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STONE AGE

Studying Technologies of Non-analogous Environments and Glacial Ecosystems

Papers in Honor of
Jürgen Richter

edited by
Thorsten Uthmeier & Andreas Maier

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VORWORT
DER HERAUSGEBER*INNEN

Die Reihe „Universitätsforschungen zur prähistorischen Archäologie“ trägt dem Bedürfnis Rechnung, Examensarbeiten und andere Forschungsleistungen in die Öffentlichkeit zu tragen. Thematisch findet darin die ganze Breite des Faches vom Paläolithikum bis zur Archäologie der Neuzeit ihren Platz.

Ursprünglich hatten sich fünf Universitätsinstitute in Deutschland zur Herausgabe der Reihe zusammengefunden, der Kreis ist inzwischen deutlich größer geworden. Alle interessierten Professoren*innen und Dozent*innen sind eingeladen, als Mitherausgeber*innen tätig zu werden und Arbeiten aus ihrem Bereich der Reihe zukommen zu lassen. Für die einzelnen Bände zeichnen jeweils die Autor*innen und Institute ihrer Herkunft, die im Titel deutlich gekennzeichnet sind, verantwortlich. Sie erstellen eine druckfertig gestaltete Datei (PDF). Bei gleicher Anordnung des Umschlages haben die verschiedenen beteiligten Universitäten jeweils eine spezifische Farbe. Finanzierung und Druck erfolgen entweder durch sie selbst oder durch den Verlag Dr. Rudolf Habelt GmbH, der in jedem Fall den Vertrieb der Bände sichert.

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Preface

Jürgen Richter and the Stone Age – A short academic biography

The contributions in this volume are all – in one way or the other – connected to Jürgen's biography and his broad research activities in different regions and periods of the Stone Age. This preface shall therefore sketch out a rough road map of his life to provide a background for the readers of this book. The authors are all linked to important steps of Jürgen´s career and include longstanding colleagues and many of his former students.

Jürgen was born in 1958 in Waldniel near Düsseldorf. Looking back, it seems like a twist of fate that his place of birth was so near to the site where little more than 100 years earlier the eponymous skeleton of the Neanderthals was found – the species that attracted much of Jürgen´s academic career and research. But we are getting ahead of us. Soon after his birth, he moved with his family to Erlangen, where his father worked as an engineer. Jürgen finished school in 1977 and one year later started studying Prehistoric Archaeology, Classical Archaeology and Art History at the Friedrich Alexander-Universität Erlangen-Nürnberg. Perhaps this came as a surprise to his family, since his two older brothers had chosen technical professions. However, archaeology was a successful choice from the start and Jürgen earned his Magister in 1983. Taken into consideration that soon after the start of his studies, Jürgen was so fascinated by the archaeology of the African continent that he took courses in Cologne, became a member of the Forschungsstelle Afrika and went to Namibia for fieldwork, he finished his Magister studies surprisingly fast. The fascination for the archaeology of Africa remained one major leitmotif of Jürgen´s work and academic career. In his PhD, he investigated stratigraphies with finds of Early Holocene hunter-gatherers from Namibia. Not only did he analyse the lithic assemblages, but also ceramic finds, ostrich eggshells, and the artistic expressions from sites located in Twyfelfontein, the Messum crater, Spitzkoppe, and Erongo in the vicinity of the Brandberg massif. His studies of these sites cover a wide range of archaeological, environmental, ecological, and ethnographical perspectives. This interest in a holistic reconstruction of past lifeways was already coupled with an excellent methodological knowledge, a sense for details in the primary archaeological data, and a graphic talent. During this period, Jürgen intensively travelled through Africa and conducted fieldwork in Namibia, Egypt, and Sudan. It was the time of large-scale expeditions, who stayed in the desert for months and transported all equipment on off-road trucks. Like many other members of the Collaborative Research

Jürgen Richter during his excavation at the Magdalenian open-air site of Bad Kösen-Lengefeld.

Jürgen Richter während seiner Ausgrabungen an der Magdalénien-Freilandfundstelle Bad Kösen-Lengefeld.

Centre "Besiedlungsgeschichte der Ost-Sahara", Jürgen spent – if taken together – several years in Africa. Jürgen's archaeological research in Afrika thus provides the context for the contributions in the first section of this volume on topics such as lake sediments as environmental archives, Acheulean biface technology, Middle Stone Age raw material sources, Later Stone Age technology, rock art, postglacial resettlement of the desert, or Holocene pastoral nomadic groups.

Concerning research areas, Jürgen is a real globetrotter. With regard to his academic education, he was down-home. For his Magister as well as for his PhD, the Friedrich-Alexander-Universität Erlangen-Nürnberg was his *alma mater*. From an outside perspective, this might come as a surprise. The main reason for his long-term relation to the University at Erlangen – despite of his intensive scientific ties to Cologne – was his close professional and amicable bond to Prof. Gisela Freund. In Cologne, Jürgen had an equally close scientific and private friendship to Prof. Wolfgang Taute, the ordinarius at the Institute in Cologne – perhaps because both shared a great interest in the archaeology of Holocene hunter-gatherers and their small geometric tools. In 1988, Jürgen became assistant professor under his supervision. This is the biographic background for the book section dedicated to contributions on Holocene archaeology, covering topics such as Early Mesolithic Aurochs hunting, Mesolithic raw material supply in the Allgäu region, Neolithic pottery raw materials in Spain, the Neolithisation at the northern fringe of the Westphalian uplands, risk management and resilience in early agrarian societies, and Neolithic sickle implements from the Caucasus.

At the time, it was a common precondition for prehistoric archaeologists focusing on a career in academia to have expertise in a larger number of periods. After studying Holocene hunter-gatherers at the transition to farming and, less intensively, the Upper Palaeolithic materials from the Aurignacian site of Breitenbach during an internship at the Germanischen Nationalmuseum Nürnberg, Jürgen opted for a Middle Palaeolithic topic for his habilitation thesis, which he completed in 1995. It can be taken as a sign esteem that Gisela Freund offered him the artefact assemblage from the G-Layers-Complex of Sesselfelsgrotte in Bavaria. The topic was demanding, not only because of the about 85.000 lithic artefacts from stratigraphically challenging, densely packed archaeological layers, but also because of the question of the relation between the Mousterian and the Micoquian in Central Europe, which sprang from the interstratification of both complexes at Sesselfelsgrotte. Jürgen played out the methodological experiences he gained when working with the African material during his PhD and ingeniously solved both the stratigraphic difficulties and the chorological question by applying sophisticated quantitative methods and interpreting the results from the perspective of Neanderthal land use. The result was a brilliant habilitation thesis that challenged some commonplaces opinions on the Central European Middle Palaeolithic research. The newly developed perspective sees the Micoquian as a specific functional part of the Mousterian ("Mousterian with Micoquian option") instead of interpreting them as two independent industries. Bifacial pieces are seen as the expression of a dynamic tool concept instead of fixed and finite types ("bifacial tool families") identified by a specific protocol for working steep analysis. In addition, it became clear that the Micoquian existed not only in the Marine Isotope Stage 5, but also – and in Jürgen´s view exclusively – in Marine Isotope Stage 3. Jürgen's interest in methodological developments and open mindedness towards creative and unconventional approaches and ways of thinking about the Stone Age is the bracket for the section on methods of this volume. It contains contributions on options for distinguishing unfinished leaf points and bifacial knives, functional aspects of bifacial tools, options for measuring assemblage diversity, cultural macroevolution, how models of time influence our conception of the past, a method for comparing potentially recurring boundary phenomena, heat altered phytoliths in the archaeological record, and implications for our understanding of Pleistocene humans when modern athletes are taken as a model.

After a prolongation of four years on the position as assistant professor, Jürgen started to apply for professorships. Given the low number of these positions in German speaking countries, this was not an easy task. The late 1990s thus were an eventful time with varying positions and phases of professional insecurity, but also with many academic merits. Between 1997–1998 he was Maître de Conférence at the Université Paris-Nanterre and was visiting professor in Frankfurt and Würzburg in 1999, and at the Université Royale de Phnom Penh in Cambodia in 1999 and 2000. Jürgen, who has always been interested in exploring cultural contexts formerly unknown to him, enjoyed these stays abroad despite of the all-day professional difficulties. After these chequered years followed a position as the head of the Forschungsstelle Afrika of the Cologne Institute for Prehistoric Archaeology. Whilst this enabled further activities in Africa, a successful application for a new project led him to another part of the world which he had not yet explored, the Ukraine. With the opportunity to study late Middle Palaeolithic sites on the Crimea, a novel important chapter in Jürgen´s research career began in 1999, with yearly research stays on the Peninsula until 2005. Jürgen's intensive occupation with Neanderthals during many periods of his career is the background for the section on the Middle Palaeolithic. It starts with contributions on the Lower Palaeolithic site of Bunker in Stuttgart Bad Cannstatt and a diachronous assessment of cultural developments from the Lower to the Middle Palaeolithic in the Almonda karst system in Portugal. Further, it unites research and reviews on Neanderthal seafaring, the Middle Palaeolithic mammalian fauna from Buhlen, settlement dynamics in the Lone valley, the Bábonyian industry at the eponymous site Sajóbábony-Méhész-tető in Hungary, and a working step analysis of artefacts from the city area of Cologne.

In 2002, Jürgen was appointed professor for the Palaeolithic at the University of Cologne. In parallel to his many international research projects, he intensified his investigations of sites in Germany. The search for underexplored areas near Cologne, already during his time as assistant professor, brought him to the region around Detmold. After several surveys and test excavations in Jerxen-Orpke and Pivitsheide, he found the important Late Palaeolithic site of Rietberg, where he excavated a large area over several years. The many years of intensive collaboration in Cologne during his time as assistant professor, scientist in the Collaborative Research Center "Besiedlungsgeschichte der Ost-Sahara", later as Principal Investigator in the Collaborative Research Centre "A.C.A.C.I.A", and eventually as full professor, allowed him to co-initiate a third Collaborative Research Centre "Our Way to Europe". Here, the many streams of his interests and former research areas merged: Central and Eastern Europe, Africa and Southwest Asia, late Neanderthals and early modern humans, the influence of human-environment interaction on human culture, and prehistoric land use. Jürgen became the speaker of this CRC and for twelve years was responsible for organising multi-disciplinary research on one of the hottest topics in Palaeolithic archaeology: the dispersal of modern humans from Afrika into Europe. The intensive cooperation between the Universities of Cologne, Aachen, and Bonn as well as between the archaeological and environmental disciplines had a long-lasting effect on the scientific landscape in the Rhineland. Several new professorships were created in Cologne and a new AMS-laboratory was built with participation of the archaeological sciences. Jürgen was not only PI of a number of projects within the CRC, but at the same time personally directed several field research projects in Ethiopia, where he was involved in the discovery of Lower Palaeolithic sites in high altitudes. In Jordan, he and his team discovered Early Upper Palaeolithic sites in the Wadi Sabra. From the excavations that lasted several years sprang – besides journal publications – a number of student theses. In parallel, he managed to offer practical experience to a larger number of students in his excavations of the Magdalenian open-air site of Bad Kösen-Lengefeld near Naumburg. This site was and still is analysed in the framework of numerous theses. Therefore, this book also contains a section dedicated to the Upper Palaeolithic, including contributions on the Early Upper Palaeolithic in the Western Black Sea region, Ahmarian lithic technology, technological variability of the Eastern European Early Upper Palaeolithic, the role of rivers as corridors for human dispersal during the Aurignacian, the Eastern Gravettian, a Late Gravettian workshop in western Slovakia, potential female figurines made from flint, and thoughts on the lithic inventory of Bad Kösen-Lengefeld.

Many readers of this book know Jürgen first and foremost as a prehistoric archaeologist with an impressively broad scientific knowledge. More than a few will also have got to know him in field and laboratory projects as a dedicated promotor of young scientists with bountiful generosity in sharing resources and welcoming hospitality for guests from Germany and abroad. Apart from all that and his sustained enjoyment of travelling, he also has some hobbies, which have probably remained hidden to most people until now. The editors at least know about his interest in art, aquarelle painting, and collecting coins. Of course, he never had enough free time for them. He once said that the coins at home were the reason why he – unlike so many other archaeologists – has no collection of prehistoric finds although he likes to sort and classify things. We hope that he will still work in archaeology after his retirement. At the same time, we wish that he will also find some time for his coins.

Thorsten Uthmeier & Andreas Maier

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Vorwort

Jürgen Richter und die Steinzeit – Eine kurze akademische Biografie

Die Beiträge dieses Bandes haben alle auf die eine oder andere Weise mit Jürgens Biographie und seiner weit gefächerten Forschungstätigkeit in verschiedenen Regionen und Epochen der Steinzeit zu tun. Dieses Vorwort soll daher als Hintergrund für die Leserinnen und Leser dieses Buches Jürgen Richters Lebensweg grob skizzieren. Die Autorinnen und Autoren sind alle mit wichtigen Stationen in Jürgen Richters Lebensweg verbunden. Darunter sind langjährige Kolleginnen und Kollegen sowie viele seiner ehemaligen Schülerinnen und Schüler.

Jürgen Richter wurde 1958 in Waldniel in der Nähe von Düsseldorf geboren. Im Rückblick erscheint es wie eine Fügung des Schicksals, dass sein Geburtsort so nahe an dem Ort liegt, an dem etwas mehr als 100 Jahre früher das namensgebende Skelett des Neandertalers gefunden wurde – jener Spezies, die einen Großteil von Jürgen Richters akademischer Laufbahn und Forschung bestimmt hat. Aber wir greifen vor. Kurz nach seiner Geburt zog er mit seiner Familie nach Erlangen, wo sein Vater als Ingenieur arbeitete. Jürgen Richter machte 1977 sein Abitur und begann ein Jahr später sein Studium der Prähistorischen Archäologie, Klassischen Archäologie und Kunstgeschichte an der Friedrich-Alexander-Universität Erlangen-Nürnberg. Für seine Familie mag das eine Überraschung gewesen sein, denn seine älteren Brüder hatten beide technische Berufe gewählt. Die Archäologie erwies sich aber von Anfang an als richtige Wahl, und schon 1983 legte Jürgen Richter überaus erfolgreich seine Magisterprüfung ab. Wenn man bedenkt, dass er schon bald nach Beginn seines Studiums von der Archäologie des afrikanischen Kontinents so fasziniert war, dass er Kurse in Köln belegte, Mitglied der Forschungsstelle Afrika wurde und zu Feldforschungen nach Namibia ging, erfolgte der Studienabschluss erstaunlich zügig. Die Faszination für die Archäologie Afrikas blieb ein wichtiges Leitmotiv für Jürgen Richters Arbeit und wissenschaftliche Laufbahn. In seiner Dissertation untersuchte er Stratigraphien mit Funden frühholozäner Jäger und Sammler aus Namibia. Er analysierte nicht nur Steinwerkzeuge, sondern auch Keramikfunde, Straußeneischalen und Felskunst von Fundstellen aus Twyfelfontein, dem Messum-Krater, der Spitzkoppe und Erongo in der Nähe des Brandbergs. Seine Forschungen an diesen Fundstellen umfassen ein breites Spektrum unterschiedlicher archäologischer, ökologischer, umweltgeschichtlicher und ethnologischer Ansätze. Dieses ausgeprägte Interesse an einer ganzheitlichen Rekonstruktion vergangener Lebensweisen verband sich schon damals mit exzellenten methodischen Kenntnissen, einem Sinn für Details in den archäologischen Primärdaten und einem ungewöhnlichen graphischen Talent. In dieser Zeit bereiste Jürgen Richter intensiv dem Afrikanischen Kontinent und führte Feldforschungen in Namibia, Ägypten und im Sudan durch. Es war die Zeit der großen Expeditionen mit monatelangen Aufenthalten in der Sahara, bei denen die gesamte Ausrüstung auf geländegängigen Lastwagen transportiert wurde. Wie viele andere Mitglieder des DFG-Sonderforschungsbereiches "Besiedlungsgeschichte der Ost-Sahara" verbrachte Jürgen Richter – wenn man alles zusammenzählt – mehrere Jahre in Afrika. Jürgen Richters archäologische Forschung in Afrika bildet den Kontext für die Beiträge im ersten Abschnitt dieses Bandes zu

Seesedimenten als Umweltarchiven, Biface-Technologien des Acheuléen, Rohstoffquellen des Middle Stone Age, Technologien des Later Stone Age, Felskunst, der postglazialen Wiederbesiedlung der Wüste oder Gruppen holozäner Pastoralnomaden.

Was seine Forschungsfelder betrifft, ist Jürgen Richter ein echter Weltenbummler – hinsichtlich seiner akademischen Ausbildung war er dagegen heimatverbunden. Sowohl für sein Magisterstudium als auch für seine Promotion war die Friedrich-Alexander-Universität Erlangen-Nürnberg seine Alma Mater. Das mag von außen betrachtet zunächst überraschen. Der Hauptgrund für seine langjährige Verbundenheit mit der Universität Erlangen war – trotz seiner intensiven wissenschaftlichen Kontakte nach Köln – eine enge berufliche und freundschaftliche Verbindung zu Prof. Gisela Freund. In Köln verband Jürgen Richter eine ebenso enge wissenschaftliche und private Freundschaft mit Prof. Wolfgang Taute, dem langjährigen Ordinarius des Kölner Instituts – vielleicht weil beide ein großes Interesse an der Archäologie holozäner Jäger-Sammler und ihren kleinen geometrischen Werkzeugen teilten. Im Jahre 1988 wurde Jürgen Richter Wolfgang Tautes wissenschaftlicher Assistent, damals als Akademischer Rat auf Zeit. Diesem biographischen Hintergrund sind Beiträge zur holozänen Archäologie in diesem Band gewidmet, die sich mit Themen wie der früh-mesolithischen Auerochsenjagd, der mesolithischen Rohstoffversorgung im Allgäu, keramischen Rohstoffen des Neolithikums in Spanien, der Neolithisierung am Nordrand des Westfälischen Berglandes, Risikomanagement und Resilienz in frühen Agrargesellschaften sowie neolithischen Sichelgeräten aus dem Kaukasus befassen.

Für prähistorische Archäologinnen und Archäologen, die im universitären System der 1990er-Jahre eine akademische Karriere anstrebten, war es üblich, sich in verschiedenen Perioden auszukennen. Nachdem er holozäne Jäger und Sammler am Übergang zum Ackerbau in Afrika und, weit weniger intensiv das jungpaläolithische Fundmaterial aus dem Aurignacien von Breitenbach während eines Praktikums im Germanischen Nationalmuseum Nürnberg untersucht hatte, wählte Jürgen Richter für seine 1995 abgeschlossene Habilitationsschrift ein mittelpaläolithisches Thema. Dass ihm Gisela Freund das Steinartefaktinventar aus dem G-Schichtkomplex der Sesselfelsgrotte in Bayern anbot, kann als Zeichen ihrer Wertschätzung aufgefasst werden. Das Thema war nicht nur wegen der ca. 85.000 lithischen Artefakte aus stratigraphisch schwierigen Schichten mit hoher Funddichte anspruchsvoll, sondern auch aufgrund der Frage nach dem Verhältnis zwischen dem Moustérien und Micoquien in Mitteleuropa, die sich aus der Interstratifikation beider Komplexe in der Sesselfelsgrotte ergab. Jürgen Richter nutzte die methodischen Erfahrungen, die er sich während seiner Doktorarbeit mit afrikanischem Material angeeignet hatte, und löste sowohl die stratigraphischen Schwierigkeiten als auch die chorologische Frage auf geniale Weise unter Einsatz quantitativer Methoden, deren Ergebnisse er aus der Perspektive der Landnutzungsmuster später Neandertaler-Gruppen interpretierte. Das Ergebnis ist eine brillante Habilitation, welche die bis dahin gängigen Forschungsmeinungen zum Mittelpaläolithikum in Mitteleuropa in Frage stellt. Anstatt sie als zwei unabhängige Industrien zu interpretieren, wird das Micoquien als funktional spezifischer Teil des Moustérien interpretiert ("Moustérien mit Micoque-Option"). Anstelle von finiten Typen sind die bifaziellen Werkstücke Ausdruck eines dynamischen Werkzeugkonzepts ("bifazielle Werkzeugfamilien"), die durch ein spezielles Protokoll der Arbeitsschrittanalyse identifiziert werden und bei längeren Aufenthalten vermehrt zur Ablage kommen. Zudem wird klar, dass das Micoquien nicht nur im Marinen Isotopenstadium 5, sondern auch – und nach Jürgen Richters Ansicht ausschließlich – im Marinen Isotopenstadium 3 existiert. Jürgen Richters Interesse an kreativen methodischen Entwicklungen und seine Aufgeschlossenheit gegenüber unkonventionellen Zugängen zur Steinzeit bilden die Klammer für denjenigen Teil dieses Bandes, der sich mit archäologischen Methoden befasst. Er enthält Beiträge zu Unterscheidungsmöglichkeiten zwischen unfertigen Blattspitzen und bifaziellen Messern, zu funktionalen Aspekten bifazieller Werkzeuge, zu Möglichkeiten der Messung der Diversität von Inventaren, zu kultureller Makroevolution, zum Einfluss von Zeitmodellen auf unsere Vorstellungen von der Vergangenheit, zu einer Methode zum Vergleich potenziell wiederkehrender Grenzphänomene, zu thermisch veränderten Phytolithen in archäologischen Befunden und zu den Konsequenzen für unser Verständnis des pleistozänen Menschen, wenn moderne Athleten als Modell herangezogen werden.

Nach der Verlängerung seiner Assistenzzeit in Köln für weitere vier Jahre begann Jürgen Richter, sich auf Professuren zu bewerben. Angesichts der geringen Zahl solcher Stellen im deutschsprachigen Raum war dies kein leichtes Unterfangen. Die späten 1990er Jahre waren für Jürgen Richter eine ereignisreiche Zeit mit häufigen wechselnden akademischen Positionen und damit eine Phase beruflicher Unsicherheit, aber auch ein Lebensabschnitt mit zahlreichen akademischen Verdiensten. So war er 1997-1998 Maître de Conférence an der Université Paris-Nanterre, 1999 Gastprofessor in Frankfurt und Würzburg sowie 1999 und 2000 an der Université Royale de Phnom Penh in Kambodscha. Jürgen Richter, der sich schon immer für die Erkundung ihm unbekannter kultureller Kontexte interessierte, genoss diese Auslandsaufenthalte trotz der täglichen beruflichen Herausforderungen.

Nach bewegten Jahren wurde er dann Leiter der Forschungsstelle Afrika am Institut für Ur- und Frühgeschichte in Köln. Während diese Position weitere Aktivitäten in Afrika ermöglichte, führte ihn ein erfolgreicher Drittmittelantrag in einen anderen Teil der Welt, den er bis dahin noch nicht erforscht hatte, nämlich in die Ukraine. Mit der Möglichkeit, spätmittelpaläolithische Fundstellen auf der Krim zu untersuchen, begann 1999 ein neues, wichtiges Kapitel in Jürgen Richters Forscherkarriere mit jährlichen Aufenthalten auf der Halbinsel bis 2005. Seine intensive Beschäftigung mit Neandertalern während vieler Phasen seiner Karriere bildet den Hintergrund für den Abschnitt des vorliegenden Bandes, der nach Kapiteln zum späten Altpaläolithikum insbesondere Themen zum Mittelpaläolithikum im Vordergrund stehen. Der Teil beginnt mit Beiträgen zur altpaläolithischen Fundstelle Bunker in Stuttgart Bad Cannstatt und einer diachronen Betrachtung der kulturellen Entwicklungen vom Alt- zum Mittelpaläolithikum im Karstsystem von Almonda in Portugal. Darüber hinaus vereint es Untersuchungen und Übersichtsarbeiten zur Seefahrt der Neandertaler, zur mittelpaläolithischen Säugetierfauna von Buhlen, zur Siedlungsdynamik im Lonetal, zum Bábonyien an der Fundstelle Sajóbábony-Méhész-tető in Ungarn und eine Arbeitsschrittanalyse von Artefakten aus dem Kölner Stadtgebiet.

Seit 2002 ist Jürgen Richter Professor für Ältere Steinzeiten an der Universität zu Köln. Neben seinen zahlreichen internationalen Forschungsprojekten hat er auf dieser Stelle seine Forschungen zu Fundstellen in Deutschland intensiviert. So führte ihn die Suche nach einem Arbeitsgebiet in der Nähe von Köln bereits während seiner Assistenzzeit in den Raum Detmold, wo er nach Surveys und Probegrabungen in Jerxen-Orpke und Pivitsheide die bedeutende spätpaläolithische Fundstelle Rietberg über mehrere Jahre hinweg auf einer großer Fläche ausgegraben hat. Die langjährige intensive Zusammenarbeit mit zahlreichen Fachkolleginnen und -kollegen in seiner Zeit als Assistent, Mitarbeiter im DFG-Sonderforschungsbereich "B.O.S.", als Teilprojektleiter im Sonderforschungsbereich "A.C.A.C.I.A." und später als ordentlicher Professor in Köln ermöglichte es ihm, den dritten DFG-Sonderforschungsbereich mit Beteiligung des Kölner Institute, den SFB 806 "Unser Weg nach Europa", mit zu initiieren. Hier flossen die vielen Stränge seiner Interessen und bisherigen Forschungsgebiete zusammen: Mittel- und Osteuropa, Afrika und Südwestasien, späte Neandertaler und frühe moderne Menschen, der Einfluss von Mensch-Umwelt-Interaktionen auf die menschliche Kultur sowie prähistorische Landnutzung. Jürgen Richter wurde Sprecher dieses SFBs und war zwölf Jahre lang verantwortlich für die Organisation der multidisziplinären Forschung zu einem der brennendsten Themen der altsteinzeitlichen Archäologie: der Ausbreitung des modernen Menschen von Afrika nach Europa. Die intensive Zusammenarbeit zwischen den Universitäten Köln, Aachen und Bonn sowie zwischen archäologischen und umweltwissenschaftlichen Disziplinen hat die Wissenschaftslandschaft im Rheinland nachhaltig geprägt. In Köln wurden unter Beteiligung der archäologischen Wissenschaften mehrere neue Lehrstühle eingerichtet und ein neues AMS-Labor aufgebaut. Jürgen Richter war nicht nur Sprecher des SFBs, sondern auch Leiter einer Reihe von Projekten, an deren Feldforschungsprojekten er regelmäßig teilnahm. So war er in Äthiopien an der Entdeckung altpaläolithischer Fundstellen in alpinen Höhen ebenso beteiligt wie in Jordanien an der Lokalisierung und Ausgrabung früh-jungpaläolithischer Fundstellen entlang des Wadi Sabra. Aus den mehrjährigen Grabungen gingen neben zahlreichen Fachpublikationen auch Abschlussarbeiten der beteiligten Studierenden hervor. Parallel dazu hat er bei den Ausgrabungen der Magdalénien-Freilandstation Bad Kösen-Lengefeld bei Naumburg einer großen Zahl von Studenten praktische Grabungserfahrungen vermittelt. Auch diese Fundstelle war und ist Gegenstand zahlreicher Abschlussarbeiten. Der vorliegende Band Buch enthält folgerichtig einen Abschnitt zum Jungpaläolithikum. Dieser umfasst Beiträge über das Frühe Jungpaläolithikum in der westlichen Schwarzmeerregion, zur Technologie des Ahmarian, zur technologischen Variabilität des Frühen Jungpaläolithikums in Osteuropa, zur Rolle von Flüssen als Korridore für die Ausbreitung des Menschen im Aurignacien, zum östlichen Gravettien, zu einem Werkplatz des späten Gravettien in der Westslowakei, zu möglichen Frauenfiguren aus Feuerstein sowie zu Überlegungen zum Steininventar von Bad Kösen-Lengefeld.

Vielen Leserinnen und Leser dieses Buches kennen Jürgen Richter in erster Linie als prähistorischen Archäologen mit einem beeindruckend breiten Wissen. Nicht wenige werden ihn darüber hinaus in Feld- und Laborprojekten als engagierten Förderer des wissenschaftlichen Nachwuchses kenngelernt haben, der bereitwillig seine Ressourcen teilt und gegenüber Kolleginnen und Kollegen aus dem In- und Ausland eine herzliche Gastfreundschaft an den Tag legt. Neben all dem und seiner nach wie vor anhaltenden Reiselust hat er aber auch einige Hobbys, die den allermeisten vermutlich bislang verborgen geblieben sind; wir als Herausgeber wissen zumindest, dass er sich für Kunst, Aquarellmalerei und das Sammeln von historischen Münzen interessiert. Jürgen hat einmal gesagt, dass die Münzen in seinem Haus der Grund dafür sind, dass er – im Gegensatz zu vielen anderen Archäologinnen und Archäologen – trotz einer großen Faszination für das Sammeln und Sortieren keine eigene Sammlung prähistorischer Funde besitzt. Wir hoffen, dass er auch nach seiner Pensionierung in der Archäologie tätig sein wird und wünschen ihm gleichzeitig, dass er daneben mehr Zeit für seine Münzen und andere Hobbies findet.

Thorsten Uthmeier & Andreas Maier

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Identification of workpieces, transformation analysis, and the transition from the Middle to the Upper Paleolithic in the Northern Black Sea Region: the case of Buran-Kaya III, Level C (Crimea, Ukraine)

Rohmaterialsortierung, Transformations-Analyse und der Übergang vom Mittel- zum Jungpaläolithikum im nördlichen Schwarzmeergebiet: Buran-Kaya III, Level C (Krim-Halbinsel, Ukraine)

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Abstract - The small rockshelter of Buran-Kaya III in the Eastern part of the second ridge of the Crimean Mountains yields one of the rare cases of a repeated interstratification between the Middle and the Early Upper Paleolithic. Two layers of an Initial Upper Paleolithic at the bottom of the sequence are followed by a Level C with Streletskayan artifacts, which is overlain the Middle Paleolithic Level B/B1 classified as Micoquian and, at the top of the Middle to Early Upper Paleolithic section, Aurignacian levels. The present study investigates in detail Levels C and B/B1 by using a high-resolution raw material sortation followed by transformation analysis. Within the Middle and Early Upper Paleolithic of the Crimea, the reconstructed landuse pattern of Buran-Kaya III, Level C shows a number of uncommon features. The Steletskayan land use in the Crimea is based on an increased number of regional micro moves, the use of other parts of the Crimean landscapes than the Micoquian, an acquisition of resources on encounter basis, and an only ephemeral overall occupation of the Crimea. Despite these differences, there is a strong structural affinity between the Streletskayan of Buran-Kaya III, Level C and the Crimean Micoquian rooted in the use of bifacial surface shaping as the dominant mode of blank production. This, and the presence of modified eagle remains, underlines the Middle Paleolithic affinities of the industry.

Zusammenfassung *- Unter dem Felsschutzdach von Buran-Kaya III im östlichen Teil der zweiten Kette des Krimgebirges konnte eine stratigraphische Abfolge aufgedeckt werden, in der eine Interstratifikation von mittel- und Jungpaläolithischen Schichten enthalten ist. Über zwei Schichten mit Inventaren des Initialen Jungpaläolithikums folgt Level C mit einem oft als früh-jungpaläolithisch eingestuften Steletskayan, das von einem Micoquien in Level B/B1 sowie mehreren Schichten bzw. Abträgen des Aurignacien überlagert wird. Die vorliegende Studie bedient sich hochauflösenden Rohmaterialsortierungen sowie Transformationsanalysen, um die Landnutzungsmuster in Level C und Level B/B1 zu rekonstruieren. Das Landnutzungsmuster der Gruppen des Steletskayan ist gekennzeichnet durch ungewöhnlich zahlreiche Ausflüge zur Beschaffung von Ressourcen in der weiteren Umgebung, wobei vermutlich andere Landschaftsteile als im Micoquien aufgesucht wurden. Alles in allem entsteht der Eindruck eine Versorgung, die mehr auf eine hohe Mobilität als auf eine konkrete vorausschauende Planung ausgerichtet war.*

Trotz dieser Unterschiede bestehen große technologische Ähnlichkeiten zum Mittelpaläolithikum, die vor allem an der Formüberarbeitung als dominierende Zerlegungsstrategie, aber auch an der Nutzung von Adlern als Lieferanten für Körperschmuck abzulesen sind.

Keywords - Middle to Upper Paleolithic transition, raw material sortation, transformation analysis, landuse pattern

Übergang vom Mittel- zum Jungpaläolithikum, Rohmaterialsortierung, Transformationsanalyse, Landnutzungsmuster

Introduction

One of the major sources of information in Paleolithic archaeology are lithic artifacts. Ideally, the investigation of technological aspects of raw material reduction and the reconstruction of land use patterns both rely on the smallest possible units in time and space. Although individual artifacts have also stored information about raw material provenance, they only represent a snapshot of the raw material reduction in a given lithic assemblage. Much more data can be collected from the analysis of artifacts coming from separate nodules. First, each nodule in almost all cases represents the remnants of the flaking activity and tool use of an individual, thus allowing insights into technological knowledge, practical know-how and decision making. Second, the comparative study of raw nodules which make up an assemblage allows insights into the strategy of raw material acquisition, the provisioning of the occupation under investigation etc. Ideally, the method to identify artifacts struck from the same raw piece is refitting (McCall 2010). However, among other things, the rate of refitting depends not only on the time investigated and on the experience of the researcher, but also on the variability of the raw material, the preservation of the site and the size of the excavated area. In addition, site function and strategies to provide sites or individuals with gear play an important role, too. For example, it is to be expected that the rate of refits at a workshop is higher than at a short-term camp. With a dominance of short-term to ephemeral occupations characterized by interrupted reduction sequences, the Middle Paleolithic is a primary candidate for low rates of refits. Due to the high mobility of individuals, artifacts and preforms, it must be considered that a deficit of refits is rather the rule than the exception (Turq et al. 2013). Despite some important examples with high refitting rates, such as Maastricht-Belvedere (Roeboecks et al. 1988; deLoecker et al. 2016) or Bettencourt-St. Quen (Locht 2002), it seems more typical that the reduction of raw material during the Middle Paleolithic started at one site, was interrupted by a move, and proceeded at the next site with the flaking of a preform or the resharpening of tools. In such a scenario, refits are rare.

One method that acknowledges the fragmentary nature of many Paleolithic assemblages, but nevertheless aims at investigation the smallest possible units of artifact manufacture and use, is transformation analysis developed by W. Weissmüller (1995) and consequently used, among others, by J. Richter (1997). It is based upon the sortation of lithic artifacts into raw material units. Being the first step in the search of refits, pioneering works of J. Hahn (1988) or W. Roebroeks et al. (1988) made use of the similarity of raw material features of refitted and not refitted artifacts. When supposed to be identical in color, inclusions etc., these were lumped in one and the same analytical unit termed raw material unit (henceforward "RMU"). In parallel, other RMUs, which also consisted of artifacts with very similar to identical raw material attributes, but lacked refits, were also treated as RMUs. W. Weissmüller (1995) went a step further and developed a classificatory system to analyze the degree of raw material transformation that happened on-site, using the presence and absence of steps of a standardized *chaîne opératoire*. The present study is dedicated to the raw material sortation and subsequent transformation analysis of Middle Paleolithic and potentially Early Upper Paleolithic assemblages from Buran-Kaya III in the Eastern part of the Crimean Peninsula. Whereas the Micoquian Level B/B1 was studied in the frames of the DFG-project "Funktionale Variabilität im späten Mittelpaläolithikum auf der Halbinsel Krim, Ukraine" initiated and directed by J. Richter in 1999 to 2003 (Uthmeier 2004a; Chabai et al. 2006, 2007, 2008, 2009; Bataille 2013; Demidenko & Uthmeier 2013;), Level C was analyzed later independently by G. Bataille (2017) and me (2013, this study). All studies used the same protocol for raw material sortation and classification of transformation sections developed in the frames of the aforementioned DFG-project (Uthmeier 2004a). This allowed the comparisons presented at the end of this contribution.

Material and methods

The site of Buran-Kaya III

Site setting and history of investigation

The assemblage under discussion comes from Buran-Kaya III in the Eastern part of the Crimean Peninsula. The site is a small, partly collapsed rock shelter in a nummulites limestone cliff of the second ridge of the Crimean Mountains and has been published extensively (e.g., Chabai et al. 2004a, 2004b, Demidenko 2004; D´Errico & Laroulandie, V. 2004; Gavris & Taykova 2004; Monigal 2004a; Uthmeier 2012; Pean et al. 2013; Bataille 2017). In first place, it gained importance due to the interstratification of Upper Paleolithic and Middle Paleolithic assemblages (in the lower part of the Paleolithic sequence: Monigal 2004b), and an exceptionally early onset of the Gravettian (near to the base of the upper part of the sequence on top of the Aurignacian levels: Péan et al. 2013). In short, the lower part of the sequence, which is of interest here, starts with Levels E and D yielding small assemblages classified as Initial or Early Upper Paleolithic (Monigal 2004b), followed by the Upper Paleolithic Streletskayan Level C (Monigal 2004a). Level C is overlain by Level B/B1 with a Middle Paleolithic Micoquian industry of Kiik-Koba type (Demidenko 2004; Uthmeier 2004b; Chabai 2008; Demidenko & Uthmeier 2013a, 2013b), and Aurigancian layers (or spits) in Levels 6-5, 6-4 and 6-3 (Péan 2013). Excavations by S. Péan et al. (2013) do not support the hypothesis of a hiatus between the Middle Paleolithic Level B/B1 and the base of Unit 6 with Aurignacian levels, deduced from re-deposited sediments in Layer A of the excavations under the rock shelter (Monigal 2004a). Péan et al. found an undisturbed sequence in a rather small opening to a larger (?) karstic system in the back wall of the rock shelter. Paradoxically, the late Middle Paleolithic of the Crimea was never fully accepted as a region with exceptionally late Neanderthal occupations that, with some certainty, overlapped with the presence of anatomically modern humans. This is even more surprising as the Crimean Peninsula, in contrast to, for example, Châtelperronian sites in France (Higham et al. 2014; Devièse et al. 2021; Hublin 2017), yields stratigraphical information for the alternating use of the same site by the two sub-species of *Homo sapiens*. In addition to Buran-Kaya III, this is also the case in Sjuren I, where in two archaeological levels Aurignacian and Middle Paleolithic Micoquian artifacts were lying on one and the same occupation surface (Demidenko & Noiret 2011).

Raw material provenance

In contrast to most other Paleolithic sites in the Crimean Mountains, all occupations at Buran-Kaya III had to cope with a scarcity of suitable raw material at the locality itself. Preliminary surveys, conducted by J. Richter, A. Yevtushenko and me, revealed that the riverbed of the Burulcha, which runs in immediate proximity to the site, lacks suitable raw materials for a distance of 5 km from the site (Uthmeier 2004c). The nearest known outcrops of primary sources are in the vicinity of the small villages of Tsvetochnoye and Russakovka, some 10 km to 15 km downstream along the Burulcha River Valley to the North, as well as in the Biyuk-Karasu Valley more than 20 km to the East. In the Crimean Middle Paleolithic, such rather large distances to the raw material sources resulted in exceptional assemblage compositions. For example, Buran-Kaya III, Level B/B1 of is one of the most important examples for the Kiik-Koba facies of the Crimean Micoquian, which is characterized by large amounts of intensively reduced and thus small surface shaped tools and scrapers (Demidenko & Uthmeier 2013a, 2013b). These findings underline the impact of transportation distances on the cost-and-benefit calculations of Crimean Paleolithic hunter-gatherers with regard to discard thresholds.

New radiocarbon dates

A revised radiocarbon chronology for the latest Middle Paleolithic of Kabazi II revealed that previous AMS-dates on bone of 34 kiloyears (ka) must be assumed too young. New hydroxyproline AMS dates show an offset of approximately 10 ka due to insufficient sample pretreatment of previously dated samples (Spindler et al. 2021). However, the discussion about the absolute dating of the Middle to Upper Paleolithic transition interface often leaves aside the fact that the repeated occurrence of Middle and Upper Paleolithic artifacts in the same archaeological levels at Sjuren I suggest an almost simultaneous use of the landscape by Neanderthals and modern humans (within the range of the sedimentation rate of the the occupation level). Independent from absolute dates, this empirical stratigraphical data suggests a considerable overlap of the two periods in the region. My last German-Ukrainian DFG-project in the Crimea, "The dispersal of modern humans into an Eastern European refugial area of late Neanderthals: interdisciplinary studies of contemporaneous industries from the Middle to Upper Paleolithic transition in the Crimea (Ukraine)" (2012-2017) commenced the research of J. Richter and other colleagues (Chabai & Uthmeier 2017). Without warning, the fieldwork of the project was stopped by the annexation of the peninsula by the Russian Federation and the following Russian war in Eastern Ukraine. Originally, it was planned to re-excavate the sequence at Sjuren I and to investigate the site formation process of the Aurignacian levels with the help of micromorphology, molecular biomarkers and magnetic susceptibility to decide about the hypothesis of an in-situ position of both the Middle and Upper Paleolithic artifacts. In parallel, a large-scale dating program was conducted on 52 samples from 27 archaeological layers from Zaskalanya V, Shaitan-Koba, Buran-Kaya III, Zaskalnaya VI and Starosele I. The dated materials were bone (N = 7), collagen (N = 2), and charcoal (N = 43). The samples mainly stem from our re-excavation of Zaskalnaya V (all charcoal and several bone samples: Chabai & Uthmeier 2017) and, in small numbers, from bone artifacts and collagen samples of previous excavations conducted by V. Chabai and A. Yanevich (see Supplement 1).

Except for four dates from Upper Paleolithic levels of Buran-Kaya III send to the AMS facility at Cologne, all other samples were coming from a late Middle Paleolithic context and were send to the ORAU radiocarbon laboratory at Oxford. The bone and collagen samples underwent ultrafiltration (ORAU pretreatment code AF), whereas the charcoal samples were too small for an ABOx pretreatment. Therefore, an ABA pretreatment (ORAU pretreatment code ZR) was used (Brock & Higham 2009). Unfortunately, all in all 40 of the samples submitted to Oxford failed due to low yield. In most cases, this was due to small sample size. After the overwhelming number of existing dates were on bone, the new dating program

level	techno-complex	material	Lab.-no.	^{14}C BP	median	cal BP to 95.4%	
bone samples, dated at Cologne with collagen extraction							
6-1	Gravettian*	projectile point from bone	COL-2065.1.1.	18,630±289	22,588	23,175	21,970
		projectile point from bone	COL-2063.1.2.	23,409±144	27,588	27,806	25,382
		projectile point from bone	COL-2064.1.1.	29,100±209	33,639	34,204	33,094
6-5	Aurignacian*	projectile point from bone	COL-2066.1.1	30,952±2016	36,054	41,363	31,665
bone samples, re-dated at ORAU with ultrafiltration							
level B/B1	Micoquian	collagen (OxA-6673)	OxA-36921	37,700±900	42,108	43,153	40,964

Tab. 1 New radiocarbon dates for the Middle to Upper Paleolithic interface of Buran-Kaya III (calibration with OxCal 4.4, version 7/7/2023, ©Christopher Bronk Ramsey 2023; *classification according to Pean et al. 2013).

Tab. 1 *Neue Radiokarbon-Datierungen für die Schnittstelle zwischen Mittel- und Jungpaläolithikum an der Fundstelle Buran-Kaya III (calibration mit der Software OxCal 4.4, Version 7/7/2023, ©Christopher Bronk Ramsey 2023; *Klassifikation nach Pean et al. 2013).*

focused on charcoal. However, because the total area of the re-excavations at Zaskalnaya V was four square meters only, most radiocarbon samples were not taken from evident fireplace features, but from sediment samples. In fact, they were bulk samples of very small charcoal fragments only. In several cases, successful dates from bone from the same level allow to refute the hypothesis that the archaeological levels were out of range of radiocarbon dating. Of relevance here are five newly obtained radiocarbon dates. One of these is the re-measurement of collagen from a previously AMS-dated sample (OxA-6673) from Buran-Kaya III, Level B/B1. The date from the now ultrafiltered collagen has the laboratory number OxA-36921. Four dates on samples from bone point fragments from the Aurignacian level 6-3 and the Gravettian level 6-1 of Buran-Kaya III were measured in Cologne without ultra-filtration, but after rigorous pre-treatment following a newly developed protocol.

The five dates on bone from Buran-Kaya III obtained by us (Tab. 1; Fig. 1) only in part confirm the dates obtained by Péan et al. For the Micoquian from level B/B1, our date of 43,153–40,964 calBP covers the range of dates from Péan et al. (2013) between 43,970–41,195 calBP and 41,472–40,107 calBP and supports the hypothesis of a comparably late Middle Paleolithic in the Crimea, which may have existed, like the latest occurrences of Neanderthals elsewhere, until app. 40.000 calBP (Devièse et al. 2021). We dated the Aurignacian Level 6-3 to 41,363–31,665 calBP, which overlaps with dates obtained by Pèan et al. (2013) that range between 41,943-37,864 calBP for the oldest and 34,488–33,155 calBP for the youngest radiocarbon date. However, due to the large standard deviation, the novel date from Cologne is not very informative and at best excludes a chronological position of the uppermost Aurignacian level at Buran-Kaya III at the very beginning of this technocomplex. For the Gravettian from Level 6–1, our dates range between 23,175–21,970 calBP and 34,204–33,094 calBP. They not only cover the entire period of the Gravettian s. l., but at the same time overlap with the earliest Epi-Gravettian in Eastern Europe (Leyngel et al. 2021). The

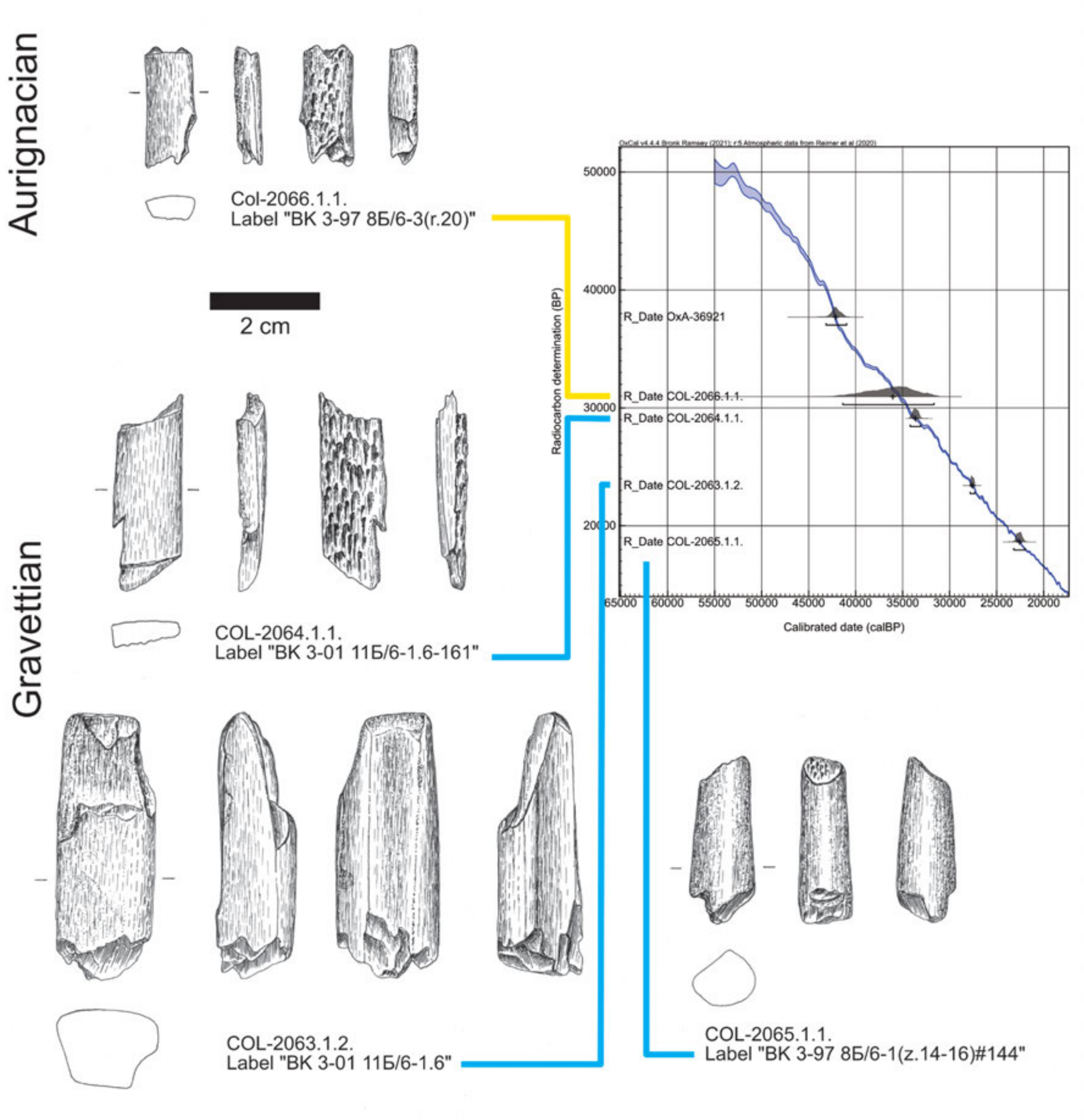


Fig. 1 Four dated bone points fragments from the Upper Paleolithic of Buran-Kaya III (left) and the plot of the respective calibrated radiocarbon dates (left, with the addition of a new date for Level B/B1: see Tab. 1; calibration and plot produced with OxCal 4.4, version 7/7/2023, ©Christopher Bronk Ramsey 2023; drawings by I. Seeberger, FAU).

Abb. 1 *Datierte Knochenspitzen aus dem Jungpaläolithikum von Buran-Kaya III sowie der Plot der aus der Kalibration der Rohdaten resultierenden absoluten Altersspannen (mit zusätzlich einem neuen Datum für Schicht B/B1: vgl. Tab. 1; Kalibration und Erstellung des Plots mit der OxCal 4.4-Software, Version 7/7/2023, ©Christopher Bronk Ramsey 2023; Zeichnungen I. Seeberger, FAU).*

dates from the same level published by Péan et al. (2013) fall into a range between 34,481–33,168 calBP and 38,430-35,505 calBP. The youngest date overlaps with the oldest date from Cologne, but the oldest date shows a considerable overlap with dates from the late Aurignacian in Central and Eastern Europe.

Side remark: in search for a geochronological marker - analysis of CI-Tephra in Crimean sites

In addition to radiocarbon dating, the more recent German-Ukrainian DFG-project "The dispersal of modern humans into an Eastern European refugial area of late Neanderthals:

interdisciplinary studies of contemporaneous industries from the Middle to Upper Palaeolithic transition in the Crimea (Ukraine)" aimed at identifying tephra of the Late Pleistocene Campanian Ignimbrite (CI) super-eruption, which occurred in the Phlegrean Fields at an $^{40}Ar/^{39}Ar$ age of 39.85 ± 0.14 ka. This tephra is a "super-marker", allowing to synchronize stratigraphical sequences over larger distances within Central and Eastern Europe. The research was part of a collaboration with the RESET Project (RESponse of humans to abrupt Environmental Transitions, 2008–2014), a UK Natural Environment Research Council (NERC) funded scientific consortium. Dustin White, Centre for the Archaeology of Human Origins, University of Southampton, UK, conducted the sampling and subsequent laboratory analysis. His laboratory report is cited in the following: "In August 2012, sediment samples were collected from the site of Zaskalnaya V (Crimea) for cryptotephra analyses. Samples were taken from cleaned profiles in 2-cm consecutive and contiguous intervals in three overlapping columns. Sediment processing and laboratory analyses were performed in the Department of Geography at Royal Holloway University of London. Methods involved the non-destructive physical separation technique outlined in Blockley et al. (2005) to check for the presence of tephra shards within the sampled stratigraphy. This involved removal of carbonates, repeated fine sieving (15–125 μm) and density flotation of sediment particles. For initial analyses, sub-samples from each of the 2-cm samples collected were combined to represent either an 8-cm or 10-cm contiguous scan sample comprising between ~5–13 grams of dry sediment. Processed samples were mounted on slides with Canada balsam and examined under microscopic in an attempt to locate tephra shards. During microscopic analyses, no unambiguous tephra shards were identified in the samples from Zaskalnaya V. However, the samples did produce a relatively high number of tephra mimics (e.g., phytoliths), particularly for the upper part of the sampled sequence. Based on these negative results, combined with previous work on samples from the sites of Suiren I and Kabazii II which also did not produce significant quantities of tephra shards, it would appear that tephra is not widely preserved in late Middle and early Upper Paleolithic rock shelter or open-air sites in this part of the Crimean Peninsula. This is not to say the tephra of this age does not exist in respective site sediments, but rather its abundance may be too limited to routinely detect tehpra through current methodological procedures and reasonable time/financial investment."

The assemblage from Level C

The Streletskaya assemblage of Level C accounts for 3,780 artifacts recovered from an excavation area that was laterally affected by erosional processes and which is, therefore, incomplete (Monigal 2004b). The loose scatter of artifacts, the lack of evident structures and the low overall number of faunal remains all point to a brief, single occupation (Monigal 2004b: 11). The comparably high impact of carnivore activities on the faunal assemblage is another argument for a short and ephemeral human presence at the site. In any case was the occupations surface open for a long period. Some burned bones as well as 3,505 lithic artifacts smaller than 3 cm underline that despite the ephemeral overall character of the stays, human hunter-gatherers still conducted some domestic activities such as the production of lithic artifacts. Speaking in Crimean Paleolithic standards, the site is exceptionally far from known raw material sources (Uthmeier 2004c), which are approximately one day of walking away (if calculated for the way to and back from the nearest primary outcrops). This was certainly a challenge, calling for a considerable amount of planning depth and raw material economy. From a methodological point of view, such a questionnaire is, in addition to attribute analysis, preferably analyzed by transformation analysis. Much like

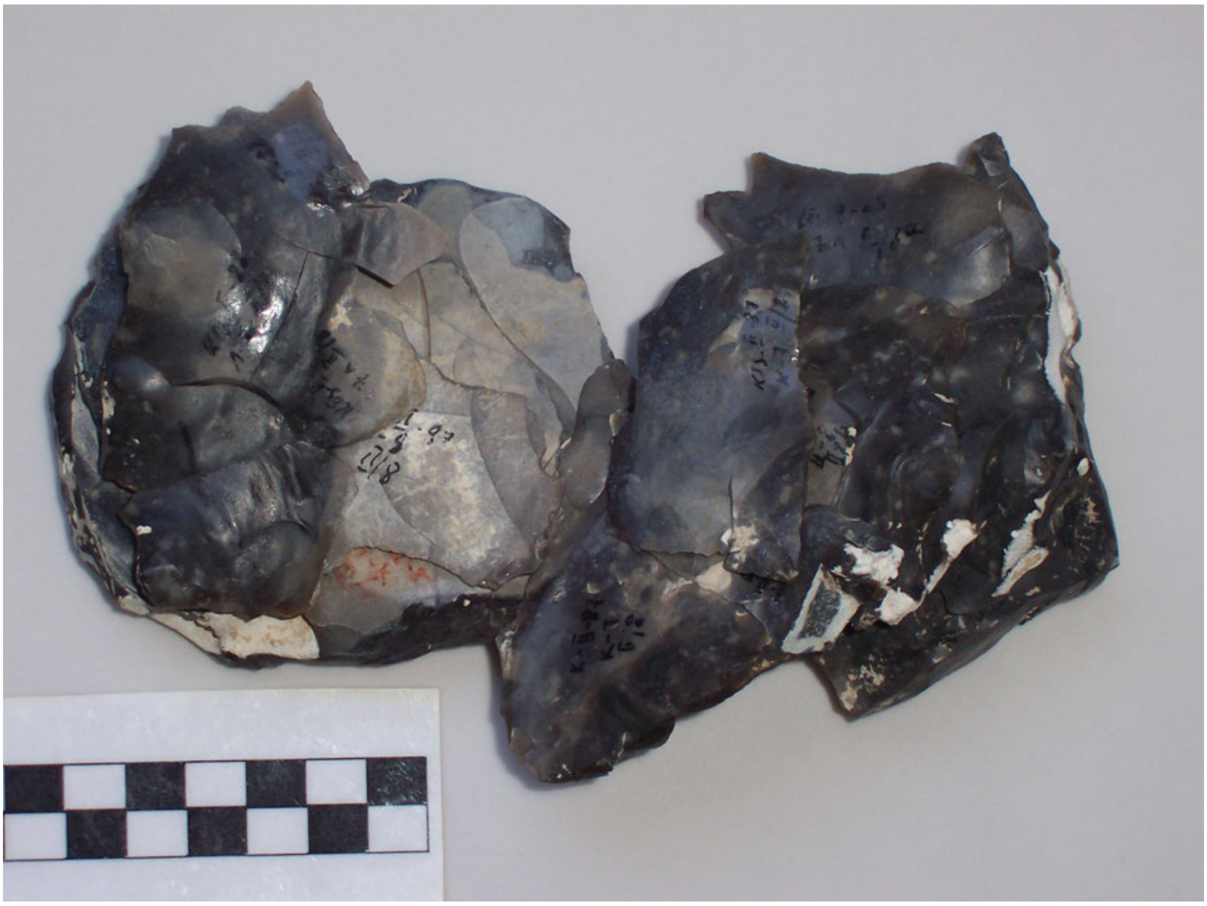


Fig. 2 Raw nodule from the Middle Paleolithic Western Crimean Mousterian of Kabazi II, Unit II, Level 8 (refit by V. Usik, photo: M. Kurbjuhn).

Abb. 2 *Rohknolle aus dem Mittelpaläolithikum des Western Crimean Mousterian aus Kabazi II, Unit II, Level 8 (Zusammensetzung durch V. Usik, Foto: M. Kurbjuhn).*

assemblages of the Kiik-Koba facies of the Crimean Micoquian, the lithic artifacts from Buran-Kaya III, Level C are best described as heavily used. Almost half of the lithic artifacts larger than chips are modified by retouch; unifacial tools are predominantly made on blanks from surface shaping (Monigal 2004b; Uthmeier 2012; Bataille 2017). In the absence of flake cores, surface shaping of biconvex bifacial blanks, which in most cases were modified into leafpoints, is the dominant mode of production. Use-wear analysis show that the leafpoints were hafted. Several backed bifacial knives ("Keilmesser") represent another category of bifacially surface shaped tools (Uthmeier 2012). In this case, they were certainly handheld tools, but it is difficult to decide whether they represent an anticipated form or were the result of (nevertheless opportunistically used) failures in an initial phase of the production of leafpoints. The shortage of raw material supply is also reflected in the use of flakes from surface shaping as blanks for end scrapers and geometric trapezoidal microlithits. The latter, in combination with biconvex leafpoints, are the main arguments for a classification of the assemblage as Streletskayan (Chabai et al. 2004b; Monigal 2004b; Uthmeier 2012; Bataille 2017). If the Streletskayan can be considered as an Upper Paleolithic industry, as suggested by Monigal (2004b) and Chabai et al. (2004b) due to the presence of (geometric) microliths, or is in fact Middle Paleolithic, indicated by the presence of bifacial tools such as leaf points and Keilmesser (Uthmeier 2012), is still open to debate (see also Bataille 2017).

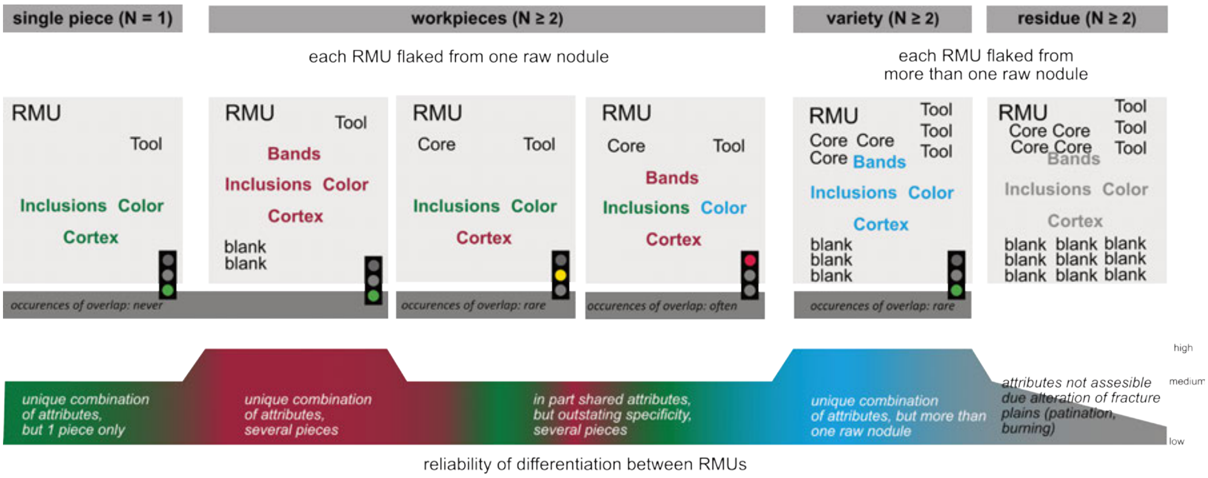


Fig. 3 Different levels of reliability in the differentiation between RMU (raw material units).

***Abb. 3** Unterschiede Auflösungen der Rohmaterialsortierung in RMU (Rohmaterialeinheiten).*

Methods

Transformation analysis relies on a correct sortation of the raw material into RMUs, or at least the best approximation in the distinction between RMUs when using macroscopic attributes. A major obstacle in the analysis of Paleolithic assemblages in this regard is the reduced number of artifacts potentially belonging to the same nodule discarded at one and the same site. The notion of an often fragmented Paleolithic lithic record is underlined by low rates of refitting even when the archaeological material is well preserved (McCall 2010). It has already been stated above that the fragmentation of the lithic production seems even more pronounced in the Middle Paleolithic (Turq et al. 2013). It follows that at most sites, the sortation of artifacts into RMUs (as well as attempts for refitting) must rely on few items per nodule, sometimes being the only indication for originally intensive reduction processes. In addition, some of the rare, more complete refits (Fig. 2) from the Crimean Middle Paleolithic)show a surprising internal variability of the raw material attributes within one and the same raw piece. In this study, the sorting of raw material as well as transformation analysis follow a protocol developed in the frames of the DFG-project "Funktionale Variabilität im späten Mittelpaläolithikum auf der Halbinsel Krim, Ukraine" (Uthmeier 2004a, 2004b, 2004c) that aims at identifying the smallest RMU possible. In general, any analysis conducted by human agents has, in contrast to those controlled by computers and executed by machines, a certain degree of subjective reasoning that almost certainly leads to errors - or better: a reduced repeatability - above the random level. It is one of the merits of "New Archaeology" and "Analytical Archaeology" (for a summary see Bernbeck 1997) to have reduced the subjectivity in lithic artifact analysis by asking for transparency of reasoning and reproductivity of results. What followed was a widespread application of attribute analysis and quantitative methods. The deconstruction of the description of artifacts into isolated attributes of low complexity has certainly minimized the degree of subjectiveness, but even measurements such as the length, width or thickness not only need a proper (common) instruction how and where to take the measurements, but this instruction has also to be followed as strict as possible. While this is seen less critical, the sortation of lithic artifacts into raw material units is often discussed as being not as reliable as attribute analysis, at least as long as no data from petrographic methods support the sortation (e.g., Pasda 2021).

Fig. 4 Sortation of raw material from Middle Paleolithic sites of the Crimea in the frames of the DFG-project "Functional variability in the Late Middle Paleolithic of the Crimea, Ukraine" of Jürgen Richter (in the background) in Malinovka, Crimea (Ukraine) in 2003 (in the foreground in orange shirt: G. Bataille; photo: Th. Uthmeier).

Abb. 4 *Rohmaterialsortierung an Material des Mittelpaläolithikums der Krim im Rahmen des DFG-Projekts "Funktionale Variabilität im Späten Mittelpaläolithikum der Krim-Halbinsel, Ukraine" von Jürgen Richter (im Hintergrund) in Malinovka, Krim (Ukraine) im Jahr 2003 (im Vordergrund mit orangenem T-Shirt: G. Bataille; Foto: Th. Uthmeier).*

Therefore, a clear description about the protocol is needed. Instead of repeating the details described in full length elsewhere (Weißmüller 1995; Uthmeier 2004a, 2004b), it follows a summary of the main pre-assumptions (see also Fig. 3). At best, RMUs are considered to comprise artifacts flaked from one and the same nodule (Fig. 3: "workpieces"), or to represent single pieces showing raw material attributes that do not match those of any of the other RMUs (Fig. 3: "singles"). Larger RMUs with more variable raw material attributes and/or several cores or preforms (except for large nodules fractured into several pieces before systematic reduction) are classified as representing more than one raw piece from the same outcrop or geological formation (Fig. 3: "variety"). For each RMU, a standardized list of attributes is recorded. In addition to attributes evaluating the petrographic properties of the RMU, this step also includes an estimation of the degree of overlap of macroscopic attributes with other RMUs.

In August 2013, a team of three trained archaeologist (Ingrid Hohenester, Laura Geyer and Thorsten Uthmeier, all FAU Erlangen-Nürnberg) sorted the lithic artifacts of Buran-Kaya III, Level C into raw material units (RMUs) by comparing differences of a series of macroscopic attributes. All artifacts subject to sorting were consecutively taken out of the find bags and placed on a table (see also Fig. 4). Provisional RMUs were arranged together and labelled by an index card with a running RMU number. Difficult assignments, potential inconsistencies within already defined RMUs, and unclear attribute combinations were discussed in the group; decisions were consensual. Only after the close of the sortation process, the data collection started. Two standardized form sheets (see Uthmeier

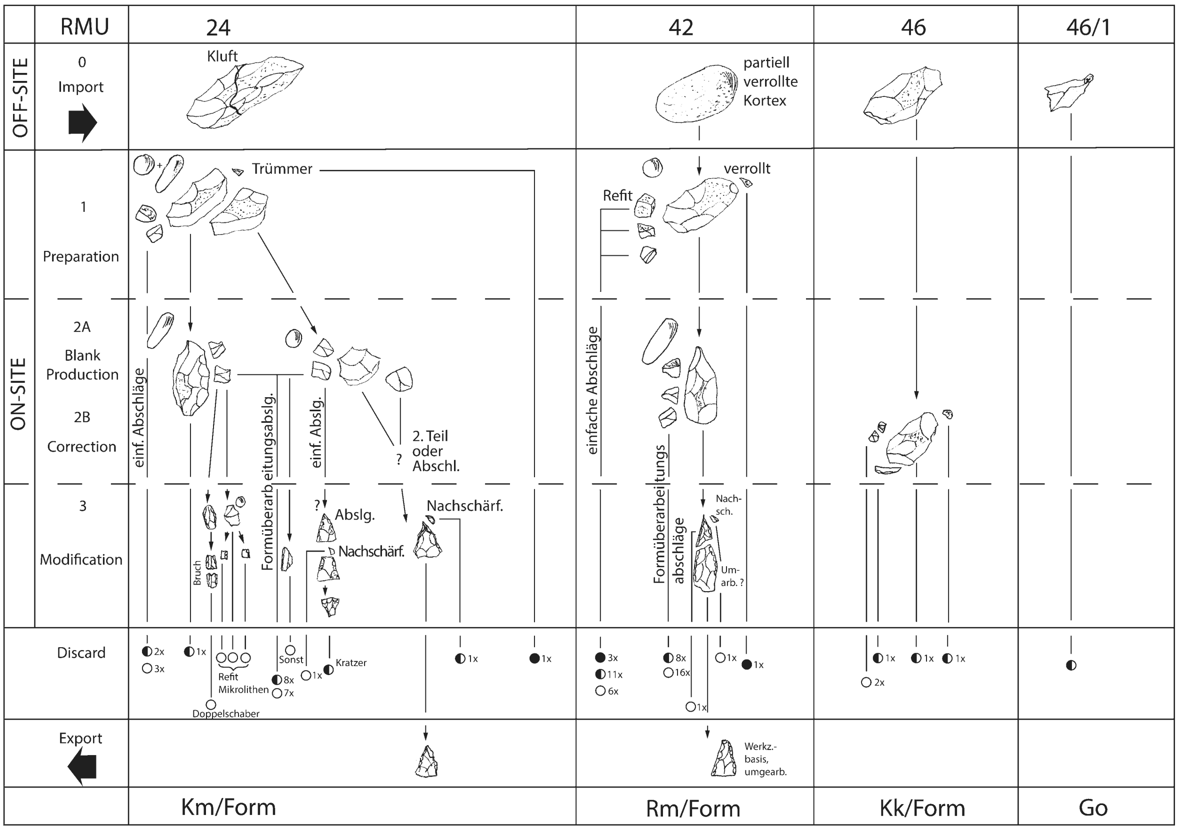


Fig. 5 Buran-Kaya III, Level C. Example of original diagrams drawn for each RMU during the study of Buran-Kaya III, Level C in 2013 in Belaya Skala, Crimea (Ukraine). The diagrams aim at documenting (in addition to several form sheets) transformation analysis using a standardized *chaîne opératoire* scheme. Translation of the labels of transformation sections: "Km/Form" = Cm/surface (surface shaping of core/preform with subsequent modification of blank/s); "Rm/Form" = Nm/surface (surface shaping of raw nodule with subsequent modification of blank/s); "Kk/Form" = Cc/surface (correction of a surface shaped preform); "Go" = Bw (single unmodified blank discarded without flaking).

Abb. 5 *Buran-Kaya III, Level C. Beispiel für die Zeichnung von Flussdiagrammen, mit denen die Transformation für jede RMU während der Arbeiten am Inventar aus Level C in 2013 in Belaya Skala, Krim (Ukraine) dokumentiert wurde. Die Diagramme greifen auf ein standardisiertes Schema der Operationskette zurück (weitere Erläuterungen und Auflösung der Kürzel siehe oben in der englischen Version).*

2004b), one for the description of the raw material of the RMU and the quality of its discrimination from other RMU, and one for transformation analysis, were filled in for each RMU. In addition, a flowchart diagram was sketched for each RMU (Fig. 5; for the complete flow charts see Supplement 2). Digital photographs taken from every RMU with daylight lamps completed the documentation of the analysis. For the photographs, artifacts were arranged on a tableau with rows for each step of the standardized *chaîne opératoire* (Fig. 6). In a second step, a transformation analysis was conducted. In general, transformation analysis treats RMUs as equivalent to refits, but enlarges this by also including single pieces and RMUs that may represent more than one nodule ("variety"). The application of this method follows the protocol of Uthmeier (2004a, 2004b), which is a further development of W. Weißmüller´s (1995) scheme. The additions allow to conduct transformation analysis also for assemblages with surface shaped tools.

In general, technological definitions are taken from Boëda (1995) and Richter (1997). This is most notably important for the understanding of the methodological handling of surface shaped tools. In this study, the class of surface shaped tools includes both unifacially and bifacially worked pieces shaped by facial soft hammer retouch covering larger parts of the lower and/or the upper surface. Surface shaped items that lack a retouch

Fig. 6 Buran-Kaya III, Level C. Examples for photographs taken in the field using a tableau that allows to arrange the artifacts according to their position in the standardized chaîne opératoire. Note the presence of retouched geometric microliths in all RMUs; in RMU 3, ventral surfaces are shown to illustrate the hypothesis that the blanks for the production of geometric microliths in part stem from ventral thinning, in this case of an end scraper). RMU 35 consists of two fragments of bifacial tool, with the basal fragment being recycled, and a geometric microlith.

Abb. 6 *Buran-Kaya III, Level C. Beispiele für Dokumentationsfotos, bei denen ein Tableau benutzt wurde, das es erlaubt, die Artefakte analog zu ihrer jeweiligen Position in der standardisierten Operationskette zu platzieren. Hinzuweisen ist auf das Vorliegen von geometrischen Mikrolithen in allen Rohmaterialeinheiten (RMU); für RMU 3 werden die Ventralflächen wiedergegeben um zu illustrieren, dass ein Teil der Grundformen für die geometrischen Milrolithen möglicherweise aus der ventralen Verdünnung von Kratzern stammen. RMU 35 besteht aus zwei Fragmenten eines bifaziell formüberarbeiteten Gerätes, bei dem die Basis durch laterale Retuschen recycelt wurde, sowie einem geometrischen Mikrolithen.*

forming at minimum one working edge are treated (analogous to blanks from debitage) as unmodified surface shaped "blanks". Only in the case of a modification of at least one lateral edge, a otherwise simple surface shaped blank is classified as formal tool. On the broadest level, transformation analysis aims at a differentiation between RMU resulting from "debitage" (e.g., hard hammer flaking of cores and preforms) and those going back to "surface shaping" (e.g., soft hammer flaking to obtain unifacial or bifacial pieces). Within these two technological classes, transformation analysis tries to identify the degree of flaking conducted on the site under analysis as indicated by the discarded artifacts. In a first step, it is possible to differentiate between RMU which are represented by single pieces only (discard without on-site transformation), and RMU with more than one piece indicating flaking processes at the site. For a further differentiation, transformation analysis considers the discard of marker pieces indicative for phases of the standardized *chaîne opératoire* as proof for an on-site conduction of the respective phase(s) (Fig. 3). Following this approach, marker pieces of the earliest and latest flaking and/or usage event in each RMU are taken as argument to conclude that the entire part of the standardized reduction sequence bracketed by these marker pieces was conducted on-site, unaware of the fact that there might be intermediate steps without marker pieces. Transformation analysis differentiates 14 main classes from on-site discard only (single pieces) to partly or full on-site transformation (two and more pieces) called "transformation sections" (Uthmeier 2004b). In greater detail, transformation sections cover ready-made imported items, modification or rejuvenation of imported pieces, short sections at the beginning of the reduction sequence (such as the preparation of a raw piece or a decorticated preform), sections at the medium part of the reduction sequence (such as the correction of a core or preform), and sections that cover most or all parts of the *chaîne opératoire* (e.g., from decortication to blank production without or with modification of blanks). In addition, the amount of cortex is used to distinguish between on-site transformations that started with a raw piece, and transformations that started with a blank, a core or a surface shaped preform.

Results

The study of Buran-Kaya III, Level C presented here used N = 702 artifacts. Compared to the study of most other Crimean Middle Paleolithic assemblages, this is a rather large parent population caused by the inclusion of all artifacts ≥ 1.5 cm. In all other transformation analysis of Crimean Middle Paleolithic material conducted by the author, the minimum size of analyzed artifacts was > 3 cm. The decision to also include smaller items was based on the impression that the overall variability of the macroscopic attributes in the assemblage of Buran-Kaya III, Level C was considerably larger than in all other assemblages from the Crimean Middle Paleolithic sorted so far (for an overview see Chabai & Uthmeier 2006). Three trained persons (Inge Hohenester, Laura Geyer, Thorsten Uthmeier) sorted and analyzed the 702 artifacts in the course of 20 working days during a research stay in the field camp of the Zaskalnaya V excavation in Belaya Skala, Crimea (Ukraine). The assemblage of Level C was void of artifacts ≥ 1.5 cm that did not allow for a proper recognition of macroscopic raw material attributes. The lack of patinated items points to a rather fast sedimentation, which is in contrast to the preservation of the faunal remains (Monigal 2004a) that show traces of weathering. Intensive damage caused by carnivores also argue for a longer period of exposure. However, in the light of data from other sites of the Crimean Middle Paleolithic where the impact of carnivores is almost negligible, this can also be interpreted as in indication for less intense human land use. The fact that burnt artifacts are not present among the larger lithics, despite the presence of a fireplace, in concert with the low find densities underlines the overall ephemeral character of the occupation. In sum, 91 RMUs of flaked siliceous raw materials were defined; one RMU was a hammerstone not included in the further analysis.

Reliability of raw material sortation

From the overall 91 RMUs with siliceous raw material (Tab. 2), 42 RMUs contained a single artifact without on-site transformation, 46 RMU were classified as "workpieces" with two or more artifacts supposed to belong to one and the same nodule flaked on-site, and four showed a variability estimated as being too large to allow for a classification as workpiece. The latter were classified as "variety". The subjective estimation of the reliability of the sortation was measured qualitatively by the

all RMUs (N = 91 + 1*)		
estimation of degree of singularity of RMU		
single	workpiece	variety
42	46	4
estimation of occurrences of overlap		
never	rare	often
9	40	43
single pieces (N = 42)		
estimation of occurences of overlap		
never	rare	often
6	16	20
size of singles		
size rank	artifact class	N
1	microlith	2
2	resharpening flake	2
3	functional end/ base of tool	9
4	flake	9
5	chunk	5
6	tool	11
7	core/preform	3
8	hammerstone	1

Tab. 2 Buran-Kaya III, Level C. Quality of the raw material sortation (for further explanations see text).

Tab. 2 *Buran-Kaya III, Level C. Qualität der Rohmaterialsortierung (weitere Erklärungen im Text).*

ex post identification as single	ex post closure of RMU
13	3

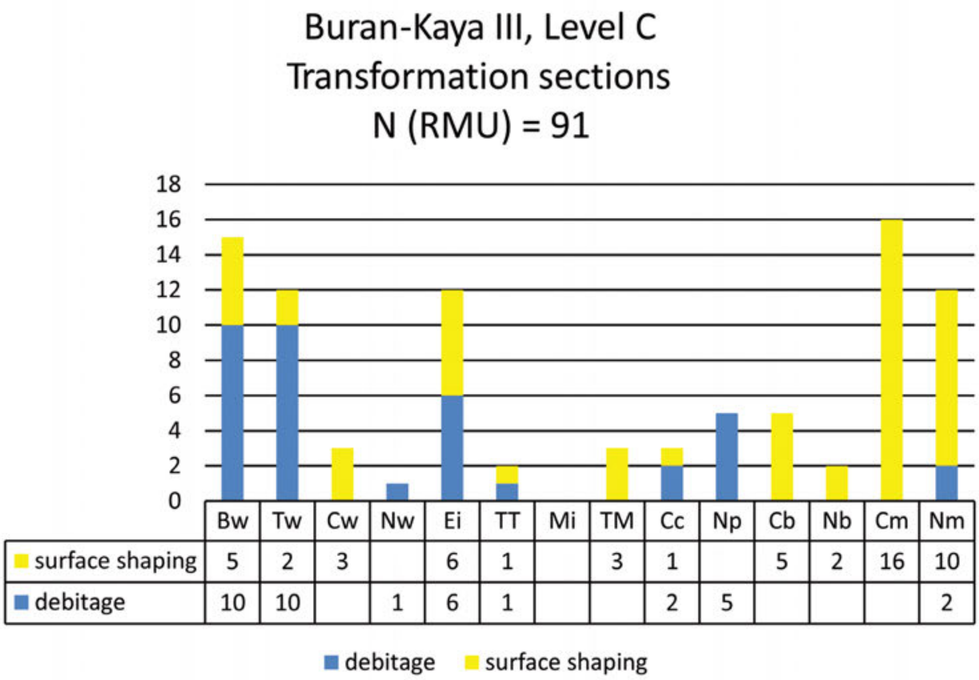
Tab. 3 Buran-Kaya III, Level C. Changes in the assignment of artifacts to RMUs made in the course of the sortation of raw material.

Tab. 3 *Buran-Kaya III, Level C. Nach der ersten Sortierung erfolgte Änderungen in der Zuordnung von Artefakten zu Rohmaterialeinheiten RMU).*

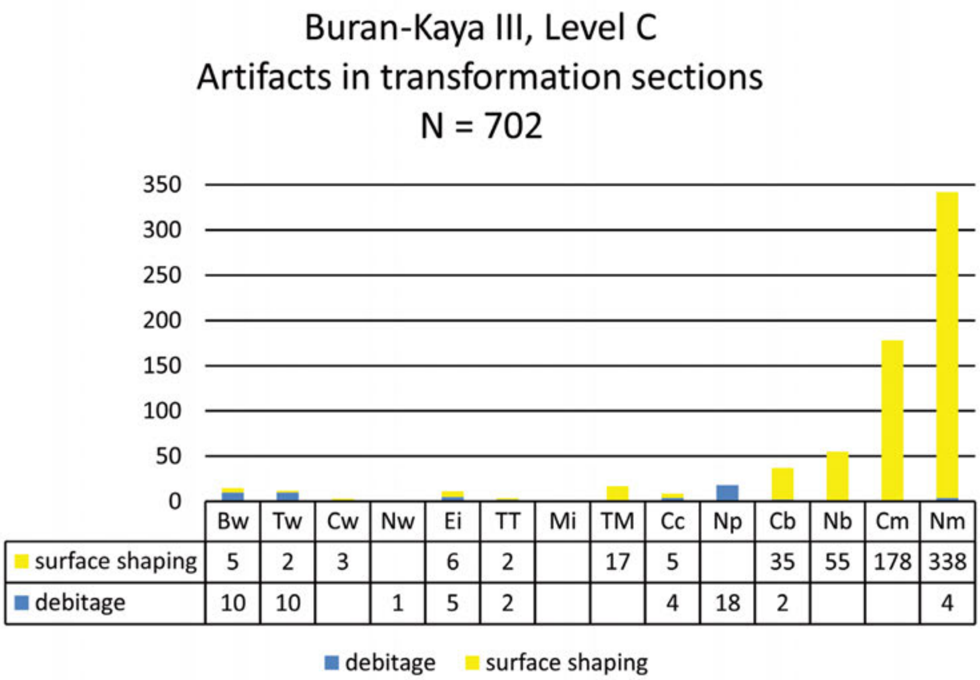
categories “never”, “rare” and “often” for the presence of overlaps with other RMUs. In little more than half of the cases the degree of potential overlap with other RMUs was valued either unlikely (category “never”, N = 9) or of medium probability (“rare”, N = 40). 43 RMUs show a considerable overlap in several parameter values (“often”), meaning that a separation from other RMUs was difficult and had to be based on single attributes, such as the presence of bands or the color of the cortex, or quantitative differences such as the amount and density of inclusions.

Apart from the combination of individual traits, the reliability of the raw material sortation also depends on the size of the pieces: the smaller the piece, the larger the chance that the fracture plain do not represent the full range of characteristic features of the original raw nodule. This problem is most apparent in cases when potential single pieces are postulated. Little more than half of the identification of RMUs as single pieces was rated secure (“never”, N = 6 and “rare”, N = 16). To crosscheck this aspect of raw material sorting of Buran-Kaya III, Level C, the size of the singles, indicated by blank type, was arranged in a ranking order (Tab. 2). From 42 RMUs with single pieces, 13 blanks were by definition small (microliths, resharpening flakes, functional end/base of tool). 29 RMUs plus 1 RMU with a complete hammerstone represent larger artifact classes. In the light of these data, there is no bias towards small artifact sizes among RMUs with single pieces. This can be taken as a proxy for the reliability of the identification of single pieces as separate RMU in Buran-Kaya III, Level C. From the fact that single pieces are the most problematic class of sorted artifacts one may, with caution, deduce that this applies also to the larger RMUs.

To some extent, the similarity of part the raw material is mirrored by changes made in the course of sorting, e.g., after critical comparisons between already defined RMUs during or at the end of a first round of sorting. Two different procedures occurred (Tab. 3): either a RMU was closed because its artifacts were sorted to already existing other or to newly formed RMUs, or selected artefacts of an existing RMU were separated to constitute



	Bw	Tw	Cw	Nw	Ei	TT	Mi	TM	Cc	Np	Cb	Nb	Cm	Nm
surface shaping	5	2	3		6	1		3	1		5	2	16	10
debitage	10	10		1	6	1			2	5				2



	Bw	Tw	Cw	Nw	Ei	TT	Mi	TM	Cc	Np	Cb	Nb	Cm	Nm
surface shaping	5	2	3		6	2		17	5		35	55	178	338
debitage	10	10		1	5	2			4	18	2			4

Fig. 7 Buran-Kaya III, Level C. Results of transformation analysis of 91 RMUs (upper part: frequency of RMU in transformation sections; lower part: frequency of artifacts in transformation sections; single pieces, no transformation: Bw = blank without [other items], Tw = Tool without [other items], Cw = Core without [other items], Nw = Nodule without [other items]; single pieces or two pieces indicating tool use: Ei = isolated End [of a tool], TT = [base of] Tool [with functional end of] Tool, Mi = isolated [chip from] Modification, TM = Tool [with chip/s from] Modification; two or more items indicating the flaking of workpieces: Cc = Core correction, Np = Nodule preparation, Cb = Core [reduction for] blanks, Nb = Nodule [reduction for] blanks, Cm = Core [reduction for blanks with] modification, Nm = Nodule [reduction for blanks with] modification; in the case of surface shaping, "core" is synonymous to "preform").

Abb. 7 *Buran-Kaya III, Level C. Ergebnisse der Transformationsanalysen an 91 Rohmaterialeinheiten (RMU; oberer Teil: Anzahl der Rohmaterialeinheiten pro Transformationsausschnitt; unterer Teil: Anzahl an Artefakten pro Transformationsausschnitt; Auflösung der Kürzel siehe oben in der englischen Version).*

novel RMUs each with a single piece only. A closure of RMUs occurred three times, whereas the separation of a single piece was decided for 13 artifacts.

Transformation analysis of Level C

With 648 artifacts, the overwhelming part of the lithics stem from RMUs with indication of surface shaping, e.g., soft hammer facial retouch (Fig. 7, lower part). Only 53 artifacts belong to reduction processes of raw pieces without surface shaping. The dominance of surface shaping as the main method of raw material reduction is less visible in the transformation sections (Fig. 7, upper part). Nevertheless, 59 RMUs with surface shaping clearly outnumber 32 RMUs with core reduction. There is an apparent mismatch between the high frequency of artifacts from RMUs flaked in the course of surface shaping and the moderate number of RMUs with a transformation section actually classified as such. The reason for this is the comparably high number of RMUs classified as debitage among the discarded single pieces (Fig. 7: “Bw”, “Tw”, “Cw”) and RMUs that represent minor transformation (Fig. 7: “Cc”, “Np”). Taken as a whole, these transformation sections are dominated by debitage. Surface shaping gains more importance either in cases where imported tools were so heavily used that they broke (Fig. 7: “Ei” and “TT”), in cases where imported blanks were modified into tools on the site (Fig. 7: “TM”), and when reduction sequences were long, e.g., in RMUs with blank production (Fig. 7: “Cb”, “Nb”, “Cm”, “Nm”). 33 RMUs with on-site surface shaping of unifacial or bifacial blanks (and in part subsequent modification) are opposed to two RMUs with full debitage and modifiation (Fig. 7: “Nm”). Even more so, the RMUs with debitage are – as already stated above – mainly restricted to short reduction sequences such as the preparation of raw nodules (Fig. 7: “Np”) or the correction of a core (Fig. 7: “Cc”).

Technologically, on-site surface shaping was almost exclusively focused on the production of bifacially surface shaped tools such as leafpoints (Monigal 2004b,Uthmeier 2012). Like in the Crimean Micoquian (Chabai & Uthmeier 2006; Uthmeier 2012), flakes from initial phases of surface shaping were the main source for blanks modified by lateral retouch into unifacial formal tools such as side scrapers. At least some of the thin and, in lateral section, straight blanks for geometric microliths (as one of the most typical features of the Streletskayan from Level C: Monigal 2004a; Uthmeier 2012) also originate from surface shaping (Fig. 6: RMU 12). C. Monigal (2004b) has already suggested that blanks for geometric microliths were struck from the lower surfaces of end scrapers, part of which were made from the remnants of bifacial tools. We found several RMUs that support this. Although we did not find refits, the similarities between the size of geometric microliths on the one hand, and the outline of negatives from ventral thinning of end scrapers on the other, in several RMU are striking (Fig. 6: RMU 3 and RMU 38/1). It needs to be further investigated at other Streletskayan sites whether the production of blanks for microliths is opportunistic in general or if this is an individual trait of Buran-Kaya III, Level C. In addition to the transformation into end scrapers, the re-cycling of bifacial tools is further attested in RMU 35 (Fig. 6). Refitting shows that the basal fragment of a bifacial tool was resharpened on both laterals to obtain a novel, double-scraper-like tool. The same RMU also yielded a geometric microlith, which in the logics of transformation analysis again has to be made on a blank from (on-site) surface shaping.

Discussion

In the discussion, the results of transformation analysis of Buran-Kaya III, Level C are compared to those from the study of G. Bataille (2017) of the same level, and Buran-Kaya III, Level B/B1 (Uthmeier 2004c). Comparisons are based on qualitative

	this study	Bataille 2017
single	42	6
workpiece	46	3
variety	4	15
sum	91	24

Tab. 4 Buran-Kaya III, Level C. Resolution of raw material sorting in RMU.

Tab. 4 *Buran-Kaya III, Level C. Auflösung der Rohmaterialsortierung.*

and quantitative aspects. Similarities and differences are analyzed quantitatively by using histograms and, to lesser extent, by the calculation of Pearson´s r to elucidate possible positive or negative correlations between two variables.

Comparison of the results of transformation analysis of Buran-Kaya III, Level C with the study of G. Bataille (2017)

In contrast to our study, G. Bataille (2017) used only 344 artifacts ≥ 3 cm for his analysis. The much smaller parent population may in part be responsible for pronounced differences in the total number of RMUs. Whereas our study defined 92 RMUs, G. Bataille´s sortation resulted in 25 RMUs. In both cases, one RMU with a hammerstone was excluded from transformation analysis. Among the siliceous raw materials, G. Bataille distinguished 19 RMUs with clearly different patterns of raw material attributes (Bataille 2017, 14: RMUs 1, 3 to 20), and six RMUs each with artifacts showing a combination of features of two of the other 19 RMUs (Bataille 2017, 14: RMUs 17, 4–6, 4–20, 6–10, 8–15 & 8–16). These and nine further RMUs were classified as "varieties", three as "workpieces" and six as "single pieces". Compared to this, our results are quite diverging (Tab. 4). In contrast to G. Bataille, we identified almost as much "single pieces" (N = 42) as "workpieces" (N = 46), whereas the number of RMUs classified as "variety" is almost negligible (N = 4).

However, due to the different basic data, the two studies are difficult to compare. First, the study of G. Bataille (N = 344) is based on about half of the artifacts used in our analysis (N = 702). Second, three persons for several working weeks conducted our sorting instead of one person, which means a higher workload invested in our study. It cannot be excluded that the discussion of decisions between different observers working on the same material also contributed to the more differentiated raw material sortation. On the other hand, the dominance of RMUs classified as "varieties" and the low number of "single pieces" in the raw material sortation of G. Bataille points to a different approach in decision making characterized by lumping rather than splitting. Without petrographic analysis, it is impossible to decide which of the two approaches is better.

How do the different approaches in the sorting of the raw material affect the results of the two transformation analysis? The overall data (Fig. 8, middle part) is very similar in the number of artifacts coming from RMUs classified as debitage or surface shaping. In both studies, more than 90 % of the lithic artifacts were obtained by surface shaping. However, whereas in G. Bataille´s study debitage is absent with the exception of imported single pieces and surface shaping in all cases started with imported (at least partly decorticated) preforms, our study sorted most artifacts into RMUs classified as starting from an imported raw nodule (Fig. 8, lower part). Admittedly, if vice versa the frequency of artifacts in RMUs is taken into consideration (Fig. 8, upper part), the picture is more balanced: artifacts from RMUs with surface shaping also dominate by far in our analysis. Nevertheless, our analysis not only supposes a higher importance of on-site flaking of imported raw nodules (Fig. 8, lower part), which essentially lack in G. Bataille´s study, but also a more intensive use of imported tools, surface shaped or not, that resulted in the breakage of the respective pieces. In addition, on-site modification (or re-sharpening) of imported single blanks

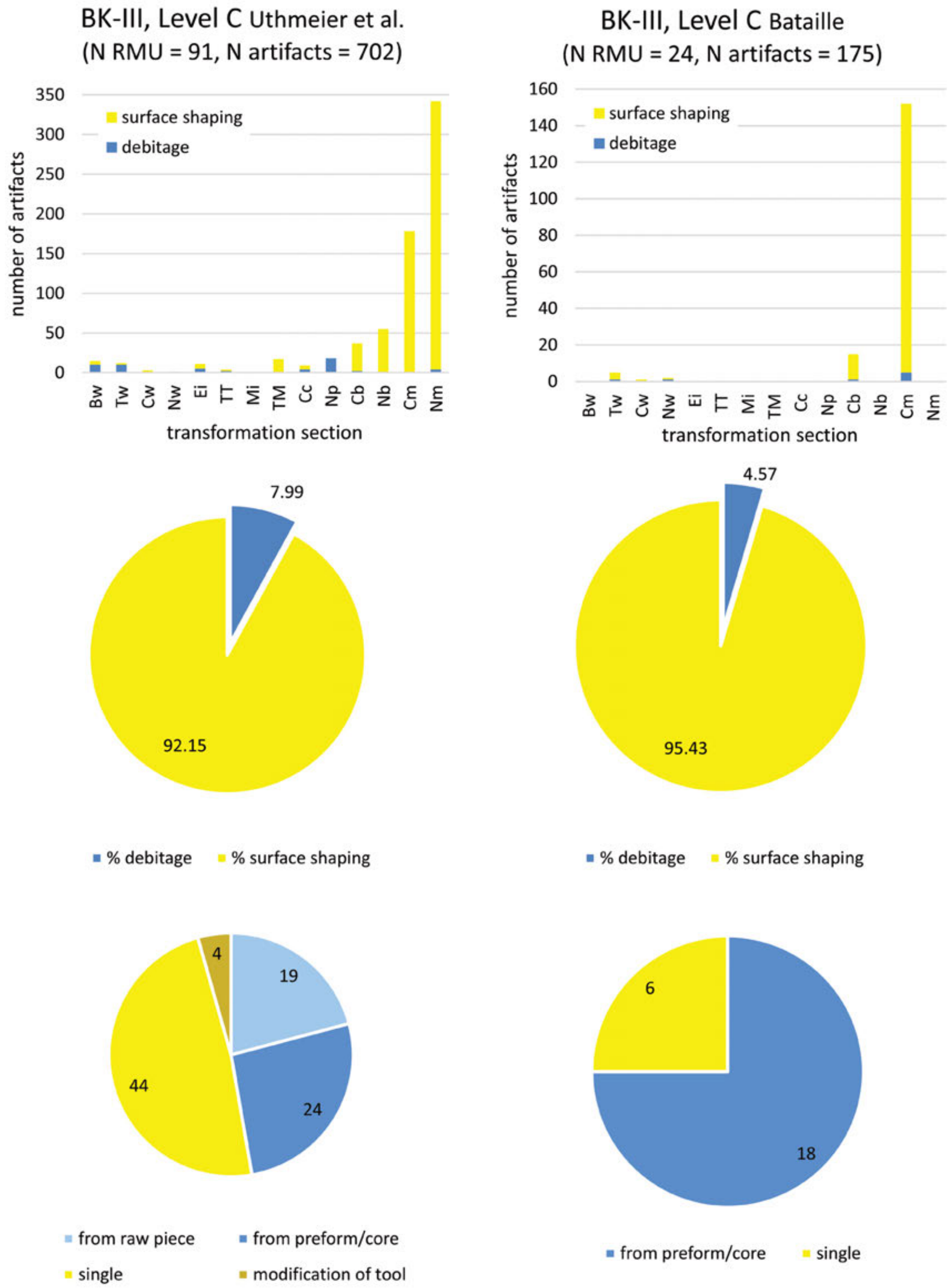


Fig. 8 Buran-Kaya III, Level C. Comparison between this study (left) and the study of G. Bataille (2017; right; for an explanation of the abbreviations of transformation sections see Fig. 7).

***Abb. 8** Buran-Kaya III, Level C. Vergleich zwischen Daten aus der vorliegenden Studie (linke Seite) und denjenigen aus der Arbeit von G. Bataille (2017; rechte Seite; für eine Auflösung der Kürzel der Transformationsausschnitte siehe Abb. 7).*

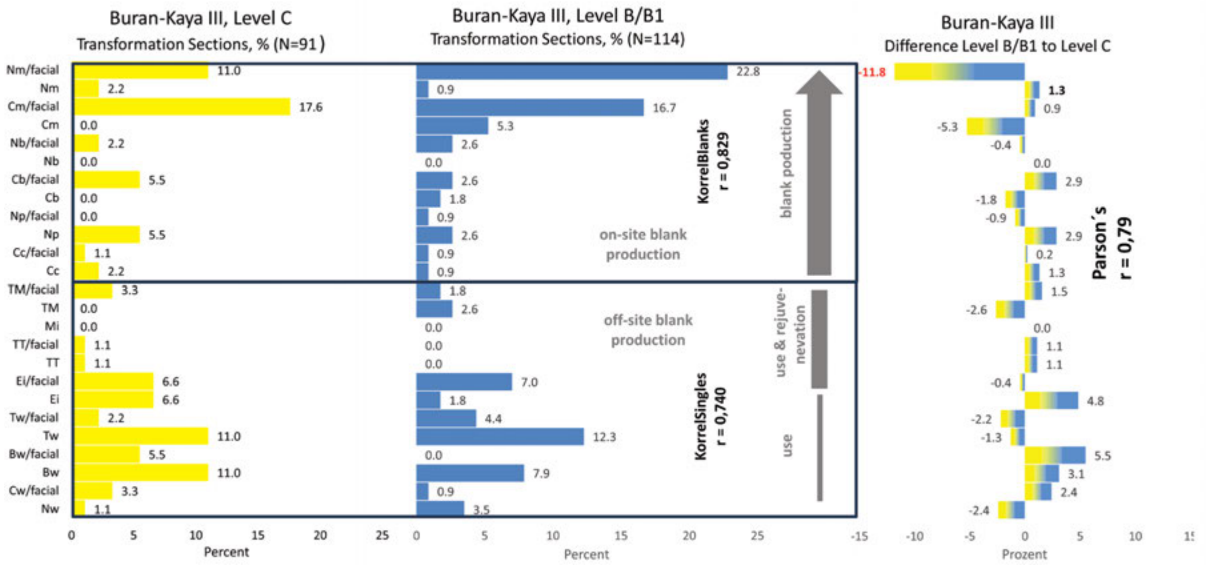


Fig. 9 Buran-Kaya III, Level C and Level B/B1. Comparison between the relative frequencies (in percent) of RMUs per transformation section (left and middle) and the respective differences between the two Levels (right; for an explanation of the abbreviations of transformation sections see Fig. 7 ; facial = RMU with surface shaping).

Abb. 9 *Buran-Kaya III, Level C und Level B/B1. Vergleich zwischen den prozentualen Häufigkeiten der Anzahl von Rohmaterialeinheiten (RMU) pro Transformationsausschnitt (links und Mitte) sowie die daraus resultierenden Differenzen zwischen den beiden Leveln (eine Erklärung für die Abkürzungen der Transformationsausschnitte findet sich in Abb. 7).*

or tools is attested, too. To conclude, the variability of transformation is considerably higher in our study.

Comparison of transformation analysis of Level C and Level B/B1

Together with several other Mousterian and Micoquian occurrences, Level B/B1 of Buran-Kaya III marks the very end of the Middle Paleolithic occupation of the Crimea (Chabai & Uthmeier 2006). The underlying Level C, on the other hand, is discussed as a very early, if not the earliest manifestation of a Upper Paleolithic in the region. Other candidates that may represent even earlier occupations of modern humans on the Crimean Peninsula are the Initial or Early Upper Paleolithic Levels D and E at the bottom of the sequence of Buran-Kaya III, but they yielded only a handful of artifacts (Monigal 2004a). To the contrary, the rich (Proto-)Aurignacian assemblages from Siuren I, which can be securely correlated to modern humans, lack reliable absolute dates (Demidenko & Noiret 2012). After the Streletskayan industry lacks human remains, it is far from granted that modern humans were the manufacturer of the assemblage of Level C. Nevertheless, a comparison between the Micoquian, which can be traced back in the Crimea until MIS 5 (Chabai & Uthmeier 2006), and the Streletskayan from Buran-Kaya III is still of great interest, as the latter almost certainly represents incoming foreign groups (Monigal 2004b).

The comparison of the frequency of transformation sections of Level C and Level B/B1 from Buran-Kaya III in a diagram (Fig. 9) already shows that these are similarly distributed in the two assemblages. This is further supported by the calculation of Pearson´s r. Pearson´s is a correlation coefficient with maximal values between $r = 1,0$ (for perfect positive correlation) and $r = -1,0$ (for perfect negative correlation) resulting from pairwise comparisons of the frequencies of the respective characteristic values. The interpretation of Pearson's r follows Cohen (1988), with $r \leq 0.10$ signaling a weak correlation, $r \leq 0.50$ a moderate correlation and $r > 0.50$ a strong correlation. For the distribution of the frequency of transformation classes in the

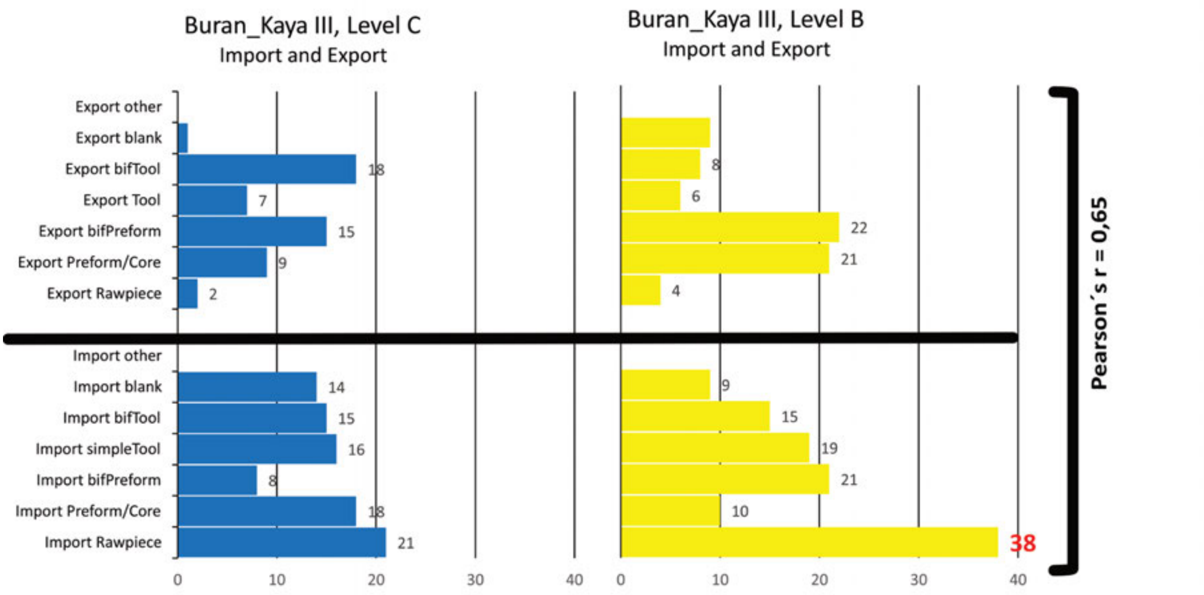


Fig. 10 Buran-Kaya III, Level B and Level C. Comparison between frequencies of the status of imported items and exported pieces as reconstructed by transformation analysis.

Abb. 10 *Buran-Kaya III, Level B und Level C. Vergleich zwischen den Häufigkeiten verschiedener Eintragungs- und Austragungszuständen, rekonstruiert anhand der Transformationanalyse.*

two assemblages, Pearson´s r = 0,790 shows a strong positive correlation between the frequencies of the transformation sections of the two Levels. The reason for the broad similarity lies in the same basic strategy of raw material reduction, which in both cases is almost exclusively surface shaping. Core-like pieces indicating debitage exist, but it is difficult to decide whether they represent a reduction strategy on their own, or are initial stages of surface shaping. A high degree of statistical agreement also concerns the separate calculation of Pearson´s r for transformation sections with on-site blank production (r = 0,829) and off-site blank production (use of ready-made tools or modification of imported blanks: r = 0,740). In sum, differences between the two levels are not very pronounced, pointing to more or less similar strategies in the treatment of raw materials when being confronted with a deficit of local raw materials.

Differences in first case affect the frequency of raw nodules that underwent the complete reduction sequence from decortication via initial surface shaping until the manufacture of tools (Fig. 9: “Nm/facial”). With a frequency of 22 %, this transformation section is the dominant one in Level B/B1. In Level C, however, it comes to 11 % and reaches only half of the value from Level B/B1. Equally relevant are differences in the frequency of RMUs representing the complete reduction sequence by a debitage mode of reduction starting from imported cores (Fig. 9: “Cm”). These are absent in Level C, but occur in Level B/B1 with 5 %. To the contrary, when transformation sections indicating the import of single items without or only minor on-site transformation are compared, it is apparent that occupants of Level C show not only a preference for simple blanks, but also for blanks from surface shaping (Fig. 9: “Bw/facial”). At the same time, they more intensively used (Fig. 9: “TT”: broken tool) or re-used (Fig. 9: “Ei”: isolated end of a tool, e.g. the base exported after breakage) imported simple tools than those of Level B/B1. The observed intensification of the use of imported simple blanks in Level C can be explained by the almost total lack of core reduction by debitage: surface shaping leads to a dominance of thin flakes less

	Buran-Kaya III, Level B/B1	Buran-Kaya III, Level C
number of moves to raw material outcrop(s)	low to moderate	high
selection of raw material	focused on nearest source with acceptable quality	focused on high-quality raw material
provision strategy for equipment	Provisioning of sites	provisioning of individuals
search strategy for resources	knowledge-based, logistical (base camps, field camps, stations)	chance encounter
import	many raw pieces	many surface shaped items (preforms, tools)
export	non-selective	more surface shaped items
logistical territory	similar to other Crimean Micoquian sites	different from known Crimean Middle Paleolithic sites
logistical Mobility	lower (base camp)	higher (ephemeral station)
site catchment for base camps	ecotone	unknown
overall subsistence strategy	focused on long-term knowledge and selective resource acquisition based on established land use system	focused on high mobility

Tab. 5 Buran-Kaya III, Level C and Level B/B1. Overview of hypothesis deduced from the results of transformation analysis of Level C (this study) and Level B/B1 (Uthmeier 2004c, 2013).

Tab. 5 *Buran-Kaya III, Level C und Leveel B/B1. Übersicht über Hypothesen, die sich aus einem Vergleich der Transformationsanalysen der Schicht C (vorliegenden Studie) und der Schicht B/B1 (Uthmeier 2004c, 2013) ergeben.*

suitable for long-lived lateral retouch. In sum, transformation sections indicating on-site flaking are more weighted towards the import of already prepared workpieces in Level C than in Level B/B1. At the same time, Level C shows an even more pronounced focus on surface shaping as mode of blank production than Level B/B1.

Transformation analysis allows for each RMU to conclude not only on the degree of on-site transformation, but also on the state of reduction at the moment of import and (if reconstructed) on the export of larger pieces, such as preforms, cores or tools (Fig. 10). Again, Pearson´s r = 0,652 calculated for the respective frequencies indicates a strong positive correlation. Broadly speaking, there is the tendency that hunter-gatherers from Level C imported less unworked raw pieces and exported more surface shaped items in advanced stages of production, e.g. bifacial tools and preforms, than those of Level B/B1.

Conclusion

Technologically speaking, there is strong structural affinity between the Streletskayan of Buran-Kaya III, Level C on the one hand, and the Crimean Micoquian on the other. It is rooted in the use of bifacial surface shaping not only as the dominant mode of blank production, but as a measure to ensure the accurate provision of future activities with sharp working edges, e.g. through reshaperning of bifacial tools and the use of flakes from surface shaping. Nevertheless, transformation analysis revealed several important differences. Within the Middle and Early Upper Paleolithic of the Crimea, Buran-Kaya III, Level C shows an unusual high diversity of raw materials. In many other sites, larger portions of the raw material used come from the same geological outcrop of the so-called “flint belt” of the Crimean Mountains (Chabai & Uthmeier 2006). Given a raw material procurement that is embedded in the acquisition of other (food) resources, the enlarged variability of raw material sources used in Level C indicates an increased number of regional micro moves (e.g., moves that started and ended at Buran-Kaya III) of single group members or part of the group. This assumption is preferred to the alternative suggestion that most – if not all – raw material was brought to the site in the course of macro moves (e.g., the relocation of a base camp). In the latter case, it is logical to assume that raw material procured prior to the macro move would have been searched for in the vicinity of the former camp or at least at one outcrop. If so, then the variability of raw material should be lower than observed.

Transformation analysis of Buran-Kaya III, Level C gives new and important information on the land use system and associated subsistence tactics of the Streletskayan settlement of the Crimea. The main hypotheses are listed in Table 5 and cannot be discussed in full length here. In short, it is hypothesized that the group, which kept the ephemeral camp of this industry at Buran-Kaya III, Level C,

- was more mobile than the Crimean Micoquian groups with regard to long-distance micro moves (of individuals);
- used other parts of the Crimean landscapes for resource acquisition than those of the Crimean Micoquian (different raw material sources);
- applied different subsistence tactics with search strategies on an encounter basis (comparably high variability of raw material sources);
- were highly selective in decisions about resource characteristics (high quality of raw materials);
- did stay in the Crimea only seasonally and/or for a short time or at base camps in site catchments yet unknown in the Crimean Middle Paleolithic.

From the point of view of subsistence tactics, the differences between Buran-Kaya III, Level C one the one hand, and the Micoquian (including Level B/B1) on the other, prevail. Other differentiating aspects include the presence of bone artifacts (tubes: Laroulandie & d´Errico 2004) and eagle remains (Gavris & Taykova 2004). The latter allow to conclude on the extraction of the legs and claws (probably for the use as personal ornament). On the territory of the Crimea, both elements only occur in the Streletskayan. In the discussion about possible affinities to either the Middle or the Upper Paleolithic it is worth mentioning that the use of feathers and claws of large birds of prey is a behavior restricted to, and at the same time deeply rooted in, the Middle Paleolithic (Jaubert et al. 2022). Taken as a whole, it can nevertheless be excluded that the Streletskayan industry in the Crimea is directly related, e.g., as facies, to the regional Micoquian. Instead, it is more probable, as suggested before (Chabai et al. 2004b; Monigal 2004b; Uthmeier 2012), that the Streletskayan emerged in the Kostenki region. The low number of sites in between point to a land use pattern characterized by a pronounced degree of mobility, as detected by our transformation analysis.

Supplementary Data: Flow charts and a table with the radiocarbon samples can be downloaded in ZENODO under the *doi 10.5281/zenodo.8414106*

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