly visible occipital crest between tuberculum linearum and the foramen magnum); and the fourth grade of the "occipital torus" expression – supreme and superior nuchal lines are clearly visible with strongly developed external occipital protuberance joining them medially (Figure 2).

On the surface of the Siemonia skull there are two osteomata located on the frontal squama: one is placed in the center of the structure, within the frontal eminence, and the other one can be found on the squama ridge, near the coronary cranial suture. Changes of this type are considered to be benign tumors of slow growth, which are derived from fully differentiated, mature bony tissue. Taking into account the localization in the bone and the histological nature of these neoplasms we can distinguish three types of osteoma: ivory osteoma (button osteoma), subperiosteal (parosteale) osteoma and intraosseous (medullare) osteoma. Osteoma observed on the calotta from Siemonia represented the first (and most common) type which was confirmed by X-ray analysis. Radiological images revealed tiny, very dense radiodense lesions in the outer table of the frontal squama, demarcated from the rest of the bone, which corresponds with typical features of button osteomas (Eshed *et al.* 2002) (Figures 2b and 4).

Another interesting feature of the skull was the morphological form of the occipital bone. The upper part of the occipital squama is separated from the rest of the occipital bone by the transverse suture, resulting in incomplete Inca bone formation. In the case of the cranial vault from Siemonia, this bone corresponds to type V according to the Hanihara and Ishida (2001) classification.

It should be noted that the skull was treated as a unique discovery, therefore, to protect it from the negative influence of external factors the whole cranial vault were coated with a thick layer of shellac. This substance penetrated deeply into the bone structure, which can be seen in the X-rays as a highly saturated outline of the whole preserved calotta, making it difficult to identify and assess the anatomical structures. Some of the details of the cranial anatomy are, however, possible to observe, for example, a clear radiological picture of the two nearly symmetrical frontal sinuses.

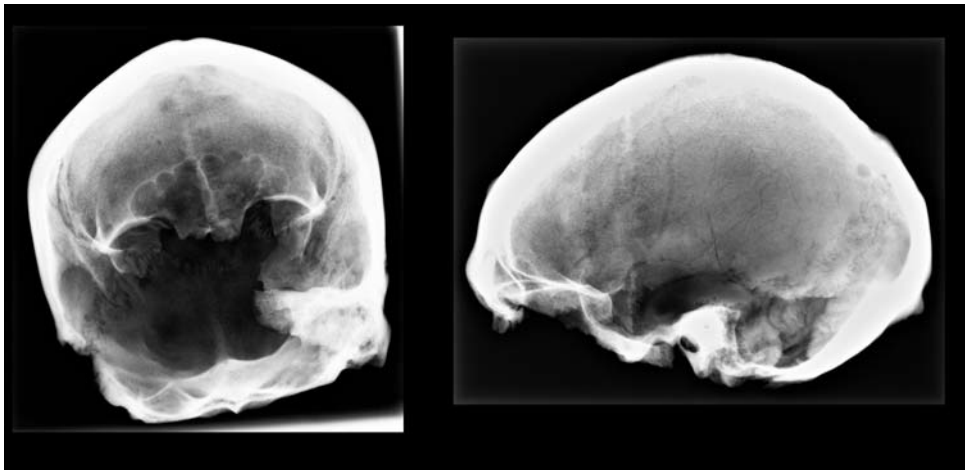

Figure 4: X-ray images of the Siemonia skull: (a) anterior view; (b) lateral view.

The right part of the sinus consists of three segments and the left of four and within them there are no visible signs of calcification and obstruction indicating on inflammatory processes (Figure 4a). X-rays also revealed lenticular, radiolucent structures along the sagittal suture; they correspond to Pacchioni granulations. In the case of the cranial vault from Siemonia their size and number do not deviate from the norm.

The quantitative traits of the Siemonia cranium

The quantitative traits (measurements and indices) concerning the Siemonia skull used in this study are presented in Table 1. Some new measurements were taken by one of the authors – i.e. they were not included in the Stęślicka (1960b) study of this specimen – using the definitions of Howells (1973) and Martin (see Bräuer 1988) (see Table 1). Taking into account that the two ossicles located in the rear part of the cranial vault (in the region of the lambda point) are not an example of a typical Inca bone and that it is highly probable that these ossicles derived from the two additional centers of ossification that appeared in the region of the posterior fontanelle during the development of this cranium (see Matsumura *et al*. 1993, Figure 10), the lambda point was located not above these two ossicles (as was the case during Stęślicka's (1960b) examination) but in the suture between these two ossicles, more specifically in the place where the extended course of each half of the lambdoid suture intersected with the midline of the cranium. This point was estimated according to the methodology suggested by Howells (1973). In the case of Stęślicka's (1960b) estimation of the lambda point, an exceptionally short arc of the parietal bones in the middle sagittal plane of the Siemonia skull was observed along with an exceptionally long arc of the occipital bone (in this plane) in comparison with the similar arcs in other *Homo sapiens* skulls (see Stęślicka 1960b, Figure 3). The new estimation of the location of the lambda point resulted in new values for several measurements related to this cranial point (see Table 1).

Table 1: The values of the quantitative traits of the Siemonia skull used in this study.

measurements and angles	abbreviation	value
maximum cranial length	GOL (g-op) – M1	194; 192*
nasion-opisthocranion length	NOL (n-op) – M1d	188*
maximum cranial breadth	XCB (eu-eu) – M8	142
basion-bregma height	BBH (ba-b) ~ M17	136##
least frontal breadth	M9 (ft-ft)	98
maximum frontal breadth	XFB (co-co) - M10	122
bistephanic breadth	STB (st-st) - M10b	117*
nasion-bregma chord	FRC (n-b) - M29	109
frontal sagittal arc	M26 (n-b arc)	125
nasion-subtense fraction	FRF – M 29c	48.5*
frontal subtense	FRS – M29b	24.7*
frontal angle	FRA – M32(5)	130.8*
bregma-lambda chord	PAC (b-l) – M30	110; 121*
parietal sagittal arc	M27 (b-l arc)	122; 135*
bregma subtense fraction	PAF – M30b	63*
bregma lambda subtense	PAS – M30a	25.9*
parietal angle	PAA – M33e	133.6*
lambda-opisthion chord	OCC (l-o) - M31	106; 99*
occipital sagittal arc	M28 (l-o arc)	136; 124*
lambda-subtense fraction	OCF – 31b	44*
lambda-opisthion subtense	OCS – M31a	33.4*
occipital angle	OCA – M33d	111.5*
lambda-inion chord	M 31(1) (l-i)	80; 68*
biasterionic breadth	ASB (ast-ast)* - M12	110#
Foramen magnum breadth	M 16	32##
indices		
(eu-eu/g-op) x 100	(M8/M1) x 100	73.2; 74*
(ba-b/eu-eu) x 100	(M17/M8) x 100	95.8
(ft-ft/eu-eu) x 100	(M9/M8) x 100	69.0
(ast-ast*/eu-eu) x 100	(M12/M8) x 100	77.5
(n-b/ n-b arc) x 100	(M29/M26) x 100	87.2
(b-l/b-l arc) x 100	(M30/M27) x 100	90.2; 89.6*

Abbreviations:
M – refers to the Martin measurement number (see Bräuer 1988); the three capital letters refer to Howells' (1973) measurement definition; * the values of the measurement taken from the Siemonia skull by one of the authors; - the other values of the measurements were collected by Stęślicka (1960b); ## the measurements estimated by Stęślicka (1960b).

To describe the metric traits of the Siemonia skull against a background of morphological variation concerning the metric traits of modern and fossil *Homo sapiens* crania, three samples of human crania were used. Two of the samples were from the Middle Ages: the first of them came from the cemetery at the Ołbin district of Wrocław (Poland) and comprised a cranium dated to the twelfth or thirteenth century CE (Kwiatkowska 2005), while the second came from a cemetery in Zalavár (in Western Hungary) comprising cranial remains dated to the ninth–eleventh century AD (Howells 1973). The third sample included Early Upper Paleolithic (EUP) crania of *Homo sapiens* (Trinkaus and Svoboda 2006). Although the results of the dating indicated that the Siemonia cranium derived from the Middle Ages, the last cranial sample was used in order to present the cranial traits of the Siemonia skull within the context of the broad morphological variation found in our species. The values of the analyzed traits of the Siemonia skull were standardized to Z-score values (Z) using appropriate statistics (e.g. by subtracting the EUP *H. sapiens* mean value and dividing by the EUP *H. sapiens* standard deviation for the analyzed variable). The appropriate metric data were taken from literature (see Kwiatkowska 2005, Tab. 11 and 14; Howells 1973, Tab. 45 and 47; Trinkaus and Svoboda 2006, Tab. 8.1). The metric traits of the Siemonia cranium standardized to Z-scores of the analyzed *H. sapiens* samples are presented in Table 2.

The values of most of the analyzed qualitative traits of the Siemonia skull are close to the mean values obtained for all three cranial samples used in this study (these values are between +/- 1 SDs). The value of the maximum cranial length (GOL) and nasion-opisthocranion length (NOL) for the Siemonia skull are closer to the mean values established for these traits for the early Upper Paleolithic *H. sapiens* cranial samples than to mean values established for these traits for the cranial samples from the Middle Ages. However, in the case of the frontal subtense (FRS) the value of this trait established for the Siemonia skull is clearly closer to the mean value of this trait for the sample from the Middle Ages (Zalavar) than the mean value of this trait for the early Upper Paleolithic cranial sample (Table 2). The results concerning the lambda-opisthion chord (OCC) and lambda-inion chord (l-i) indicate that in the case of the values of these traits established by Stęślicka (1960) for the Siemonia skull an exceptionally great distance of these values from the mean values for the Middle Age male cranial sample from Ołbin can be observed (higher than 2 SD and 3 SD, respectively). This observation is in accordance with the suggestion that the lambda point was located too high on the cranial vault of the Siemonia skull by Stęślicka (1960b). The values of the analyzed cranial indices of the Siemonia skull are very close to the mean values of these indices calculated for the male cranial sample from Ołbin (Poland) (between +/- 1 SDs).

→ → Abbreviations:
M – males; F – females; EUP – early Upper Paleolithic; X – mean, n – number of the specimens in the samples; * values of "Z" calculated based on measurements of the Siemonia skull taken from this skull by one of the authors; see Table 1 for details concerning the trait definitions.

Table 2: The measurements and indices of the Siemonia skull standardized to Z-scores (Z) of the *Homo sapiens* samples used in this study.

variables	Ołbin/(Poland) M crania (X/n)	Zalavar/(Hungary) M crania (X/n)	EUP H. sapiens F and M crania (X/n)
measurements			
GOL (g-op) – M1	Z = 1.08; Z = 0.84* (185.4/29)	Z = 1.52; Z = 1.18* (185.2/54)	Z = -0.14; Z =- 0.37* (195.2/19)
NOL (n-op) – M1d	Z = -	Z = 1.03* (182.3/54)	Z = -0.15* (189.7/6)
XCB (eu-eu) – M8	Z = 0.40 (139.3/28)	Z = 0.15 (141.4/54)	Z = 0.34 (139.8/19)
BBH (ba-b) ~ M17	Z = 0.35 (133.4/20)	Z = 0.20 (135.0/54)	Z = 0.14 (101.2/12)
M9 (ft-ft)	Z = 0.30 (96.4/30)	Z = -	Z = -0.27 (99.5/15)
XFB (co-co) - M10	Z = -0.27 (123.8/23)	Z = 0.59 (119.3/54)	Z = -0.14 (123.2/17)
STB (st-st) - M10b	Z = -	Z = -0.01 (117.0/54)	Z = -0.48 (120.6/7)
FRC (n-b) - M29	Z = -0.98 (113.3/27)	Z = -0.97 (112.7/54)	Z = -0.87 (114.3/17)
M26 (n-b arc)	Z = -0.63 (129.4/27)	Z = -	Z = -
FRF – M 29c	Z = -	Z = -0.52* (50.1/54)	Z = -
FRS – M29b	Z = -	Z = -0.83* (26.7/54)	Z = -2.73* (28.8/6)
FRA – M32(5)	Z = -	Z = 0.55* (128.8/54)	Z = -
PAC (b-l) – M30	Z = -1.23; Z = 1.11* (115.8/25)	Z = -1.10; Z = 1.11* (115.5/54)	Z = -1.19; Z = 0.09* (120.2/18)
M27 (b-l arc)	Z = -0.25; Z = 0.23* (128.7/25)	Z = -	Z = -
PAF – M30b	Z = -	Z = 1.21* (58.8/54)	Z = -
PAS – M30a	Z = -	Z = 0.28* (25.2/54)	Z = 0.87* (23.2/6)
PAA – M33e	Z = -	Z = 0.27* (132.7/54)	Z = -
OCC (l-o) - M31	Z = 2.30; Z = 0.67* (96.1/16)	Z = 1.90; Z = 0.53* (96.3/54)	Z = 1.54; Z = 0.02* (98.9/14)
OCF – 31b	Z = -	Z = -0.71* (47.6/54)	Z = -
OCS – M31a	Z = -	Z = 1.22* (29.7/54)	Z = -0.80* (35/3)
OCA – M33d	Z = -	Z = -1.04* (116.3/54)	Z = -
M 31(1) (l-i)	Z = 3.16; Z = 1.56* (58.7/26)	Z = -	Z = -
ASB (ast-ast)* - M12	Z = -0.25 (111.4/23)	Z = -0.28 (111.0/54)	Z = 0.05 (109.7/14)
M 16	Z = 0.79 (29.8/12)	Z = -	Z = -
indices			
(M8/M1) x 100	Z = -0.37; Z = -0.20* (74.9/27)	Z = -	Z = -
(M17/M8) x 100	Z = -0.05 (96.4/20)	Z = -	Z = -
(M9/M8) x 100	Z = 0.13 (69.6/27)	Z = -	Z = -
(M12/M8) x 100	Z = -0.52 (79.9/23)	Z = -	Z = -
(M29/M26) x 100	Z = -0.11 (87.6/27)	Z = -	Z = -
(M30/M27) x 100	Z = 0.13; Z = -0.25* (90.0/25)	Z = -	Z = -

Discussion and conclusion

The age evaluation of the Siemonia cranium results in placing this find in a completely different temporal and cultural context than has been assumed thus far. Those dating outcomes indicate that the skull belonged to a man from the twelfth or thirteenth century, that is a person living in the late period of the Early Middle Ages or the early period of the Late Middle Ages. There are two archeological sites from this period within this area. One of them is at a distance of just 1.6 km to the northeast (the site in the area of Góra Siewierska) and is also in the zone of the southern slope of the same river valley. The second site is located at a distance of 2.1 km to the southwest in a place called Rogoźnik. On the basis of the material found on the surface of the fields, both sites are dated to between the tenth and the thirteenth centuries (Abłamowicz 2007). The development of settlements at that time on the land of today's southern Poland is well documented, mainly from larger urban and monastic centers (Buko 2008).

The morphology of the Siemonia skull is typical for the *Homo sapiens* cranium (Stęślicka 1960b). However, this skull exhibits high grades of expression of robusticity characters and thick bones of the cranial vaults, thus overall the skull is massive. Taking into account the observation that the crania of modern humans do not show exceptional morphological traits in comparison with crania of fossil *Homo sapiens*, the relatively high massiveness of the Siemonia skull can explain why this skull was described by Stęślicka (1960b) as belonging to fossil *Homo sapiens*. Unfortunately, the results of the dating of this specimen indicate that this skull was not an example of the oldest human remains known from Poland. Currently, the oldest *Homo sapiens* remains known from Poland are represented by two distal phalanges of the hand excavated in Obłazowa Cave (located on the northern edge of the Polish Carpathians) dated to 31.0 ky BP (Valde-Nowak *et al*. 2003) and a few deciduous teeth found in Borsuka Cave (located in the Szklarka River valley near Cracow) dated to 27.0 ky BP (Wilczyński *et al*. 2012a).

Acknowledgements
The authors thank Dominik Abłamowicz and Mirosław Furmanek for valuable information. We are indebted to Maksym Mackiewicz and Andrzej Traczyk for their help in preparation of the graphics. Sincere thanks are also due to Bogusław Pawłowski.

Résumé
Dans le présent article nous présentons les résultats récents d'analyses radiométriques et anthropologiques sur le crâne humain du site de Siemonia, près de Będzin en Silésie (Pologne). Le crâne humain de Siemonia fut trouvé accidentellement par les travailleurs d´une sablière en 1955. Jusqu'à récemment, le crâne de Siemonia était considéré comme le plus vieil homme anatomiquement moderne connu en Pologne. Cependant, plusieurs datations directes du crâne par la méthode du AMS ont livré un âge holocène, à l'encontre de son attribution au Paléolithique supérieur jusque-là. D'après la calibration des dates, le crâne appartiendrait à un individu masculin du 12^{éme} ou 13ème siècle de notre ère. La

morphologie du crâne de Siemonia est typique pour l'Homo sapiens. Il n'en demeure pas moins que le crâne est massif et présente des caractères de robustesse prononcés, y compris une voûte crânienne épaisse.

Zusammenfassung

In diesem Beitrag stellen wir die Ergebnisse der neuesten Datierungen und anthropologischen Untersuchungen zu dem Schädel der Fundstelle Siemonia bei Bedzin in Schlesien (Polen) vor. Der menschliche Schädel von Siemonia wurde zufällig 1955 von Arbeitern in einer Sandgrube gefunden. Bis vor kurzem wurde der Schädel von Siemonia als ältester Beleg für den frühen modernen Menschen in Polen gewertet. Die Ergebnisse der direkten AMS Datierung des Schädelknochens zeigen jedoch, dass das Individuum im Holozän gelebt hat, und nicht, wie zuvor angenommen, zur Zeit des Jungpaläolithikums. Die Kalibration der Daten weisen auf ein junges Alter in Kalenderjahren und platzieren den Schädel des Mannes in das 12. oder 13. Jahrhundert. Die Morphologie des Craniums von Siemonia ist typisch für Homo sapiens. Allerdings ist der Schädel hochgradig robust und die Kalotte ist sehr dickwandig, wodurch der Schädel insgesamt massiv wirkt.

RETRIEVAL OF A DEVELOPMENTAL RECORD FROM DENTAL REMAINS: STRESS CHRONOLOGY AND AGE AT DEATH ASSESSMENT OF A JUVENILE SKELETON FROM A MEDIEVAL SITE IN MORAVIA, CZECH REPUBLIC

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Abstract

The study of tooth development provides an important source of knowledge about the evolution, prehistory and history of the human species. The unique ability of teeth to record physiological upsets and stressful events during the formation of dental tissues and to preserve these detailed developmental records throughout childhood and into adulthood enable reconstruction of much of the life history of an individual. The purpose of the present study was to reconstruct ages of physiological perturbations/growth disruptions, and assess age at death of a highly stressed individual (Grave 95) from the Medieval site in Moravia, Czech Republic. We analyzed accentuated lines and micro-structural growth markers of the teeth in histological thin sections. This approach utilizes microscopic internal growth markers of teeth and provides an independent chronology of dental development without relying on reference collections or modern dental developmental standards and an independent determination of age at death in skeletal remains of subadults whose dentitions were still forming at the time of death.

Keywords

Odontochronology, dental development, dental histology, accentuated increments, stress

DOI: 10.5817/CZ.MUNI.M210-7781-2015-39

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Introduction

Accurate, precise and reliable estimation of the age at death from unknown immature or mature human skeletal remains is crucial in different fields of anthropology (Katzenberg and Saunders 2008; Black and Ferguson 2011; Hillson 2014). Unfortunately, this is associated with several problems. To determine the ages of individuals from past populations, almost all of the normally applied age

estimation methods rely on reference collections and use growth and aging standards developed from modern people, mostly sex- and population-nonspecific. Determination of age at death of an individual is thus always an approximation, a probability statement with varying ranges of estimation (White *et al*. 2011). There is an approach that overcomes this problem and offers the possibility of an independent determination of chronological age, although it is limited to individuals who did not reach dental maturity (FitzGerald and Rose 2008; Schwartz and Dean 2008; Antoine *et al*. 2009; Dean 2010; Hillson 2014). This approach, based on histological analyses of dental remains, utilizes microscopic internal growth markers of teeth and provides an accurate endogenous record of tooth development.

Throughout the period of development and growth of the teeth, dental tissues are formed in periodic regularly repeating intervals resulting in distinctive incremental growth markers in both enamel and dentin. Matrix secretion is governed by various metabolic rhythms, which change the rate and mineral density of secretion over a cycle with regular periodicity, leaving microstructural time markers permanently preserved in the dental tissues (FitzGerald and Rose 2008). These features in the microstructure of both tissues correspond to each other and are often referred to as short-period markers or daily increments representing a 24-hour rhythm and long-period markers representing more than a 24-hour rhythm. Daily increments are known as *cross striations* in enamel and as *von Ebner's lines* in dentin; the long-period increments as *striae of Retzius* or *Retzius lines* in enamel and *Andresen lines* in dentin (Dean 2000; Smith 2008; Smith and Tafforeau 2008).

As ameloblasts and odontoblasts are very sensitive to physiological upsets during matrix secretion and formation of enamel and dentin, irregular metabolically stressful events may cause changes in the rate of secretion or in the structure of the matrix, and in some cases even premature cell death. Altered or incomplete matrix is subsequently mineralized, leading to a permanent record of metabolic events in the microstructure of dental hard tissues as enamel is not remodeled and changes in dentin structure are minimal. This record is visible in histological sections of teeth as *accentuated lines* or stress lines in both the enamel and dentin (Dean 2000; Smith 2008; Smith and Tafforeau 2008). As metabolic and physiological disturbances occur at a particular point in development, they are simultaneously recorded in the microstructure of all the teeth that are forming at the time of the stress event (Goodman and Rose 1990; Dirks *et al*. 2002; FitzGerald and Rose 2008; Schwartz and Dean 2008). Analyses of these growth markers make it possible to reliably reconstruct a chronology of dental development from histological sections of teeth. Accentuated lines can be used as registration lines and cross-matched between teeth. As teeth develop in an overlapping sequence, lines can be matched across the development of the whole dentition. One specific, very prominent accentuated line marking the event of birth can be observed in all deciduous teeth and in the permanent first molars. This so-called neonatal line is very important in histological aging and timing of developmental events as it forms at birth and sets age calculations to zero. In dentally immature individuals, the sequence of subsequent accentuated lines ending with the last-formed increment on the least developed

Figure 1: Macroscopic stress indicators and pathological changes observed in a highly stressed individual from a Medieval site in Moravia, Czech Republic. Macrophotography of dental enamel hypoplasia, photography of cribra orbitalia and X-ray of Harris lines (upper row, from left to right); photography of a serious antemortem shaft fracture of the proximal half of diaphysis of right femur and CT scan of a detail of the fracture (lower row, from left to right).

tooth can be used to assess chronological age at death (Dean and Beynon 1991; Dirks 1998; Reid *et al*. 1998; Thomas 2003; Smith *et al*. 2006; Schwartz and Dean 2008; Antoine *et al*. 2009; Hillson 2014).

Purpose of study

The purpose of the present study was to reconstruct ages of physiological perturbations/growth disruptions, and assess age at death of the juvenile (Grave 95) from the Medieval site Dětkovice (11th century AD), Prostějov district, locality „Za zahradama" in Moravia, Czech Republic (Fojtík 2010) using microscopic analysis of accentuated lines and microstructural growth markers of the teeth in histological thin sections.

Detailed histological study of the dental remains of this individual was motivated in part by the presence of macroscopic stress indicators, i.e. dental enamel hypoplasia, cribra orbitalia and Harris lines, and also by the presence of a serious antemortem shaft fracture of the proximal half of diaphysis of right femur that had healed (Figure 1). All epiphyses and diaphyses of long postcranial bones as well as bones of the os coxae in the acetabulum were unfused. Within the dentition, all permanent teeth had erupted and were fully in occlusion except for third molars which were in their crypts with recently completed crowns and about 2 mm of root formation. The age estimate before histological analysis using conventional methods (White *et al*. 2011), fell within the early juvenile age of 14–15 years (±3 years). An iron knife and silver coin were found outside the left hand and under the left femur respectively (Fojtík 2010). The knife may indicate grave goods from a male burial.

Materials and methods

Tooth sectioning

Histological thin sections from ten permanent maxillary teeth (11, 21, 13, 23, 15, 25, 16, 27, 18, 28) were analyzed. All teeth were gently cleaned, radiographed, photographed and replicated prior to sectioning. The plane of cut was marked on the tooth to facilitate precise orientation and produce the optimal plane of section through the dentin horns before it was embedded in resin.

Sections of all teeth except 16 and 27 were prepared in the Hard Tissue Laboratory at the School of Dental Sciences, Newcastle University, UK. All teeth were first embedded in polyester resin. Longitudinal sections approximately 1 mm thick were then cut with an annular diamond saw (Microslice II) through the midline labio-lingual axial plane of the anterior teeth (11, 21, 13, 23) and bucco-lingual plane of mesial cusps of the posterior teeth (15, 25, 18, 28). The sections were lapped on a Logitech PM2A Lapping machine with 3 micron alumina suspension. The lapped surfaces were zero-bonded to glass slides using UV-cured resin and lapped to a final thickness of approximately 100 μm from the other side, polished with 1 micron liquid diamond solution, then ultrasonically cleaned,

Table 1: Stress chronology and age at death assessment of the juvenile skeleton from a Medieval site in Moravia, Czech Republic. Italics are used to demark measurements in dentin. FDI system is used for dental notation; mb and mp represent mesiobuccal and mesiopalatal cusps in molars, b and p refer to buccal and palatal cusps in premolars.

stress	age in years	age in days	average interval in days	16 mb	16 mp	11	21	13	23	15 b	15 p	25 b	25 p	27 mb	27 mp	28 mb	28 mp	18 mb	18 mp
birth	0.00	0	0																
1	0.23	84	84	84	84														
2	0.40	146	62	59	62	64	62												
3	0.55	201	55	56	54	54	55												
4	0.67	246	45	47	44	45	45												
5	0.83	304	58	60	57	57	57												
6	0.90	329	25	24	26	24	25												
7	0.96	349	20	20	20	20	20												
8	1.06	387	38	39	38	37	38												
9	1.36	496	109		110	110	108												
10	1.53	557	62		63	61	62	62	61										
11	1.69	618	60		58	62	61	62	58										
12	1.80	656	39		38	40	41	37	38										
13	2.29	837	181		181	181	179	181	181										
14	2.89	1054	217				220	215	214										
15	3.10	1132	79				81	79	79					76					
16	3.43	1252	120				118	118	120					122	120				
17	3.82	1393	141				138	142	138	139	143	142	138	142	145				
18	4.03	1473	80					77	84	80	78	77	81	81	81				
19	4.36	1593	120					117	115	123	120	125	118	118	123				
20	4.94	1802	209					201	205	212	210	219	217	202	210				
21	5.49	2003	201						*201*	203	203	198	202						
22	6.10	2227	223						*222*	*225*			*223*						
23	7.45	2719	492						*495*	*496*			*485*						
24	8.11	2958	240						*235*	*241*			*243*						
25	8.71	3178	219						*220*	*220*			*218*						
26	9.31	3397	219						*220*	*219*			*218*						
27	9.57	3494	97						*92*	*107*			*94*						
28	10.06	3671	177						*176*	*183*			*173*						
29	10.31	3762	91						*90*	*93*			*90*						
30	10.59	3866	104						*110*	*98*			*104*						
31	10.86	3963	97						*95*	*102*			*94*			97			

stress	age in years	age in days	average interval in days	16 mb	16 mp	11	21	13	23	15 b	15 p	25 b	25 p	27 mb	27 mp	28 mb	28 mp	18 mb	18 mp
32	11.09	4046	84						*83*	*81*			*79*			91	87	82	
33	11.35	4141	95						*96*	*101*			*94*			92	95	92	95
34	11.57	4224	82						*80*	*85*			*81*			85	80	82	81
35	11.72	4277	53						53	55			*51*			53	56	53	51
36	12.07	4406	129						*131*	*135*			*125*			130	131	129	125
37	12.61	4604	197						*200*				*200*			193	*190*	202	197
38	13.08	4773	170						*171*				*176*			*163*	*165*	172	172
39	13.64	4977	204						*206*							*200*	*206*	*199*	207
40	13.69	4998	21						*20*							*21*	*20*	*23*	21
death	15.28	5577	579													*581*	*578*	*574*	*584*

dehydrated in alcohol, cleared with Histoclear and mounted with a cover slip in Histomount. Sections of 16 and 27 were prepared at the Department of Geology, Faculty of Science, Masaryk University. Both teeth were embedded in epoxy resin (Araldite 2020) prior to sectioning. Longitudinal approximately 1 mm sections were cut with an annular diamond saw (Struers Discoplan-TS cutting machine, cutting disc 200 µm) through the bucco-lingual plane of mesial cusps. The sections were lapped and polished to a final thickness of approximately 100 µm on a Struers LaboPol 21 grinder and by hand on a glass plate with an abrasive compound mixed with water, then ultrasonically cleaned, dehydrated in alcohol, and mounted in Canada balsam.

Microscopy and image analysis

Histological sections were examined using transmitted light microscopy. Observations were made with a Nikon Eclipse 50i transmitted light microscope fitted with a 10× eyepiece and 2×, 4×, 10×, 20×, and 40× objectives. Digital images were captured with a NikonDS-Fi1 microscope camera attached to the microscope using NIS-Elements 3.0 image analysis software. To visualize different structures within the tooth sections, different objectives were used and three types of images were made: (1) low-power (2× or 4× objective) transmitted light images at 20× or 40× magnification for identifying accentuated lines; (2) mid-power (10× objective) images at 100× magnification for taking measurements along enamel prisms/dentin tubules; and (3) high-power (20× objective or 40× objective) images at

200× or 400× magnification for taking measurements of daily increments. High resolution digital photomontages of the entire tooth section and particular parts of enamel and dentin were created using Adobe Photoshop from the acquired low- and mid-power adjacent images, respectively. Measurements were captured from these photomontages and high-power images using SigmaScan Pro 5.0 software.

Creating a dental chronology, timing of stressful events and assessment of age at death

In all the teeth examined, the accentuated lines were identified in the enamel of crowns or dentin of roots using criteria recommended by Goodman and Rose (1990) and FitzGerald and Saunders (2005).

Each section was analyzed to determine the number of days between accentuated lines. Intervals between them were then used to verify cross matching of stress events among teeth beginning from accentuated lines in the first molar then first incisors, canines, second premolars and second molar, and ending with the last-formed increment on the least developed teeth (third molars) which formed at death. Using this extended sequence of stress lines, a total chronology of each disturbance and age at death was assessed.

To determine the chronological ages at formation of accentuated increments, the neonatal line was marked in the first molar and considered as zero day of the chronology. Age at formation of subsequently formed accentuated lines was obtained by using measurements of the distance between daily increments rather than by counting daily increments between adjacent accentuated lines as they were mostly obscured and could not be counted completely (Dirks *et al*. 2012; Dirks *et al*. 2010). In the crown, the distance along enamel prisms from the edge of an accentuated line to the edge of another accentuated line was measured in two different areas where direction of prism path and daily increments were more clearly visible and then divided by the mean value of daily secretion rate in that area (obtained numbers of days were then averaged). The mean daily secretion rate was determined primarily by taking measurements across pairs or groups of several daily increments in series, and then dividing the total length of them all by the total number of them. In the root, the distance between adjacent accentuated lines was measured along dentin tubules from the edge of one accentuated line at its intersection with the enamel-dentin junction/cement-dentin junction to the edge of another marked line. A similar procedure of measurement and calculation was repeated until the point of cross matching was reached, continuing in the later forming teeth until the age at formation of all marked stresses was compiled and age at death assessed. Periodicity of daily increments between adjacent long-period increments was determined for all teeth. In segments of lateral enamel with a clear number of long-period striae, the obtained number of days between marked accentuated lines was divided by the number of striae. Periodicity was used for calculation of enamel formation time in the cervical region of crowns (from the last marked accentuated line). Times and ages of developmental events were summed to give the crown formation time for each tooth and estimates of the chronological ages of crown initiation and completion.

Results and discussion

Chronology of dental development

The identification of the neonatal line in both mesial cusps of the right first molar and the overlap of subsequent accentuated lines and partially developed root of the third molars allowed assessing chronological ages of developmental events. The ages at the formation of accentuated lines, i.e. the ages at which significant stresses occurred in the life of this individual, along with the assessment of the age at death are given in Table 1. The ages are given in days and years for each tooth, together with the number of days between accentuated lines. The table includes the ages for the most prominent accentuated lines, however, in total more than 70 accentuated lines were identified in teeth. There was good correspondence between the patterns of accentuated lines in those teeth in which there is an overlap in the initiation and completion of tooth formation. Successive accentuated lines in the first molar could be clearly matched with accentuated lines in the anterior teeth, and the pattern of accentuated lines in the lateral enamel and cervical region of anterior teeth could be clearly linked with the pattern of accentuated lines in second premolars, allowing registration of onset of mineralization in those teeth. In the third molars, it was possible to identify accentuated lines in the enamel that corresponded to lines in

Figure 2: Composite dental chronology for the juvenile skeleton from a Medieval site in Moravia, Czech Republic
Ages for the most prominent accentuated lines are plotted against bar charts illustrating age at initiation and completion of crown formation, root formation, and cross-match of the patterns of accentuated lines among teeth.
FDI system is used for dental notation; mb and mp represent mesiobuccal and mesiopalatal cusps in molars, b and p refer to buccal and palatal cusps in premolars.

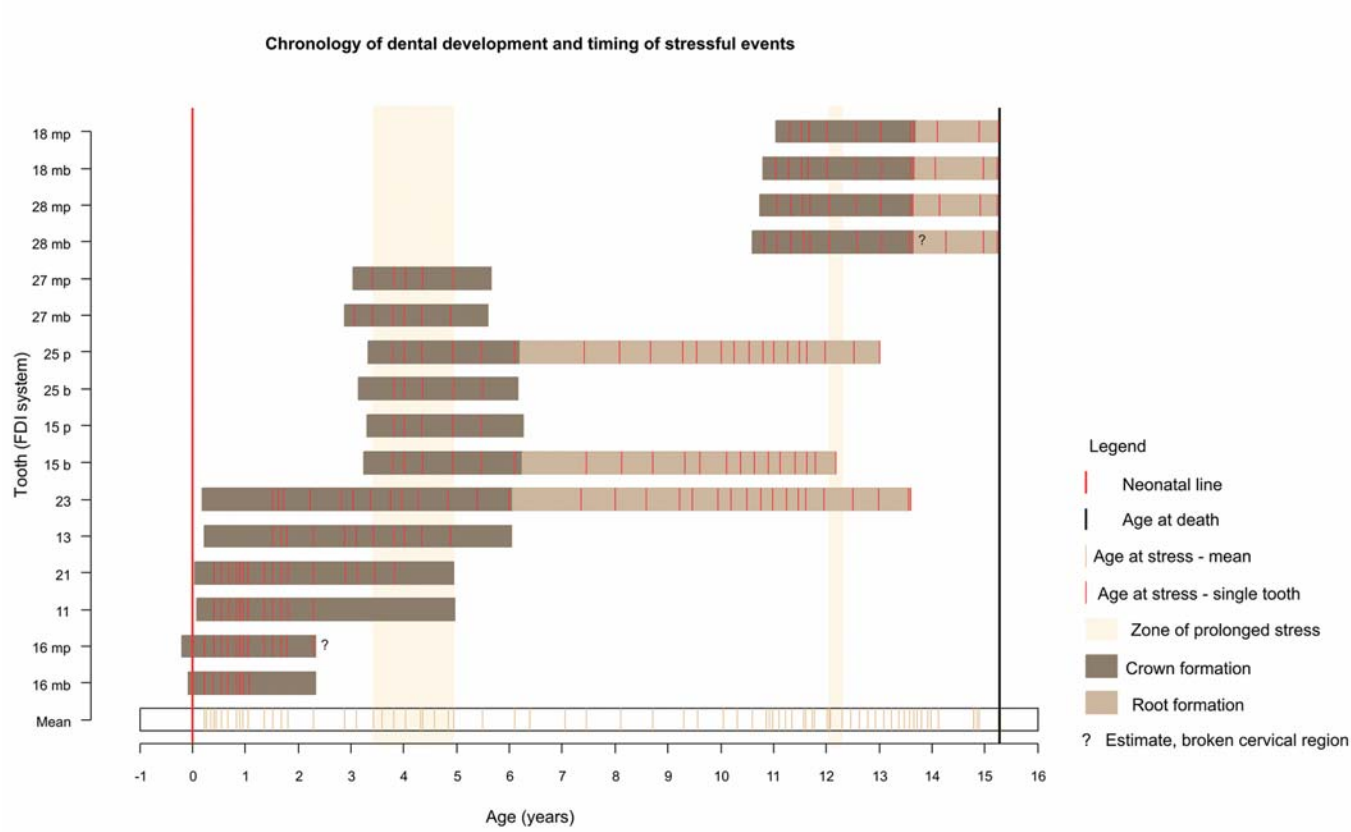

Table 2: Crown initiation, formation and completion times in the juvenile skeleton from a Medieval site in Moravia, Czech Republic FDI system is used for dental notation; mb and mp represent mesiobuccal and mesiopalatal cusps in molars, b and p refer to buccal and palatal cusps in premolars; cross signs indicate broken cervical region.

Tooth	Age at initiation in years	Crown formation time in years	Age at completion in years
16 mp	-0.08	2.41	2.34
16 mb	-0.20	×	×
11	0.08	4.88	4.96
21	0.04	4.91	4.95
13	0.23	5.81	6.04
23	0.19	5.86	6.05
15 b	3.24	3.01	6.24
15 p	3.31	2.96	6.26
25 b	3.15	3.02	6.17
25 p	3.33	2.89	6.21
27 mb	2.87	2.73	5.60
27 mp	3.04	2.60	5.65
18 mb	10.80	2.85	13.65
18 mp	11.04	2.65	13.69
28 mb	10.59	×	×
28 mp	10.73	2.92	13.65

the root dentin of the canine and premolars. The periodicity of daily increments between two adjacent long-period striae was ten. The initiation time, crown formation time and age at crown completion for all analyzed teeth are presented in Table 2. Figure 2 plots a composite developmental chronology for this individual.

Timing of stress episodes

The first accentuated line identified in the first molar can be confidently interpreted as the neonatal line, which marks the event of birth. During the first year of postnatal life, this individual experienced a high frequency of stress, which may be tied to different factors associated with the period of infancy. The accentuated lines formed early in postnatal development could be considered as markers of reactions of a generally immature (secondary altricial) human infant to adverse environmental conditions. At the age of 3.4 years, the individual experienced a very pronounced and prolonged period of stress that persisted for approximately one and a half years until the age of 5 years. This manifested on the canine crown surface as an extensive hypoplastic defect. Accentuated lines formed during this period of development may reflect nutritional stress post weaning and infectious diseases and injuries common for toddlers. After that, the most prominent accentuated lines occurred in

the life of this individual around the age of 12 years. Although it is not possible to say what the accentuated lines represent for an individual without knowing their clinical history, it is possible that these stress lines coincide with the time of the fracture of the right femur. Shaft fracture of the proximal half of the diaphysis of the right femur indicates a very strong stress episode as fractures of the proximal part of the femur are usually associated with significant blood loss and long convalescence (Špaček *et al*. 1973). Significant blood loss associated with anemia would also be consistent with the presence of trabecular type cribra orbitalia, degree III observable in both orbits, although the etiology of cribra orbitalia is still uncertain (Walker *et al*. 2009; Wapler *et al*. 2004). The appearance of the fracture and state of healing suggest that the femur was most likely broken later in life rather than when the hypoplastic defect on the canine formed, as bone broken early in childhood would be remodeled differently. During childhood, infractions or subperiosteal fractures are more common at this site, due to differences in biomechanical properties of growing bones. Moreover, this type of fracture is seen commonly in adults in modern medical practice and very rarely in children (Havránek 2002). Although the fracture resulted in significant displacement of the bone fragments (the overlap between the fragments was in the range of 80-85 mm), it healed quite well. However, the entire right leg remained shortened after the healing of the fracture, causing a pathological gait (claudication). As a result of the changed biomechanical relationships, a post-traumatic arthrosis of the knee joint could have developed, but due to poor preservation of skeletal remains it was not possible to analyze the condition of the knee joint. The age at formation of the last-formed increment, and thus the age at death of this individual, is 15.3 years. Figure 3 illustrates histological reconstruction of the developmental history of this individual from birth to death.

Conclusions

The purpose of the present study was to reconstruct the stress chronology and assess age at death of a juvenile skeleton from a Medieval site in Moravia, Czech Republic, whose skeletal remains exhibit serious pathological changes (severe fracture of the femur) and macroscopic stress indicators (dental enamel hypoplasia, cribra orbitalia and Harris lines). As this individual survived a very serious stress episode, a femur fracture that had healed, we attempted to estimate the age at which this injury occurred. We carried out a detailed histological analysis of dental remains of this individual and our findings suggest that this individual was exposed to significant physiological perturbations/growth disruptions throughout life. The high frequency of microscopic perturbations visible in histological sections of teeth as accentuated lines shows that hypoplastic defects observable on crown surface with the naked eye represent only the most visible part of a wide spectrum of the stressful events experienced. A significant accumulation of stress lines was observed during the first year of life, between 3.4 and 5 years, and around the age of 12 years. Although it is not possible to say what the accentuated lines represent for an individual without

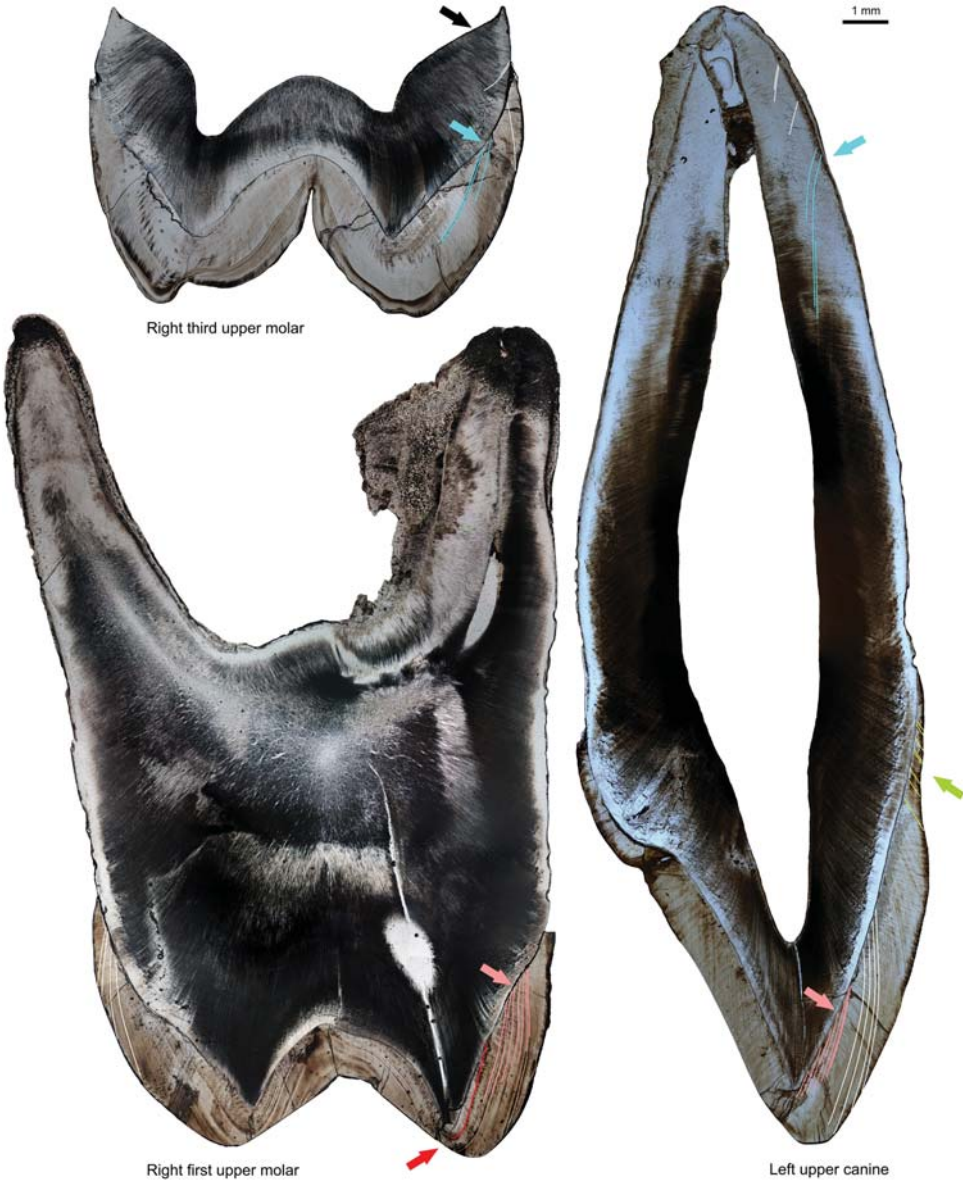

Figure 3: Low-power photomontages of the right first upper molar, left upper canine and right third upper molar in the juvenile skeleton from a Medieval site in Moravia, Czech Republic illustrating histological reconstruction of an individual developmental history from birth to death.
Red arrow points to the neonatal line, marking birth (red line); salmon arrows point to the group of accentuated lines that were formed during the first year of life (salmon lines); green arrow points to the very pronounced and prolonged period of stress at the age of 3.4–5 years, which manifested on the canine crown surface as an extensive hypoplastic defect (green lines); blue arrows point to major accentuated lines that were formed around the age of 12 years (blue lines); black arrow points to the last-formed increment which formed at death around the age of 15.3 years. Two groups of white and light grey lines illustrate a sequence of subsequent, cross-matched accentuated lines.

knowing their clinical history, we can assume, based on the type, localisation and appearance of the fracture and state of healing, that the femur was most likely broken later in life. Identification of the event of birth, the overlap of sequences of subsequent accentuated lines among teeth, and incomplete dental development of this individual also allowed assessing chronological age at death, sex- and population-independent. The age at formation of the last-formed increment, and thus the age at death of this individual, was determined as 15.3 years. The study of the developmental record in the microstructure of teeth can be a very useful and perspective tool for reconstructing stress events during the long period of ontogeny, applicable in different fields of anthropology.

Acknowledgements
We are very grateful to Pam Walton for technical assistance, advice about tooth section preparation and the opportunity for the first author to visit the Hard Tissue Laboratory at the School of Dental Sciences, Newcastle University, UK. We thank Pavel Fojtík (Institute of Archeological Heritage, Brno, CZ) for access to the material used in our study and information about the archeological research. We also thank Lenka Vargová (Department of Anatomy, Faculty of Medicine, Masaryk University, CZ) for analysis of the femur fracture, and Petr Zaunstöck (Department of Geology, Faculty of Science, Masaryk University, CZ) for tooth thin section preparation. This study is part of the EU program Formation of International Team on Evolutionary Anthropology of the Moravian Populations (FITEAMP CZ.1.07/2.3.00/20.0181). Part of this study was funded by MUNI/A/0835/2012 grant.

Résumé
L'étude du développement des dents est une source importante de connaissances d'évolution, de la préhistoire et de l'histoire de l'espèce humaine. Grâce à la capacité unique des dents pour noter les perturbations physiologiques et les événements dits éprouvants au cours de la formation des tissus dentaires et de sauvegarder ces points de développement détaillés tout au long de l'enfance et l'âge adulte, on peut de reconstruire une grande partie de l'histoire de la vie d'un individu. La présente étude a pour objet de réaliser une reconstruction chronologique des perturbations physiologiques et/ou discontinuités de croissance et d'établir l'âge achevé au moment du décès d'une personne très usée du Moyen-Âge (tombe numéro 95) trouvée dans dans une localité en Moravie, région de la République tchèque, en utilisant une analyse des lignes accentuées et les marqueurs microstructuraux de croissance dans les coups mincés histologiques des dents. Les techniques d'histologie dentaire utilisent des marqueurs de croissance interne microscopiques de dents et fournissent ainsi une référence endogène précise de développement de ces dents. Cette approche fournit une chronologie indépendante de développement dentaire sans compter sur les collections de référence ou des normes de développement dentaire modernes et une détermination indépendante de l'âge au moment du décès dans les restes de squelettes des jeunes adultes dont les dentitions étaient encore en train de se former au moment de la mort.

Zusammenfassung
Das Studium der Zahnentwicklung gibt eine wichtige Informationsquelle über die Entwicklung, die Vorgeschichte und Geschichte der menschlichen Spezies. Die einzigartige Fähigkeit der Zähne, alle physiologischen Störungen und belastenden Ereignisse während der Bildung des Zahngewebes aufzuzeichnen und diese detaillierten Entwicklungsaufzeichnungen während der Kindheit und dem Erwachsenenalter zu bewahren, erlauben es, die Lebensgeschichte eines Individuums zu rekonstruieren. Der Zweck der vorliegenden Studie war es, das Alter von physiologischen Störungen/Wachstumsstörungen zu rekonstruieren und das Sterbealter eines hochbelasteten Individuums (Grab 95) einer mittelalterlichen Ausgrabung in Mähren, Tschechische Republik, zu bestimmen. Wir führten die Analyse anhand der akzentuierten Linien und Mikrowachstumsmarker der Zähne in histologischen Dünnschnitten durch. Dieser Ansatz nutzt die mikroskopischen internen Wachstumsmarker der Zähne und bietet eine unabhängige Chronologie der Zahnentwicklung, ohne sich auf Referenzsammlungen oder moderne Zahnentwicklungsstandards und eine unabhängige Bestimmung der Sterbealter in Skelettresten von Subadulten, deren Gebisse noch zur Zeit ihres Todes in Bildung waren.

ETHNOARCHEOLOGY OF TIERRA DEL FUEGO HUNTER-FISHER-GATHERER SOCIETIES. THE SITE OF LANASHUAIA

Ester Verdún[1], Jordi Estévez[2] and Assumpció Vila[3]

Abstract
Since 1988, a Spanish-Argentinian team has been developing ethnoarcheological projects in Tierra del Fuego (Argentina). Our objective was to develop a methodology and conceptual instruments in order to go further in the study of prehistoric hunter-gatherer societies. In the frame of these projects, we excavated some archeological sites corresponding to the period of the European contact with native societies (nineteenth century). Lanashuaia was one of the excavated archeological sites. Prof. Jiri Svoboda participated in the fieldwork carried out during 1996. In this paper we present some of the results obtained of the study of Lanashuaia.

Keywords
Ethnoarcheology, Yamana tribe, Tierra del Fuego, settlement structure

DOI: 10.5817/CZ.MUNI.M210-7781-2015-40

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Introduction

An Argentinian team from the Centro Austral De Investigaciones Científicas-CONICET and a team from the Spanish National Research Council (CSIC) of Barcelona and the Universitat Autònoma of Barcelona have been involved in a series of research projects carried out since 1988 in Tierra del Fuego (Argentina). Our main objectives were to verify the ethnographic image of the native Fuegian people through archeological analysis and to test the potential and adequacy of the analytical and inferential systems in archeology (Estévez and Vila 1995a). In order to do this, we studied archeological sites that chronologically correspond to the contact moment, when the first European settlers and sailors arrived in the area.

Moreover, the recent chronology of the sites allowed our Argentinian colleagues to carry out diachronic studies in order to get a broad explanation of the variations and continuities in the hunter-fisher-gatherer economic strategies through the whole occupation sequence of the area.

The main objective of the Barcelona team was indeed the search for archeological indicators of the social relations in prehistoric hunter-gatherers. We understand ethnoarcheology as experimenting to develop systems of analysis and to evaluate the variables that allow insight to be obtained into past social relationships (Estévez and Vila 1998; Vila and Estévez 2000). Going beyond ethnographic direct analogy, actualism and uniformitarianism or simple environmental determinism, we would see: a) how we can demonstrate and measure social inequality archeologically; b) what the indicators of the inequality in a known hunter-fisher-gatherer society are; c) what kind of indicators we could find archeologically for social organizations of prehistoric societies; and d) how we can obtain the significant archeological record of the indicators for inequality. Thus we started from an ethnographically and historically well-known society, which could be studied both with archeological methods and through the study of historical and ethnographic sources. The excavation and analysis of the archeological evidence of sites dated from the European first contact time will serve as a methodological control experiment.

We assumed that social relationships materialize during the processes of production, distribution and consumption of economic goods. The archeological evidence is composed of abandoned items and consumption remains discarded in a settlement. The organization of the human use of space during these processes is something that has to be analyzed prior to considering the distribution of remains as a random feature. The possibility of a random nature of deposition has to be demonstrated in any case. Thus we believe that we can potentially reconstruct the social organization behind those processes through the analysis of the organization and the character of those remains.

The detailed ethnographic records (such as chronicles, graphs, photographs, film, etc.) about the Yamana indigenous society living in the area (e.g. Hyades and Deniker 1891; Bridges 1975; Gusinde 1986) and the archeological context (e.g. Orquera and Piana 1999a) of the coasts of the Beagle Channel were the most appropriate way to find answers to all these questions.

The Yamana were a hunter-fisher-gatherer society with a high mobility subsistence strategy, based mainly on littoral resources and the use of canoes, organized through a sexual division of labour and inequality between men and women. They inhabited the coastal area from the Fuegian Channels southwards to Cape Horn.

Shell middens are a common type of site in Tierra del Fuego. Most of the sites are composed of a high-density accumulation of mollusk shells (mainly mussels and limpets) and other remains of littoral resources (Orquera 1999; Piana and Orquera 2010; Verdún-Castelló 2014b). In general, they are the result of a succession of short occupation periods of the same spots, as is described in the ethnographic chronicles (Gusinde 1986).

Figure 1: Adaptation: Jiří Svoboda at Lanashuia drinking the typical Argentinian "mate."

The sites are very easy to localize because they are formed by discrete occupation units that can be perceived on the landscape as a series of concavities surrounded by a raised ring on the surface. In the sites we excavated we could relate garbage areas constituted mainly by mussel middens with other areas that were cleaned. The sites were formed by the accumulation of deposition lumps produced during successive short and discrete episodes of occupation and that could be separated during excavation. Thus we could analyze the recurrences in the consumption and deposition patterns that are the consequences of the social organization of those processes. Therefore we propose our ethnoarcheological experience as a reference frame for other cases (Vila *et al.* 2010).

Here we present some preliminary archeological results obtained from the study of the Lanashuaia site (Figures 1 and 2).

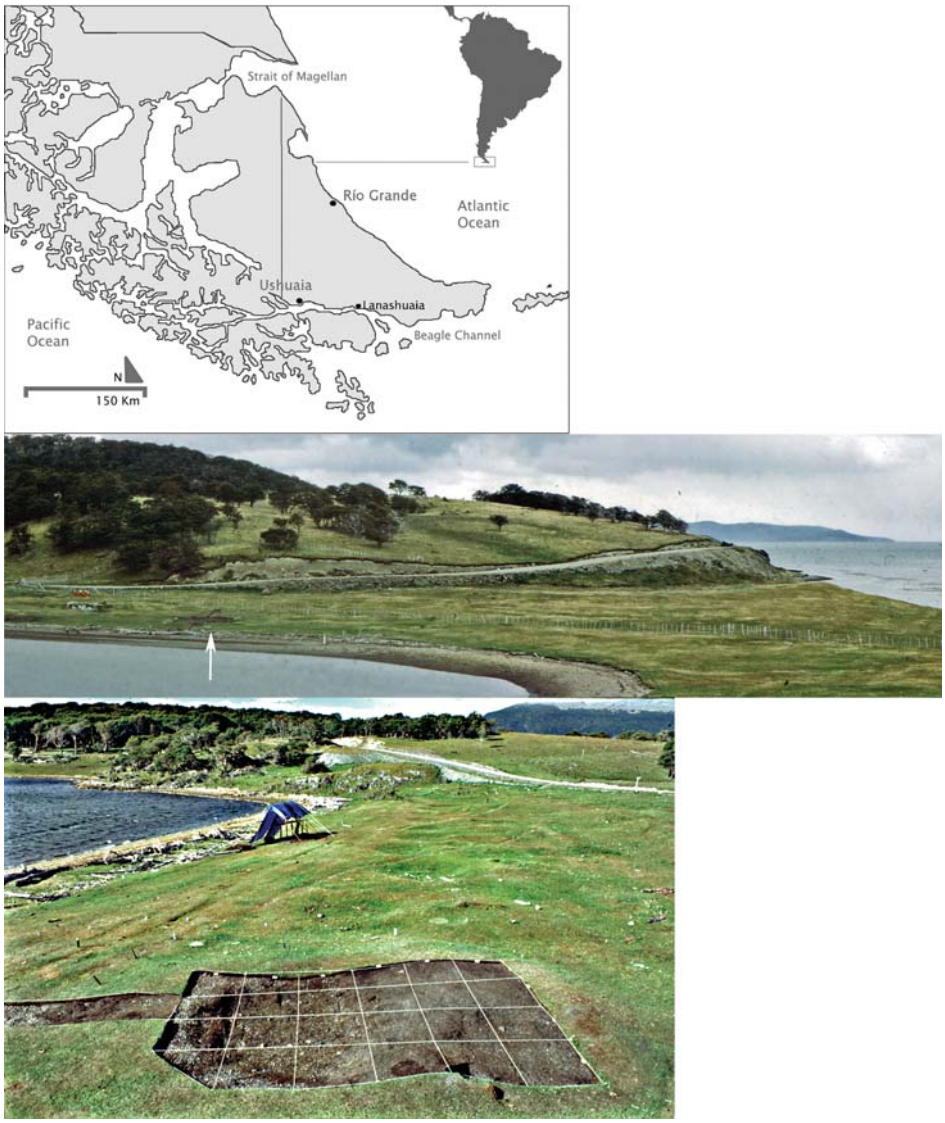

Figure 2: Map of Tierra del Fuego. Lanashuaia site landscape (white arrow signals the emplacement of the site). Concavity of the hut excavated during 1995.

The site

The Lanashuaia site is located in Isla Grande de Tierra del Fuego, on the northern coast of the Beagle Channel (Argentina) (Piana *et al.* 2000), in the isthmus between the inner and outer Cambaceres bays (54°52'48.79"S; 67°16'22.77"W). Lanashuaia was excavated during 1995 and 1996 and in the frame of the European Union project "CEE-CI1-CT93-0015: Marine Resources at the Beagle Channel prior to the industrial exploitation" (1994–1997) and the project "The integrity of the social space: ethnoarcheology of settlements in the Beagle Channel, Tierra del Fuego (2004–2005)" (Ministerio de Cultura, Gobierno de España) (Piana *et al.* 2000; Estévez and Vila 2007; Vila *et al.* 2007; Estévez, Vila and Piqué 2013).

Like most of the sites in the area, Lanashuaia is part of a set of similar structures that are located along the coastline. The excavated area corresponds to one of these structures, which has been interpreted as an occupation unit (the remains of a hut). It is composed of an annular raised rim surrounding a central depression (Piana and Orquera 2010). The central area of the excavation corresponds to the place where a hut was located (Piana *et al.* 2000). It was originally slightly dug out, taking advantage of the natural relief of the beach. According the ethnographic information, Yamana people used branches and some skins to build their huts (Gusinde 1986; Orquera and Piana 1999b). Marks of postholes and the spatial distribution analyses of the archeological remains delineate a circular structure of c. 3–4 m in diameter with a central fireplace, which is very common in the Yamana area (Piana and Orquera 2010). The entrance to the hut was facing the beach (to the east) and was located on an old storm berm. The ring surrounding the central depression was a protection against the rain and the wind (Verdún-Castelló 2010). It was built up by the earth extracted from the central depression and by the deposition of shell lumps.

Stratigraphic structure of Lanashuaia

The stratigraphic structure of the shell middens is very complex (Orquera and Piana 1992; Estévez and Vila 2000). It is composed of the accumulation of discrete waste packages, which represent singular moments of deposition. Thanks to a specially developed excavation methodology (Vila *et al.* 2010) we have been able to distinguish stratigraphic subunits ("*minimal unities of stratigraphical deposition*"). Each subunit represents a discrete period of time (a single moment or a long period of continuous deposition). The differentiation among them is achieved through the identification of stratigraphic layers (compacted trampled surfaces, discontinuities on the sedimentary structure, etc.) and by the recognition of variations in the deposit structure and composition (Orquera and Piana 1992). These differences have been confirmed by the study of soil micromorphology as well (Balbo *et al.* 2010). We could therefore isolate different successive activities of residue deposition and establish intra-site patterns of space management (Mameli *et al.* 2002; Mameli and Estévez 2004; Estévez and Vila 2006).

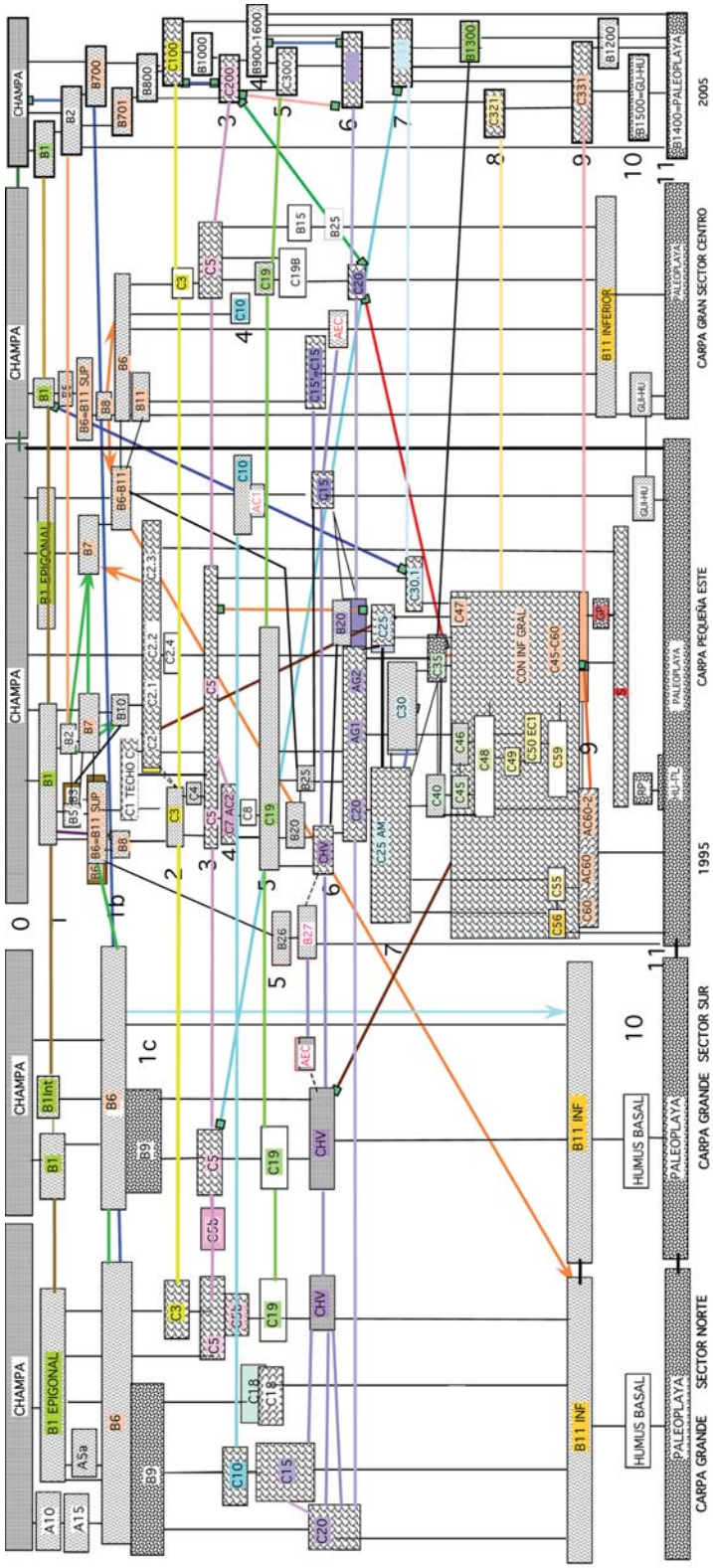

Figure 3: Stratigraphic structure of Lanashuaia site: boxes signal stratigraphic subunits; arrows indicate refittings.

In Lanashuaia, we could identify different deposition units in the shell midden. However, only one (maximum two) different occupation periods have been registered (Figure 3). This differs from most of the excavated shell middens in the area, where different occupation moments have been documented (Orquera and Piana 1999a; Estévez and Vila 2006). For this reason, we think that Lanashuaia could correspond to an occupation period longer than other sites. The location of the occupation structures following the shoreline, the documentation of minke whale (*Balaenoptera acutorostrata*) bones at the bottom of these units and the information afforded by the ethnographic data (e.g. Gusinde 1986) led us to conclude that Lanashuaia could correspond to a social aggregation of different social units in order to consume a stranded whale (Piana *et al.* 2000).

Methodology

The 93 m^2 whole area of a circular structure and the surroundings in Lanashuaia have been excavated. Moreover, two trenches (one to the sea and another one to the opposite side) have been excavated in order to verify the extension of the occupation area and the deposition of the remains.

The site has been excavated isolating and extracting each one of the stratigraphic subunits. All the remains larger than 1 cm^2 have been registered using a total station. In addition, we implemented an experimental program in order to understand the formation processes of the site (Juan-Muns 1993; Estévez and Mameli 2000; Mameli *et al.* 2002). We did experiments of sampling strategies for malacological remains (Verdún-Castelló 2014a), fish remains (Juan-Muns 1993), soil micromorphology and chemical composition of the soil. The results demonstrate that a sample of 1 dm^3

of sediment (for subunits without shells) or 4 dm^3 (in shell midden subunits) was statistically representative. We collected homogenized sedimentary samples from each stratigraphic subunit for the analysis of malacologial and fish remains and recorded the total volume of each subunit during fieldwork to estimate the total amount of fish and mollusks (Orquera and Piana 2000, 2001).

The analysis of the production and consumption of goods involves the study of the archeozoological record together with lithic tools (Briz *et al.* 2005) and other remains in their spatial context. In order to get a complete interpretation of the site, the articulation of working activities should be analyzed: all the processes of manufacturing utensils and tools, the resharpening and recycling of tools and other items, butchering, dismembering, cooking, distribution of products (qualified by their real and consumption values) and lastly the consumption of goods and food. To do this we analyzed the spatial distribution and densities of consumed goods and residues as well as the refitting of skeletons, broken bones and debitage. Refitting was not only designed to fix stratigraphic links and to control postdeposition processes but to accomplish the identification of activity and reject areas, the intra-site circulation of products and the articulation of working activities such as processes of flaking, using, resharpening and recycling tools and other items, or butchering, dismembering, cooking and consuming food, and lastly the way of rejecting residues and the maintenance of the living areas.

Dynamics of the animal resource management strategies

In Lanashuaia, food remains and the accumulation of shells are mostly concentrated in the circular ring that surrounds the central area of the hut, in the outer area east of the hut and to the north of the entrance as well. Two fireplaces have been recorded: one in the central area and another one behind the hut surrounded by a stone knapping area.

Although in Lanashuaia only one occupation moment (perhaps with a short lapse of absence) has been recorded, we also observed significant changes in the NISP of vertebrate taxa during its longer-lasting but maybe unique period of occupation. There was a concentration of cetacean bones at the base of the occupation, deposited in two specific areas of the hut: an accumulation of mainly entire ribs in the outer area of the structure, opposite to the entrance, and another accumulation of fragments of crushed epiphysis that was located inside the hut in the northern corner. Two patches of sediments with a high content of fat besides two accumulations of heated pebbles were documented outside the structure, one to the south and another to the south-east. The fatty acid studies applied to these pebbles revealed that they were related to the processing of marine fauna, probably whale (March unpublished manuscript). There was also a large accumulation of these heated pebbles at the base of the shell midden mound towards its eastern periphery.

In the successive shell midden deposits, first the avian remains predominate (Mameli and Estévez 2004) and later the remains of guanaco, sea lion and finally fish successively increase.

The archeo-malacological remains cover directly the cetacean ribs lying on the basal floor. Mollusks are the most abundant taxa in the site. A total number of 345, 165 mollusks and 320 sea urchins were estimated. The most abundant (73.8%) edible species is mussels (*Mytilus edulis* LINNÉ, 1758), then limpets (8.7%) (*Fissurella*, sp. BRUGUIERE, 1789, *Nacella deaurata* GMELIN, 1791 and *Nacella magellanica* GMELIN, 1790) and finally chitons (3.6%) (*Plaxiphora aurata* SPALOWSKY, 1795, *Tonicia* sp. GRAY, 1847, and *Chitonina* THIELE, 1909). The amount of chitons is significant since such a large quantity has not been documented in other sites of the Beagle Channel (Verdun-Castelló 2014b).

Biometric analyses have been applied to the most important species (*Nacella deaurata*, *Nacella magellanica* and *Mytilus edulis*). They show significant differences between the size obtained from the archeological and the size from collected modern specimens since the archeological shells are significantly smaller than the modern ones. This difference could indicate an intensive use of this resource (Verdun-Castelló 2014a, b).

Morphometric analyses applied to the same species show that mollusks have been collected across the whole intertidal area but mainly the lower zone (Verdun-Castelló 2014b). Furthermore, it has been demonstrated that most of the mussels were collected in the outer Cambaceres bay. Oxygen isotopic analyses and readings of growth increments applied to *Nacella magellanica* indicate that these individuals were collected predominantly in autumn-winter (Colonese *et al.* 2011; Verdún-Castelló 2014b).

Discussion

The study of the Lanashuaia site together with the data obtained from Túnel VII, the other settlement that we excavate also situated on the Beagle Channel shores, allow us to obtain a description of the socio-economic activities carried out by the last hunter-fisher-gatherer groups of the Beagle Channel before the settlement of the European people. The Túnel VII site is located 60 km west of Lanashuaia and both have similar characteristics (Estévez and Vila 1995b, 2006; Estévez and Clemente 2013).

In relation to the consumption of mollusks, the collecting of species that can be found in the intertidal area has been recorded at both sites as well as in samples of older sites (Orquera and Piana 2000, 2001). However, Lanashuaia shows a higher consumption of chitons than the other sites (Verdún-Castelló 2014b).

Regarding the management of vertebrate faunal resources, Lanashuaia presents some differences from the occupations of the Túnel VII site. Divergences in the taxonomical composition of the assemblages have been detected. These differences could be related to the duration and nature of the occupations, the season when the sites were occupied (resources availability), and the activities (types and intensity) carried out in each occupation event (Estévez and Vila 2006).

At both sites, people worked in knapping and formatting stone tools, both in and outside the huts. The raw materials for stone tools are local, but differ in their

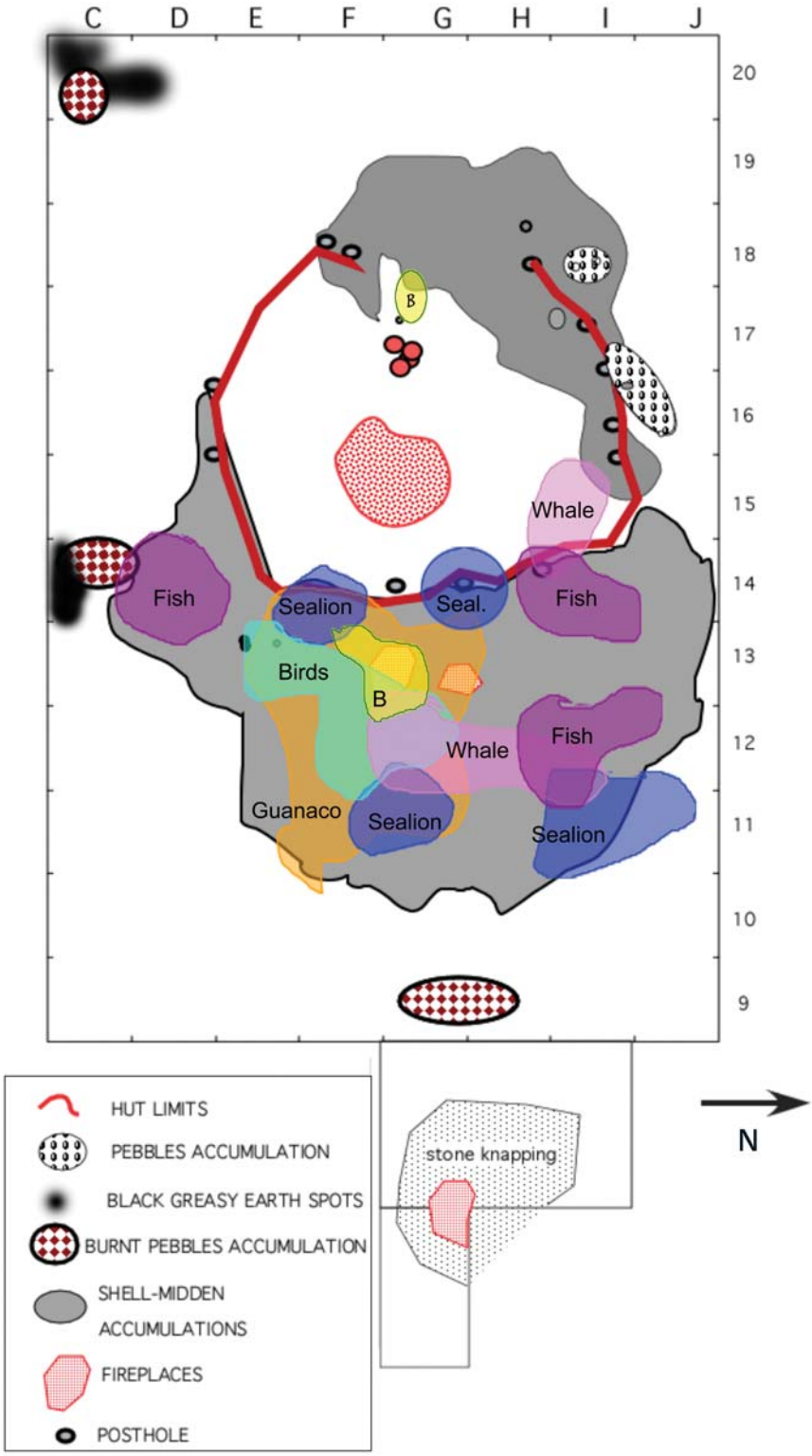

Figure 4: Distribution of the main features of the occupation unit of Lanashuaia. The significant concentrations of bone implements (B), fish (Fish) and bird bones (Birds), sea lion remains (Sealion), whale (Whale) and guanaco bones (Guanaco) are displayed.

relative frequencies. The proportions of stone tools used to modify different types of raw materials are also very similar (predominantly they have worked on wood and soft animal tissues), but in Lanashuaia there are more tools for preparing hides and in Túnel VII more tools for manufacturing objects in bone. This coincides with a higher abundance of guanacos in the first site and with more objects made from animals' hard tissues in the Túnel VII site (Clemente and Terradas 1993, 2009).

Some extraordinary remains in the habitation structures may be related to ideational activities. There is a coincidence of consuming rare birds at the beginning of the occupation of both sites: Austral parakeet has been consumed during the first occupation of Túnel VII and some rare King Penguin remains have also been deposited at the very beginning of Lanashuaia's occupation.

Thus, over a short period of time, people adopted a wide range of strategies to adjust to small environmental variations in space and time. We called this strategy "nonspecialized specialization" (Gassiot and Estévez 2006), because although relying on a broad spectrum of resources, they were caught very efficiently and with a wide range of specialized and curated tool kits.

The spatial distribution of remains allows us to make a first approach to the analysis of the formation process of the Fuegian shell middens and to the recurrences in the processes of exploitation, distribution and consumption of resources (Figure 4). In Lanashuaia and Túnel VII, food remains (both shells and bones) are deposited mainly in the shell midden around the hut (Estévez and Vila 1995b, 2006; Estévez and Clemente 2013). We interpreted this as result of the task of cleaning and maintenance of the habitation area. However, remains are not randomly distributed but concentrated differentially in space, suggesting also differences in the consumption.

The presence of whalebones at the base of Lanashuaia has been recorded in Túnel VII as well. This indicates that Yamana people selected both emplacements first due to the nearby presence of this type of resource (probably a beached whale). The nonrandom distribution of remains stated and the simulation of sampling procedures showed that we need samples from broad excavated surfaces to get an adequate picture of the global content of a site. The faunal remains on living surfaces have to be treated differently than on rubbish mounds. The latter are the results of maintenance work and are therefore not entropic, but can provide a good dissection of the process of formation of the deposit.

In Lanashuaia it could be proved that a long-lasting episode can result in very similar archeozoological evidence, like a sum of short, more specialized occupations. In the Túnel VII site it has already been demonstrated none of the occupation episodes represent a meaningful sample of the global strategies over a century.

Conclusion

In Lanashuaia we were able to document some ethnographic well-described fundamental features through archeological research. We have seen an intensive broad spectrum use of resources emphasizing littoral resources. Also we have

remarked that the exploitation of mollusks, although maintaining great pressure on them, was organized in a sustainable way. The size of the collected specimens was smaller than today's ones, but it did not change significantly during the sequence of occupation. This demonstrates that the population of mollusks did sustain the collecting pressure of native people.

Furthermore, the results indicate differences in the spatial distribution of residues within the area where the hut was located, but we still don't know whether these differences refer to or are caused by the inequality between men and women inside the social units, as documented in the ethnographic record.

Differences and similarities with the ethnographic record referring to the same Yamana group that produced the excavated settlements will allow us to refine the methodology, especially in regard to the social organization of this group. As we have said, our objective is to develop a methodology that could be applied further to prehistoric hunter-fisher-gatherer societies.

Acknowledgements
This work has been funded by research funds of the Spanish Research Agency of the Ministry for Science and Technology and is supported now through the project HAR 2011-24356.

Résumé
Depuis 1988, une équipe hispano-argentine développe des projets ethnoarchéologiques en Terre de Feu (Argentine). Notre objectif est de développer une méthodologie et des outils conceptuels dans le but d'étudier les sociétés de chasseurs-cueilleurs. Dans le cadre de ces projets, nous avons fouillé plusieurs sites archéologiques correspondant à la période du contact entre européens et sociétés natives (XIXème siècle). Lanashuaia est un des sites qui a été fouillé. Le Professeur Jiří Svoboda a participé à la campagne de terrain conduite en 1996. Dans cet article nous présentons quelques-uns des résultats obtenus lors de l'étude de Lanashuaia.

Zusammenfassung
Seit 1988 entwickelt ein spanisch-argentinisches Team ethnoarchäologische Projekte in der Tierra del Fuego (Argentinien). Unser Ziel war es eine Methodologie und konzeptuelle Instrumente zu entwickeln, um tiefer in das Studium prähistorischer Jäger/Sammler Gesellschaften einzudringen. Im Rahmen dieser Projekte haben wir einige archäologische Fundstellen, die aus der Zeit des Kontaktes der Europäer mit indigenen Gesellschaften (19. Jh.) stammen, ausgegraben. Prof. Jiří Svoboda nahm an den Feldforschungen während des Jahres 1996 teil. In dieser Arbeit präsentieren wir einige Ergebnisse der Studien in Lanashuaia.

SARAY AL HAMRA : THE UNESCO PROJECT FOR BUILDING THE NATIONAL HISTORIC MUSEUM IN TRIPOLI, LIBYA (1979–1981)

Ivan Ruller

It is a great pleasure to join the group of contributors who commemorate in this way to the beautiful birthday of Professor Jiří Svoboda.

Abstract
During the years 1979–1981 the new building of the National historic museum in Tripoli, Libya was projected and located as a part of old fortress in the area of Saray al Hamra on coast of the Mediterranean Sea. This UNESCO project was launched by the framework of its ICOM organization, at that time leaded by President Professor Jan Jelínek, who was organizing the whole project and other short-time expeditions to Libyan terrain. This expedition involved several other people with different field of scientific, artistic or craft interest, namely Květa Jelínková, Jiří Svoboda, Ivo Ruller, Valér Kováč, Stanislav Hrbek, Jiří Pink, Gustav Morávek and Karel Mejzlík.

Keywords
ICOM, architectural project, Libya, museum, field expedition

DOI: 10.5817/CZ.MUNI.M210-7781-2015-41

Introduction

I first met Jiří when working on the design of the new building for the National historical museum in Tripoli, Libya, which was was projected and located as a part of old fortress in the area of Saray al Hamra on the Mediterranean Sea coast. This UNESCO project was launched by the framework of its ICOM organization, at that time leaded by President Professor Jan Jelínek, who was organizing the whole project. In the years 1979 to 1981, a young, promising and enthusiastic anthropologist and archeologist, Jiří Svoboda, worked in this team. I, as architect, had to work out all the basic documents needed for the solution of this building, the study and the general layout plan, on the basis of which an American company made the

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contract documentation. The next phase of our work consisted in the design of the interior spaces of the building and of the whole exhibition, according to the scenario devised by Professor Jelínek. The last phase of our mission consisted in the field survey of some examples of Berber vernacular architecture on the Jabal Nafusa plateau, as showpieces of the exhibition. This took place in 1981 when our activity on the museum, started in 1976, was finished.

Persons involved to our expedition

Jiří Svoboda was engaged in the historical and archeological evaluation of these vernacular monuments, the artist Valér Kováč made drawings and I, as architect, was responsible for their survey, layout and photographic documentation. As part of this activity, an exhibition was arranged on the occasion of Libya's jubilee. Beside Professor Jelínek, Valér Kováč and me, the craftsmen Stanislav Hrbek, Jiří Pink, Gustav Morávek and Karel Mejzlík co-operated in the preparation of the exhibition. Apart from our professional duties, we used to spend the evenings in the fortress, in which we were accommodated. And there Professor Jelínek, an eminent scholar of rare talent, passed on to us his unique experience gained in his expeditions all over the world. He acquainted us with the unknown facts of the life and culture of prehistoric man. These common evenings were the most beautiful moments of our expedition. Several times, Mrs. Květa Jelínková, M.D., joined our expedition and cared for the state of health of her husband who was weakened after a disease. Further members of the expedition were Michal Tůma, photographer, Jiří Vrožina, cameraman of Czech TV, and Vilém Gebauer, taxidermist of the provincial museum in Brno. The administrative aspects of the successful course of the whole expedition were arranged for by Dr. Věra Slaná and Dr. Alena Mizerová. The commercial aspects of the expedition were arranged by Artcentrum Prague, a national enterprise headed by JUDr. Hubert Matějíček, general manager, PhDr. Jauris and Ing. Častulík. They repeatedly accompanied our expedition. Earlier, apart from the main mission, in the framework of UNESCO, we carried out architectural studies of Sabha and Cyrene, and a comprehensive project for the reconstruction of the regional museum in Jarmah, in the center of the Sahara.

Our Libyan fieldworks

As regards the survey and investigation of the historic vernacular architecture, it concerned mainly the so called *gasrs*, fortified structures containing small storerooms for grain and oil, usually at least one for each family. They provided the necessary protection of foodstuffs against enemy raiders. The amazing variety of forms of the individual structures, and their dominant location in the landscape, were very interesting and impressive. The biggest one, Ben Irian, situated on a rocky tongue of land above the Zafarah plain extending to the Mediterranean Sea; the oval-shaped Kabao and the oblong Nalut, with built-in narrow alleys, were the most interesting ones.

Figure 1: Historic vernacular architecture “gasr”, drawing by Valér Kováč.

Figure 2: Jiří Svoboda with Valér Kováč and Libyan guide, Jabal Nafusa Mts., Libya. Photo by author.

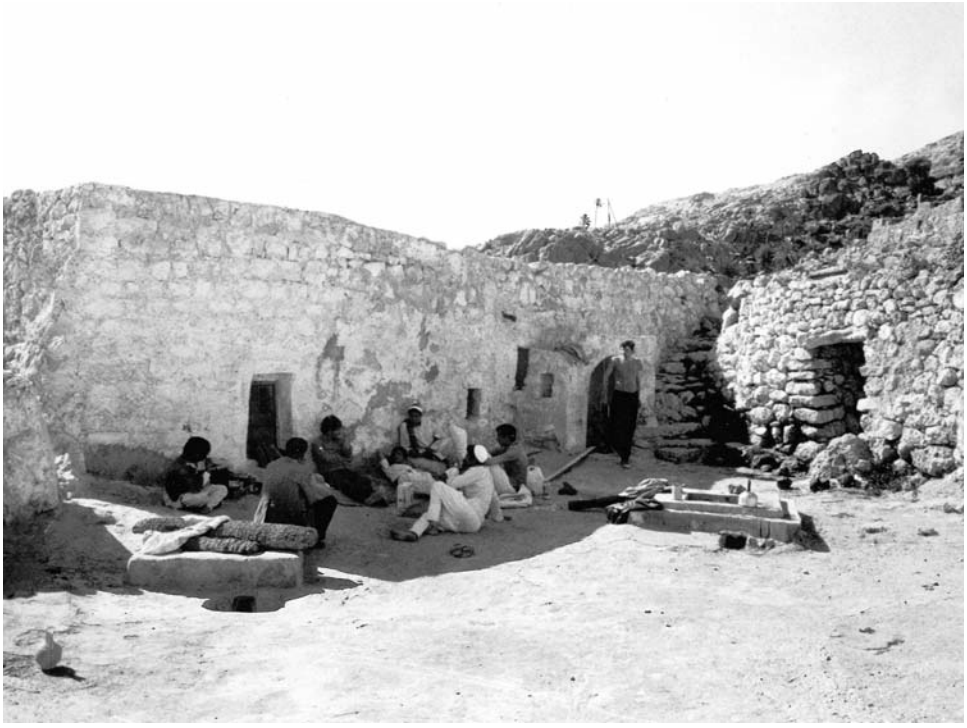

Figure 3: Forsatta before the mosque, Jabal Nafusa Mts., Libya. Photo by author.

Figure 4: Historic vernacular architecture “gasr”, drawing by Valér Kováč.

Figure 5: Afternoon break, Jabal Nafusa Mts., Libya. From left: Shiruz the lonely local inhabitant, Valér Kováč, Ibrahim the antiquities inspector, the antiquities driver and Ivan Ruller.

→ Figure 6: Before the expedition car, Jabal Nafusa Mts., Libya. From left: Valér Kováč, the antiquities driver, inspector Ibrahim and Jiří Svoboda. Photo by author.

→ Figure 7: Berber pastoralist and his goat, Jabal Nafusa Mts., Libya. Photo by author.

Figure 8: Mara but Graves, Jabal Nafusa Mts., Libya. Photo by author.

However, the most impressive was Forsata, a hill built-up with individual cells. Its monumental and dynamic form dominated the dramatic African landscape. Another group of surveyed structures were the mosques – Al Baruni, Shiruz, Um Al Tubul, Abú Kár, and Forsata, some of which included a small religious school. There were also small works: *Mara buts*, sacrificial shrines, as well as an extensive cemetery in Tiji, below the plateau, the forms of which evoke the contemporary expressions of modern sculpture, as well as keeps or underground troglodytic shelters.

We also made an interesting visit to an olive press workshop, with an old, ingenious and functioning technology, in the community of Rhadat. Quite different were our impressions of the visit to the old, relatively well preserved antique cities, the Roman Leptis Magna and Sabratha on the cost of the Mediterranean Sea, and the Greek city of Cyrene, inland, in the so called green mountain chain. A special task was the survey and documentation of prehistoric rock engravings in a series of dried up river valleys, rich in art expressions of prehistoric humans, found on the rocky banks and bearing testimony to the Sahara's former character. This task fell on Jiří Svoboda, Professor Jelínek and Vilém Geabauer.

Conclusion

The whole expedition was a great adventure and lifelong experience, enriched, in addition, with the ties of friendship with Professor Jelínek, Jiří Svoboda and other participants of the expedition.

Résumé
Au cours des années 1979–1981, la construction d'un nouveau bâtiment destiné à abriter le Musée historique national de Tripoli, en Lybie, fut projetée au sein de la vieille forteresse dans la région côtière de Saray al Hamra, en bord de Méditerranée. Ce projet Unesco fut initié par l'organisation ICOM, alors dirigée par le professeur Jan Jelinek, chargé de coordonner l'ensemble du projet, en ce compris de courtes expéditions en Lybie. Divers chercheurs aux horizons scientifiques, artistiques et artisanaux variés, furent impliqués dans ces expéditions, notamment Květa Jelínková, Jiří Svoboda, Ivo Ruller, Valér Kováč, Stanislav Hrbek, Jiří Pink, Gustav Morávek et Karel Mejzlík.

Zusammenfassung
In den Jahren 1979–1981 wurde das neue Gebäude für das Nationale Historische Museum in Tripolis, Libyen, geplant und als Teil einer alten Festung innerhalb des Areals des Saray al Hamra an der Mittelmeerküste platziert. Das UNESCO Projekt wurde im Rahmen des ICOM gestartet, dem zu dieser Zeit Professor Jan Jelínek als Präsident vorstand, der das gesamte Projekt organisierte neben weiteren kurzzeitigen Expeditionen nach Libyen. Diese Expeditionen schlossen mehrere Personen aus unterschiedlichen wissenschaftlichen, künstlerischen und handwerklichen Disziplinen ein: Květa Jelínková, Jiří Svoboda, Ivo Ruller, Valér Kováč, Stanislav Hrbek, Jiří Pink, Gustav Morávek und Karel Mejzlík.

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POSTSCRIPT
IN HONOUR OF JIŘÍ SVOBODA

This monograph presents a tribute to Professor Jiří Svoboda's systematic and unfaltering research work in paleoanthropology and archeology leading to several hundreds of scientific and popular science papers, studies, monographs and edited anthologies. Beside these tangible results, his work has built a comprehensive network of collaborations and friendships. Thus, it is a great honor for us and all the contributors to dedicate this book to him and to wish him a lot of energy in future scientific work, more great publications and a much deserved rest.

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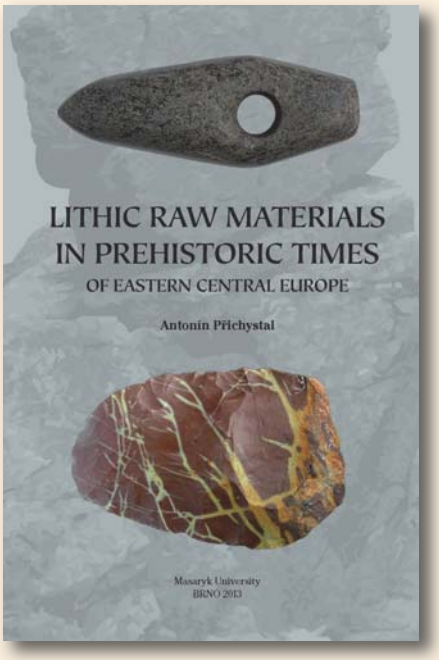

LITHIC RAW MATERIALS IN PREHISTORIC TIMES OF EASTERN CENTRAL EUROPE

Antonín Přichystal

The book comprises results of the author's cooperation with archaeologists during the last 35 years and systematically describes lithic raw materials used in prehistoric times of Eastern Central Europe. It covers the area of Czech Republic, Slovakia, Hungary, Poland, eastern part of Germany and northern Austria. The attention is also focused on sources of rock-salt, the usage of fossils in prehistory and finds of pseudoartefacts or fakes. Within the text there are 147 black-and-white pictures or maps and the final annex contains 384 coloured photos of raw materials seen by naked eye, under a stereomicroscope, in a thin section or as interesting artefacts.

prof. RNDr. Antonín Přichystal, DSc. – Geologist; he teaches at the Faculty of Science of Masaryk University. He specialises in volcanism of Moravia and Silesia, regional geology of the Czech Massif and West Carpathians and in the prehistoric stone industry.

MORAVA V DOBĚ LEDOVÉ / MORAVIA IN THE ICE AGE

Rudolf Musil
Illustrated by Petr Modlitba

Few countries can boast such rich history of Quaternary research as Moravia, especially finds of fauna, flora and the prehistoric man. It is mainly due to its location on a natural interface between north and south Europe. Moravia thus served throughout the Quaternary for seasonal and global movement of vegetation and animals. While now you can go through the gorges of the Moravian Karst on tarmac roads, not so long ago there were only narrow winding forest roads where in some places two horse-drawn carriages barely avoided each other. But what was there before? This book sets out to find the answer.

prof. RNDr. Rudolf Musil, DSc. – Internationally renowned palaeontologist and geologist; he works at the Department of Geological Sciences, Faculty of Science of Masaryk University. He has carried out field research in Moravia as well as abroad, particularly in Germany. He is the author of more than 300 scientific publications including 17 monographs that were published in the Czech Republic and in further 11 countries of Europe and America.

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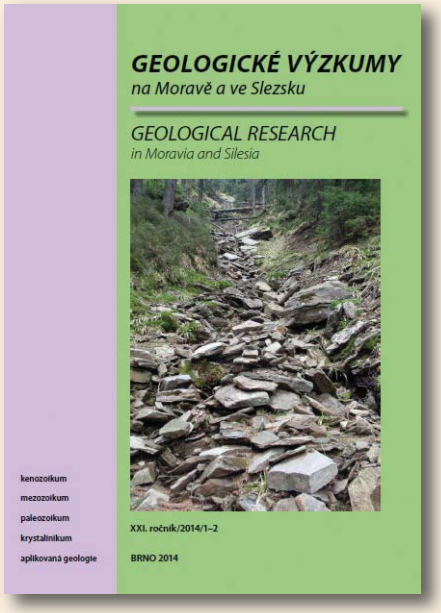

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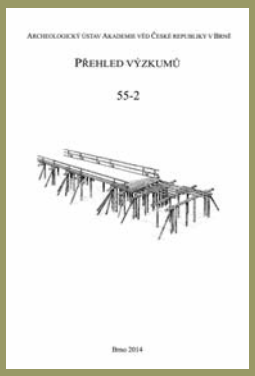

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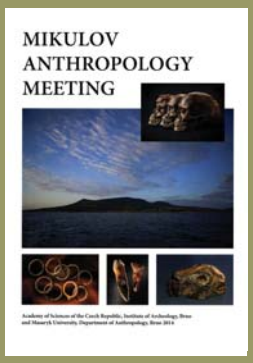

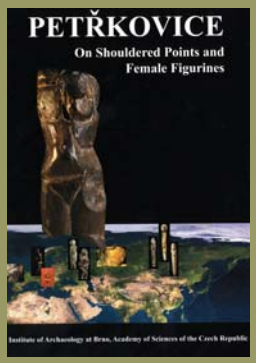

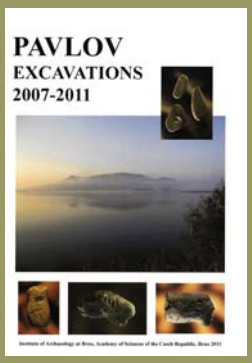

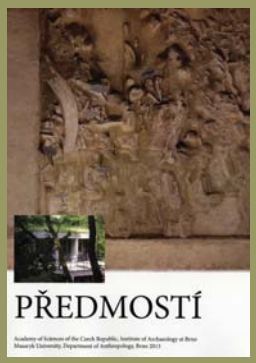

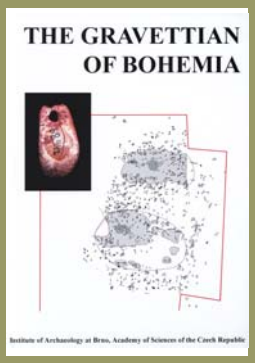

FORGOTTEN TIMES AND SPACES

New perspectives in paleoanthropological, paleoetnological and archeological studies

Edited by Sandra Sázelová, Martin Novák and Alena Mizerová
Graphic design by: Eva Lufferová and Lea Novotná
Illustrations on cover and title page by Pavel Dvorský
Published in 2015 by Institute of Archeology of the Czech Academy of Sciences, Brno, v.v.i. and Masaryk University
1st Edition

ISBN 978-80-7524-001-9 (online : pdf) (Institute of Archeology of the Czech Academy of Sciences. Brno)
ISBN 978-80-210-7782-9 (online : pdf) (Masaryk University. Brno)
DOI: 10.5817/CZ.MUNI.M210-7781-2015

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Human lives and evolution are spanned through different times and spaces. The destiny of man may seem inexorable, though, for witnesses, memories, and tangible evidences tend to be inevitably forgotten. This book seeks to accomplish two main goals: On the one hand, collecting and describing the shreds of previous, forgotten styles of life, and on the other hand, reflecting the scope of Jiří Svoboda's physical and intellectual cooperation with all our contributors, including those who were just seeking inspiration in his work.