



HAL
open science

Neanderthal technological variability: A wide-ranging geographical perspective on the final Middle Palaeolithic

Francesca Romagnoli, Victor Chabai, Brad Gravina, David Hérissou, Erella Hovers, Moncel Marie-Hélène, Marco Peresani, Thorsten Uthmeier, Laurence Bourguignon, María Gema Chacón, et al.

► To cite this version:

Francesca Romagnoli, Victor Chabai, Brad Gravina, David Hérissou, Erella Hovers, et al.. Neanderthal technological variability: A wide-ranging geographical perspective on the final Middle Palaeolithic. Francesca Romagnoli; Florent Rivals; Stefano Benazzi. Updating Neanderthals. Understanding Behavioural Complexity in the Late Middle Palaeolithic, Academic Press, pp.184-226, 2022, 978-0-12-821428-2. 10.1016/B978-0-12-821428-2.00012-3 . hal-03709299

HAL Id: hal-03709299

<https://hal.science/hal-03709299>

Submitted on 18 Jul 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Updating Neanderthals

Understanding Behavioural Complexity in the Late Middle Palaeolithic

Edited by

Francesca Romagnoli, Florent Rivals
and Stefano Benazzi



Updating Neanderthals

Understanding Behavioural Complexity in the Late Middle Palaeolithic

This page intentionally left blank

Updating Neanderthals

Understanding Behavioural Complexity in the Late Middle Palaeolithic

Edited by

Francesca Romagnoli

Departamento de Prehistoria y Arqueología, Universidad Autónoma de Madrid, Madrid, Spain

Florent Rivals

ICREA and Institut Català de Paleoecologia Humana i Evolució Social, Tarragona, Spain

Stefano Benazzi

Dipartimento di Beni Culturali, Università di Bologna, Bologna, Italy



ACADEMIC PRESS

An imprint of Elsevier

Academic Press is an imprint of Elsevier
125 London Wall, London EC2Y 5AS, United Kingdom
525 B Street, Suite 1650, San Diego, CA 92101, United States
50 Hampshire Street, 5th Floor, Cambridge, MA 02139, United States
The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom

Copyright © 2022 Elsevier Inc. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher. Details on how to seek permission, further information about the Publisher's permissions policies and our arrangements with organizations such as the Copyright Clearance Center and the Copyright Licensing Agency, can be found at our website: www.elsevier.com/permissions.

This book and the individual contributions contained in it are protected under copyright by the Publisher (other than as may be noted herein).

Notices

Knowledge and best practice in this field are constantly changing. As new research and experience broaden our understanding, changes in research methods, professional practices, or medical treatment may become necessary.

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds, or experiments described herein. In using such information or methods they should be mindful of their own safety and the safety of others, including parties for whom they have a professional responsibility.

To the fullest extent of the law, neither the Publisher nor the authors, contributors, or editors, assume any liability for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions, or ideas contained in the material herein.

ISBN 978-0-12-821428-2

For information on all Academic Press publications
visit our website at <https://www.elsevier.com/books-and-journals>

Publisher: Nikki P. Levy
Acquisitions Editor: Anna Valutkevich
Editorial Project Manager: Lena Sparks
Production Project Manager: Selvaraj Raviraj
Cover Designer: Matthew Limbert

Typeset by STRAIVE, India



Contents

Contributors	xi		
Foreword	xv		
Preface	xvii		
Cover caption	xix		
1. Updating Neanderthals: Taking stock of more than 160 years of studies			
<i>Francesca Romagnoli, Florent Rivals, and Stefano Benazzi</i>			
1 Discovery, first studies, and the illustration of the dumb ape	1		
2 The main scientific debates between 1930 and 1980: Anthropological and cultural data	3		
3 The end of the 20th century	6		
4 The 21st century: Updating Neanderthals	6		
5 From brutality to rehabilitation and narration	8		
Acknowledgements	9		
References	9		
2. The climatic and environmental context of the Late Pleistocene			
<i>María Fernanda Sánchez Goñi</i>			
1 Introduction	17		
2 Orbital and abrupt climate changes through the Late Pleistocene	17		
3 Vegetation response to Late Pleistocene climate changes	22		
3.1 The Last Interglacial <i>sensu lato</i> (MIS 5)	22		
3.2 80,000 years ago, the return of the Ice age	25		
3.3 Millennial-scale climatic variability during MIS 4 and 3 (~73–27ka)	26		
4 How did Neanderthals cope with climate changes?	28		
4.1 The impact of the Last Interglacial environments on Neanderthal population	31		
4.2 Were Western European Neanderthals favoured by the entering in glaciation at 80ka?		31	
4.3 Survival and disappearance of Neanderthals		31	
5 Final remarks		33	
Acknowledgements		34	
References		34	
3. Diet and ecological interactions in the Middle and Late Pleistocene			
<i>Florent Rivals, Hervé Bocherens, Edgard Camarós, and Jordi Rosell</i>			
1 Introduction		39	
2 Dietary ecology of animals and Neanderthals		40	
2.1 Primary consumers, the herbivores		40	
2.2 Secondary consumers, the carnivores (except the cave bear)		43	
2.3 Omnivores, the cave bear and the wild boar		43	
2.4 Dietary traits of the Neanderthals		44	
2.5 Role of megaherbivores as keystone species		44	
3 Complex interactions between Neanderthals and animals		45	
3.1 Prey–predator relationships		45	
3.2 Sharing common caves alternatively		46	
3.3 Confrontation between Neanderthals and carnivores		48	
4 Final remarks		49	
Acknowledgements		49	
References		49	
4. Different species on the horizon: The Denisova hominins			
<i>Bence Viola</i>			
1 Denisova cave and the Altai (overview)		55	
1.1 Stratigraphy		55	

1.2 Dating	55	8 Final remarks	82
1.3 Fauna	56	Acknowledgements	83
1.4 Archaeology	56	References	83
2 Denisovan fossils from Denisova cave	57		
3 Xiahe	59	6. The Neanderthal brain: Biological and cognitive evolution	
3.1 Mandible	60	<i>Fabio Macchiardi and Fabio Martini</i>	
3.2 Sedimentary DNA	61	1 How to investigate a palaeo-brain: Tools and methods	89
4 Denisovan genetics	61	1.1 Structural and functional anatomical brain characteristics of Neanderthals	91
4.1 Denisovan gene flow into recent populations	62	2 The molecular basis of brain evolution in Neanderthal and <i>H. sapiens</i>: DNA and RNA (genes, polymorphisms, and noncoding, regulatory elements)	94
4.2 'Superarchaic' gene flow into Denisovans	63	2.1 Neural genes and their possible role in the evolution of the Neanderthal brain: A few examples	95
4.3 Effects of Denisovan introgression on present populations	63	3 Not only technology: The graphical record of the Neanderthals as a window on their cognitive traits	96
5 Other Denisovans?	64	3.1 Considerations on Neanderthal engravings and their formal makeup	97
5.1 East Asian Middle Pleistocene <i>Homo</i>	64	4 Cognitive studies and archaeological evidence for the creation of meaning	101
5.2 South East Asia	65	5 Final remarks	101
6 Final remarks	65	References	102
References	65		
		7. Selection versus opportunism: A view from Neanderthal subsistence strategies	
5. Neanderthals: Anatomy, genes, and evolution		<i>William Rendu</i>	
<i>Antonio Rosas, Markus Bastir, and Antonio García-Taberner</i>		1 Introduction	109
1 Introduction	71	2 Selection at a regional scale	111
2 What are Neanderthal traits?	72	3 Selection at a local scale	113
3 Two explanatory evolutionary models	73	4 The hunter's choice	113
4 Evolutionary anatomy of the Neanderthal phenotype	74	5 Selection within animal carcasses	114
4.1 Body mass	74	6 Diversification of the diet and the exploitation of nonungulate animals	115
4.2 Height	74	7 Final remarks	117
4.3 Body shape	74	Acknowledgements	117
4.4 Interlimb proportions	74	References	118
4.5 Endocranium	74		
4.6 Neurocranium	75	8. Small animal use by Neanderthals	
4.7 Face	75	<i>Ruth Blasco, David Cochard, Andre C. Colonese, Véronique Laroulandie, Jacqueline Meier, Eugène Morin, Anna Rufà, Laura Tassoni, and Jessica C. Thompson</i>	
4.8 Mandible	76	1 Introduction	123
4.9 Dentition	77	2 Rabbits and hares	124
4.10 Thorax	78		
4.11 Spine vertebral column	78		
4.12 Pelvis	78		
4.13 Trunk (encompassing the pelvis, spine, and costal skeleton)	79		
4.14 Pectoral girdle	79		
4.15 Upper limbs	79		
4.16 Hands	79		
4.17 Lower limbs	80		
4.18 Foot	80		
5 Evolutionary morphology of Neanderthal characters	80		
6 Phase 1. Origin of <i>H. heidelbergensis</i> (s.s.)	80		
7 Phase 2. Origin of <i>H. neanderthalensis</i>	81		

3 Birds	126	5.2 Strategies of lithic production	175
4 Tortoises	128	5.3 Retouched items and transported toolkits	176
5 Aquatic resources	133	6 North-western Europe and southern France	177
6 Final remarks	135	6.1 Raw material types, catchment areas, and mobility settings	178
Acknowledgements	135	6.2 Strategies of lithic production	178
Author contributions	136	6.3 Retouched items and transported toolkits	181
References	136	7 Mediterranean Europe	181
9. The use of plants by Neanderthals as food, medicine, and raw materials		7.1 The Iberian Peninsula	181
<i>Karen Hardy</i>		7.2 Italy	185
1 Introduction	145	7.3 The Balkans	187
2 Methods used in recovery of evidence for plant use	146	8 Neanderthal variability	188
2.1 Microfossils	146	9 Final remarks	190
2.2 Biomolecules, DNA	146	Acknowledgements	190
2.3 Use wear and residues	150	References	190
3 Archaeological evidence for plants	150	11. The organisation of living spaces in Neanderthal campsites	
3.1 Food	150	<i>Manuel Vaquero</i>	
3.2 Medicine and plant secondary compounds	154	1 Introduction	207
3.3 Raw materials	155	2 Constructing the paradigm: What does a hunter-gatherer camp look like?	208
4 Behavioural implications of the plant evidence	156	3 Ethnographic concepts, archaeological facts	210
5 Final remarks	157	4 Spatial units in Middle Palaeolithic sites	212
References	157	5 Beyond activity areas: Time uncertainties in campsite layout	217
10. Neanderthal technological variability: A wide-ranging geographical perspective on the final Middle Palaeolithic		6 Final remarks	220
<i>Francesca Romagnoli, Victor Chabai, Brad Gravina, David Hérison, Erella Hovers, Marie-Hélène Moncel, Marco Peresani, Thorsten Uthmeier, Laurence Bourguignon, M. Gema Chacón, Kevin Di Modica, Jean-Philippe Faivre, Kseniya Kolobova, Ariel Malinsky-Buller, Petr Neruda, Joseba Rios Garaizar, Marcel Weiss, Andrzej Wisniewski, and Rebecca Wragg Sykes</i>		Acknowledgement	221
1 The 'Mousterian debate' today	163	References	221
2 Concepts and abbreviations	165	12. Fire among Neanderthals	
3 The Levant	166	<i>Ethel Allué, Carolina Mallo, Vera Aldeias, Aitor Burguet-Coca, Dan Cabanes, Ángel Carrancho, Rory Connolly, Lucia Leierer, Susan Mentzer, Christopher Miller, Dennis Sandgathe, Mareike Stahlschmidt, Isabelle Théry-Parisot, and Manuel Vaquero</i>	
3.1 Raw material types, catchment areas, and mobility settings	167	1 Introduction	227
3.2 Strategies of lithic production	167	2 Background to research on European Middle Palaeolithic fire: History, archaeological evidence, and debates	228
3.3 Retouched items and transported toolkits	168	3 Methods and techniques	230
4 The eastern regions: From the Altai to Eastern Europe	169	3.1 Experiments and ethnography	230
4.1 Main Middle Palaeolithic industries	170	3.2 Fire as an artefact	231
5 Central Europe	173	3.3 Soil micromorphology	231
5.1 Raw material types, catchment areas, and mobility settings	175	3.4 Archaeobotany	232

3.5 Biogeochemistry	233		
3.6 Geophysics	234		
4 Fire among Neanderthals	234		
4.1 Neanderthal pyrotechnology	234		
4.2 Fuel	236		
4.3 Lighting fire	237		
4.4 Fire use	238		
4.5 Fire reuse, abandonment, and taphonomy	239		
4.6 From fire to hearth: The social meaning of combustion features in Neanderthal lifeways	240		
5 Final remarks	241		
Author contributions	242		
Acknowledgements	242		
References	242		
13. 'Art': Neanderthal symbolic graphic behaviour			
<i>Marcos García-Diez</i>			
1 Portable graphic symbolism	252		
2 Parietal graphic symbolism	254		
3 Cognitive implications	257		
4 Final remarks	258		
References	258		
14. Spiritual and symbolic activities of Neanderthals			
<i>Jacques Jaubert, Bruno Maureille, and Marco Peresani</i>			
1 Introduction	261		
2 Neanderthal funerary activities	262		
3 Marine shells and pigment use	264		
4 Wings and feathers	266		
5 Raptor claws	267		
6 Non-utilitarian objects, <i>curiosa</i>	268		
7 Appropriation of the darkness of the underground world	268		
8 Final remarks	268		
Acknowledgements	271		
References	271		
15. Beyond European boundaries: Neanderthals in the Armenian Highlands and the Caucasus			
<i>Boris Gasparyan and Phil Glauberman</i>			
1 Eco-geography and Pleistocene palaeoenvironment of the Armenian Highlands and the Caucasus	275		
		2 Middle Palaeolithic sites in the Armenian Highlands and the Caucasus. Site types, chronology, and distribution	277
		3 Middle Palaeolithic technological concepts, traditions or cultural features, and the regional sequence	279
		4 Middle Palaeolithic technological organisation, land use, and regional artefact discard patterns	283
		5 Middle Palaeolithic hunter-gatherer subsistence and hunting strategies and use of fire	289
		6 Art and symbolic behaviour? Modified cave bear bones and teeth from Middle Palaeolithic deposits in the Armenian Highlands and the Caucasus	291
		7 The problem of replacement of Neanderthals by <i>Homo sapiens</i> in the study area	293
		8 Final remarks	294
		Acknowledgements	295
		References	295
		16. Methodological advances in Neanderthal identification, phylogeny, chronology, mobility, climate, and diet	
		<i>Hervé Bocherens, Klervia Jaouen, Florent Rivals, Viviane Slon, Sahra Talamo, and Frido Welker</i>	
		1 Introduction	303
		2 Neanderthals and their contemporaries	303
		2.1 Ancient DNA	303
		2.2 Palaeoproteomics	305
		3 The radiocarbon dating and the last Neanderthal. Present status quo	307
		3.1 The radiocarbon from two-hand clock to three-hand precision	307
		3.2 Why bones?	309
		3.3 The 'statistic' surrounding Neanderthals and <i>Homo sapiens</i> chrono-interaction	310
		4 Reconstructing Neanderthal's way of life (diet, habitat, weaning, mobility)	310
		4.1 Neanderthal isotopes	310
		4.2 Dental macrowear and microwear, dietary traits, and tooth use in Neanderthals	312
		5 Final remarks	313
		References	314

17. The arrival of *Homo sapiens* in the Near East and Europe

Andrea Picin, Adriana Moroni, and Stefano Benazzi

1 Introduction	321
2 The Initial Upper Palaeolithic (IUP)	322
2.1 Levantine Initial Upper Palaeolithic	323
2.2 Bachokirian	324
2.3 Bohunician	325
2.4 Uluzzian	326
3 The Early Upper Palaeolithic (EUP)	327
3.1 Ahmarian	328

3.2 Proto-Aurignacian and Early Aurignacian	331
3.3 An overview from the East European Plains	332
4 The transitional industries	334
5 Final remarks	335
Acknowledgements	336
References	336
Afterword—From a homogeneous population to a great diversity: Discussing perspectives on Middle Palaeolithic studies for the coming years	349
Index	351

Contributors

Numbers in parentheses indicate the pages on which the authors' contributions begin.

Vera Aldeias (227), Interdisciplinary Center for Archaeology and the Evolution of Human Behavior (ICArEHB), University of Algarve, Faro, Portugal

Ethel Allué (227), Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA); Departament d'Història i Història de l'Art, Universitat Rovira i Virgili (URV), Tarragona, Spain

Markus Bastir (71), Department of Paleobiology, Museo Nacional de Ciencias Naturales (CSIC), Madrid, Spain

Stefano Benazzi (1, 321), Dipartimento di Beni Culturali, Università di Bologna, Ravenna, Italy

Ruth Blasco (123), Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA); Departament d'Història i Història de l'Art, Universitat Rovira i Virgili, Tarragona, Spain

Hervé Bocherens (39, 303), Department of Geosciences, Biogeology; Senckenberg Centre for Human Evolution and Palaeoenvironment (SHEP), University of Tübingen, Tübingen, Germany

Laurence Bourguignon (163), Inrap UMR7041 Antet, Villeneuve-Les-Béziers, France

Aitor Burguet-Coca (227), Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA); Departament d'Història i Història de l'Art, Universitat Rovira i Virgili (URV), Tarragona, Spain

Dan Cabanes (227), Department of Anthropology and Center for Human Evolutionary Studies (CHES), Rutgers University, Biological Sciences Building, New Brunswick, NJ, United States

Edgard Camarós (39), McDonald Institute for Archaeological Research, University of Cambridge; King's College, Cambridge, United Kingdom

Ángel Carrancho (227), Área de Prehistoria, Departamento de Historia, Geografía y Comunicación, Universidad de Burgos, Edificio I+D+I, Burgos, Spain

Victor Chabai (163), Institute of Archaeology, The National Ukrainian Academy of Sciences, Kyiv, Ukraine

M. Gema Chacón (163), Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Zona Educacional 4, Campus Sescelades URV (Edifici W3); Universitat Rovira i Virgili, Departament d'Història i Història de l'Art, Tarragona, Spain; UMR 7194 HNHP, MNHN-CNRS-UPVD, Département Homme et Environnement, Muséum National D'Histoire Naturelle, IPH, Paris, France

David Cochard (123), PACEA UMR 5199, Université de Bordeaux, CNRS, MCC, Pessac, France

Andre C. Colonese (123), Department of Prehistory and Institute of Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona, Bellaterra, Spain

Rory Connolly (227), Instituto Universitario de Bio-Orgánica Antonio González (IUBO); Departamento de Geografía e Historia, Universidad de La Laguna, Santa Cruz de Tenerife, Spain; School of Archaeology, University College Dublin, Belfield, Dublin, Ireland

Jean-Philippe Faivre (163), PACEA, UMR 5199—Université de Bordeaux, Bât. B18, Pessac Cedex, France

Joseba Rios Garaizar (163), Arkeologi Museoa Bilbao, Bilbao, Spain

Marcos García-Diez (251), Department of Prehistory, Ancient History and Archaeology, Complutense University of Madrid, Madrid, Spain

Antonio García-Taberner (71), Department of Paleobiology, Museo Nacional de Ciencias Naturales (CSIC), Madrid, Spain

Boris Gasparyan (275), Department of Early Archaeology, Institute of Archaeology and Ethnography, National Academy of Sciences of the Republic of Armenia; Department of Archaeology and Ethnography, Yerevan State University, Yerevan, Armenia

- Phil Glauberman** (275), Department of Early Archaeology, Institute of Archaeology and Ethnography, National Academy of Sciences of the Republic of Armenia, Yerevan, Armenia; Department of Early Prehistory and Quaternary Ecology, Karls Eberhard University of Tübingen, Tübingen, Germany; School of Humanities and Social Sciences, Xi'an Jiaotong-Liverpool University, Suzhou, China
- Brad Gravina** (163), Musée national de Préhistoire, MC, Les Eyzies de Tayac; PACEA, UMR 5199—Université de Bordeaux, Bât. B18, Pessac Cedex, France
- Karen Hardy** (145), ICREA, Lluís Companys 23; Department of Prehistory, Autonomous University of Barcelona, Barcelona, Spain
- David Hérison** (163), CNRS-UMR7041 ArScAn, Équipe AnTET (Anthropologie des Techniques, des Espaces et des Territoires au Pliocène et au Pléistocène), MSH Mondes, Université Paris Nanterre, Nanterre Cedex, France
- Erella Hovers** (163), The Institute of Archaeology, The Hebrew University of Jerusalem, Jerusalem, Israel; Institute of Human Origins, Arizona State University, Tempe, AZ, United States
- Klervia Jaouen** (303), Géosciences Environnement Toulouse, Observatoire Midi Pyrénées, Toulouse, France
- Jacques Jaubert** (261), Université de Bordeaux, CNRS, MC, PACEA, UMR 5199, Pessac, France
- Kseniya Kolobova** (163), Institute for Archaeology and Ethnography, Siberian Branch, Russian Academy of Sciences, Novosibirsk, Russia
- Véronique Laroulandie** (123), PACEA UMR 5199, Université de Bordeaux, CNRS, MCC, Pessac, France
- Lucia Leierer** (227), Instituto Universitario de Bio-Organica Antonio González (IUBO); Departamento de Geografía e Historia, Universidad de La Laguna, Santa Cruz de Tenerife, Spain
- Fabio Macchiardi** (89), Department of Psychiatry and Human Behavior, School of Medicine, University of California, Irvine (UCI), CA, United States
- Ariel Malinsky-Buller** (163), The Institute of Archaeology, The Hebrew University of Jerusalem, Jerusalem, Israel; MONREPOS, Archaeological Research Centre and Museum for Human Behavioural Evolution, Neuwied, Germany
- Carolina Mallol** (227), Instituto Universitario de Bio-Organica Antonio González (IUBO); Departamento de Geografía e Historia, Universidad de La Laguna, Santa Cruz de Tenerife, Spain; Interdisciplinary Center for Archaeology and the Evolution of Human Behavior (ICArEHb), University of Algarve, Faro, Portugal
- Fabio Martini** (89), Dipartimento di Storia, Archeologia, Geografia, Arte e Spettacolo (SAGAS)-Prehistory Unit, University of Florence; Museo e Istituto Fiorentino di Preistoria, Florence, Italy
- Bruno Maureille** (261), Université de Bordeaux, CNRS, MC, PACEA, UMR 5199, Pessac, France
- Jacqueline Meier** (123), Department of Sociology, Anthropology and Social Work, University of North Florida, Jacksonville, FL, United States
- Susan Mentzer** (227), Senckenberg Centre for Human Evolution and Paleoenvironment at the University of Tübingen (HEP-Tübingen), Tübingen, Germany
- Christopher Miller** (227), Senckenberg Centre for Human Evolution and Paleoenvironment at the University of Tübingen (HEP-Tübingen); Institute for Archaeological Sciences and Senckenberg Centre for Human Evolution and Paleoenvironment, University of Tübingen, Tübingen, Germany; SFF Centre for Early Sapiens Behaviour (SapienCE), University of Bergen, Bergen, Norway
- Kevin Di Modica** (163), Scladina Cave Archaeological Centre, Andenne, Belgium
- Marie-Hélène Moncel** (163), UMR 7194 HNHP, MNHN-CNRS-UPVD, Département Homme et Environnement, Muséum National D'Histoire Naturelle, IPH, Paris, France
- Eugène Morin** (123), PACEA UMR 5199, Université de Bordeaux, CNRS, MCC, Pessac, France; Department of Anthropology, Trent University, DNA Block C, Peterborough, ON, Canada
- Adriana Moroni** (321), U.R. Preistoria e Antropologia, Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, Università degli Studi di Siena, Siena; Istituto Italiano di Paleontologia Umana, Anagni; Centro Studi sul Quaternario Onlus, Italy
- Petr Neruda** (163), Anthropos Institute, Moravian Museum, Brno, Czech Republic
- Marco Peresani** (163, 261), Dipartimento di Studi Umanistici, Sezione di Scienze Preistoriche e Antropologiche, Università di Ferrara, Ferrara; Consiglio Nazionale delle Ricerche, Istituto di Geologia Ambientale e Geoingegneria, Gruppo di Ricerche Stratigrafiche Vegetazione, Clima, Uomo, Laboratorio di Palinologia e Paleoecologia, Milano, Italy
- Andrea Picin** (321), Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig; Friedrich Schiller Universität Jena, Bereich für Ur- und Frühgeschichtliche Archäologie, Jena, Germany

- William Rendu** (109), ArchaeoZOOlogy in Siberia and Central Asia—ZooSCAn, CNRS—IAET SB RAS, International Research Laboratory IRL2013, Novosibirsk, Russia
- Florent Rivals** (1, 39, 303), ICREA, Barcelona; Institut Català de Paleoeologia Humana i Evolució Social (IPHES-CERCA); Departament d’Història i Història de l’Art, Universitat Rovira i Virgili (URV), Tarragona, Spain
- Francesca Romagnoli** (1, 163), Departamento de Prehistoria y Arqueología, Facultad de Filosofía y Letras, Universidad Autónoma de Madrid, Madrid, Spain
- Antonio Rosas** (71), Department of Paleobiology, Museo Nacional de Ciencias Naturales (CSIC), Madrid, Spain
- Jordi Rosell** (39), Institut Català de Paleoeologia Humana i Evolució Social (IPHES-CERCA); Departament d’Història i Història de l’Art, Universitat Rovira i Virgili (URV), Tarragona, Spain
- Anna Rufà** (123), PACEA UMR 5199, Université de Bordeaux, CNRS, MCC, Pessac, France; Interdisciplinary Center for Archaeology and Evolution of Human Behaviour (ICArEHB), Universidade do Algarve, Faro, Portugal
- María Fernanda Sánchez Goñi** (17), Ecole Pratique des Hautes Etudes (EPHE, PSL University), Earth and Life Sciences, Paris; University of Bordeaux, Oceanic and Continental Environments and Paleoenvironments (EPOC), UMR 5805, Pessac, France
- Dennis Sandgathe** (227), Department of Archaeology, Simon Fraser University, Burnaby, BC, Canada
- Viviane Slon** (303), Department of Anatomy and Anthropology and Department of Human Molecular Genetics and Biochemistry, Sackler Faculty of Medicine; The Dan David Center for Human Evolution and Biohistory Research, Tel Aviv University, Tel Aviv, Israel
- Mareike Stahlschmidt** (227), Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany
- Rebecca Wragg Sykes** (163), PACEA, UMR 5199—Université de Bordeaux, Bât. B18, Pessac Cedex, France; School of Archaeology, Classics and Egyptology, University of Liverpool, Liverpool, United Kingdom
- Sahra Talamo** (303), Department of Chemistry “G. Ciamician”, University of Bologna, Bologna, Italy
- Laura Tassoni** (123), Department of Chemistry G. Ciamician, Università di Bologna, Bologna, Italy
- Isabelle Théry-Parisot** (227), Université Côte D’Azur, CNRS, CEPAM, UMR 7264, Nice, France
- Jessica C. Thompson** (123), Department of Anthropology, Yale University, New Haven, CT, United States
- Thorsten Uthmeier** (163), Institut für Ur- und Frühgeschichte, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany
- Manuel Vaquero** (207, 227), Departament d’Història i Història de l’Art, Universitat Rovira i Virgili (URV); Institut Català de Paleoeologia Humana i Evolució Social (IPHES-CERCA), Tarragona, Spain
- Bence Viola** (55), Department of Anthropology, University of Toronto, Toronto, ON, Canada
- Marcel Weiss** (163), Institut für Ur- und Frühgeschichte, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany
- Frido Welker** (303), GLOBE Institute, University of Copenhagen, Copenhagen, Denmark
- Andrzej Wiśniewski** (163), Institute of Archaeology, University of Wrocław, Wrocław, Poland

Neanderthal technological variability: A wide-ranging geographical perspective on the final Middle Palaeolithic

Francesca Romagnoli^a, Victor Chabai^b, Brad Gravina^{c,d}, David Hérison^e, Erella Hovers^{f,g}, Marie-Hélène Moncel^h, Marco Peresani^{i,j}, Thorsten Uthmeier^k, Laurence Bourguignon^l, M. Gema Chacón^{m,n,h}, Kevin Di Modica^o, Jean-Philippe Faivre^d, Kseniya Kolobova^p, Ariel Malinsky-Buller^{f,q}, Petr Neruda^r, Joseba Rios Garaizar^s, Marcel Weiss^k, Andrzej Wiśniewski^t, and Rebecca Wragg Sykes^{d,u}

^aDepartamento de Prehistoria y Arqueología, Facultad de Filosofía y Letras, Universidad Autónoma de Madrid, Madrid, Spain, ^bInstitute of Archaeology, The National Ukrainian Academy of Sciences, Kyiv, Ukraine, ^cMusée national de Préhistoire, MC, Les Eyzies de Tayac, France, ^dPACEA, UMR 5199—Université de Bordeaux, Bât. B18, Pessac Cedex, France, ^eCNRS-UMR7041 ArScAn, Équipe AnTET (Anthropologie des Techniques, des Espaces et des Territoires au Pliocène et au Pléistocène), MSH Mondes, Université Paris Nanterre, Nanterre Cedex, France, ^fThe Institute of Archaeology, The Hebrew University of Jerusalem, Jerusalem, Israel, ^gInstitute of Human Origins, Arizona State University, Tempe, AZ, United States, ^hUMR 7194 HNHP, MNHN-CNRS-UPVD, Département Homme et Environnement, Muséum National D'Histoire Naturelle, IPH, Paris, France, ⁱDipartimento di Studi Umanistici, Sezione di Scienze Preistoriche e Antropologiche, Università di Ferrara, Ferrara, Italy, ^jConsiglio Nazionale delle Ricerche, Istituto di Geologia Ambientale e Geoingegneria, Gruppo di Ricerche Stratigrafiche Vegetazione, Clima, Uomo, Laboratorio di Palinologia e Paleoecologia, Milano, Italy, ^kInstitut für Ur- und Frühgeschichte, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany, ^lInrap UMR7041 Antet, Villeneuve-Les-Béziers, France, ^mInstitut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Zona Educacional 4, Campus Sescelades URV (Edifici W3), Tarragona, Spain, ⁿUniversitat Rovira i Virgili, Departament d'Història i Història de l'Art, Tarragona, Spain, ^oScladina Cave Archaeological Centre, Andenne, Belgium, ^pInstitute for Archaeology and Ethnography, Siberian Branch, Russian Academy of Sciences, Novosibirsk, Russia, ^qMONREPOS, Archaeological Research Centre and Museum for Human Behavioural Evolution, Neuwied, Germany, ^rAnthropos Institute, Moravian Museum, Brno, Czech Republic, ^sArkeologi Museoa Bilbao, Bilbao, Spain, ^tInstitute of Archaeology, University of Wrocław, Wrocław, Poland, ^uSchool of Archaeology, Classics and Egyptology, University of Liverpool, Liverpool, United Kingdom

1 The 'Mousterian debate' today

Since the stone tool assemblages identified at the site of Le Moustier in France at the end of the 19th century were given their name, Neanderthals have often been identified as 'Mousterian man'. From the beginning of the 20th century until roughly its final quarter, cultural classifications were based primarily on typological features of lithic assemblages, determined by studying the shape of the artefacts and specific characteristics of retouch. This approach was based on the 'index fossil' concept borrowed from the natural sciences, such that each cultural context was clearly identifiable due to the presence of a distinct retouched tool or set of tools (see [Monnier, 2006](#), and bibliography therein).

During the first half of 20th century, the cultural material associated with Neanderthal fossils was progressively recovered across Eurasia, which showed an internal variability in terms of both retouched items and technological traits ([Romagnoli et al., 2022](#)). During this period, archaeological

debates mainly focused on characterising and interpreting this techno-typological variability within the cultural category of the Mousterian. The debate persisted throughout the last century and is still ongoing, albeit with some differing perspectives.

In recent decades, lithic assemblages have increasingly been investigated from a techno-economic perspective that has greatly modified our understanding of Neanderthal material culture. Key factors in this research have included resource distribution across the landscape, strategies of acquisition, differential selection of raw materials, reduction technology, hominin mobility, and modalities of resource and toolkit transport (e.g. [Delpiano and Uthmeier, 2020](#); [Derevianko et al., 2015](#); [Glauberger et al., 2020](#); [Golovanova and Doronichev, 2003](#); [Malinsky-Buller et al., 2021](#); [Turq et al., 2013, 2017](#)). Studying assemblages as dynamic production processes (contrary to the static index fossil approach) has made researchers more aware of the importance of dependable and solid chronological and paleoenvironmental frameworks to

interpret local adaptations and compare strategies across space and time. These frameworks are still often lacking, making it difficult for variability to be understood from a long-term, evolutionary perspective. Furthermore, the huge geographical distribution of the Neanderthals, from the Atlantic coasts of Europe to the Levant and the Altai mountains in east-central Asia, currently makes it impossible to draw a general scenario, given the many different contexts and—most probably—just as numerous specific local economic, social, and cultural dynamics. During the long existence of the Neanderthals, from approximately 400 ka to 35 ka (Galway-Witham et al., 2019; Rosas et al., 2022), climatic cycles triggered specific population dynamics in some regions. This was the case in northern latitudes, where the cyclical ice covering drove occupational hiatus and affected human north–south movement and re-colonisation events (Colleoni et al., 2016; Lambeck et al., 2006), while in coastal regions, continental shelves and available landmass varied due to sea-level fluctuations (Dendy et al., 2017; Siddall et al., 2003).

In addition to the geographical specificities across such an extensive territory and their unclear relationship with culture and cultural changes, three other elements contribute to difficulties in gaining in-depth understanding of technological trends and their causes. The first is the disparity in the density of studies between the various regions, which continues to limit large-scale comparisons. The second is the presence of hominins other than Neanderthal populations. Genetic studies have shown repeated interbreeding events with the closely related Denisovans and *Homo sapiens* (Prüfer et al., 2014). Thus, it should be acknowledged that fossil populations and the cultural material they created that are currently defined as ‘Neanderthal’ may in some contexts be much more complex. The third factor is diversity in cultural expressions. Today we know that there is substantial variability not only within the traditional Mousterian cultural category (Romagnoli et al., 2022) but also beyond it. Vast areas of northern, central, and eastern Europe contain lithic industries characterised by bifacially shaped items classed as separate cultural entities, such as Micoquian and *Keilmessergruppen* (Frick, 2020; Jöris, 2006; Kolobova et al., 2020; Uthmeier, 2016). These industries, and their own internal variability, are often sidelined when discussing ‘the Mousterian’, leading to the misleading predominance of western European archaeological record as the dominant technological expression of the Eurasian Middle Palaeolithic. Furthermore, alongside this spatial and temporal diversity in Middle Palaeolithic technologies, Neanderthal cultural expressions that appeared just prior to the disappearance of these groups from the archaeological record (followed by the appearance of Upper Palaeolithic industries) present particular technological variability and specific problems related to

the timing and modalities of the arrival of *H. sapiens* in Eurasia and their interactions with indigenous hominins including Neanderthals (Picin et al., 2022).

In the last two decades, the emergence of a dynamic technological perspective has modified some concepts and ideas about Neanderthal lithic material culture in three main domains: technology, typology, and the temporal and spatial dynamics of the production sequence. The idea of a single Mousterian technological entity, characterised by well-defined subgroups within a homogeneous cultural framework of time and space, significantly underrepresents the diversity of Neanderthal adaptations and population dynamics in Eurasia. A more holistic vision of Neanderthal stone tool technology has culminated in the adoption of lithic ‘techno-complexes’, defined as a collection of knowledge, expertise, and practices shared by a set of human groups (Delagnes et al., 2007). Techno-complexes are distinguished primarily by what are now well-understood flake production systems, namely Quina, discoid, Levallois, blade (see Delagnes et al., 2007, and bibliography therein), and by bifacial *chaînes opératoires*, including bifacial blank production and bifacial shaping (Boëda, 1991; Boëda et al., 1990). The high level of raw material, technical and retouched tool variability in Late Middle Palaeolithic assemblages across Eurasia highlights small-scale differences suggestive of local techno-complexes. However, the efforts of archaeologists to constrain this technological mosaic within a few well-defined entities complicates the identification and interpretation of broader trends, flexibility, and technological evolution, by overlooking local expressions of knowledge, expertise, and practices.

Another aspect of this debate is evident in the difficulties of classifying lithics within volumetric core reduction concepts (recurrent centripetal, discoid, Levallois, orthogonal, etc.; González-Molina et al., 2020; Rahnorn et al., 2019; see papers in Dibble and Bar-Yosef, 1995; Peresani, 2003a). Clearly across Eurasia, there is immense diversity in lithotypes (and, consequently, raw material constraints) encountered by hominins in various regions and even across time (visible through the stratigraphic sequence of a site). In addition, there is also significant variability within technical solutions, techniques, knapping methods and concepts applied by humans and expressed in the archaeological records of the extensive area inhabited by Neanderthals. Consequently, when conducting comparative research, it is difficult to ascertain whether archaeologists working on different areas have used compatible classification terminologies. In the 2000s, the technological approach was a driving force for identifying production systems and knapping concepts such as Levallois and discoid in archaeological assemblages. The result of this collective endeavour was a ‘typology of the technology’ characterised by an effort to make lithic items fit within a specific technological concept. Today, it is clear that multiple factors can modify the sequence of technical

gestures and the way in which the volumetric concept of knapping is applied. These include the skill of the knapper, the quality and morphology of the raw material, and requirements in terms of products (i.e. number of tools needed, specific requirements of flakes with regard to shape, length, width and thickness, and functional aims), in addition to mobility strategies within the landscape and social and cultural aspects. What is needed today is an improved local and regional scale of analysis to understand how general knapping concepts were locally expressed according to landscape management strategies and the transmission of knowledge within the local human groups.

The complete confidence in typology as the prime indicator of human behaviour and its cultural context, which characterised most of the 20th century, had partially faded by the late 1990s through the implementation of use–wear analysis and the perspective of technology as process. Looking at the lithic elements that compose a stone tool assemblage, it is neither quick nor easy to identify all the tools produced by humans for their daily tasks. In recent years, it has been widely shown that functional edges were not necessarily modified beforehand through retouch (e.g. [Claud et al., 2019](#)), and even management flakes, removed to control core volume during knapping, could have been used as tools. Furthermore, the concept of a tool can change over time. Functional items such as flakes and retouched tools can be switched to production items (i.e. become cores), and waste can later be gathered (by the same human groups or by others that encountered it after discard), modified by resharpening its edge(s) and put back to use (recycling: [Amick, 2007](#); [Gravina and Discamps, 2015](#); and papers in [Barkai et al., 2015](#); see [Vaquero et al., 2015, 2017](#) for a spatial perspective on recycling). Furthermore, it is clear that even early hominin species moved in search of food and raw materials, and the development of mobility strategies and planning of tasks in different locations have become central topics in current research in terms of how they modified the composition of transported lithic toolkits.

Taking into account the research history discussed and its complexities, in this chapter, we attempt a synthesis of Neanderthal Late Middle Palaeolithic technology as currently understood. It considers major characteristics in terms of raw material management, tools and mobile toolkits mainly during MIS 4–3 (c. 70–40 ka), and across the known geographic distribution of Neanderthals. The result is of course incomplete, but represents a reference map for setting out further improvements in our understanding of Neanderthal technologies at varied spatio-temporal scales. We intend it as a means to help build a novel framework to identify possible bias related to less investigated areas and to overcome the simplistic, often outmoded view of a dominant western European prehistory that has been uncritically applied over much of the last century.

2 Concepts and abbreviations

Here we define some abbreviations and concepts used in the chapter.

Middle Palaeolithic (MP). This broadly spanned from approximately 400/350 ka to 35 ka. From a technological point of view, it is characterised by novel elements when compared with the preceding Lower Palaeolithic, namely prepared core technology; emergence of blade technology; production of small- and medium-sized elements; greater resource variability for tool production; higher typological diversification and incidence of retouching; the development of composite and hafted tools; intensification of ramified or branched production sequences and recycling (e.g. [Adler et al., 2014](#); [Hérisson et al., 2016](#); [Romagnoli, 2021](#); [Rots, 2016](#); [Turq et al., 2013](#); [Wiśniewski, 2014](#)). In some regions, these features appeared long before the demise of strictly Lower Palaeolithic industries (e.g. [Méndez-Quintas et al., 2019](#); [Santonja et al., 2016](#)). In Eurasia, the upper boundary of the MP is the Upper Palaeolithic, which is associated with novel technological features and *H. sapiens*. The transition between Middle and Upper Palaeolithic shows diverse and specific technological patterns across different regions, probably at least partly in relation to local population dynamics between *H. sapiens* and local indigenous hominins ([Fewlass et al., 2020](#); [Higham et al., 2014](#); [Picin et al., 2022](#)).

Late Middle Palaeolithic (LMP). This spans from approximately 130 ka to 35 ka (MIS 5–3), corresponding to the period of anatomically ‘classic’ Neanderthals ([Rosas et al., 2022](#)). In this chapter, we mainly present technologies from approximately 70 ka to 40 ka (MIS 4–3) representing the latter half of the LMP, up to the demise of this population (in fossil and cultural terms).

Cores-on-flake (COF). The exploitation of a functional object (i.e. a blank with a cutting edge, whether modified by retouch or not) as a core (i.e. a debited volume) has been identified in archaeological assemblages since the Lower Palaeolithic. This behaviour intensified during the MP and has been described as ramification or a ‘branched sequence’. There is no consensus on the interpretation of ramification, with some seeing it as a structured provisioning strategy intended from the outset of the reduction sequence, while others identify it as expedient behaviour aimed at responding to immediate needs (see [Mathias and Bourguignon, 2020](#); [Romagnoli et al., 2018](#) for discussion). Significantly, a direct link between COF and greater distances to raw material sources has not been systematically demonstrated (see, e.g. [Amick, 2007](#); [Bourguignon et al., 2004](#); [Hovers, 2007](#); [Mathias and Bourguignon, 2020](#); [Romagnoli et al., 2018](#) among others). Recent studies suggest that COF can reflect different economic strategies, social interactions, and levels of planning proficiency. Therefore, in order to interpret ramified production, it is

necessary to take into account the temporal and spatial relationships of the *chaîne opératoire*. The products of COF are typically small or very small flakes with sharp cutting edges that were used unmodified or sometimes retouched (Claud et al., 2012; Lemorini et al., 2015).

Keilmessergruppen (KMG). Assemblages ascribed to this group are characterised by bifacial elements, especially the asymmetric backed bifacial knife (*‘Keilmesser’*) as an index fossil. They show marked differences in bifacial tool design when compared with bifaces found in western European Mousterian of Acheulean Tradition (MTA). A modified tip, natural or blunted back, and bifacial asymmetric cutting edge are the basic morphological features. In some cases, the cutting edge is modified by a Prondik removal (see below). KMG assemblages also contain a variety of sidescrapers, often bifacial, with thinned backs or coin-like sidescrapers (grozaks). Due to the variability of this group, assemblages with bifacial backed knives have been progressively termed Micoquian (Bosinski, 1967, 1968), Micoquo-Prondnikian (Chmielewski, 1969; cf. discussion in Frick, 2020), and KMG (Jöris, 2004, 2006; Mania, 1990; Veil et al., 1994). Assemblages ascribed to the KMG are also present in the eastern regions inhabited by Neanderthals, albeit with several technological differences (see below in this chapter). KMG sites appear to reflect groups with significant shared concepts of tool design, production, and maintenance that were quite different from those employed in other regions (Jöris, 2004; Uthmeier, 2016).

Mousterian of Acheulean Tradition (MTA). First defined by Peyrony (1920) at the site of Le Moustier, MTA assemblages are characterised typologically by retouched tools including sidescrapers, denticulates, backed knives, sometimes elongated flakes, and above all by the presence of bifaces, often cordiform and triangular examples (Soressi et al., 2008). The apparent morphological standardisation of bifaces through time and space in north-western Europe suggested that the MTA was a cultural tradition that originated in south-west France at approximately 50 ka (Locht, 2019). It has been proposed that the LMP bifacial component in western and central Europe, beyond technological differences, was related to specific social patterns, and that MTA vs KMG bifaces were potentially signals for social identity (Uthmeier, 2016).

Curation and toolkit. The concept of curation in hunter-gatherer archaeology was first introduced by Binford (1973, 1979) in relation to the transport of artefacts as part of personal gear selected to respond to future tasks to be performed elsewhere and later came to encompass concepts surrounding the efficiency of tool use and tool maintenance, recycling, transport, and design for multiple uses (Bamforth, 1986). Regardless the numerous definitions of curation (see Andrefsky, 2009, for an extensive overview), how technology interfaces with human mobility patterns is of fundamental importance. Hunter-gatherers often organise their

technology according to cyclical movements across the landscape, with retouched tools as a key element for reconstructing mobility strategies, particularly in relation to the concept of curation. Transported tools are characterised by longer duration of use, higher intensity of retouch, and large size (the largest and thickest blanks have the greatest resharpening and COF potential). When discarded, curated tools are expected to be significantly reduced in size due to resharpening, and these features are also expected to be more intense on exogenous raw materials. However, not all transported lithic artefacts fit this pattern, and more complex behavioural scenarios must be considered (for a detailed discussion, see Vaquero and Romagnoli, 2018). Furthermore, the transported toolkit may also include unmodified blanks, COF, and cores (see below). The identification of mobile toolkits sheds light on cognitive capabilities related to the anticipation of needs and the planning of tasks by hominins, as part of wider landscape techno-economy (e.g., Kuhn, 1995; Turq et al., 2013).

Regional setting. This chapter focuses on lithic technology. The regional framework was selected according to environmental factors as well as research history to facilitate the identification of technological trends in the regional archaeological records and stress variation in the extent of research and multidisciplinary studies in the different regions. While much of the focus of the chapter is on MIS 3, the inclusion of MIS 4 contexts in some sections helps better characterise the specificity of each geographical area and local cultural dynamics between 70 and 40 ka.

3 The Levant

The Levantine LMP (c. 70–45 ka) spans the duration of MIS4–MIS3. This period holds the richest MP record from both caves and open-air sites (Fig. 10.1). This corpus of excavated sheltered and open-air sites in the Mediterranean zone and semidesert has been interpreted as residential home bases with variable occupation length and number of visits (Bretzke et al., 2016; Ekshtain et al., 2019; Goder-Goldberger and Bar-Matthews, 2019; Goder-Goldberger et al., 2020; Hauck, 2011; Hovers, 2001; Hovers and Belfer-Cohen, 2013; Malinsky-Buller et al., 2021; Meignen et al., 2006, 2019; Mitki et al., 2021; Nishiaki et al., 2012). Human occupations took place in the context of a gradual drying trend with some shorter periods of ameliorated climate (Bar-Matthews and Ayalon, 2003; Langgut et al., 2011, 2018; Torfstein et al., 2013). The effects of climatic fluctuations would be more considerable for human groups in the arid and semiarid areas of the Levant, while in the Mediterranean zone, human populations may have experienced the very same climatic shifts as being milder and less detrimental to their lifeways (Goring-Morris et al., 2009).

It has been suggested that the LMP residential mobility of small groups within restricted home ranges implied increased

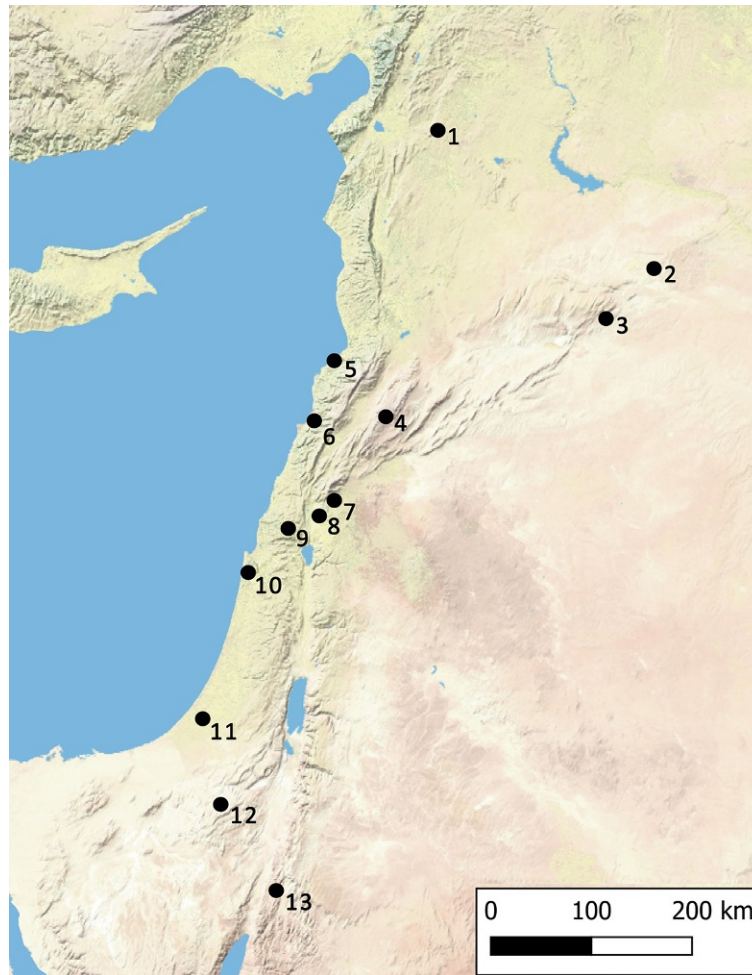


FIG. 10.1 Distribution map of the main final MP sites in the Levant. 1 Dederiyeh Cave; 2 Umm el Tiel, Hummal; 3 Jerf Ajla; 4 Yabroud; 5 Keoua; 6 Ksar Akil; 7 Quneitra; 8 Nahal Mahanayeem Outlet (NMO); 9 Shovakh Cave, Amud Cave, Emireh Cave; 10 Sefunim Cave, Tabun Cave, Kebara Cave, Ein Qashish; 11 Farah II; 12 Rosh Ein Mor, Nahal Aqev; 13 Tor Sabiha, Tor Faraj.

territoriality. This was interpreted in turn as an indication of higher density of hunter-gathers within the Mediterranean ecological zone of the Levant (Hovers, 2001, 2009; Meignen et al., 2006). Yet, those LMP populations exhibited a broad technological repertoire. The main characteristics of the assemblages fall within the overall lithic technological variability observed in the region since at least ~ 150 ka as a result of settlement and mobility patterns as well as technological traditions (Hovers and Belfer-Cohen, 2013).

3.1 Raw material types, catchment areas, and mobility settings

Lithic assemblages are made almost exclusively of chert, and only two open-air sites contain important reduction sequences in basalt (Goren-Inbar, 1990a) and limestone (Gilead and Grigson, 1984). Chert was procured mostly in the vicinity of the sites (< 10 km) and could have been obtained both through ‘embedded procurement’ and

planned quarrying activities within the daily exploitation territory (DET; Ekshtain et al., 2012, 2014, 2017; Finkel et al., 2018).

At many sites, there is a certain component of chert (20%–40%) that is derived from areas 10–30 km away from the focal site and outside the boundaries of the DET (Ekshtain et al., 2014). In some cases, these raw materials reached the sites as Levallois and retouched items (Ekshtain et al., 2014). In other cases, partially modified cores on ‘exotic’ chert were transported to the sites and flaked in a manner similar to that of the local raw material (Crew, 1976; Ekshtain et al., 2017; Hovers, 1990; Munday, 1976).

3.2 Strategies of lithic production

The lithic assemblages during this time period show a high degree of technological variation that is associated with a restricted number of lithic technological systems (Hovers and Belfer-Cohen, 2013).

Levallois production is the dominant reduction system, designed primarily for the manufacture of flakes, points, and blades (in decreasing order of frequency; [Abadi et al., 2020](#); [Hauck, 2011](#); [Krakovsky, 2017](#); [Meignen, 1995, 2019](#)). Arguably, the use of Levallois reduction facilitated the hafting of end products in some assemblages (e.g. [Bonilauri, 2015](#)). Most Levallois morphotypes were produced through more than one combination of flaking modes and methods ([Bar-Yosef and Van Peer, 2009](#); [Hovers, 2009](#); [Inizan et al., 1992](#); [Van Peer, 1992](#)). Flaking systems were modular with recurrent and (to a lesser degree) preferential methods of Levallois flaking combined variably with modes of core preparation (i.e. centripetal, unidirectional, unidirectional convergent, and bidirectional). Despite a tendency in the literature to emphasise the dominance of the unidirectional convergent flaking, broad-based Levallois points do not dominate any of the assemblages. Changes of flaking modes during the course of reduction have often been documented, from convergent, unidirectional, or bidirectional patterns in early stages to centripetal ones when discarded ([Hovers, 1998](#); [Meignen, 2019](#); [Nishiaki and Copeland, 1992](#); see below). There are only a few assemblages in which a single Levallois flaking variant accounts for over half of the Levallois blank population (e.g. [Goren-Inbar, 1990a](#); [Hauck, 2011](#); [Meignen, 2019](#)).

Non-Levallois laminar production entails the use of single-platform blade cores (reported from nearly each published assemblage) as well as semirotated cores where both wide faces and the narrow lateral face were used for blade production ([Ashkenazi, 2005](#); [Goder-Goldberger and Bar-Matthews, 2019](#); [Hauck, 2011](#); [Malinsky-Buller et al., 2014](#)).

COF represent a discrete production system ([Hovers, 2007](#)) that is variably encountered in all assemblages. The size and shape ranges of the products typically fall within those resulting from the reduction of nodules. A shared trait of all the assemblages is the preference for the largest available flakes for use as cores ([Goren-Inbar, 1990b](#); [Hauck, 2011](#); [Hovers, 2007](#); [Malinsky-Buller et al., 2014, 2021](#); [Mitki et al., 2021](#)). Among these are sometimes cortical and hinged items, which in addition to their relatively large dimensions also provide natural convexities that facilitate flake removals. Reduction sequences of COF are typically short, resulting in 1–3 products. Both the ventral and dorsal surfaces of the original flakes could be exploited. COF are sometimes formally prepared by partially or fully truncating and faceting the core's circumference ('Nahr Ibrahim'; [Schroëder, 1969](#); [Solecki and Solecki, 1970](#)) as a preparation for flake removals. In many instances, however, COF do not exhibit any formal preparation, and the bulb of percussion of the parent flake may still exist ([Dibble and McPherron, 2006](#); [Goren-Inbar, 1988](#); [Hovers, 2007](#); [Mitki et al., 2021](#); [Newcomer and Hivernel-Guerre, 1974](#)).

The production strategies used for bladelet manufacturing are similar to those used for non-Levallois blades. Still, it is

clear from their technological and metric characteristics (e.g. amount and location of cortex on the cores and products in relation to their size) that they derive from separate reduction sequences, even in assemblages that contain both technological groups. Overall, bladelets are not abundant in LMP Levantine assemblages, and the products are nonstandardised within and between assemblages ([Hovers et al., 2011](#); [Malinsky-Buller et al., 2014](#); [Pastoors et al., 2008](#)). In some instances, bladelets occur as by-products of the Levallois production of pointed pieces through unidirectional convergent modes ([Boëda et al., 2015](#); [Meignen, 1995](#); see below).

Quina flaking and bifacial shaping are almost absent from Levantine LMP assemblages, unlike those in Europe.

Despite the availability and accessibility of good-to-excellent raw materials, many assemblages contain some exhausted cores (as manifested in size—mainly their thickness relative to width—and cortical cover). Within the Levallois system, these are recognised by a shift throughout the flaking sequence from uni- and bidirectional removals of larger items to smaller products removed by centripetal flaking (as evidenced by the scar patterns of cores; see, e.g. [Abadi et al., 2020](#); [Hauck, 2011](#); [Hovers, 1998](#); [Malinsky-Buller et al., 2014, 2021](#); [Meignen and Bar-Yosef, 1992](#)). Similarly, COF form a constant and important component of each assemblage. This technological behaviour may have lengthened the temporal intervals between trips to raw material sources on the landscape.

3.3 Retouched items and transported toolkits

The frequencies of retouched items in LMP assemblages in the Levant are typically low (~3%–10% of total assemblage in most cases), Quneitra, with >30% of retouched items, being the sole exception ([Goren-Inbar, 1989](#)). All the assemblages contain composite tools, namely items retouched in a way that enables their classification as several tool types executed on a single blank. Again, the frequencies of such items among the retouched tools are highest in the assemblage of Quneitra (9.5%; [Goren-Inbar, 1989](#)). As is the case with COF, there is a clear preference for larger items for retouch, resulting in high frequencies among the retouched blanks of cortical items from the early stages of reduction or of Levallois items. The most common morphotypes are unstandardised, such as retouched flakes and blades. Sidescrapers are the most abundant formal tool, among which the various single sidescrapers defined by [Bordes \(1961\)](#) are dominant. There are few retouched Levallois points in all assemblages. Only a number of assemblages (Kebara XI, X, Hummal A1) contain relatively high frequencies of retouch on the ventral face (~15% and 11%, respectively [[Hauck, 2011](#); [Meignen, 2019](#)], and as high as 48% in Tor Faraj C [[Henry, 2003](#)]). Massive tools (e.g. massive sidescrapers) are only found in the basalt component of the Quneitra assemblage ([Goren-Inbar, 1990a](#)).

Use–wear studies indicate that both unretouched and retouched blanks were used as multipurpose implements for exploiting animal tissues and plant materials (Beyries, 1988; Bonilauri et al., 2007; Shea, 1991). The interpretation of pointed forms as elements of weaponry is not substantiated in all cases (see discussion in Hovers and Belfer-Cohen, 2020). Signs of hafting occur as mechanical damage (Shea, 1988, 1998), residues (Boëda et al., 2008; Bonilauri, 2015; Hauck et al., 2013; Monnier et al., 2012) or are reflected in patination patterns (Friedman et al., 1994) on all types of blanks, including broad-based points.

Within transported toolkits, it is possible to include items produced from resources collected far from the site. This is the case for some Levallois blanks and retouched tools (Ekshtain et al., 2014) and partially modified cores (Crew, 1976; Ekshtain et al., 2017; Hovers, 1990; Munday, 1976).

4 The eastern regions: From the Altai to Eastern Europe

Across the huge territory from the Eastern Carpathians to the Altai, stratified MP sites are patchily distributed (Fig. 10.2). Main MP site clusters are located in the Prut and Dniester Valleys, Crimea, northern Caucasus, Donbass region, and Altai piedmont midlands (Chabai et al., 2004; Derevianko et al., 2003; Golovanova and Doronichev, 2003; Kolesnik,

1994; Nehoroshev and Vishnyatsky, 2000; Sytnyk, 2012). MP stratified sites are also known in the Lower Volga and the northern and central Ural Mountains. In general, the degree of preservation of artefacts and faunal remains is much better in rock shelter and cave deposits than in the loess soil sequences of open-air sites on the river terraces and mountain areas.

In eastern Europe, the only evidence for a Middle Pleistocene MP industry comes from the open-air site of Neporotovo in the Dniester Valley (Gerasimenko et al., 2016; Nigst et al., 2019). Despite several MP occupations in the Dniester Valley, Crimea, and Volga Basin from MIS 5d to MIS 4, the majority of the occupations belong to MIS 3. The upper chronological limit of the MP in the Crimea and northern Caucasus is still a matter of debate (Spindler et al., 2021), but the interstratification of Middle and Early Upper Palaeolithic industries at well-preserved sites in the Crimea shows that, without doubt, the MP occupations in eastern Europe are among the latest in the western Eurasian subcontinent (Chabai, 2012; Chabai et al., 2004; Demidenko et al., 2012; Jöris et al., 2011; Monigal, 2004; Péan et al., 2013; Uthmeier, 2012).

In the Altai region, the earliest occupations are at Karama and Denisova Cave, where the lower layers date to as early as MIS 9–7. However, MP sites dating from MIS 6–3 are more numerous (Derevianko et al., 2003; Kolobova et al., 2020).

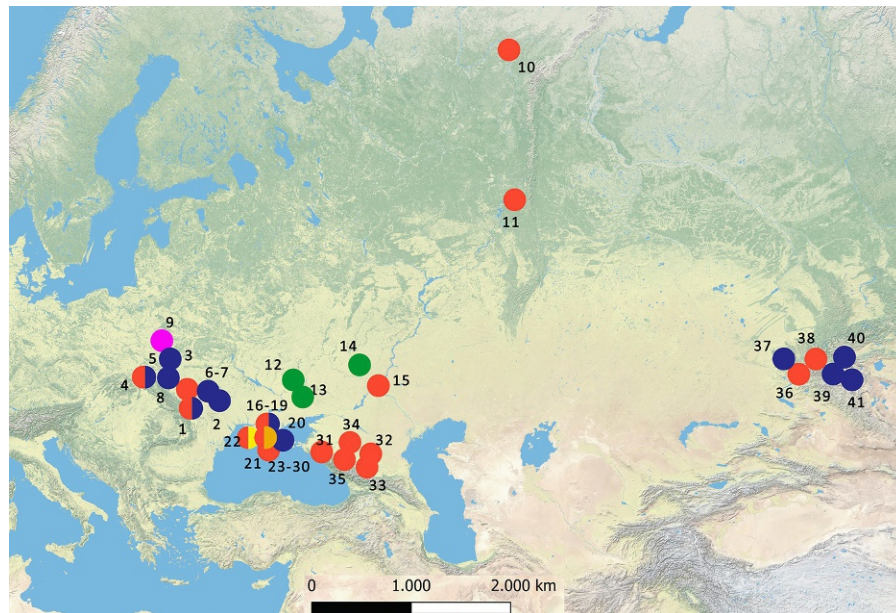


FIG. 10.2 Distribution map of MP sites in the eastern regions cited in the chapter and their technological characteristics. *Red dots*: Micoquian industries; *Red and yellow dots*: Micoquian/Streletskaia industries; *Red and orange dots*: Micoquian/Aurignacian industries; *Red and blue dots*: Micoquian/Levallois-Mousterian industries; *Blue dots*: Levallois-Mousterian industries; *Purple dots*: Bohunician industries; *Green dots*: Blade Mousterian industries. 1 Ripiceni-Izvor; 2 Neporotovo; 3 Kolodiiv; 4 Yezupil; 5 Proniatin; 6 Molodova I; 7 Molodova V; 8 Ketrosoy; 9 Kulychivka; 10 Byzovaya; 11 Garchi; 12 Belokuzminovka; 13 Kurdiuimovka; 14 Shlyakh; 15 Sukhaya Mechetka; 16 Kabazi II; 17 Kabazi V; 18 Karabai I; 19 Karabi Tamchin; 20 Shaitan Koba; 21 Siuren I; 22 Buran Kaya III; 23 Chokurcha I; 24 Starosele; 25 Kiiik Koba; 26 Zaskalnaya V; 27 Zaskalnaya VI; 28 Prolom I; 29 Prolom II; 30 Sary Kaya; 31 Ilskaya I; 32 Barakaevskaya; 33 Monasheskaya; 34 Gubs shelter 1; 35 Matuzka; 36 Chagyrskaya Cave; 37 Strashnaya Cave; 38 Okladnikov Cave; 39 Denisova Cave; 40 Ust'-Karakol-1; 41 Kara-Bom.

Following a patchy distribution of forest, forest–steppe and open steppe environments during MIS 5, MP habitats became more uniform in eastern Europe during MIS 4 and MIS 3. Climatic fluctuations led to an alternation of forest–steppe and steppe environments in all regions with MP site clusters. However, the absence of arcto-boreal flora in the Crimea is worth mentioning and indicates, despite the overall similarities, some degree of regional climatic variability (Gerasimenko, 2004, 2005, 2007). Diachronic ecological reconstructions of environments in the Altai region show a different picture and attest to cold, dry-to-cold, and humid conditions during MIS 5. It is only over the course of MIS 4 and MIS 3 that the spread of dark coniferous forests, meadow communities, and later, dry and cold steppes indicates a stabilisation of less harsh climatic conditions (Jacobs et al., 2019; Rudaya et al., 2017).

4.1 Main Middle Palaeolithic industries

On a broad scale, three MP techno-complexes can be distinguished for eastern Europe and the Altai region: the Micoquian, the Levallois-Mousterian, and the Blade Mousterian (Chabai et al., 2004; Derevianko et al., 2003; Krivoshapkin et al., 2018; Rybin and Kolobova, 2005; Fig. 10.2). For some of them, regional research has established more detailed subdivisions. In essence, the variability observed within Micoquian industries falls into the broad definition of the KMG. In contrast with the central European record, which also includes the Levallois concept, flake reduction is mainly conducted by radial (half-discoidal) or orthogonal cores. In the Levallois-Mousterian and the Blade Mousterian, bifacial tools are rare (Kolobova et al., 2019b). The blank production of the Levallois-Mousterian is dominated by cores of the Levallois method with preferential flake and Levallois and volumetric blade cores, while the Blade Mousterian is characterised by the exploitation of cores that followed a volumetric concept (Derevianko et al., 2000; Lesage et al., 2020).

The available information about the relative and radiometric chronology of the industries mentioned above is regionally diverse and related to the number of sites and their preservation as well as to the history of research. As in other regions of Europe, multilayered sequences excavated with modern methods and dated with several absolute dating methods (such as AMS dating using ultra-filtration and/or ABOx-SC, OSL dating, or ESR dating) are not numerous.

If only relative stratigraphical relations are used, then Levallois-Mousterian occupations are always overlain by levels with Micoquian occupations in the Prut and Dniester Basins (Păunescu, 1993; Sytnyk, 2012). In the Crimea, Micoquian occupations are overlain by Levallois-Mousterian occupations at Kabazi II, Karabi Tamchin, and Karabai I. However, at Kabazi V, Micoquian and Levallois-Mousterian levels were found to be interstratified (Chabai

et al., 2007, 2008). In the Altai, no evidence of assemblage interstratification has been found. At the current state of research, no stratigraphic correlation between the Blade Mousterian and any other MP industry has been observed.

4.1.1 The Micoquian of eastern Europe and the Altai: Spatial distribution, raw material transport, strategies of lithic production and tools

Micoquian assemblages are found throughout eastern Europe and western Siberia (Fig. 10.2). The spatial distribution of the Micoquian extends from the Prut valley in the west to the Altai piedmont in the east and from the Crimea in the south to possibly as far north as the northern Urals. However, the northernmost distribution is difficult to assess because of the unclear MP character of assemblages from the northern Urals with bifacial pieces, some of which are classified as *Keilmesser* (Pavlov et al., 2004), from surface collections and layers in secondary stratigraphical contexts documented at the Byzovaya site (Slimak et al., 2011). It has been discussed that these are similar to Streletskayan sites in the same area, such as Garchi I (Zwyns et al., 2012, but see reply in Slimak et al., 2012).

The earliest Micoquian occupations in eastern Europe and the Altai were found in the soil complex of Units V and VI at the Crimean open-air site Kabazi II, which is dated to the final part of the last interglacial (MIS 5d; Chabai et al., 2005). Micoquian occupations dating to MIS 5 are also found in the Dniester Basin at Kolodiiv and Yezupil, layer II (Sytnyk, 2012). The majority of archaeological levels with Micoquian assemblages date to MIS 4 and MIS 3. This is well attested by numerous sites from the Prut Valley, Crimea, northern Caucasus, and Altai (Chabai et al., 2004; Derevianko et al., 2018). The relatively late age of Micoquian assemblages from the Crimea is supported by a succession of *in situ* occupation surfaces with Micoquian and Aurignacian palimpsests at Siuren I and the fact that an Upper Palaeolithic level with Streletskaya artefacts is overlain by a Micoquian of the Kiik-Koba facies at Buran Kaya III (Demidenko et al., 2012; Monigal, 2004). In the Altai, Sibiryachikha assemblages of the Micoquian were dated to 59–40 ka (Kolobova et al., 2020).

The technology of Micoquian assemblages (Fig. 10.3) is based on the plano-convex surface shaping of bifacial tools (Chabai, 2013; Kolobova et al., 2019c; Shalagina et al., 2020; Veselsky, 2008). Cores are usually rare and represented by radial (half-discoidal) or orthogonal scar patterns of the flaking surfaces. Instead of flakes from core reduction, unifacial tools are often made from surface-shaping flakes, thus giving bifacial tools the double function of tools and source of blanks. This, and the correlation between the intensity of the reduction of bifacial tools and distance to outcrops, points to an economical use of raw material

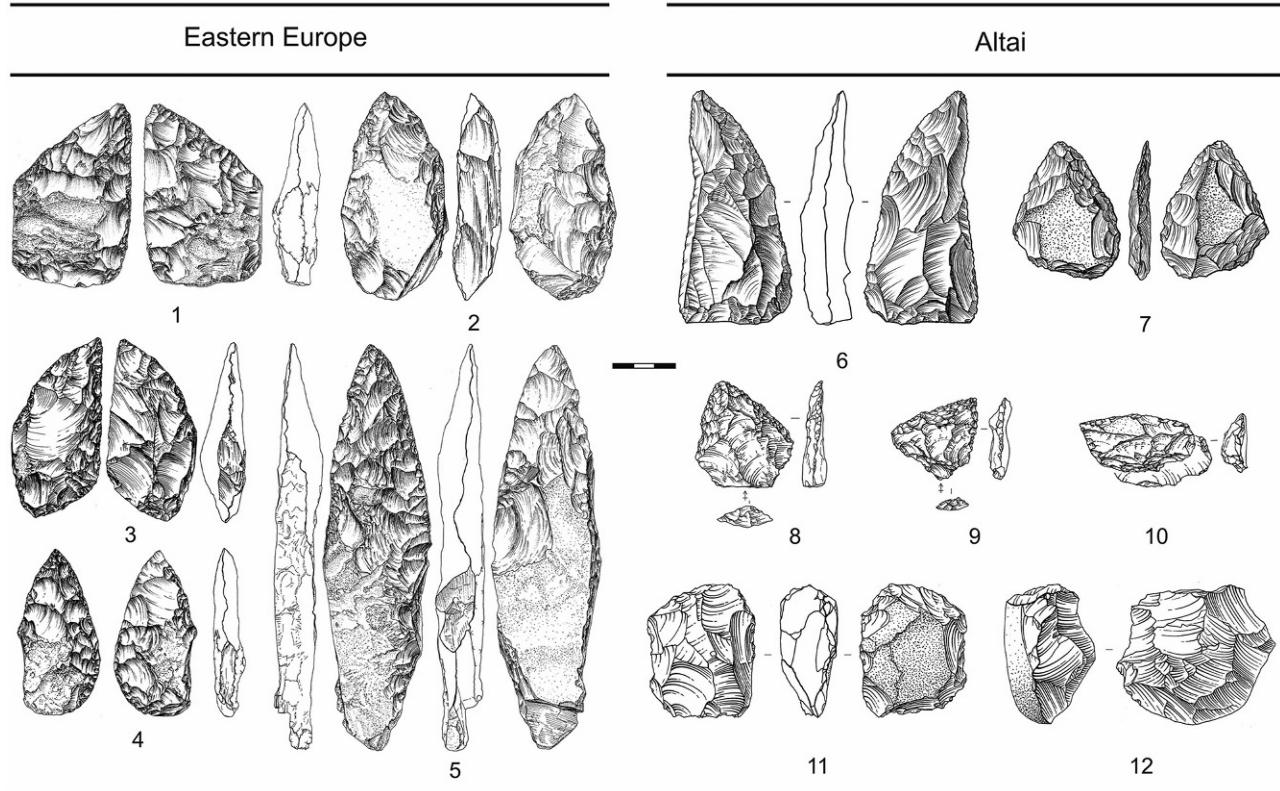


FIG. 10.3 Overview of the main lithic tool and core types in the Micoquian of eastern Europe and the Altai: 1–6 plano-convex backed bifacial knives/*Keilmesser*; 7 plano-convex bifacial scraper; 8 convergent side scraper; 9 point; 10 retouched flake from surface shaping; 11 flake core with radial reduction of one flaking surface; 12 unipolar flake core (1: Zaskalnaya V, L. III/10, 2: Karabai I, L. I, 3: Kabazi V, L. III/2, 4: Zaskalnaya V, L. I/4, 5: Karabai I, L. 4-2, 6–11: Chagyrskaya Cave). (Modified from Chabai, V.P., Richter, J., Uthmeier, Th. (Eds.), 2008. *Kabazi V: Interstratification of Micoquian and Levallois-Mousterian Camp Sites 3/2*. Shlyakh, Simferopol – Cologne; Chabai, V.P., Uthmeier, T., 2017. *New excavations at the Middle Paleolithic site Zaskalnaya V, Crimea. The 2012 and 2013 field seasons—a preliminary report*. *Quartär* 64, 27–71; Derevianko, A.P., Markin, S.V., Kolobova, K.A., Chabai, V.P., Rudaya, N.A., Viola, B., Buzhilova, A.P., Mednikova, M.B., Vasiliev, S.K., Zykin, V.S., Zykina, V.S., Zazhigin, V.S., Volvakh, A.O., Roberts, R.G., Jacobs, Z., Li, B., 2018. *Multidisciplinary Studies of Chagyrskaya Cave—A Middle Paleolithic Site in Altai*. Institute of Archaeology and Ethnography, Siberian Branch of the Russian Academy of Sciences, Novosibirsk (in Russian).)

sources best seen in the Crimea (Uthmeier and Chabai, 2010). The evidence for the application of the *Prodnik* technique—i.e. the detachment of a lateral sharpening flake to rejuvenate the working edges—is rare. The latter, as well as a plano-convex-alternate concept of bifacial tool production (*‘wechselseitig-gleichgerichtete Kantenbearbeitung’*), exists, but neither features are numerous nor do they exhibit temporal or spatial patterning. Typologically, most parts of bifacial tools fall into the categories of leaf-shaped points and sidescrapers, as well as *Keilmesser* types. Among these, *Keilmesser* of the *Klaussenische* type are the most numerous. Tools on flake are represented by points and sidescrapers with leaf and trapezoidal shapes.

Micoquian sites in all regions lack evidence for long distances of raw material transportation, but show different strategies of raw material exploitation that strongly depend on the respective site function (Chabai and Uthmeier, 2006; Uthmeier and Chabai, 2010). Short-term kill-and-butchery stations are supported by imported bifacial and

flake tools made off-site, while all stages of raw material reduction and tool rejuvenation are employed at campsites. Differences in the intensity of raw material exploitation allow a subdivision of the Micoquian techno-complex into three facies. The least intensive reduction is attested for short-term occupations near to raw material sources, which exhibit lithic assemblages mainly based on imported tools discarded after short use-lives. Consequently, assemblages of the corresponding Ak-Kaya facies are characterised by large tool sizes and the highest relative frequency of bifacial tools within the Micoquian techno-complex, which include *Keilmesser* types. In general, assemblages of the Ak-Kaya facies are dominated by simple sidescrapers on flakes. Lithic assemblages found at camp sites depict different degrees of tool rejuvenation, depending on the distance to raw material sources, duration of occupation, and possibility of scavenging the lithic artefacts of previous occupations. An increase in these factors leads to a rise in tool resharpening and, occasionally, recycling. Compared with the Ak-Kaya

facies, more intensively used toolkits are characterised by a decrease in the number of bifacial items, a growing predominance of convergent tools on flakes and overall smaller tool dimensions. Camps with a medium degree of tool reduction correspond to the Starosele facies, whereas sites of the Kiik-Koba facies show the most intense rejuvenation processes leading to the lowest number of bifacial tools and extraordinary small tool dimensions.

In the Altai, assemblages from Chagyrskaya Cave, the key site of the Sibirychikha variant of the Micoquian, occupy an intermediate position between the Starosele and the Kiik-Koba facies, demonstrating all characteristic features of a consumption camp with complete lithic and bone reduction sequences (Baumann et al., 2020; Kolobova et al., 2019a). The occupations have been identified as basecamps and show a predominance of convergent tools and simple sidescrapers, whereas plano-convex bifacial tools, including *Keilmesser* types, are less numerous. Raw material procurement was focused on locally available sources (Derevianko et al., 2015).

4.1.2 *The Levallois-Mousterian of south-eastern Europe and the Altai*

Compared with the Micoquian, the spatial distribution of the Levallois-Mousterian is more confined and concentrated in south-eastern Europe and south-western Siberia, including the Prut and Dniester Basins, the Crimea, and the Altai. The earliest Levallois-Mousterian occupation in eastern Europe is known from the loess soil deposits of the Neporotovo site, which is situated on a bank of the Dniester River and is preliminarily dated to the Middle Pleistocene (Gerasimenko et al., 2016; Nigst et al., 2019). The most recent occurrences of the Levallois-Mousterian in this region belong to MIS 3 and come from the Dniester (Molodova I and V) and Prut (Ripiceni-Izvor, layers I–III) Basins (Haesaerts et al., 2003; Păunescu, 1993). In contrast to all the other regions described here, the Levallois-Mousterian is not known in the Crimea before the onset of MIS 3.

The Levallois-Mousterian is based on the Levallois concept (Fig. 10.4) and includes Levallois cores with a single preferential flake as well as cores of recurrent methods for uni- and bipolar blades (Chabai, 2006). Cores with a convergent scar pattern to produce Levallois points are not characteristic. Sidescrapers of simple shapes and triangular points made on both flakes and blades are dominant. The major characteristic feature of the Levallois blank production from both the Dniester Basin and the Crimea is a specific bilateral preparation of the flaking surface of Levallois preferential cores from lateral supplementary striking platforms (Usik, 2006). Such a preparation offers the possibility of giving the core-working surface a rectangular shape that allows the detachment of a rectangular preferential flake. In some assemblages, additional uni- and bidirectional cores for blades with volumetric flaking surface occur at sites of the Dniester Basin and Crimea (Fig. 10.4). However, the combination of lateral supplementary platforms and intensively faceted strik-

ing platforms is not only characteristic of blade cores but also of Levallois cores with a preferential flake. High frequencies of simple sidescrapers and points on flakes and blades are attested, including a specific type of points on blades with a retouched tip and/or one retouched lateral edge.

In contrast to the Micoquian, Levallois-Mousterian assemblages show no obvious correlation between the modes of raw material exploitation and function of the sites. The available data show that on-site core reduction and tool production, often followed by rejuvenation, are characteristic of both kill-butchery stations and campsites (Chabai and Uthmeier, 2006).

In western Ukraine, the appearance of a Levallois technology described as similar to that of the Emirian and Bohunician Kulychivka, layers III and IV (Fig. 10.2), is worth mentioning because it indicates the presence of a transitional industry between the Middle and the Upper Palaeolithic and is dated to between 45 ka and 35 ka cal BP (Škrdlá and Nikolajev, 2014; Škrdlá et al., 2016).

The Levallois-Mousterian of the Altai is dated between MIS 6 and MIS 4 and can be subdivided into two entities, the Denisova variant and the Kara-Bom variant (Rybin and Kolobova, 2005). The Kara-Bom variant is a later phenomenon that starts at 120 ka. The Denisova variant is represented by layers 19–12 of the Central Chamber and layers 15–11.2 of the Eastern Gallery of Denisova Cave, as well as Strashnaya Cave (layers 11–4) and Ust'-Kanskaya Cave (Krivoshapkin et al., 2018; Lesage et al., 2020; Shunkov et al., 2020). The Kara-Bom variant is known from Kara-Bom MP levels 5–6 and Ust'-Karacol-1 layers 18–13, as well as Anui-3 (Derevianko et al., 2000). Both variants are characterised by cores belonging to the Levallois method with one preferential flake and the Levallois method with recurrent convergent flakes, but they also include radial and orthogonal cores. The toolkits include simple sidescrapers, notches, and denticulates as well as Levallois points. Bifacial tools are rare and have, in contrast to Micoquian bifaces, a bi-convex cross section, indicating a different technological concept (Kolobova et al., 2019b). The two variants have been regarded as culturally different industries, but with technological convergence resulting from several factors such as the procurement of similar raw materials and similar site function (Rybin and Kolobova, 2004, 2005). The most significant technological difference between the two is the large proportion of Levallois products, including the bidirectional exploitation of cores of the convergent method, in the Kara-Bom variant (Rybin and Kolobova, 2005).

4.1.3 *The Blade Mousterian of the Don and Lower Volga basins*

Blade Mousterian industries have so far only been found in the Don and Lower Volga basins (Chabai et al., 2004; Kolesnik, 2003; Fig. 10.2). Assemblages derive from loess soil sequences at Belokuzminovka, Kurdumovka, and Shlyakh and,

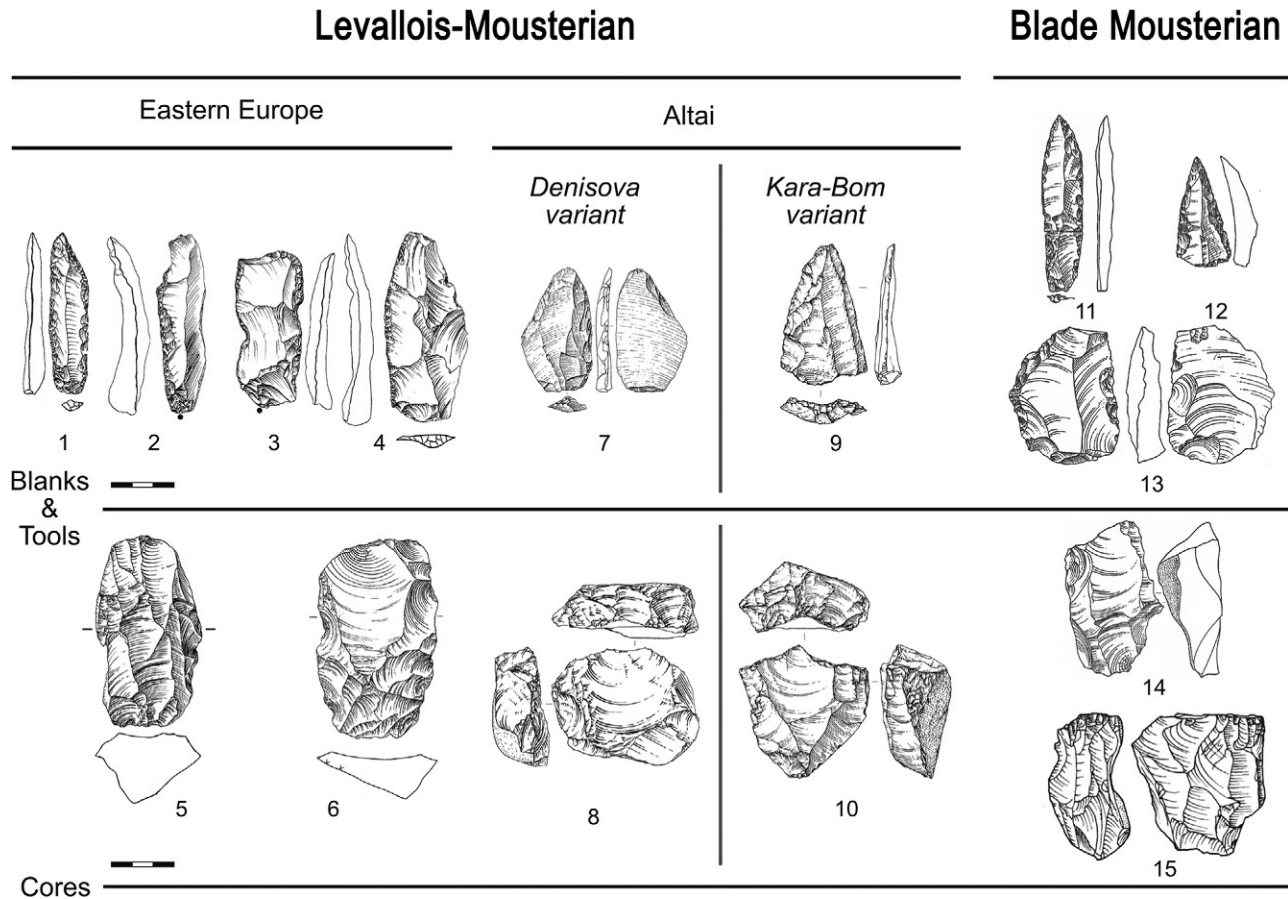


FIG. 10.4 Overview of the main lithic tool and core types in the Levallois-Mousterian and Blade Mousterian of eastern Europe and the Altai: 1 point on blade; 2 side scrapper on blade; 3 double-side scrapper on rectangular target flake from preferential Levallois method; 4 side scrapper on (first order) Levallois flake; 5 bidirectional core for blades with volumetric flaking surface; 6, 8 Levallois preferential core; 7 convergent side scrapper; 9 Levallois point from core with recurrent convergent target flakes; 10 Levallois core with recurrent convergent target flakes; 11 point on blade; 12 point on flake; 13 truncated-faceted flake (Kostienki knife); 14, 15 uni-directional blade cores (1, 2 Kabazi II, L. II/6, 3 Kabazi II, L. II/7C, 4 Kabazi II, L. II/8, 5 Kabazi II, L. II/1, 6 Kabazi II, L. II/8, 7, 8 Strachnaya Cave, 9, 10 Kara-Bom, 11, 13–15 Kurdumovka, Uday complex, 12 Belokuzminovka, Vitachev complex). (Modified from Kolesnik, A.V., 2003. *The Middle Palaeolithic of Donbass. Archeol. Almanac 12 (in Russian)*; Rybin, E., Kolobova, K.A., 2005. *Srednii paleolit Altaya: Variabelnost i evolyutsiya (Altai Middle Paleo-lithic: variability and evolution). Stratum Plus 1, 33–78 (in Russian)*; Chabai, V.P., 2006. *The Western Crimean Mousterian and Micoquian at Kabazi II, Units A, II, IIA and III: environment, chronology and artifacts. In: Chabai, V., Richter, J., Uthmeier, Th. (Eds.), Kabazi II: The 70000 Years Since the Last Interglacial. Palaeolithic Sites of Crimea 2. Shlyakh, Simferopol-Cologne, pp. 1–36.*)

based on environmental studies, can be placed to the period between the beginning of the Early Glacial and the end of the lower Pleniglacial (approximately MIS 4). Core reduction usually took place on-site and involves local chert, which was preferred for nodules with a cylindrical shape.

The core reduction sequences themselves (Fig. 10.4) are similar to those observed at Rocourt or Roc-de-Combe (Kolesnik, 2000; Nehoroshev and Vishnyatsky, 2000). The uni- and bidirectional cores have a volumetric or narrow flaking surface and unafaceted striking platforms, and they lack lateral supplementary platforms. The most distinguishing tool type is represented by truncated-faceted flakes and blades, which have been described as ‘Proto-Kostienki knives’. Other frequent tools are simple sidescrapers and points on both flakes and blades, whereas Upper Palaeolithic tool types are unknown.

5 Central Europe

Open-air sites have played an important role in the history of research on the central European MP and especially in its northern. In southern and eastern parts of central Europe that have a more pronounced topographic relief, open-air sites are less frequent compared with sites in (mostly) smaller caves and rock shelters (e.g. southern German caves of the Swabian and Franconian Jura; Conard et al., 2019; Freund, 1963; Uthmeier, 2019; and the Polish Jura; Alex et al., 2017; Cyrek et al., 2014). Exceptions include Slovakia (Kaminská, 2014), the eastern part of the Czech Republic and Hungary, where open-air sites prevail.

With the beginning of the last interglacial (MIS 5e), MP sites significantly increased in number all over central Europe (Bosinski, 1967; Kozłowski, 2014; Richter, 2016).

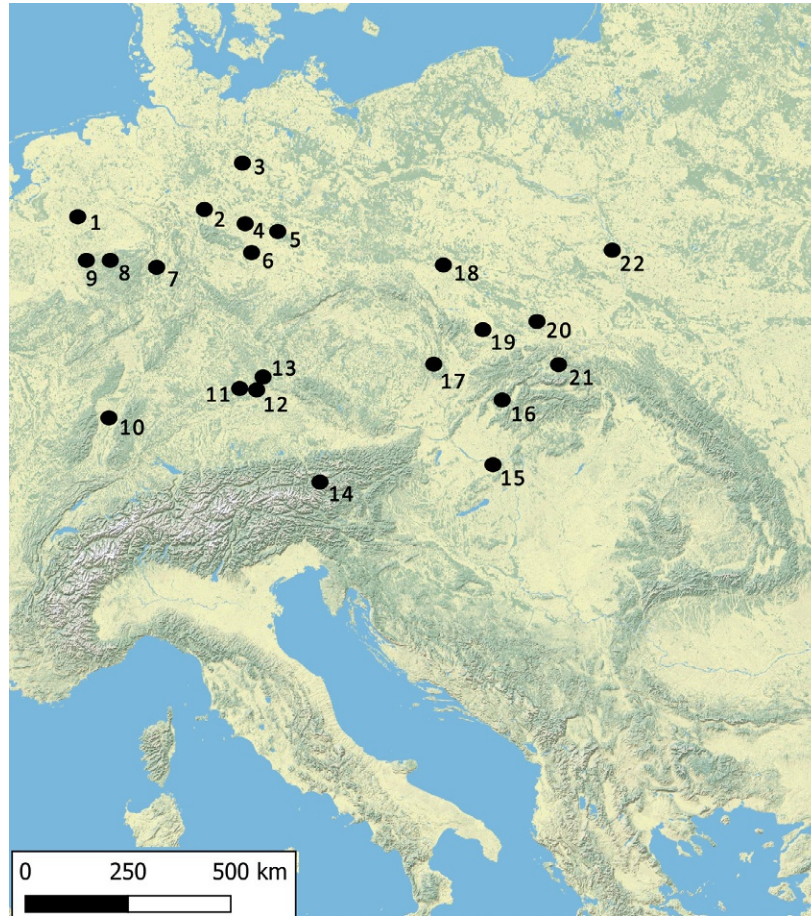


FIG. 10.5 Distribution map of main LMP sites in central Europe. 1 Coesfeld-Stevede; 2 Salzgitter–Lebenstedt; 3 Lichtenberg; 4 Königsau; 5 Pouch; 6 Neumark-Nord; 7 Buhlen, Rörshain; 8 Balve IV; 9 Kleine Feldhofer Grotte; 10 Achenheim; 11 Hohler Stein bei Schambach; 12 Klausenhöhle, Sesselfelsgrotte; 13 Abri I am Schulerloch; 14 Bockstein; 15 Tata; 16 Bojnice I; 17 Külna; 18 Wrocław-Hallera; 19 Pietraszyn 49a; 20 Cienna, Kraków–Księża Józefa, Kraków-Zwierzyniec, Piekary IIa, Wylotne; 21 Oblazowa; 22 Zwoleni.

Nevertheless, the LMP occupation remained discontinuous, mainly due to periodical growth of the continental inland ice sheet and severely cold permafrost conditions of the periglacial zones (Jöris, 2014). In addition, the discontinuity of the MP record may also be an artefact of the scarcity of well-dated sites and often poor preservation conditions resulting from periglacial environments that favour erosion. Besides stratigraphic unconformities, the LMP record of central Europe (Fig. 10.5) can nevertheless be interpreted as reflecting demographic changes within generally small overall metapopulations, leading to periods of population presence (e.g. Kindler et al., 2020; Nielsen et al., 2017), regional population retreat (e.g. Jöris, 2004; Richter, 2016), and even extinction(s) (e.g. Hublin and Roebroeks, 2009) followed by the (repeated) re-occupation of formerly abandoned regions. The number of sites assigned to MIS 3 indicates a significant increase of central European Neanderthal population that followed a period of relative decrease during MIS 4 (Richter, 2016; cf. Kozłowski, 2014). However, even during the peak

phase of MIS 4, isolated MP occurrences have been attested in the mid-latitudes of central Europe (Uthmeier et al., 2011).

With regard to the early LMP during the last interglacial (MIS 5e), the central European record is dominated by mainly unifacial assemblages of small dimensions sometimes termed ‘Taubachian’ (for an overview, see Wenzel, 1998), which occasionally include single bifacial pieces. In the subsequent period of MIS 5d to MIS 5a, with more open forest-to-steppe environments, the north-western part of central Europe belongs to a distribution area of MP assemblages with high amounts of blades, regionally termed ‘Rheindahlian’ (Conard, 1992). It is during this same period that bifacial tools—interpreted as part of the mobile toolkit (Delpiano and Uthmeier, 2020)—gained importance with the emergence of KMG assemblages (e.g. Hein et al., 2020; Jöris, 2004). During the first half of MIS 3, KMG sites dominated the MP archaeological record of central Europe (e.g. Richter, 2016). At the present stage of research, the central European KMG record is nevertheless spatially

and chronologically quite discontinuous (Jöris, 2004), and the relation of KMG sites to sites that are predominantly characterised by unifacial tools is still poorly understood (Richter, 1997, 2012). The same applies for assemblages with high frequencies of leaf points, which are either seen as a functional component of the KMG (Uthmeier, 2000) or a discrete, chronologically late industry (Bosinski, 1967; Conard et al., 2019). Given the discontinuous sedimentary sequences, the mid-MIS 3 LMP that succeeded the KMG assemblages at around 55–45 ka is poorly documented and marked by a significant decline of bifacial tools (e.g. Sesselfelsgrötte E3: Böhner, 2009; Conard et al., 2019). Occasionally, open-air sites from this period have been well preserved in the loess archives of eastern central Europe, such as in the area around Kraków, at Kraków-Zwierzyniec I sector P (Chmielewski et al., 1977), and Piekary IIa layers 7b–7a (Sitlivy et al., 2008), where MP Levallois methods for systematic blade production occur.

5.1 Raw material types, catchment areas, and mobility settings

Overall, LMP knappers preferred homogeneous, fine-grained raw materials such as chert; however, if necessary, other raw materials including quartzite or quartz were also used. Erratic or ‘Baltic’ flint¹ is a variant of chert widely found in the northern European lowlands from the northern Netherlands to Poland. It originates from the southern Baltic region and was transported during the Middle Pleistocene advances of the Fennoscandian ice sheet as far south as the northern fringes of the central European low mountain ranges (*Mittelgebirge*) and the Carpathian foothills. Nodules of high quality and decent size are scattered all over the landscape and provided a relatively predictable resource. In addition, the large river valleys in the northern lowlands accumulated nodules as coarse erosional residuals from the moraine deposits (Weber, 2012; Weiss, 2015). The pivotal role of river terraces for the procurement of raw materials in this region was independent from the respective vegetation cover (Wiśniewski et al., 2013). The high-quality Baltic flint nodules were mainly exploited using the Levallois concept and bifacial tool technology, although discoidal reduction strategies are also occasionally attested on this resource (e.g. Coesfeld-Stevede site in Westphalia: Richter, 2013).

Further to the south, raw material occurrences are restricted to smaller regional or even local occurrences of varying quality (e.g. Böhner, 2012; Burkert, 2012; Dobosi, 2011; Féblot-Augustins, 1997, 1999; Floss, 2012; Marcó, 2009; Marcó et al., 2003; Neruda, 2011; Wiśniewski, 2014),

often leading to heterogeneous raw material spectra in the respective assemblages.

Raw materials imported over larger distances (> 30 km) rarely exceed more than 10% of the assemblages (Féblot-Augustins, 1999; Floss, 1994). Several MIS 3 workshop sites are known in the central German region of Hesse, where quartzite outcrops have been locally exploited over lengthy periods (e.g. Rörshain: Campen and Hahn, 1973; Luttrupp and Bosinski, 1967).

5.2 Strategies of lithic production

The strategies for lithic raw material exploitation include hierarchical reduction concepts (Levallois and blade production) as well as discoidal and Quina-type reduction concepts (Hérisson et al., 2016; Richter, 1997). Most assemblages are characterised by the parallel use of several (mostly two) such concepts. Aside from these more standardised reduction strategies, a pragmatic irregular exploitation of raw materials is frequently observed.

In the long MIS 3 sequence of the southern German Sesselfelsgrötte, for example, the KMG assemblages are generally dominated by Levallois methods with recurrent centripetal and orthogonal flakes, whereas cores and flakes related to the Quina method become less important and finally disappear in favour of Levallois methods with recurrent parallel flakes (Richter, 1997, 2016). In all of these assemblages, bifacial tools represent an additional concept of blank and tool manufacture (Fig. 10.6). In the KMG horizons 7c, 7a, and 6a of Kůlna Cave, dated to early MIS 3, the dominant Cretaceous chert is generally reduced following discoidal methods (Neruda, 2011; Valoch, 1988). From an overall perspective, the variability of core reduction concepts in the LMP of central Europe to obtain predetermined flakes stands in contrast to the scarcity of comparable concepts for the production of blades and/or bladelets. In the aforementioned layers at Kůlna Cave, non-Levallois laminar production appears as a supplementary method, whereas in the G-layers of Sesselfelsgrötte, blades were obtained during the initial (decorticating) phase of the production of bifacial tools from plaquettes (Richter, 1997, pp. 186–187). In some instances, such as in the Balver Höhle (Pastoors and Tafelmaier, 2010), bladelets were obtained from simple unidirectional cores and unidirectional cores of the Le Pucueil type.²

Levallois methods not associated with bifacial tools and targeting the uni- and bi-directional detachment of elongated laminar blanks and, of secondary importance, points, are attested at Kraków-Zwierzyniec I sector P (Chmielewski

1. In this chapter, both ‘flint’ and ‘chert’ are used to indicate a sedimentary, microcrystalline rock mainly made of silica (SiO₂). The terms are used alternatively according to specific geological formation and tradition of studies.

2. Le Pucueil-type concept represents the secondary production of wide flakes with elongated transversal sharp working edge extracted from a flat surface of bulky flakes, chunks, and cores (Delagnes, 1993; Lazuén and Delagnes, 2014).

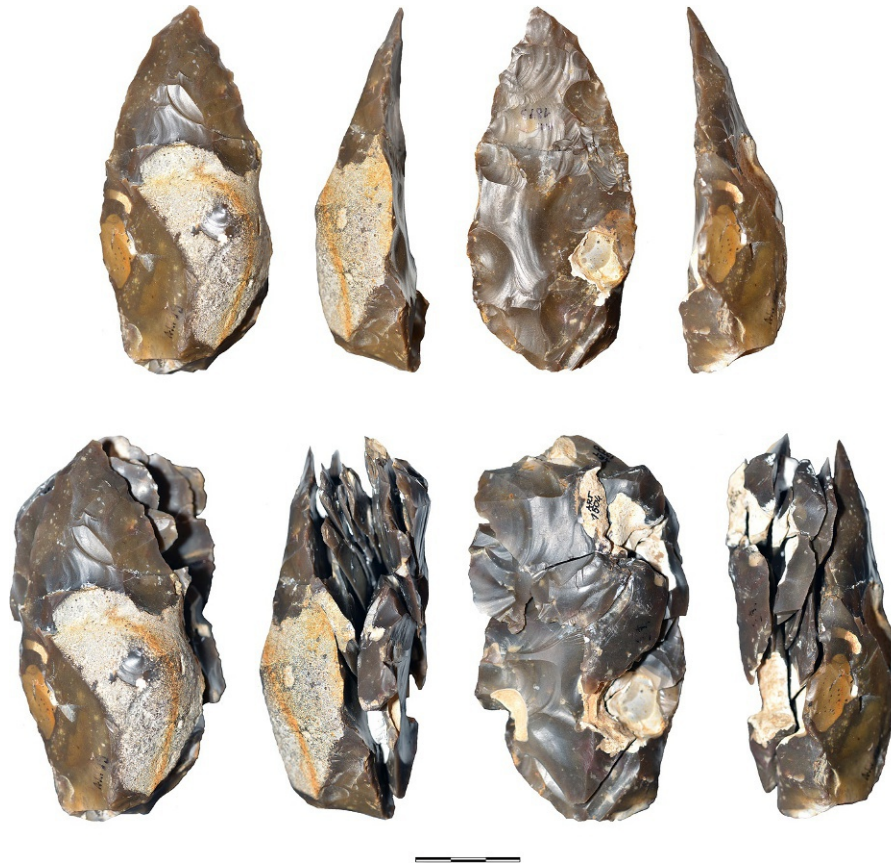


FIG. 10.6 Refit of a *Keilmesser* production sequence (bottom) and the resulting *Keilmesser* (top) from the site of Pietraszyn 49a. (Photos A. Wiśniewski.)

et al., 1977) and Piekary IIa layers 7b–7a (Sitlivy et al., 2008), and at Buhlen II in western central Europe. At this latter site, and in Piekary IIa, Levallois technology succeeds a KMG assemblage (Piekary IIa, layer 7c²).

At layer III (lower complex) of the Księcia Józefa site in Kraków, the reduction of globular flint nodules has often resulted in the adoption of polyhedral reduction strategies dominated by uni- and bidirectional, but also orthogonal reduction. Occasionally, Levallois reduction is also present, including the production of Levallois points. Levallois and discoidal technology is very well represented at another open-air site, Hallera, Wrocław, lower level (Wiśniewski et al., 2013).

5.3 Retouched items and transported toolkits

Retouched items are dominated by single or double sidescrapers and transverse scrapers, while pointed tools also occur. Marginally retouched unifacial items sometimes appear with backs in the final phase of the LMP (Księcia Józefa layer III: Sitlivy and Zięba, 2006; Sitlivy et al., 2009).

Typical tools in KMG assemblages are bifacially shaped asymmetric ones (Fig. 10.6) with single acute edges and natural or roughly/crudely worked back (Jöris, 2006, 2012), so-called *Keilmesser*. Detailed technological analysis from

several central European KMG sites has documented a focus on the long-term maintenance of tool usability through different and often repeated phases of reduction and resharpening, leading to significant morphological transformation in shape and size (Buhlen: Jöris, 2001; Cienna: Krukowski, 1939–1948; Wylotne Shelter: Chmielewski, 1969; Mańka et al., 2004; Urbanowski, 2003; Lichtenberg: Veil et al., 1994; Weiss, 2020; Sesselfelsgrötte: Delpiano and Uthmeier, 2020; Richter, 1997). In KMG assemblages, the overall design of *Keilmesser* is extremely important and requires high levels of planning depth and anticipation, skill and experience. Less elaborate items that do not display a long use-life history may either have been made by less experienced knappers, probably children or novices, or for use in more expedient situations, as has been argued for the Buhlen III (Jöris and Uomini, 2019) and Balver Höhle assemblages (Jöris and Schunk, 2021). Backed scrapers could easily have substituted bifacially backed knives, probably when long use-life was not required (Delpiano and Uthmeier, 2020; Weiss et al., 2018). To interpret asymmetric *Keilmesser*, arguments have been put forward that they were optimised for individual hand preferences (Jöris, 2001, 2006) and also that users were most likely the makers of their own tools (Jöris and Uomini, 2019).

At some exceptional LMP open-air sites (e.g. Pietraszyn 49a: [Wiśniewski et al., 2019, 2020](#); Księcia Józefa: [Sitlivy et al., 2014](#)), single blank and tool production sequences are preserved with the highest degree of spatial resolution, documenting which stages of the reduction sequence were carried out on-site and which items were transported elsewhere.

6 North-western Europe and southern France

Technological variability is visible between the northern and the southern regions of this area ([Fig. 10.7](#)). These differences are due to several factors, including the geological setting, climatic-environmental context, and technological traditions, in association with site function, mobility strategies, and possibly, social constraints. The British LMP of MIS 3 is dis-

tinctive ([Wragg Sykes, 2017](#)), representing a re-colonisation between 60 ka and 45 ka following a post-MIS 7 occupational hiatus (two late MIS 5 flakes have been claimed; [Wenban-Smith et al., 2010](#)). The record from Belgium suffers from a lack of chronostratigraphic data related to the early date of most excavations. Nevertheless, recent excavations and reappraisals of collections reveal three main groups, namely the Mousterian, MTA, and KMG. Belgium was repopulated at the onset of MIS 3 from both central (e.g. KMG, Spy Cave) and southern Europe (e.g. MTA, Scladina). The current LMP record in northern France is less documented than the preceding MIS 5 record ([Locht et al., 2016](#)); nevertheless, our understanding of this period has been improved thanks to new excavations (e.g. Havrincourt: [Goval and Hérisson, 2018](#)) and advances in the synthetic chronostratigraphic regional sequence, particularly in the more detailed Saint-Acheul soil complexes ([Antoine et al., 2014](#); [Locht, 2019](#)).

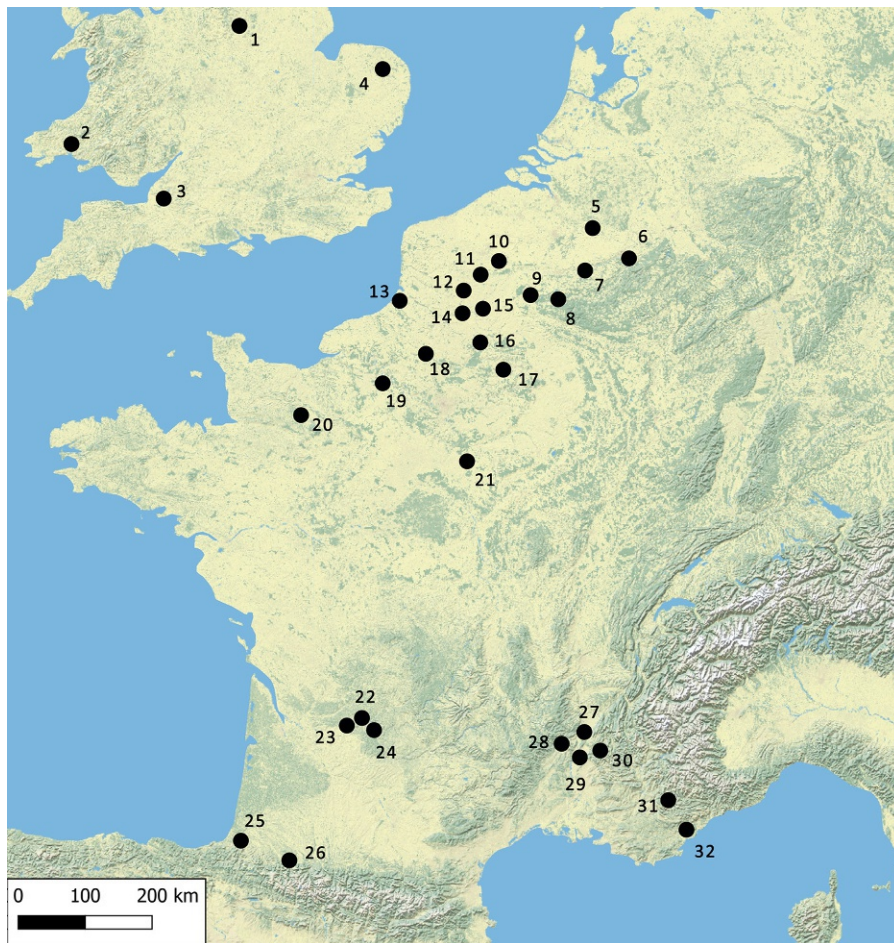


FIG. 10.7 1 Creswell Crags caves; 2 Coygan Cave; 3 Hyaena Den, Picken's Hole; 4 Lynford; 5 Trou Al'Wesse; 6 Walou Cave; 7 Scladina Cave, Goyet Cave, Station de l'Hermitage; 8 Hezerwater, Trou du Diable; 9 Spy Cave, Trou de l'Abîme, Saint-Hilaire-sur-Helpe; 10 Saint-Armand-les-Eaux; 11 Corbehem; 12 Hénin-sur-Cojeul; 13 Ault; 14 Rencourt-lès-Bapaume; 15 Havrincourt, Hermies; 16 Atilly, Catigny; 17 Poisy; 18 Beauvais; 19 Saint-Julien-de-la-Liègue; 20 Saint-Brice-sous-Rânes; 21 Ormesson; 22 Regourdou, Le Moustier, La Ferrassie, Roc-de-Marsal; 23 Cantalouette II & IV, Corbiac, Combe Brune I; 24 Pech de l'Azé I & IV, Combre Grenal, Roc-de-Combe; Les Fieux; 25 Le Prissé, Jupiter, Isturitz, Harregi, Gatzarria; 26 Calavanté, Le Noisetier; 27 Baume Néron, Abri Moula; 28 Baume Vallée; 29 Grotte de Saint Marcel, Grotte du Figuier, Abri du Maras, Ranc Pointu 2, Baume d'Oullins, Abri des Pêcheurs, Barasses II; 30 Grotte Mandrin; 31 Bau de l'Aubesier; 32 Abri Pié-Lombard.

South-western France, and in particular the Aquitaine Basin, has recently been the focus of a renewed overview of lithic technology (Delagnes et al., 2007; Faivre et al., 2017). This was based on new excavations of multiple ‘classic’ archaeological sequences (i.e. Combe-Grenal, Le Moustier, Roc de Marsal, Pech de l’Azé IV, La Ferrassie), the revision of previously excavated assemblages, and the discovery of new sites, especially open-air sites in both research and rescue archaeology contexts. Similarly, in south-eastern France, recent fieldwork and revision of stone tool collections have improved our understanding of Neanderthal technology at a regional scale. In this area, sites are mainly located along the Rhône Valley (Saint-Marcel, Abri du Maras, Grotte Mandrin, Ranc Pointu 2, Baume Néron, Abri Moula, Baume d’Oullins, Grotte du Figuier, Barasses II, Abri des Pêcheurs). Furthermore, sites, both caves and rock shelters, are located on the south-eastern margins of the Massif Central (e.g. Baume Vallée), on the southern margin of the Alps (e.g. Bau de l’Aubesier), and along the Mediterranean coast (e.g. Pié-Lombard).

6.1 Raw material types, catchment areas, and mobility settings

Siliceous sedimentary rocks were the main exploited raw materials, and were mainly collected from local sources, albeit with some regional differences. In the British MP, flint dominated in the south-east, while quartzite is associated with discoïd/alternate reduction at Creswell Crags in the Midlands, alongside flint bifaces and sidescrapers transported over more than 60 km (Wragg Sykes, 2017). In Wales, igneous sources were used for bifaces, and no imported flint is known. In Belgium, raw materials mostly come from the area surrounding the site. Flint was always preferred when available, while quartz, quartzite, and limestone were also used. Only sites far away from sources witnessed the importation of a large quantity of flint. This pattern was driven by a total absence of chert surrounding the sites (Di Modica, 2010; Di Modica et al., 2016). In northern France, flint was the exclusive abiotic resource, and the large majority of it came from local outcrops, even if it is still difficult to distinguish the precise outcrops exploited due to the similarities between the different Senonian and Turonian deposits.

In south-western France, raw materials were generally transported less than 50 km. Their movement only rarely exceeds 100 km (see Turq et al., 2017, for a recent synthesis), with long-distance transport connecting areas rich in good-quality raw materials (i.e. the Périgord and Bergerac areas) with those where high-quality chert outcrops are rarer (the Quercy and Brive Basin). Differences in raw material diversity and the distance from which they were gathered also seem to be associated with technological aspects: discoïd assemblages are generally associated with low diversity and the exploitation of immediately available sources (Gravina

and Discamps, 2015; Thiébaud, 2005; Turq et al., 2017), whereas MIS 3 Levallois occurrences commonly contain a greater variety of raw materials transported over longer distances. Contrary to the Massif Central, the Rhône region is rich in chert outcrops. Raw materials usually circulate in a range of between 20 and 40 km (Defleur, 2015; Defleur et al., 1994; Moncel et al., 2014). Various local stones were used simultaneously (quartz, basalt, quartzite, limestone), not only to produce flakes but also in the form of cobble as hammerstone/anvil during different percussive activities. At Pié-Lombard on the Mediterranean coast, chert is associated with diverse stones transported over long distances such as radiolarite and micro-quartzite (60–240 km) (Texier et al., 2011).

6.2 Strategies of lithic production

Bifacial shaping is attested in the northern regions and the south-west of France. In the British LMP, bifaces were important (Fig. 10.8) and largely hierarchically produced cordate, elongated cordate, and so-called ‘bout coupé’ forms; curation and maintenance between different locales are clear, e.g. at the open-air locale Lynford (Boismier et al., 2012). In northern France, the most representative site with plano-convex handaxes is the workshop of Saint-Amand-les-Eaux (Feraud et al., 2013), which yielded only bifaces and clusters of bifacial shaping waste. Such bifaces, typical of the MTA, are also present at Corbehem (Locht, 2019; Sellier and Bostyn, 2005) and Ploisy (N1: Locht et al., 2013) and are associated with Levallois flakes. In Normandy, bifacial shaping is attested at the famous bifacial tool workshop of Saint-Brice-sous-Rânes (Cliquet et al., 2009) and the complex of sites at Saint-Julien-de-la-Liègue (Cliquet and Lantier, 1988), which are characterised by small bifaces, bifacial tools, and the presence of recurrent centripetal Levallois flaking at Saint-Julien-de-la-Liègue. A link with the Armorican ‘groupe du Bois-du-Rocher’ and affinities with industries of the middle and central Europe has been proposed (Cliquet et al., 2009). In the Aquitaine Basin, bifacial shaping is usually a minority component of MIS 3 lithic assemblages and associated with multiple flake production systems (see Faivre et al., 2017, for a recent synthesis). To date, very few regional assemblages (e.g. layers G1/G2 of Le Moustier or layer 4 of Pech de l’Azé I) are characterised almost exclusively through bifacial shaping. This has led some authors to propose the abandonment of Bordes’ MTA typological facies, as it presents an image of uniformity among assemblages that often differ substantially in terms of flake production systems (Gravina, 2017).

In south-western France, the Quina techno-complex, primarily associated with the rigorous climatic conditions of MIS 4, was subsequently replaced by substantial variability in lithic technology with the onset of more oscillating MIS 3 climatic conditions in the region characterised

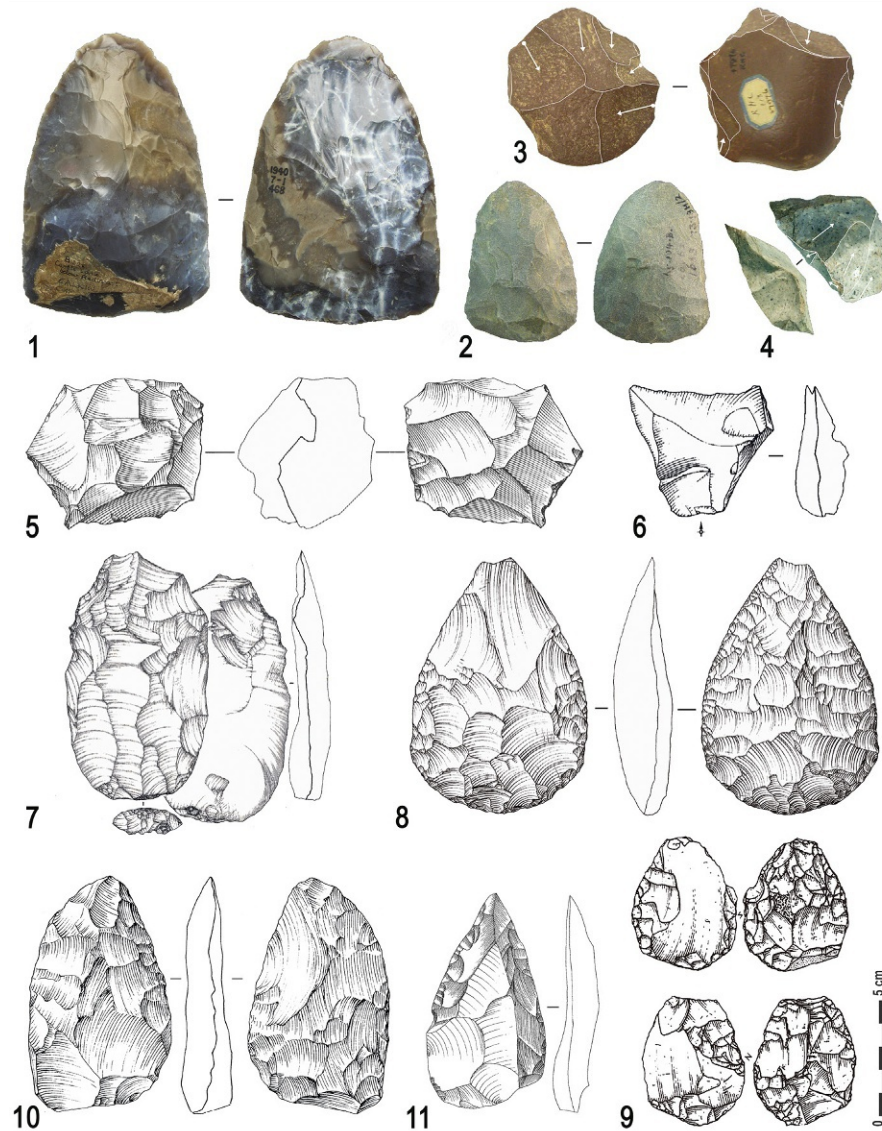


FIG. 10.8 Example of LMP lithic industries of north-western Europe. United Kingdom: 1 *bout coupé* type biface—Castle Lane, Bournemouth (chert); 2 *bout coupé* type biface—Coogan Cave (rhyolite); 3 Discoïd core—Robin Hood’s Cave, Creswell Crags (quartzite); 4 *éclats débordants* resulting from discoïd reduction—Hyaena Den, Wookey (Carboniferous chert). Northern France: 5 Discoïd core—Beauvais (flint); 6 *pseudo-Levallois* point stemming from Discoïd reduction—Beauvais (flint); 7 preferential Levallois flake—Havrincourt Hav.1-N3 (flint), drawing Eve Boitard; 8 MTA type handaxe—Ploisy N1; 9 bifacial tools—Saint-Brice-sous-Rânes (flint), drawing Philippe Alix. Belgium: 10 foliaceous piece—Spy Betche aux Rotches cave (chert); 11 Mousterian point—Le Trou du Diable cave, Hastière-Lavaux (chert). (1–4: Modified from Wragg Sykes, R.M., 2017. *Neanderthals in the Outermost West: technological adaptation in the Late Middle Palaeolithic (re)-colonization of Britain, Marine Isotope Stage 4/3*. *Quat. Int.* 433, 4–32; 5–6: Modified from Locht, J., Swinnen, C., 1994. *Le débitage discoïde du gisement de Beauvais (Oise): aspects de la chaîne opératoire au travers de quelques remontages*. *Paléo* 6, 89–104; 7: Modified from Goval, E., Hérisson, D. (Eds.), 2018. *Les chasseurs des steppes durant le dernier glaciaire en France septentrionale. Paléoenvironnement, techno-économie, approche fonctionnelles et spatiale du gisement d’Havrincourt*. *Études et Recherches Archéologiques de l’Université de Liège*; 8: Modified from Locht, J.-L., Coutard, S., Antoine, P., Sellier, N., Ducrocq, T., Paris, C., Guerlin, O., Kiefer, D., Defaux, F., Deschodt, L., Limondin-Lozouet, N., 2013. *Données inédites sur le Quaternaire et le Paléolithique du Nord de la France*. *Rev. Archeol. Picardie* 3, 5–70; 9: Modified from Cliquet, D., Mercier, N., Lautridou, J.-P., Alix, P., Beugnier, V., Bianchini, R., Caspar, J.-P., Coutard, S., Lasseur, E., Lorren, P., Gosselin, R., Rivard, J.-J., Valladas, H., 2009. *Un atelier de production et de consommation d’outils bifaciaux de la fin du Paléolithique moyen à Saint-Brice-sous-Rânes (Orne, France) dans son contexte environnemental*. *Quaternaire* 20, 361–379; 10–11: Modified from Di Modica, K., 2010. *Les productions lithiques du Paléolithique moyen de Belgique: variabilité des systèmes d’acquisition et des technologies en réponse à une mosaïque d’environnements contrastés* (Ph.D. thesis). Museum national d’histoire naturelle Paris & Université de Liège.)

by an increase in multistratified archaeological sites (Faivre et al., 2014; Jaubert, 2010; Jaubert et al., 2011). In the south-east, a Quina facies has been identified at Grotte du Figuier based on the characteristics of retouch (Moncel et al., 2012). The Quina production system is observed at some sites (e.g. Grotte Mandrin: Giraud et al., 1998), but it has not been clearly identified in the Rhodanian Quina facies, which was proposed for sites of the Rhône Valley (Bordes, 1984; Combier, 1967; Le Tensorer, 1981; Slimak, 1999, 2006).

In the British LMP, bearing in mind the low site numbers and early excavation history, Levallois is extremely rare (one core, few preferential flakes, no points). Instead, core reduction is often informal, combining discoidal and alternate/centripetal methods. Mousterian industries in Belgium are characterised by the use of expedient technologies and a limited toolkit (e.g. Goyet) or Levallois and Mousterian point production (e.g. Trou du Diable; Di Modica et al., 2016).

Discoidal and Levallois assemblages dominate MIS 3 on French open-air sites, rock shelters, and caves (Fig. 10.9). These production strategies often reflect a ramified *chaîne opératoire* that, depending on the system of technology, produces a wide variety of different-sized flakes with varying morphologies and different COF exploitation strategies

(Bourguignon et al., 2004; Dibble and McPherron, 2006; Moncel and Daujeard, 2012).

Levallois assemblages are well attested in the region. In northern France, several sites show sole Levallois flake production that is mainly devoted to the production of large preferential Levallois flakes. It is the case at Havrincourt (Hav.1-N3: Goval and Hérison, 2018; Goval et al., 2015), Atilly (N1 and N2: Loch et al., 2013), Ault (Antoine et al., 2011), and Hermies-Le Tio Marché (Vallin et al., 2006). Recurrent Levallois flakes complete the toolkit at these sites or constitute almost the entirety of assemblage at other sites that have little or no preferential production, such as at Hénin-sur-Cojeul (G: Marcy et al., 1993) and Havrincourt (2-N3: Goval and Hérison, 2018). In the Aquitaine Basin, Levallois exclusive assemblages show recurrent knapping methods (centripetal and unipolar) and typically contain a variety of retouched tool types, primarily different sidescraper forms, made on blanks with highly predetermined morphologies. In certain contexts, especially at open-air sites, these two flake production systems can co-occur and compose a mixed techno-complex that may reflect either adaptations to local raw material constraints or imported artefacts. In the south-east region, assemblages show associations of different knapping methods, albeit with one dominant. This pattern seems to be independent of short/

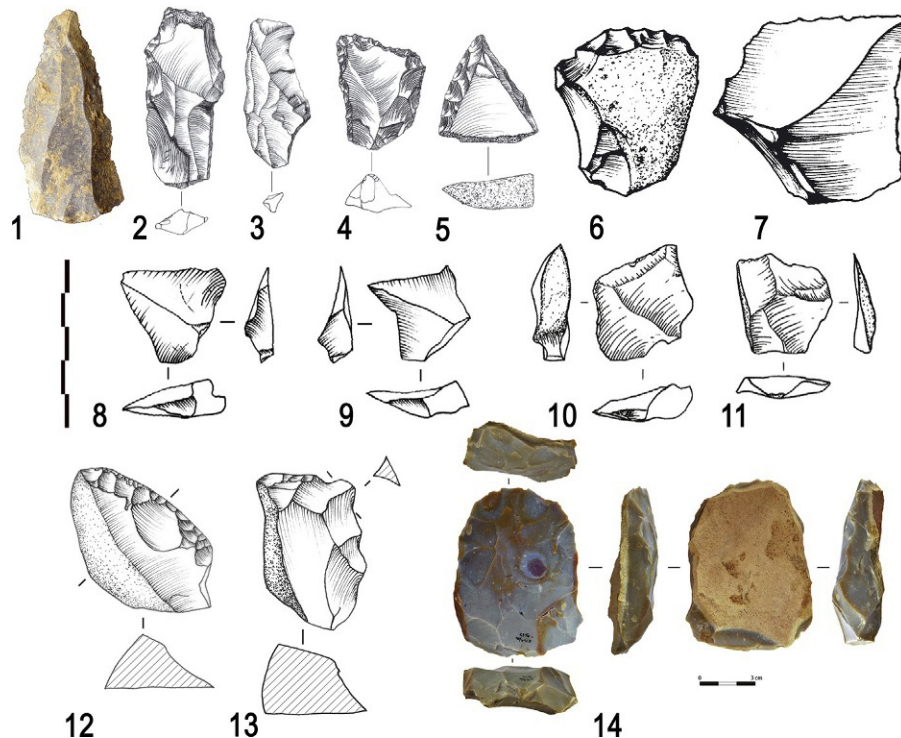


FIG. 10.9 Example of LMP lithic items in southern France. 1 Levallois point (Abri du Maras, level 4.2); 2–5 retouched and unretouched elongated flakes (Grotte du Figuier, chamber 3); 6, 7 Flakes (Saint-Marcel, level I); 8, 9 Pseudo-levallois points; 10, 11 *éclats débordants*; 12, 13 Quina-type flakes; 14 Levallois core. 8–14 From sites on the northeastern Aquitaine Basin. (Modified from Faivre, J.-Ph, Gravina, B., Bourguignon, L., Discamps, E., Turq, A., 2017. Late Middle Palaeolithic lithic technocomplexes (MIS 5–3) in the northeastern Aquitaine Basin: advances and challenges. *Quat. Int.* 433 (Part B), 116–131.)

long-term site occupations. In addition to Levallois, present in various modalities, the main knapping concept is a discoidal type (unifacial or bifacial). Secondary technologies, including expedient ones, are also usually present, as at Saint-Marcel (Moncel, 1996, 1998; Moncel et al., 2004; Szmidi et al., 2010).

In south-western France, regional discoidal assemblages are primarily characterised by the production of pseudo-Levallois points and *éclats débordants* to be used unmodified or retouched (Fig. 10.9). In the north, at Beauvais (Locht and Swinnen, 1994) and Ormesson (Bodu et al., 2014), a toolkit has been identified that was exclusively produced by discoidal flaking.

Several other punctual or discrete occurrences attest to the presence of other technical traditions. For example, bifacial foliates at Rencourt-Lès-Bapaume, niv. B1 in the north of France (Tuffreau, 1993) and Saint-Hilaire-sur-Helpe (Féray et al., 2013) or the production of thick, large flakes at Catigny (Lamotte et al., 2010). In the French Basque Country and Spanish Cantabria region, the ‘Vasconian’ is characterised primarily by discoidal debitage associated with sidescrapers, flake cleavers, and bifaces (Bordes, 1953; Deschamps, 2017).

6.3 Retouched items and transported toolkits

In addition to bifacial tools, the main retouched items in MP assemblages of northern and southern France are sidescrapers and, to a lesser extent, points. Notches and denticulates are usually more abundant in discoidal assemblages. In south-eastern France, the ratio of retouched tools differs according to site function and the duration of occupations. However, a general trend is visible in the low intensity of retouch and little evidence of resharpening, except for bivouacs and specialised occupations (Moncel et al., 2021) and for the Quina facies (Moncel et al., 2012).

Transported toolkits during MIS 3 included retouched tools, but also unmodified blanks (Moncel et al., 2021; Slimak, 2006; Turq et al., 2013). Pseudo-Levallois points and *éclats débordants* typical of discoidal reduction were frequently used unmodified. Levallois flakes circulate as both retouched and unretouched tools and are usually larger than flakes produced on-site (e.g. Abri du Maras, Bau de l’Aubesier: Carmignani et al., 2017; Fernandez and Legendre, 2003; Hardy et al., 2013, 2020; Moncel et al., 2014).

The tools transported by Neanderthal groups are not only linked to the distance from raw material sources. In south-east France, for example, Abri des Pêcheurs and Barasses II produced evidence for the transport of semilocal chert (Moncel and Lhomme, 2007; Moncel et al., 2008). In this area, a high ratio of transported tools is usually evident in bivouacs and short-term specialised occupations (Daujeard et al., 2019; Moncel et al., 2018; Richard et al., 2015; Vettese et al., 2017), where imported elements reflect different technologies than

the those carried out on-site. These data suggest complex task planning and management of the raw materials, even in an area rich in chert outcrops. The same scenario is observed in the northern France record, despite the difficulties of tracking raw material displacement, the *chaînes opératoires* depict spatio-temporal discontinuities in knapping activities, revealing a high mobility of some items such as the large preferential Levallois flakes or bifaces at the scale of the sites and landscape (Goval and Hérisson, 2018).

7 Mediterranean Europe

Neanderthals continuously inhabited southern Europe throughout the entire MP. Settlement patterns and mobility strategies varied in the different geographic and environmental areas that constitute the three peninsulas at the southern fringe of Europe (Iberian, Italian, and Balkan). The specific Neanderthal adaptations to environmental and ecological factors are still poorly known across this vast area. It seems that the LMP is characterised by a complementarity between long-term occupations and several locations showing short-time, repeated occupations. The different mobility strategies, in association with technological traditions and Neanderthal behavioural flexibility, could explain this techno-economic variability. The result is a complex mosaic between expedient and curated technology and continuity and rupture of different technological productions and tool manufacturing. Currently, this dynamic, kaleidoscopic scenario cannot be interpreted according to a universal spatio-temporal model (e.g. Delpiano et al., 2019; Rios-Garaizar, 2017; Romagnoli et al., 2018; Vaquero and Romagnoli, 2018).

7.1 The Iberian Peninsula

Starting from MIS 9, the coexistence of Late Acheulean and MP technologies is evident. Assemblages with clear Acheulean technological features (large cutting tools) are present on open-air sites in the central Iberian Peninsula until at least MIS 6 (Torralba and different sites located around Madrid: Baena Preysler and Torres Navas, 2019; Méndez-Quintas et al., 2020; Santonja et al., 2016) and in northern areas until MIS 5 (Méndez-Quintas et al., 2019), which is long after the appearance of early MP assemblages (Álvarez Alonso and Arrizabalaga, 2012; Barroso Ruíz et al., 2011; Eixea et al., 2020a; Falguères et al., 2019; Fernández-Peris, 2007; Jiménez-Arenas et al., 2011; Ollé et al., 2016; Santonja et al., 2016; Fig. 10.10).

Concerning the Middle to Upper Palaeolithic boundary, new data have been published in recent years. The chronology of the last MP occurrences in the Iberian Peninsula has been seriously discussed with new and improved radiometric dates (Higham et al., 2014), and it is now widely accepted that the MP lasted a little beyond 42 ka cal BP (Haws et al., 2020; Marín-Arroyo et al., 2018).

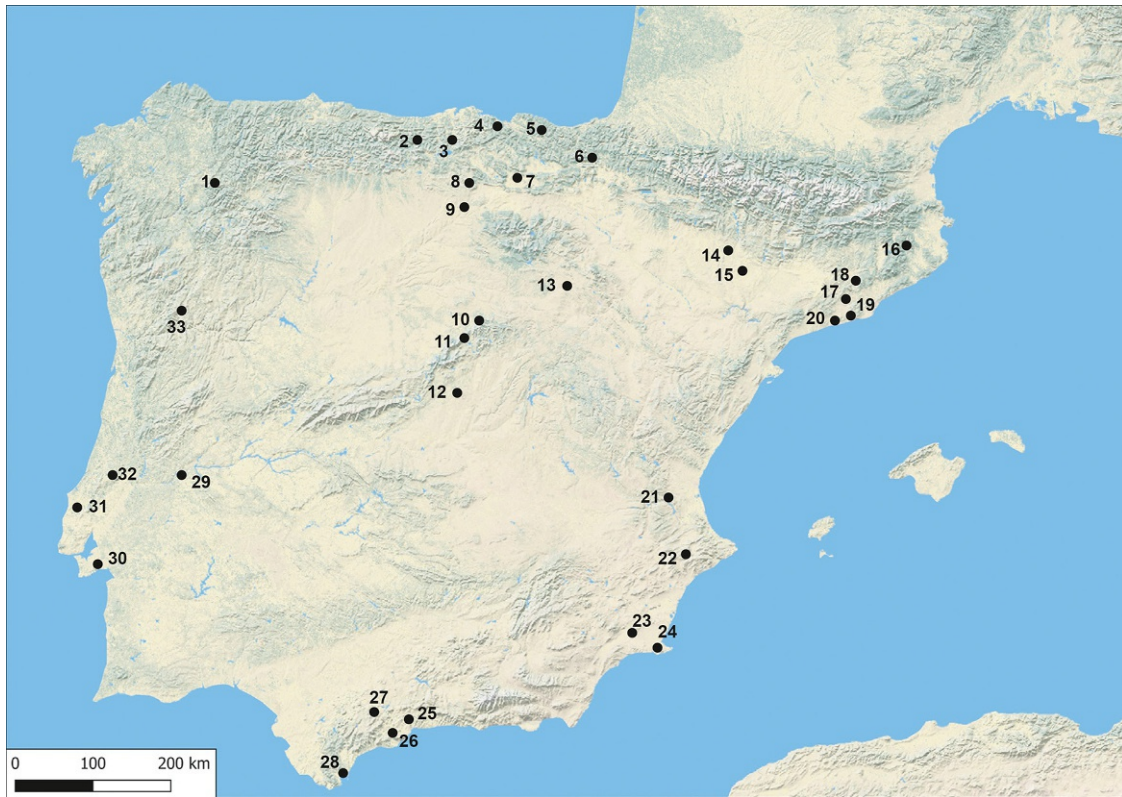


FIG. 10.10 Location map of LMP sites in the Iberian Peninsula. 1 Cova Eirós; 2 Esquilleu; 3 Cueva Morín, Hornos de la Peña, Covalejos, El Castillo; 4 El Cuco; 5 Amalda, Axlor; 6 Abauntz; 7 Peña Miel; 8 Prado Vargas, Valdegoba; 9 Cueva Millán, Fuente Mudarra; 10 Jarama IV; 11 Navalmaillo; 12 El Cañaverál; 13 Los Casares; 14 Gabasa, Fuente del Trucho; 15 Roca del Bous, Cova Gran de Santa Linya; 16 Ermitons, L'Arbreda; 17 Abric Romaní; 18 Teixoneres; 19 Cova del Gegant, Cova del Coll Verdaguer; 20 Cova Foradada; 21 Abrigo de la Quebrada; 22 Abric del Pastor, El Salt, Cova Beneito; 23 Cova Antón; 24 Sima de las Palomas; 25 Zafarraya; 26 Bajondillo; 27 Ardales; 28 Gorham Cave, Vanguard Cave; 29 Foz do Enxarrique; 30 River Lis Basin; 31 Gruta da Columbeira; 32 Lapa do Picareiro; 33 Cõa Valley.

7.1.1 Raw material types, catchment areas, and mobility settings

A huge variability of raw material procurement strategies has been identified. The main raw material exploited was usually chert, but several differences are notable at different spatial and temporal scales in chert quality (mechanical properties, size, and abundance) and in the ratio of other resources. If good-quality chert was widely available, it was the preferred material, and other rocks were used as hammerstones or to shape macro-tools (Deschamps and Flas, 2019; Minet et al., 2021; Rios-Garaizar, 2017; Utrilla et al., 2015). When chert was scarce and with little internal homogeneity, or the initial blanks were very small, then raw materials usually categorised as 'low-quality' (e.g. quartz, quartzite, limestone, sandstone, mudstone, hornfels, schist) were frequently used. Examples of this pattern include Amalda, Esquilleu, Hornos de la Peña, Teixoneres, Cova Eirós, Arbreda, Navalmaillo rock shelter, and Fox do Enxarrique, among others (e.g. Abrunhosa et al., 2019; Aubry et al., 2016; Baena et al., 2019, 2021; Cunha et al., 2019; de Lombera Hermida, 2020; Duran and Soler, 2006;

Fernández Peris et al., 2008; Márquez et al., 2016; Pereira et al., 2017; Picin et al., 2020a,b; Prieto et al., 2018, 2021; Rios-Garaizar et al., 2020; Roy et al., 2017). The application of specific knapping concepts was not necessarily directly affected by the quality of raw materials. Rather, it seems that Neanderthals had great technological flexibility to adapt their production sequences to the constraints of raw materials (Eixea et al., 2016; Romagnoli et al., 2016a). However, coarser-grained resources were usually not exploited for Levallois methods.

According to distance–decay models (e.g. Renfrew, 1977; Wilson, 2007), an indirect correlation is usually expected to exist between the distance from a catchment area and the quantity of raw materials brought to the site. However, several LMP sites in the Iberian Peninsula show a different pattern, with the abundance of resources collected in a regional range of 10–30 km from the site (see Eixea et al., 2020b; Gómez de Soler et al., 2020; Rios-Garaizar and García Moreno, 2015; Sánchez de la Torre et al., 2020). The raw material catchment strategies include direct procurement; however, this seems more commonly embedded in wider and more complex mobility and subsistence strate-

gies. In this sense, the use of ramified production strategies gives an extended use to the transported raw material (Cortés-Sánchez et al., 2011; Eixea et al., 2018, 2020a; Rios-Garaizar et al., 2015; Romagnoli et al., 2018). At present, the few sites that can be described as real workshops are those situated on the chert outcrops in the El Cañaverl site in Madrid (Ortiz Nieto-Márquez and Baena, 2017).

The modalities of introducing resources to the site can be related to multiple factors, including recycling and the use of the site as a storage location over time, the duration of human occupation and site function, and cultural patterns (e.g. Bargalló et al., 2020; Machado et al., 2017; Mayor et al., 2020; Mora et al., 2018; Rios-Garaizar, 2017; Vaquero et al., 2015, 2017, 2019). Some sites attest to the minor exploitation (less than 10%) of abiotic resources collected far away, at distances of more than 100 km (see Eixea et al., 2014, 2020b). Raw materials other than chert were usually collected locally, less than 10 km far away from the site.

Despite the climatic fluctuations of MIS 3, the distribution of LMP sites in the Iberian Peninsula and catchment areas seems to have been more strongly affected by mobility strategies with a complex mosaic between long-term and short-term camps. Mobility patterns were most probably dependent on subsistence strategies (e.g. exploitation of small prey) and general economic settings (e.g. Blasco et al., 2016; Gómez-Olivencia et al., 2018; Marín et al., 2020;

Nabais, 2018; Real et al., 2022; Rufà et al., 2014; Yravedra et al., 2019). Variability in hunting strategies and tool provisioning was most likely the result of a complex mosaic of planned and socially driven strategies (Rios-Garaizar and García Moreno, 2015). This is likely to be due to the great capacity of Neanderthals to be highly adapted to a changing environment and the resources that were available.

7.1.2 Strategies of lithic production

The main knapping strategies used during the LMP in the Iberian Peninsula are discoid and Levallois (Fig. 10.11). Both production methods show a great technological flexibility that allows for the exploitation of different resources (e.g. Barroso Ruíz et al., 2014; Benedetti et al., 2019; Carrión Santafé et al., 2008; Chacón et al., 2013; Cortés-Sánchez et al., 2011; Daura et al., 2010, 2017; Eixea et al., 2020b; Maroto, 1993; Martínez-Moreno et al., 2010; Mora et al., 2018; Navazo Ruíz et al., 2020, 2021; Picin et al., 2020a; Ramos-Muñoz et al., 2020; Rios-Garaizar, 2017, 2020; Romagnoli et al., 2016a; Sánchez de la Torre et al., 2020; Santamaría et al., 2020; Shipton et al., 2013; Vaquero et al., 2012b; Zilhão et al., 2011, 2016).

Discoid strategies (mainly bifacial, although unifacial ones have also been identified, e.g. Jarama IV: Navazo Ruíz et al., 2020) were applied to a huge variety of raw materials.

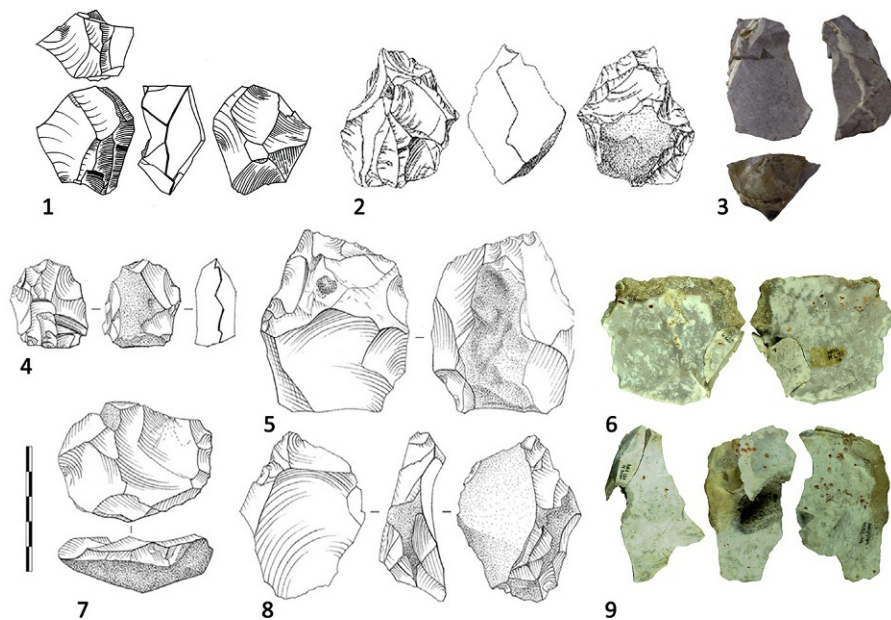


FIG. 10.11 Technological core knapping strategies in LMP in the Iberian Peninsula. 1 Discoidal core (Abric Romaní); 2 Discoidal core (Roca dels Bous); 3 Quina core (Axlor); 4, 5, 7, 8 Levallois cores (Cova Gran); 6, 9 Refitted cores-on-flakes and micro-products (Abric Romaní). (1: Modified from Romagnoli, F., Gómez de Soler, B., Bargalló, A., Chacón, M.G., Vaquero, M., 2018. Here and now or a previously planned strategy? Rethinking the concept of ramification for micro-production in expedient contexts: implications for Neanderthal socio-economic behavior. *Quat. Int.* 474, 168–181; 2: Modified from Eixea, A., 2018. Middle palaeolithic lithic assemblages in western Mediterranean Europe from MIS 5 to 3. *J. Archaeol. Sci. Rep.* 21, 643–666; 3: Modified from Rios-Garaizar, J., Eixea, A., Villaverde, V., 2015. Ramification of lithic production and the search of small tools in Iberian Peninsula Middle Paleolithic. *Quat. Int.* 361, 188–199; 6, 9: Modified from Romagnoli, F., Gómez de Soler, B., Bargalló, A., Chacón, M.G., Vaquero, M., 2018. Here and now or a previously planned strategy? Rethinking the concept of ramification for micro-production in expedient contexts: implications for Neanderthal socio-economic behavior. *Quat. Int.* 474, 168–181.)

Discoid was often orientated to the production of typical debordant flakes and pseudo-Levallois points (e.g. Amalda I, Hornos de la Peña, Peña Miel, Abric Romaní, Teixoneres, Coll Verdaguer, and Cueva Morín: [Baena et al., 2019](#); [Carrión Santafé et al., 2008](#); [Daura et al., 2017](#); [Maíllo Fernández, 2007](#); [Picin et al., 2020a,b](#); [Rios-Garaizar and Eixea, 2021](#); [Rios-Garaizar et al., 2020](#)).

Regarding Levallois methods, the recurrent centripetal modality predominates, with less evidence of preferential, bidirectional, and laminar Levallois production. In general, Levallois products are small and medium quadrangular flakes, with the production of points being rare ([Machado et al., 2017](#); [Mayor et al., 2019, 2020](#)).

Some assemblages, including centripetal and hierarchised knapping sequences, are difficult to classify as Levallois or discoid. They are usually made of quartzite and other so-called low-quality materials. However, similar chert assemblages are also attested (e.g. Prado Vargas, Jarama IV: [Navazo Ruíz et al., 2020, 2021](#); Abric Romaní: [Chacón et al., 2013](#); Roca dels Bous: [Casanova et al., 2009](#)). This technology could reflect the adaptation of Levallois schemes to raw material constraints.

A typical technological pattern of Levallois and discoid methods is the systematic production of small and very small flakes regardless of the scarcity of raw materials and the size of the initial blanks. That is the case at several sites in the Cantabrian area, northern plateau, and north east of the Iberian Peninsula (e.g. Amalda I, Axló, El Cuco, Navalmaíllo rock shelter, Bajondillo cave, Coll Verdaguer, Abric Romaní and Roca dels Bous: [Abrunhosa et al., 2019](#); [Cortés-Sánchez et al., 2011](#); [Daura et al., 2017](#); [Gutiérrez-Zugasti et al., 2018](#); [Márquez et al., 2016](#); [Martínez-Moreno et al., 2006, 2010](#); [Rios-Garaizar, 2020](#); [Rios-Garaizar et al., 2015](#); [Romagnoli et al., 2018](#)).

Quina strategies have rarely been identified in the Iberian Peninsula and are probably hidden behind productions defined as orthogonal, but this cannot yet be proven. The Quina is quite well represented in sites of northern Spain, such as Axló, Covalejos, and Esquilleu, where typical Quina products and ramified reduction sequences have been identified ([Baena et al., 2012, 2019](#); [Carrión Santafé et al., 2008](#); [Rios-Garaizar, 2017](#)). Beyond the Cantabrian region, Quina production has been identified at Cueva del Niño in the southern Meseta ([García Moreno et al., 2014](#)) and probably at Cueva Millán and Prado Vargas in the northern Meseta ([Moure Romanillo and García Soto, 1983](#); [Navazo Ruíz et al., 2021](#)).

Blade and bladelet productions were very rare ([Rios-Garaizar, 2020](#)). Blade production has been identified by recent studies at several sites in the Mediterranean area (e.g. Cova Gran de Santa Linya, Fuente del Trucho, and Abrigo de la Quebrada: [Eixea et al., 2018](#); [Mora et al., 2018](#); [Sánchez de la Torre et al., 2020](#)) and in the Cantabrian region (e.g. Axló level B: [Rios-Garaizar, 2017](#); Cova Morín:

[Maíllo Fernández, 2005](#); however, this latter study is based on an early collection with an important stratigraphic bias). These productions do not correspond to the typical laminar volumetric production ('Upper Palaeolithic type'), as it has been defined in northern France and the Périgord ([Ortega et al., 2013](#)).

Finally, the shaping of macro tools on pebbles and large flakes is rare, except in the Cantabrian region. In this area, the production and use of cleavers and small bifaces are usually linked with the 'Vasconian' techno-complex that is also known in the French Basque Country ([Deschamps, 2017](#); [Deschamps and Flas, 2019](#); [Minet et al., 2021](#)). Some functional analysis suggests that these tools are related to the exploitation of vegetable resources and the processing of large prey ([Claud et al., 2015](#); [Utrilla Miranda and Mazo, 1996](#)).

7.1.3 *Retouched items and transported toolkits*

The tools used by Neanderthals seem to be multipurpose and characterised by a low degree of functional specialisation (e.g. [Navazo Ruíz et al., 2020](#); [Picin et al., 2020b](#)), coherent with the high technological plasticity that seems to be a typical pattern of these populations. Regardless of the raw materials used and the duration of site occupations, sidescrapers, denticulates, and notches, to a lesser extent, are the most common retouched tools during Iberian LMP (e.g. [Alcaraz-Castaño et al., 2017](#); [Eixea et al., 2020b](#); [Finlayson et al., 2014](#); [Martínez-Moreno et al., 2006](#); [Mayor et al., 2020](#); [Santamaría et al., 2020](#); [Shipton et al., 2013](#); [Vaquero et al., 2012a](#)). Points are less frequent. At present, weapons have rarely been identified through use-wear analysis ([Galván et al., 2008](#); [Rios-Garaizar, 2016](#)). Other tools, such as burins, endscrapers, borers, backed tools, and chisels ('the Upper Palaeolithic Group') are poorly represented ([Daura et al., 2017](#); [Maroto, 1993](#); [Martínez-Moreno et al., 2010](#); [Mora et al., 2018](#); [Navazo Ruíz et al., 2020](#)).

Quina scrapers, frequent in LMP in the Cantabrian region, show a long use-life with repeated evidence of resharpening, ramification, and recycling (see [Baena et al., 2012](#); [Rios-Garaizar, 2017](#)). It seems that Quina scrapers were part of transported personal gear ([Carrión Santafé et al., 2008](#)). As highlighted in other western European regions (e.g. [Bourguignon et al., 2006](#); [Delagnes and Rendu, 2011](#)), these tools were polyvalent.

According to retouch, two complementary strategies characterise different sites, and it is not yet possible to interpret them in relation to economic and social factors. On the one hand, there are intensely retouched tools made of exogenous raw materials, and on the other, there is low intensity of retouch, regardless of supply distance ([Barroso Ruíz, 2003](#); [Bustos-Pérez et al., 2017](#); [Chacón et al., 2007](#)). The mobility of cores has also been identified ([Chacón et al., 2013](#); [Mayor et al., 2020](#); [Vaquero et al., 2012b](#)).

Unretouched tools were also part of the transported toolkits (Vaquero, 2008) and depict greater complexity in planning strategies and landscape-level technological and ecological dynamics than previously thought (Romagnoli and Vaquero, 2019). Furthermore, small, unretouched flakes extracted during COF reduction are also present and have usually been interpreted as expedient tools with effective cutting edge designed to fulfil immediate needs and formed part of transported toolkits (Romagnoli et al., 2018). Use–wear analysis of unretouched toolkits is still rarely applied, but available evidence suggests that these small, unretouched flakes at Amalda I were used for different activities. Results from layer M at the Abric Romaní sites suggest the use of these tools for butchering activities, similar to the blanks produced on-site (Martín-Viveros et al., 2020).

7.2 Italy

The chronology of the Middle Pleistocene still lacks a solid framework, limiting the possible understanding of the variability and evolutionary patterns of the Late Acheulean and earliest Mousterian techno-complexes. Currently, early MP technology, including Levallois and prepared-core technologies, ramification, and a large variety of retouched items, is attested to from MIS 9–8 in central Italy at Cave dall’Olio (Fontana et al., 2013) and in Latium (Soriano and Villa, 2017).

In recent years, several studies have focused on the Middle-to-Upper Palaeolithic transition and the differ-

ences between the final Mousterian and proto-Aurignacian through the still-debated Uluzzian transitional phase. The Middle-to-Upper Palaeolithic transition provides the opportunity to discuss the demise of the Neanderthals, and possible migration routes of Sapiens into Europe have therefore aroused interest (e.g. Arrighi et al., 2020; Collina et al., 2020; Holt et al., 2019; Marciani et al., 2020; Moroni et al., 2013; Peresani et al., 2016, 2019). Instead, LMP technologies (Fig. 10.12) are still poorly investigated in Italy. The dates of proto-Aurignacian layers indicate that this techno-complex, associated with *H. sapiens*, emerged at approximately 43–41 ka (Douka et al., 2012) and shortly before for the Uluzzian (Douka et al., 2014; Zanchetta et al., 2018).

7.2.1 Raw material types, catchment areas, and mobility settings

Chert is the main raw material exploited in LMP, and it was generally collected locally and regionally (within 30 km of the site). However, the presence of very homogeneous resources related to supply areas located more than 100 km away has occasionally been identified and is always present in low percentages at the site (Negrino and Starnini, 2010; Porraz and Peresani, 2006; Romagnoli et al., 2016b). Resources collected from distant sources would usually arrive at the site as finished tools as part of a personal toolkit. Resources other than chert are also frequently attested, suggesting a high degree of adaptability of these communities



FIG. 10.12 Location map of the main LMP sites in Italy and the Balkans. 1 Grotta del Cavallo, Grotta and Riparo Bernardini; 2 Riparo dell’Oscursciuto; 3 Grotta di Castelcivita; 4 Grotta Reali; 5 Riparo Mochi, Grotta del Principe, Riparo Bombrini; 6 Madonna dell’Arma; 7 Grotta di Fumane, Riparo Tagliente; 8 Grotta del Broion, Grotta di San Bernardino, Grotta De Nadale; 9 Grotta del Rio Secco; 10 Divjie Babe; 11 Vindija Cave; 12 Mujina Pecina; 13 Crvena Stijena, Bioče; 14 Asprochaliko; 15 Klisoura; 16 Pešturina; 17 Temnata Dupka; 18 Bacho-Kiro.

to the local landscape. The frequency of this varies from layer to layer and from site to site. Considering the modalities of adaptation to the resources, it is worth mentioning the Pontinian Mousterian in coastal Latium (Bietti et al., 2009–2010; Blanc, 1937; Kuhn, 1990; Palma di Cesnola, 1996). This facies is characterised by the exploitation of small coastal pebbles flaked by bipolar percussion on anvils and further exploited by free-hand percussion or retouched to obtain tools. Although the dates are uncertain, the Pontinian should have been a local technological tradition from MIS 5–3. A further example of specific Neanderthal adaptation to local resources is attested by the exploitation of *Callista chione*'s marine shells to shape retouched tools. This behaviour is attested in several coastal sites along the Tyrrhenian and Ionian coasts, although the chronological framework is still problematic (Romagnoli, 2018; Romagnoli et al., 2016c; Villa et al., 2020).

7.2.2 Strategies of lithic production

Levallois was the dominant production method at the majority of LMP sites, regardless of their function, geomorphological and ecological context, raw materials, and hunting behaviours of their inhabitants (Marciani et al., 2020; Moroni et al., 2019; Palma di Cesnola, 1996; Peresani, 2011). Nevertheless, multilayered sites record the alternation or co-existence with other lithic exploitation strategies represented by discoid (e.g. Fumane and Rio Secco caves in the north-east: Peresani, 2003b, 2011; Bombrini and Mochi rock shelters and Principe Cave in the north-west: Riel-Salvatore and Negrino, 2018; Cavallo cave and Bernardini rock shelter in the south-east: Carmignani and Romagnoli, 2017a; Romagnoli et al., 2016b; Sarti et al., 2017). Laminar production is also known in the Italian LMP. Blades were produced both following Levallois modalities (e.g. Fumane, Rio Secco, Mochi, and Tagliente rock shelter) and as unipolar volumetric debitage (e.g. Tagliente and Madonna dell'Arma cave in the north and Reali cave, Castelvita cave, Ocoruscuto rock shelter, Cavallo and Bernardini in the south: Carmignani, 2010, 2017; Carmignani and Romagnoli, 2017b; Cauche, 2007; Marciani et al., 2020; Peresani et al., 2014; Peretto et al., 2020). The production of bladelets is sporadically present, and the assemblages are never characterised by a sole production method. Furthermore, in the assemblages, expedient productions are usually associated with more formal technologies. Quina-featured assemblages are attested throughout Italy (Palma di Cesnola, 1996). Dates are still sparse. In northern Italy, at De Nadale cave, Quina production has been dated to MIS 4 (Jéquier et al., 2015).

Levallois frequently involves one main reduction sequence and at least one ramified sequence centred on the exploitation of COF. Furthermore, different levels of variability result from the coexistence or alternation of unidi-

rectional and centripetal recurrent modalities. The main goal was the production of blades and flake blades with thin and regular edges, whereas the extraction of points had minor importance. The maintenance of the core convexities in the unidirectional modality was reduced to a minimum and prevalently related to core-edge removal flakes, although some technical variants were adopted. The centripetal modality was sometimes adopted systematically either when approaching the end of the core reduction or when flake cores were exploited, or once the size of the unidirectional elongated blanks exceeded the lower threshold and the core exploitation turned to centripetal. Nonetheless, cores were also exploited through a continuous centripetal reduction sequence. The preferential modality was adopted occasionally.

The discoid reduction concept is associated with a high degree of variability in blank shapes. Normally, primary products are obtained from the earliest decortication stages and the creation of the crest delimiting the two core surfaces around which the entire production is arranged. There are also modifications in the morphological and functional arrangements and the face convexities of the cores, the outline of which changes to polyhedral. This variability seems to respond to production needs (Delpiano and Peresani, 2017). Ramification and COF are also attested in discoid assemblages. The COF exploitation is mostly unifacial and located on the ventral surface. These two reduction sequences share the same goal of producing short, strong, and sometimes pointed implements, as evidenced by pseudo-Levallois points, backed flakes, and subcircular, squared, and triangular flakes (Peresani, 2003b). Unifacial discoidal exploitation is also attested.

7.2.3 Tools and transported toolkits

Sidescrapers are the most frequent retouched tools, followed by denticulates and notched tools and rare points. The intensity of retouch and resharpening is quite variable from site to site, as is the ratio between retouched and unretouched items (Fig. 10.13).

Although the majority of retouched tools were obtained from raw materials provisioned in the home-range/surroundings of the site, several examples demonstrate that a variable part of the toolkit was made and maintained on exogenous materials. A notable case is the reuse of patinated artefacts resharpened and used after a gap between their first phase of life (production and use) and the new functional cycle, attested since the earlier period of MP assemblages (Romagnoli, 2015). At Fumane, San Bernardino, and Broion caves, it seems that the recycling of previously abandoned and patinated flakes was not focused on specific blanks (variable morpho-technical and dimensional characteristic; Peresani et al., 2015). At these sites, recycling responded to both expedient and curated behaviours in different layers

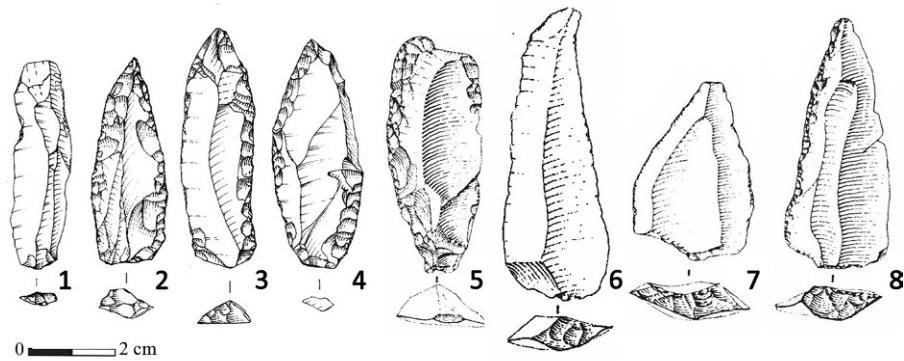


FIG. 10.13 Retouched and unretouched artefacts from Grotta di Fumane (1–4) and Grotta di Castelcivita (5–8). (Modified from Marciani, G., Ronchitelli, A., Arrighi, S., Badino, F., Bortolini, E., Boscato, P., Boschin, F., Crezzini, J., Delpiano, D., Falcucci, A., Figus, C., Lugli, F., Oxilia, G., Romandini, M., Riel-Salvatore, J., Peresani, M., Spinapolice, E., Moroni, A., Benazzi, S., 2020. Lithic technocomplexes in Italy from 50 to 39 thousand years BP: an overview of lithic technological changes across the Middle-Upper Palaeolithic boundary. *Quat. Int.* 551, 123–149.)

across the stratigraphic sequences, probably due to changes in mobility strategies and toolkit provisioning according to site function and the duration of occupation. However, this behaviour seems to have played an ephemeral role in the general raw material economy of the LMP.

Functional data of MP assemblages are still rare in Italy. The use–wear analysis conducted at Tagliente LMP assemblage suggests that, at this site, blades were frequently used in butchery activities, while convergent morphologies (Mousterian, Levallois, and pseudo-Levallois points and triangular flakes) were mainly associated with undifferentiated uses including carcass processing, hide working, and probably, woodworking (Berruti et al., 2020). It is interesting to highlight that this study identified clear traces of wear on flakes that would usually be considered waste according to the technological analysis (e.g. reshaping flakes and core management flakes). At Grotta Breuil, Lemorini identified use-wear on tiny retouched flakes related to the working of a wide range of organic tissues (Grimaldi and Lemorini, 1993). At Fumane, retouched and unretouched flakes issued from Discoid core technology were used on soft, medium-hard and hard materials (Lemorini et al., 2003). The processing of medium-hard material along with edge damage possibly related to hafting was recognised at this site on backed pieces made of local and allochthonous chert, which outcrops at least 80 km from the site (Delpiano et al., 2018, 2019).

7.3 The Balkans

MP single-layered or stratified sites systematically investigated are so sparse in the Balkan Peninsula that a very low number of late Mousterian sites is known (Fig. 10.12). Sites are located in two main continental and Adriatic geographic regions, from the south-eastern Alps to the southernmost Greek peninsula and in the southern edge of the Pannonian Basin, with different landscapes settled (Karavanić, 2004; Karavanić and Kamenjarin, 2020; Karavanić et al., 2021;

Mihailović, 2020; Tourloukis and Harvati, 2018; Turk, 1997). Cave sites occur in the mountainous area on the periphery of the Pannonian basin, while open-air sites are grouped in the Sava Valley. Main sites are Divjje Babe, Vindija Cave, Mujina Pecina, Crvena Stijena, and Bioče, with some of them attracting debate about the revision of archaeological and paleontological associations at the taphonomic, chronological, and interpretative levels.

There is a clear correlation between the increased intensity of settlements (in terms of the quantity and structure of the archaeological remains) and the topography of the terrain and mineral resources (Dogandžić and Đuričić, 2017). Artefacts from all stages of production are found at sites in lowlands and hilly landscapes, while the remains from caves in the mountain zone testify to the ephemeral nature of settlements.

7.3.1 Raw material: Types, catchment areas, and mobility settings

Knappable lithic resources are represented in the Balkan Peninsula mainly by chert and radiolarite, which differ in lateral and stratigraphic distribution according to the regional paleogeographic domains, being rare to absent in a few epicontinental basins, as in the case of radiolarite in Dalmatia and Istria. Chert outcrops in the sedimentary rocks contain nodules and layers that differ in size, colour, texture, structure, paleontological content, degree of silicification, and tectonic integrity (Perhoč, 2020). Systematic research of lithic collections and outcropping knappable rocks has been continued in the last two decades, covering large zones such as Istria and Dalmatia (Perhoč, 2020). Petrography of the knapped artefacts from Dalmatia suggests that Neanderthals practised a broad exploitation of locally available lithic resources. Generally, the accessibility of pebbles and nodules can significantly vary, making it rather challenging to assess their availability. Primary

sources and their availability and size have been tentatively estimated at many sites, although river nodules could be larger than the primary raw materials imported, as in the cases of Bioče and Crvena Stijena (Dogandžić and Đuričić, 2017). Secondary resources of chert in the form of nodules from rivers flowing in proximity to the rock shelter or cave were used for stone tool production.

7.3.2 Strategies of lithic production

Levallois was the most used flaking method at these sites, regardless of their function and geomorphological context. Levallois centripetal core exploitation seems to increase with respect to the unidirectional one when approaching the latest MP. This has been observed along several sequences, such as at Crvena Stijena and Bioče (Dogandžić and Đuričić, 2017; Mihailović and Whallon, 2017). Levallois reduction could be associated to other knapping methods characterised by a high degree of expediency (e.g., Lakonis I: Starkovich et al., 2020). Centripetal core reduction technology was also based on the discoid method and other centripetal and not strictly Levallois, core reductions. To increase variability, flakes were produced neither using Levallois nor discoid technologies at Vindija level G3. At other sites, splinters and small flakes were produced using bipolar percussion on an anvil and small flakes were obtained from COF.

Micro-Mousterian industries, so-called due to the small average size of the artefacts, are documented in the Mediterranean area and on the southern edge of the Pannonian basin. They are sometimes associated with sites containing large numbers of lithic artefacts, faunal remains, and fire residues (Mihailović, 2020). Micro-Mousterian industries are interpreted as the outcome of intense exploitation of the local raw material. Levallois cores shortened in size as the reduction process continued as a consequence of intensified reduction, resulting in smaller numbers of residual cores (Gowlett and Carter, 1997). This could also explain the lack of preferential Levallois cores. Nonetheless, raw material size constraints are one of the driving factors determining core flaking options, core reduction patterns, and overall microlithisation of industries at Crvena Stijena, Klissoura, Mujina cave, and other sites on the southern edge of the Pannonian basin, having a similar set of artefact classes as in any other Mousterian assemblages in southern Europe, including the Pontinian in Italy.

Nevertheless, studies stress the lack of a clear definition of whether the micro-Mousterian corresponds to a specific mean artefact size. In some contexts, artefacts were made of small, locally available raw materials of low quality, so their size did not result from the overexploitation of natural cobbles (Karavanić, 2004). In others, the selection of small nodules, regardless of the local availability of larger river pebbles, reveals that obtaining micro-tools was intentional

(Đuričić, 2006). Given that both these factors could drive reduction of the overall size of artefacts, it would be difficult to isolate the effects of each, and most of the features of lithic industries result from a combination of their effects.

7.3.3 Tools and transported toolkits

Often referred to as the micro-Mousterian, the MP industries of the Balkan Peninsula include retouched flakes, sidescrapers, denticulates, and notched pieces as the most frequent tools. Sidescrapers are generally the dominant tool. Assemblages rich in denticulates have been reported at Crvena Stijena and open-air sites along the Dalmatian coast (Karavanić, 2007). Bifacial tools also occur, albeit in small numbers, at several sites. Typological and economical variability observed in these industries implies that different strategies were employed in stone tool production in cases of limitations in raw material provisioning. This might also partly explain the higher tool reduction as a result of repeated rejuvenation stages in function of the distance of the raw materials and not only of the physical properties of the knapped stones. However, studies at Crvena Stijena and Bioče reveal that tool reduction was not as strongly affected by raw materials as by core reduction intensity (Dogandžić and Đuričić, 2017).

8 Neanderthal variability

This extensive overview shows that spatio-temporal trends of reduction strategies are not clearly discernible for the period between 70 and 35 ka across the territories occupied by Neanderthals. Knapping concepts and technological procedures were broadly distributed and persisted over long time spans. Archaeologists are still unable to interpret them and discern to what degree lithic assemblages and tool composition may reflect adaptations to certain environmental constraints or be driven by similar ecological challenges. Moreover, assemblage composition can equally result from the influence of local contexts (e.g. the characteristics and accessibility of raw materials and the duration of site occupation), the response to similar social dynamics, or reflect specific ‘cultures’ of particular Neanderthal populations and continuity in cultural transmission. The chronological and palaeoecological framework still needs further refinement in order to better understand demographic dynamics and adequately describe local processes. Furthermore, significant disparities remain in terms of the density of studies. This, combined with different research traditions, impedes systematic comparisons between sites and makes it difficult to clearly define trends and evaluate the variables underlying such trends. Finally, the possibility that the specific dynamics between different Neanderthal populations and between Neanderthals and other human groups affect aspects of technology should be taken into consideration.

In recent years, several regional syntheses have been attempted (e.g. Faivre et al., 2017; Loch et al., 2016; Rios-Garaizar, 2017). These studies, as well as the numerous case studies published over the last two decades that are summarised in this review, suggest that differences in assemblage structure and tool composition most probably result from the combined influences of several factors. The data also suggest that some approaches could be useful for identifying variability and possible underlying factors. These include analysis of landscape perception and management, understanding the strategies applied by humans to invest in the use-life of tools, the identification of transported items, transport strategies related to technological costs, the social organisation of activities, and possible intra-group contacts. Further analysis of these topics, and the improvement of use-wear analysis, could open perspectives on social and demographic dynamics and MP behaviours, especially if linked to paleoclimatic and palaeoecological data.

This review shows that the term ‘Mousterian’ is no longer appropriate for MP technologies. First, the term describes specific traits of stone tool assemblages in a limited part of western Europe, meaning that it excludes the variability of technological expressions in most Neanderthal territories and in specific ecological areas (northern latitudes, coastal areas, etc.). Secondly, it leads MP lithic assemblages to be seen as a homogeneous and single phenomenon. Instead, future studies should focus more on identifying and interpreting local differences and specificities and then using them to visualise possible human groups (within Neanderthal metapopulations as well as within Neanderthals and other Pleistocene human groups) and their possible mutual relationships.

Other Middle and Late Pleistocene populations inhabited Eurasia at the same time as the Neanderthals. *H. sapiens* have been documented in the Levant from at least ≈ 170 ka (HersHKovitz et al., 2018), where they are associated with early MP assemblages, and in East Asia since more than 80 ka (Liu et al., 2015). A recent study points to the presence of *H. sapiens* in south-eastern Europe at approximately 200 ka, suggesting human dispersals and complex demographic processes in the Middle Pleistocene at least between this part of Europe and the Levant (Harvati et al., 2019). Genetic studies have revealed that *H. sapiens* and Neanderthals interbred (Green et al., 2010; HersHKovitz et al., 2021; Prüfer et al., 2014; Sankararaman et al., 2014; Vernot and Akey, 2014), revealing interactions between different Neanderthal and *H. sapiens* groups to have occurred repeatedly over different times and spaces, and we can expect that these encounters affected aspects of culture, at least in some regions (e.g. Hovers, 2006).

In the Altai Mountains, despite the limited territory of this region, several human subspecies interacted and interbred, as shown by paleogenetic analysis (Slon et al., 2017a, 2018). In Denisova Cave, the remains of Denisovans

as well as Neanderthals were recovered from various MP layers of the East Gallery (Slon et al., 2017a; Viola, 2022). The most numerous Neanderthal remains are known from Chagyrskaya Cave ($N = 76$). In some cases, a clear association between typical artefacts and human fossils demonstrates reliable correlations between human (sub)species and lithic industries (Kolobova et al., 2020).

Undoubtedly, the earliest stages of the Altai MP during MIS 8 and MIS 7 are associated with Denisovans (Slon et al., 2017b). Later Levallois-Mousterian assemblages of the Denisova and Kara-Bom variants, dated between MIS 7 and MIS 3, cannot be securely related to a specific hominin species. In this later phase of the Altai MP, only the caves of Chagyrskaya and Okladnikov demonstrate a direct association of anthropological/genetic data and lithic assemblages for the late MIS 4 to early MIS 3. During this period, the two caves were inhabited by late Neanderthals who produced Micoquian assemblages (Kolobova et al., 2020). More broadly, the correlation between the Micoquian and Neanderthals seems to be well documented by several burials and/or fossils in the Crimea, the northern Caucasus, and the Altai. To date, no human fossils associated with the Levallois-Mousterian are known from these eastern regions. Furthermore, genetic data suggest that Neanderthal populations arrived in this region via at least two waves of dispersal from more western regions (Krause et al., 2007; Mafessoni et al., 2020). The occupation of the Altai starts with a Denisovan population at the end of the Middle Pleistocene. Then, the first migration of Neanderthals reached the region and, according to the genetic inheritance of the father of Denisova 11, mixed with the regional Denisovans. Later, during MIS 4, a second, genetically distinct group of Neanderthals came to the Altai and occupied Chagyrskaya and Okladnikov Caves. At about 40 ka, Neanderthals in the Altai disappeared, which is approximately synchronous with the arrival of *H. sapiens* in the region (Fu et al., 2014; Zavala et al., 2021).

Finally, we cannot exclude the possibility that interactions also occurred between Neanderthal metapopulations and groups. The presence of different Neanderthal groups/populations has been suggested by genetic analysis and proposed by theoretical models based on the density of lithic items and the frequency of retouch as proxies for human mobility (Barton et al., 2011). Interactions could have been driven by different spatio-temporal factors. In northern latitudes, cyclical climatic and environmental changes could have been the main driving force underlying north-south migrations during cold periods and in the opposite direction during warmer conditions. Further studies should investigate this issue in detail and the hypothesis of settlement dynamics from west to east during the Pleniglacial phase should be also explored. In coastal areas, human interactions could also have been related to climatic aspects, determining the opening and restriction of territories due to the movements

of coastal lines. Furthermore, environmental shifts, social dynamics, and other factors could have changed landscape management in other areas and modified local population dynamics throughout the MP, as suggested by the two different migration waves to the more eastward territories inhabited by Neanderthals.

9 Final remarks

The study of lithic remains is, by its very nature, based on the classification of lithic objects into types and of assemblages into larger units. Although essential, such a systematics is difficult for MP stone tool assemblages. The difficulty is due to the low temporal resolution of each assemblage as well as different research traditions and goals. In coming years, Palaeolithic archaeologists should rethink their systematics and analytical categories. Currently, our archaeological definitions ('culture', 'technological traditions', 'techno-complexes', etc.) have become so generalised that their meaning and utility to depict the diversity of human behaviours across space and time require reassessment. Emphasis should return to local expression of human behaviour to understand technological responses at smaller spatio-temporal scales. Moreover, technological concepts and techniques are broadly distributed and persisted for significant periods. Levallois reduction, for example, is documented from MIS 12 (Moncel et al., 2020; but see Boëda, 2021; Hérison and Soriano, 2020 for more discussion) and more frequently from late MIS 9 (Adler et al., 2014). How can we use such a long-lasting technology to identify social or cultural phenomena that exist on a much more reduced temporal and geographical scale? Rethinking Palaeolithic systematics and taxonomy of lithic variability would likely contribute to our understanding of both how cultural traits became fixed across very large areas and the dynamics of local cultural transmission.

Several other perspectives can be identified as important milestones to be achieved over the next few years and decades. One will be the growing awareness of the relevance of postdepositional processes and palimpsests in archaeological layers and their effects on the composition and distribution of stone tool assemblages in open-air sites, caves, and rock shelters to limit as much bias as possible in the interpretation of archaeological evidence. Quantitative approaches in the definition of morphological variability of stone tools (3D geometric morphometric approaches, multivariate statistics, and machine learning) should enable the identification of knapping concepts, simplify analyses, and allow the possible diversity of technological expressions to be better quantified. Finally, the improvement of multidisciplinary analysis, advances in environmental and chronological frameworks, and better understanding of technological and mobility strategies both at local and regional scales of analysis would most probably allow research on Neanderthal

technologies to go further in the understanding of population dynamics and socioeconomic patterns. This could lead to an increase in the identification of marker of identity or social groups, as well as improve our understanding of the adaptive responses of human groups to their environmental, social, and symbolic landscapes.

Acknowledgements

The authors are extremely grateful to Olaf Jöris for his valuable collaboration.

This work has been supported by the research project S11/PJI/2019-00488 funded by Comunidad de Madrid and Universidad Autónoma de Madrid and led by FR. The research of FR is also supported by the Spanish Ministry of Science, Innovation and Universities through the projects ID2019-103987GB-C33 and PID2020-116732RB-I00. Comparison of the Eastern European and Altai complexes was funded by the RSF–DFC (projects 19-48-04107 and UT 41/8-1). Research of the Chagyrskaya Cave was funded by the RSF project 21-18-00376. Research of MGC is funded by (1) CERCA Programme/Generalitat de Catalunya, (2) Research Groups Support 'GAPS' (Ref. 2017 SGR 836), and (3) the Spanish Ministry of Science, Innovation and Universities through the 'María de Maeztu' programme for Units of Excellence (Ref. CEX2019-000945-M) and PID2019-103987GB-C31.

References

- Abadi, I., Bar-Yosef, O., Belfer-Cohen, A., 2020. Kebara V—a contribution for the study of the Middle-Upper Paleolithic transition in the Levant. *PaleoAnthropology* 2020, 1–28.
- Abrunhosa, A., Pereira, T., Márquez, B., Baquedano, E., Arsuaga, J.L., Pérez-González, A., 2019. Understanding Neanderthal technological adaptation at Navalmañillo Rock Shelter (Spain) by measuring lithic raw materials performance variability. *Archaeol. Anthropol. Sci.* 11, 5949–5962.
- Adler, D.S., Wilkinson, K.N., Blockley, S., Mark, D.F., Pinhasi, R., Schmidt-Magee, B.A., Nahapetyan, S., Mallol, C., Berna, F., Glauberman, P.J., Raczyński-Henk, Y., Wales, N., Frahm, E., Jöris, O., Macleod, A., Smith, V.C., Cullen, V.L., Gasparian, B., 2014. Early Levallois technology and the Lower to Middle Paleolithic transition in the southern Caucasus. *Science* 345, 1609–1613.
- Alcaraz-Castaño, M., Alcolea, J., Kehl, M., Albert, R.M., Baena, J., de Balbín, R., Cuartero, F., Cuenca-Bescós, G., Jiménez-Barredo, F., Lopez-Sáez, J.A., Piqué, R., Rodríguez-Antón, D., Yravedra, J., Weniger, G.-C., 2017. A context for the last Neanderthals of interior Iberia: Los Casares cave revisited. *PLoS ONE* 12 (7), e0180823.
- Alex, B., Valde-Nowak, P., Regev, L., Boaretto, E., 2017. Late middle paleolithic of southern Poland: radiocarbon dates from ciemna and oblazowa caves. *J. Archaeol. Sci. Rep.* 11, 370–380.
- Álvarez Alonso, D., Arrizabalaga, Á., 2012. La secuencia estratigráfica inferior de la cueva de Lezetxiki (Arrasate, País Vasco). Una reflexión necesaria. *Zephyrus* 69, 15–29.
- Amick, D.S., 2007. Behavioral causes and archaeological effects of lithic artifact recycling. In: McP-herron, S. (Ed.), *Tools Versus Cores: Alternative Approaches to Stone Tool Analysis*. Cambridge Scholars Publications, pp. 223–252.
- Andrefsky Jr., W., 2009. The analysis of stone tool procurement, production, and maintenance. *J. Archaeol. Res.* 17, 65–103.

- Antoine, P., Auguste, P., Bahain, J.-J., Louquet, S., 2011. Datation et reconstitution paléoenvironnementale d'un site paléolithique moyen submergé en Manche est: Ault-Onival (Somme, France). *Quaternaire*, 221–233.
- Antoine, P., Gouval, E., Jamet, G., Coutard, S., Moine, O., Hérisson, D., Auguste, P., Guérin, G., Lagroix, F., Schmidt, E., Robert, V., Debenham, N., Meszner, S., Bahain, J.-J., 2014. Les séquences loessiques pléistocène supérieur d'Havrincourt (Pas-de-Calais, France): stratigraphie, paléoenvironnements, géochronologie et occupations paléolithiques. *Quaternaire*, 321–368.
- Arrighi, S., Marciani, G., Rossini, M., Pereira Santos, M.C., Fiorini, A., Martini, I., Aureli, D., Badino, F., Bortolini, E., Fígus, C., Lugli, F., Oxilia, G., Romandini, M., Silvestrini, S., Ronchitelli, A., Moroni, A., Benazzi, S., 2020. Between the hammerstone and the anvil: bipolar knapping and other percussive activities in the late Mousterian and the Uluzzian of Grotta di Castelcivita (Italy). *Archaeol. Anthropol. Sci.* 12, 271.
- Ashkenazi, H., 2005. Standardization of Blade Production in the Levantine Middle Paleolithic (Unpublished M.A. Thesis). The Institute of Archaeology, The Hebrew University of Jerusalem.
- Aubry, T., Barbosa, A.F., Luís, L., Santos, A.T., Silvestre, M., 2016. Quartz use in the absence of flint: Middle and Upper Palaeolithic raw material economy in the Côa Valley (North-eastern Portugal). *Quat. Int.* 424, 113–129.
- Baena, J., Carrión, E., Cuartero, F., Fluck, H., 2012. A chronicle of crisis: the Late Mousterian in north Iberia (Cueva del Esquilieu, Cantabria, Spain). *Quat. Int.* 247, 199–211.
- Baena, J., Carrión Santafé, E., Torres Navas, C., Rodríguez, V., 2019. Mousterian inside the upper Paleolithic? The last interval of El Esquilieu (Cantabria, Spain) sequence. *Quat. Int.* 508, 153–163.
- Baena, J., Pardo, J.F.J., Carrión Santafé, E., Torres Navas, C., Carral Gonzalez, P., Yravedra Sainz, J., 2021. A road to nowhere? The non-transitional sequence at El Esquilieu (Cantabria, Spain). *C. R. Palevol* 20, 277–295.
- Baena Preysler, J., Torres Navas, C., 2019. Explaining links from the past: material distribution in Charco Hondo 2 Acheulian archaeological site (Madrid, Spain). *Archaeol. Anthropol. Sci.* 11, 4397–4421.
- Bamforth, D.B., 1986. Technological efficiency and tool curation. *Am. Antiq.* 51, 38–50.
- Bargalló, A., Gabucio, M.-J., Gómez de Soler, B., Chacón, M.-G., Vaquero, M., 2020. Rebuilding the daily scenario of Neanderthal settlement. *J. Archaeol. Sci. Rep.* 29, 102139.
- Barkai, R., Lemorini, C., Vaquero, M. (Eds.), 2015. The origins of recycling: a paleolithic perspective. *Quat. Int.* 361, 1–342.
- Bar-Matthews, M., Ayalon, A., 2003. Climatic conditions in the Eastern Mediterranean during the Last Glacial (60–10 ky) and their relations to the Upper Palaeolithic in the Levant as inferred from oxygen and carbon isotope systematics of cave deposits. In: Goring-Morris, A.N., Belfer-Cohen, A. (Eds.), *More Than Meets the Eye: Studies on Upper Palaeolithic Diversity*. Oxbow Press, Oxford, pp. 13–18.
- Barroso Ruíz, C. (Ed.), 2003. El Pleistoceno Superior de la Cueva del Boquete de Zafarraya. *Arqueología. Serie Monografías. vol. 15. Consejería de Cultura, Junta de Andalucía*.
- Barroso Ruíz, C., Botella Ortega, D., Caparrós, M., Moigne, A.M., Celiberti, V., Testu, A., Barsky, D., Notter, O., Riquelme Cantal, J.A., Pozo Rodríguez, M., Carretero León, M.I., Monge Gómez, G., Khatib, S., Saos, T., Grégoire, S., Bailón, S., García Solano, J.A., Cabral Mesa, A.L., Djerrab, A., Hedley, I.G., Abdessadok, S., Batalla Llasat, G., Astier, N., Bertin, L., Boulbes, N., Cauche, D., Filoux, A., Hanquet, C., Milizia, C., Moutoussamy, J., Rossoni, E., Verdú Bermejo, L., de Lumley, H., 2011. The Cueva del Ángel (Lucena, Spain): an Acheulean hunters habitat in the South of the Iberian Peninsula. *Quat. Int.* 243, 105–126.
- Barroso Ruíz, C., Caparrós, M., Barsky, D., Moigne, A.M., Monclova, A., 2014. Boquete de Zafarraya cave: a Neanderthal site in southern Iberia. In: Sala, R. (Ed.), *Pleistocene and Holocene Hunter-Gatherers in Iberia and the Gibraltar Strait: The Current Archaeological Record*. Fundación Atapuerca. Universidad de Burgos, pp. 463–472.
- Barton, C.M., Riel-Salvatore, J., Anderies, J.M., Popescu, G., 2011. Modeling human ecodynamics and biocultural interactions in the Late Pleistocene of Western Eurasia. *Hum. Ecol.* 39, 705–725.
- Bar-Yosef, O., Van Peer, P., 2009. The *Chaîne Opératoire* approach in Middle Paleolithic Archaeology. *Curr. Anthropol.* 50, 103–131.
- Baumann, M., Plisson, H., Rendu, W., Maury, S., Kolobova, K., Krivosheina, A., 2020. The Neanderthal bone industry at Chagyrskaya cave, Altai Region, Russia. *Quat. Int.* 559, 68–88.
- Benedetti, M.M., Haws, J.A., Bicho, N.F., Friedl, L., Ellwood, B.B., 2019. Late Pleistocene site formation and paleoclimate at Lapa do Picareiro, Portugal. *Geoarchaeology* 34, 698–726.
- Berruti, G.L.F., Bianchi, E., Daffara, S., Gomes, M., Ceresa Genet, A.J., Fontana, F., Arzarello, M., Peretto, C., 2020. The use of blades and pointed tools during middle palaeolithic, the example of Riparo Tagliente (VR). *Quat. Int.* 554, 45–59.
- Beyries, S., 1988. Functional variability of lithic sets in the Middle Palaeolithic. In: Dibble, H.L., Montet-White, A. (Eds.), *Upper Pleistocene Prehistory of Western Eurasia*. University Museum Monograph 54, The University Museum, University of Pennsylvania, Philadelphia, pp. 213–225.
- Bietti, A., Cancellieri, E., Corinaldesi, C., Grimaldi, S., Spinapolice, E., 2009–2010. La percussion sur enclume en Italie centrale tyrrhénienne. In: Mourre, V., Jarry, M. (Eds.), *Entre le marteau et l'enclume. Proceedings of the Round Table. Paléo, Numéro Spécial*, pp. 143–180.
- Binford, L.R., 1973. Interassemblage variability: the Mousterian and the "functional" argument. In: Renfrew, C. (Ed.), *The Explanation of Culture Change: Models in Prehistory*. Duckworth, London, pp. 227–254.
- Binford, L.R., 1979. Organization and formation processes: looking at curated technologies. *J. Anthropol. Res.* 35, 255–273.
- Blanc, A.C., 1937. Nuovi giacimenti paleolitici del Lazio e della Toscana. *Studi Etruschi* XI, pp. 273–304.
- Blasco, R., Rosell, J., Rufà, A., Sánchez Marco, A., Finlayson, C., 2016. Pigeons and choughs, a usual resource for the Neanderthals in Gibraltar. *Quat. Int.* 421, 62–77.
- Bodu, P., Salomon, H., Leroyer, M., Naton, H.-G., Lacarrière, J., Dessoles, M., 2014. An open-air site from the recent Middle Palaeolithic in the Paris Basin (France): Les Bossats at Ormesson (Seine-et-Marne). *Quat. Int.* 331, 39–59.
- Boëda, E., 1991. Approche de la variabilité des systèmes de production lithique des industries du Paléolithique inférieur et moyen: chronique d'une variabilité attendue. *Tech. Cult.* 17–18, 37–79.
- Boëda, E., 2021. Le phénomène technique en préhistoire: une réflexion épistémologique à partir et autour du Levallois. In: *L'Harmattan, Cahiers d'Anthropologie des Techniques* 4, Paris.
- Boëda, E., Geneste, J.-M., Meignen, L., 1990. Identification de chaînes opératoires lithiques du Paléolithique ancien et moyen. *Paléo* 2, 43–80.
- Boëda, E., Bonilauri, S., Connan, J., Jarvie, D., Mercier, N., Tobey, M., Valladas, H., al Sakhel, H., 2008. New evidence for significant use of bitumen in Middle Paleolithic technical systems at Umm el Tlel (Syria) around 70,000 BP. *Paléorient* 34, 67–83.

- Boëda, E., Bonilauri, S., Kaltnecker, E., Valladas, H., Al-Sakhel, H., 2015. Un débitage lamellaire au Proche-Orient vers 40 000 ans cal BP. Le site d'Umm el Tlel, Syrie centrale. *L'Anthropologie* 119, 141–169.
- Böhner, U., 2009. Sesselfelsgrötte IV. Die Schicht E3 der Sesselfelsgrötte und die Funde aus dem Abri I am Schulerloch. Späte Micoquien-Inventare und ihre Stellung zum Moustérien. Franz Steiner Verlag, Stuttgart.
- Böhner, U., 2012. Silex-Rohmaterialien in Bayern. In: Floss, H. (Ed.), *Steinartefakte—vom Altpaläolithikum bis in die Neuzeit*. Kerns, Tübingen, pp. 79–91.
- Boismier, W., Gamble, C., Coward, F., 2012. Neanderthals Among Mammoths. Excavations at Lynford Quarry. English Heritage, Norfolk.
- Bonilauri, S., 2015. Le débitage Levallois: un concept de préhension normalisé et varié? Exemples de productions levalloiso-moustériennes issues du site d'Umm el Tlel, Syrie centrale. *Paléorient* 41, 83–115.
- Bonilauri, S., Boëda, E., Griggo, C., Al-Sakhel, H., Muhesen, S., 2007. Un éclat de silex moustérien coincé dans un bassin d'autruche (*Struthio camelus*) à Umm el Tlel (Syrie centrale). *Paléorient* 33, 39–46.
- Bordes, F., 1953. Essai de classification des industries "moustériennes". *Bull. Soc. Préhist. Fr.* 50, 457–467.
- Bordes, F., 1961. *Typologie du Paléolithique Ancien et Moyen*. Institut de Préhistoire, Bordeaux.
- Bordes, F., 1984. Leçons sur le Paléolithique. In: Tome 2: le Paléolithique en Europe. Editions du CNRS, Paris.
- Bosinski, G., 1967. Die Mittelpaläolithischen Funde im Westlichen Mitteleuropa. In: *Fundamenta A/4*. Böhlau-Verlag, Köln, Graz.
- Bosinski, G., 1968. Zum Verhältnis von Jungacheuleen und Micoquien in Mitteleuropa. In: Piveteau, J. (Ed.), *La Préhistoire: Problèmes et Tendances*. Éditions du CNRS, Paris, pp. 77–86.
- Bourguignon, L., Faivre, J.-P., Turq, A., 2004. Ramification des chaînes opératoires: une spécificité du Moustérien? *Paléo* 16, 37–48.
- Bourguignon, L., Delagnes, A., Meignen, L., 2006. Systèmes de production lithique, gestion des outillages et territoires au Paléolithique moyen: où se trouve la complexité? In: Astruc, L., Bon, F., Léa, V., Milcent, P.-Y., Philibert, S. (Eds.), *Normes techniques et pratiques sociales. De la simplicité des outillages pré- et protohistoriques. Actes des XXVI Rencontres d'Archéologie et d'Histoire d'Antibes*. APDCA, pp. 75–86.
- Bretzke, K., Kandel, A.W., Conard, N.J., 2016. The Middle Paleolithic sequence of Wadi Mushkuna Rockshelter and its implications for hominin settlement dynamics in western Syria. *Quat. Int.* 435, 106–114.
- Burkert, W., 2012. Silex-Rohmaterialien in Baden-Württemberg. In: Floss, H. (Ed.), *Steinartefakte—vom Altpaläolithikum bis in die Neuzeit*. Kerns, Tübingen, pp. 63–78.
- Bustos-Pérez, G., Chacón, M.G., Rivals, F., Blasco, R., Rosell, J., 2017. Quantitative and qualitative analysis for the study of Middle Paleolithic retouched artifacts: unit III of Teixoneres cave (Barcelona, Spain). *J. Archaeol. Sci. Rep.* 12, 658–672.
- Campan, I., Hahn, J., 1973. Eine Grabung auf dem mittelpaläolithischen Fundplatz Rörshain, Gemeinde Schwalmstadt, Kreis Ziegenhain. *Fundber. Hessen* 13, 75–86.
- Carmignani, L., 2010. L'industria litica del livello FIIIc di Grotta del Cavallo (Nardò, Lecce): osservazioni su una produzione laminolamellare in un contesto del Musteriano finale. *Origini* 32, 7–26.
- Carmignani, L., 2017. Between the flake and the blade: associated systems of production at Riparo Tagliente (Veneto, norther Italy). *J. Lithic Stud.* 4. <https://doi.org/10.2218/jls.v4i1.1842>.
- Carmignani, L., Romagnoli, F., 2017a. Revisione dell'industria litica musteriana di Grotta Mario Bernardini (Nardò, Lecce). In: Radina, F. (Ed.), *Preistoria e Protostoria della Puglia. Studi di Preistoria e Protostoria* 4, pp. 139–144.
- Carmignani, L., Romagnoli, F., 2017b. Grotta del Cavallo: problemi di terminologia e di definizione intorno al concetto di laminarità. In: Radina, F. (Ed.), *Preistoria e Protostoria della Puglia. Studi di Preistoria e Protostoria* 4, pp. 657–661.
- Carmignani, L., Moncel, M.H., Fernandes, P., Wilson, L., 2017. Technological variability during the Early Middle Palaeolithic in Western Europe. Reduction systems and predetermined products at the Bau de l'Aubesier and Payre (South-East France). *PLoS ONE* 12 (6), e0178550.
- Carrion Santafé, E., Baena, J., Conde, C., Cuartero, F., Roca, M., 2008. Variabilidad tecnológica en el musteriense de Cantabria. *Treballs d'Arqueologia* 14, 279–318.
- Casanova, J., Martínez, J., Mora, R., De la Torre, I., 2009. Stratégies techniques dans le Paléolithique Moyen du sud-est des Pyrénées. *L'Anthropologie* 113 (2), 313–340.
- Cauche, D., 2007. Les cultures moustériennes en Ligurie italienne: analyse du matériel lithique de trois sites en grotte. *L'Anthropologie* 111, 254–289.
- Chabai, V.P., 2006. The Western Crimean Mousterian and Micoquian at Kabazi II, Units A, II, IIA and III: environment, chronology and artifacts. In: Chabai, V., Richter, J., Uthmeier, T. (Eds.), *Kabazi II: The 70000 Years Since the Last Interglacial. Palaeolithic Sites of Crimea 2*. Shlyakh, Simferopol - Cologne, pp. 1–36.
- Chabai, V.P., 2012. The fate of the last Eastern European Neanderthals. *Arkheologia* 3, 5–26 (in Ukrainian).
- Chabai, V.P., 2013. The Crimean Micoquian: the reasons for typological variability. In: Molodin, V.I., Shumnikov, M.V. (Eds.), *Basic Issues in Archaeology, Anthropology and Ethnography of Eurasia*. Institute of Archaeology and Ethnography, Novosibirsk, pp. 118–141 (in Russian).
- Chabai, V.P., Uthmeier, T., 2006. Settlement Systems in the Crimean Middle Palaeolithic. In: Chabai, V.P., Richter, J., Uthmeier, T. (Eds.), *Kabazi II: 70000 Years Since the Last Interglacial. Palaeolithic Sites of Crimea 2*, Shlyakh, Simferopol – Cologne, pp. 297–359.
- Chabai, V.P., Marks, A.E., Monigal, K., 2004. Crimea in the context of the eastern European Middle Paleolithic and Early Upper Paleolithic. In: Chabai, V., Monigal, K., Marks, A. (Eds.), *The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea 3. Études et Recherches Archéologiques de L'Université de Liège*, vol. 104, pp. 419–460.
- Chabai, V.P., Richter, J., Uthmeier, T. (Eds.), 2005. *Kabazi II: Last Interglacial Occupations, Environment & Subsistence. Palaeolithic Sites of Crimea I*. Shlyakh, Simferopol – Cologne.
- Chabai, V.P., Richter, J., Uthmeier, T. (Eds.), 2007. *Kabazi V: Interstratification of Micoquian and Levallois-Mousterian Camp Sites 3/1*. Shlyakh, Simferopol – Cologne.
- Chabai, V.P., Richter, J., Uthmeier, T. (Eds.), 2008. *Kabazi V: Interstratification of Micoquian and Levallois-Mousterian Camp Sites 3/2*. Shlyakh, Simferopol – Cologne.
- Chacón, M.G., Fernández-Laso, M., García-Antón, D., Allué, E., 2007. Level K and L from Abric Romaní (Barcelona, Spain): procurement resources and territorial management in short occupations during the Middle Paleolithic. In: Moncel, M.-H., Arzarello, M., Moigne, A.M., Peretto, C. (Eds.), *Aires d'approvisionnement en matières premières et aires d'approvisionnement en ressources alimentaires: approche intégrée des comportements*. BAR International Series S1725, Oxford, pp. 187–197.

- Chacón, M.G., Bargalló, A., Gómez de Soler, B., Picin, A., Vaquero, M., Carbonell, E., 2013. Continuity or discontinuity of Neanderthal technological behaviours during Mis 3: level M and level O of the Abric Romaní site (Capellades, Spain). In: Pastoors, A., Auffermanns, B. (Eds.), *Pleistocene Foragers on the Iberian Peninsula: Their Culture and Environment. Festschrift in Honour of Gerd-Christian Weniger for His Sixtieth Birthday. Wissenschaftliche Schriften des Neanderthal Museum 7*, Mettmann, pp. 55–84.
- Chmielewski, W., 1969. Ensembles Micoquo-Prondniens en Europe Centrale. *Geogr. Pol.* 17, 371–386.
- Chmielewski, W., Betley-Konecka, K., Madeyska, T., 1977. Palaeolithic Site Kraków-Zwierzyńiec I in the Light of Investigations 1972-1974. *Buletyn Inst. Geol.* 305, 13–30.
- Claud, É., Soressi, M., Jaubert, J., Hublin, J.-J., 2012. Étude tracéologique de l'outillage moustérien de type Quina du bonebed de Chez-Pinaud à Jonzac (Charente-Maritime). *Nouveaux éléments en faveur d'un site de boucherie et de traitement des peaux. Gallia Préhistoire* 54, 3–32.
- Claud, É., Deschamps, M., Colonge, D., Mourre, V., Thiébaud, C., 2015. Experimental and functional analysis of late Middle Paleolithic flake cleavers from southwestern Europe (France and Spain). *J. Archaeol. Sci.* 62, 105–127.
- Claud, E., Thiébaud, C., Deschamps, M., Coudenneau, A., Lemorini, C., Mourre, V., Venditti, F., 2019. Les études tracéologiques sur les industries lithiques. *Paléolithique* 10, 296–327.
- Cliquet, D., Lautridou, J.-P., 1988. Le Moustérien à petits bifaces dominants de Saint-Julien de la Liègue (Eure). *Rev. Archeol. Picardie* 1, 175–185.
- Cliquet, D., Mercier, N., Lautridou, J.-P., Alix, P., Beugnier, V., Bianchini, R., Caspar, J.-P., Coutard, S., Lasseur, E., Lorren, P., Gosselin, R., Rivard, J.-J., Valladas, H., 2009. Un atelier de production et de consommation d'outils bifaciaux de la fin du Paléolithique moyen à Saint-Brice-sous-Rânes (Orne, France) dans son contexte environnemental. *Quaternaire*, 361–379.
- Colleoni, F., Wekerle, C., Näslund, J.-O., Brandefelt, J., Masina, S., 2016. Constraint on the penultimate glacial maximum northern hemisphere ice topography (≈ 140 kyrs BP). *Quat. Sci. Rev.* 137, 97–112.
- Collina, C., Marciani, G., Martini, I., Donadio, C., Repola, L., Bortolini, E., Arrighi, S., Badino, F., Figus, C., Lugli, F., Oxilia, G., Romandini, M., Silvestrini, S., Piperno, M., Benazzi, S., 2020. Refining the Uluzzian through a new lithic assemblage from Rocca San Sebastiano. *Quat. Int.* 551, 150–168.
- Combiér, J., 1967. Le Paléolithique de l'Ardèche dans son cadre paléoclimatique. *Imprimeries Delmas, Bordeaux*.
- Conard, N.J., 1992. Tönchesberg and its position in the Paleolithic prehistory of Northern Europe. In: *Monographien des Römisch-Germanischen Zentralmuseums, Band 20*. Dr. Rudolf Habelt GmbH, Bonn.
- Conard, N.J., Schmid, V.C., Bolus, M., Will, M., 2019. Lithic assemblages from the Middle Paleolithic of Geißenklösterle Cave provide insights on Neanderthal behavior in the Swabian Jura. *Quartär* 66, 51–80.
- Cortés-Sánchez, M., Gibaja Bao, J.F., Simón-Vallejo, M.D., 2011. Level 14 of Cueva Bajondillo and the end of the Middle Palaeolithic in the south of Iberian Peninsula (Málaga, Spain). In: Conard, N.J., Richter, J. (Eds.), *Neanderthal Lifeways, Subsistence and Technology. One Hundred Fifty Years of Neanderthal Study. Springer, Vertebrate Paleobiology and Paleoanthropology Series*, pp. 241–248.
- Crew, H.L., 1976. The Mousterian site of Rosh Ein Mor. In: Marks, A.E. (Ed.), *Prehistory and Paleoenvironments in the Central Negev, Israel. Vol I: The Avdat/Aqev Area, Part 1*. SMU Press, Dallas, pp. 75–112.
- Cunha, P.P., Martins, A.A., Buylaert, J.-P., Murray, A.S., Gouveia, M.P., Font, E., Pereira, T., Figueiredo, S., Ferreira, C., Bridgland, D.R., Yang, P., Stevaux, J.C., Mota, R., 2019. The lowermost Tejo River terrace at Foz do Enxarrique, Portugal: a palaeoenvironmental archive from c. 60–35 ka and its implications for the last Neanderthals in westernmost Iberia. *Quaternary* 2, 3.
- Cyrek, K., Sudot, M., Czyżewski, Ł., Osipowicz, G., Grelowska, M., 2014. Middle Palaeolithic cultural levels from Middle and Late Pleistocene sediments of Biśnik Cave, Poland. *Quat. Int.* 326–327, 20–63.
- Daujeard, C., Vettese, D., Britton, K., Béarez, P., Boulbes, N., Crégut-Bonnoure, E., Desclaux, E., Lateur, N., Pike-Tay, A., Rivals, F., Allué, E., Chacón, M.G., Courty, M.-A., Gallotti, R., Hardy, B., Puaud, S., Moncel, M.-H., 2019. Neanderthal selective hunting of reindeer in the Upper Pleistocene of Western Europe: the example of Abri du Maras (Southeastern France, Level 4.1, MIS 3). *Anthropol. Archaeol. Sci.* 11, 985–1011.
- Daura, J., Sanz, M., Pike, A.W.G., Subirà, M.E., Fornós, J.J., Fullola, J.M., Julià, R., Zilhão, J., 2010. Stratigraphic context and direct dating of the Neanderthal mandible from Cova del Gegant (Sitges, Barcelona). *J. Hum. Evol.* 59 (1), 109–122.
- Daura, J., Sanz, M., Allué, E., Vaquero, M., López-García, J.M., Sánchez-Marco, A., Domènech, R., Martinell, J., Carrión, J.S., Ortiz, J.E., Torres, T., Arnold, L.J., Benson, A., Hoffmann, D.L., Skinner, A.R., Julià, R., 2017. Palaeoenvironments of the last Neanderthals in SW Europe (MIS 3): Cova del Coll Verdaguier (Barcelona, NE of Iberian Peninsula). *Quat. Sci. Rev.* 177, 34–56.
- de Lombera Hermida, A., 2020. Gestión de materiales silíceos macrocristalinos en el Pleistoceno de Europa occidental. Evolución de las estrategias de adaptación a los condicionantes litológicos (Ph.D. dissertation). vol. 2 Universidade de Santiago de Compostela.
- Defleur, A., 2015. Les industries lithiques moustériennes de la Baume Moula-Guercy (Soyons, Ardèche). *Fouilles 1993–1999. L'Anthropologie* 119 (2), 170–253.
- Defleur, A., Bez, J.F., Crégut-Bonnoure, E., Fontugne, M., Jeannet, M., 1994. Industries, biostratigraphie, restes humains et datation du gisement moustérien de la Baume Néron (Soyons, Ardèche). *C. R. Acad. Sci. Sér. 2 Sci. Terre Planets* 318 (10), 1409–1414.
- Delagnes, A., 1993. Un mode de production inédit au Paléolithique moyen dans l'industrie du niveau 6e du Pucueil (Seine-Maritime). *Paléo* 5, 111–120.
- Delagnes, A., Rendu, W., 2011. Shifts in Neanderthal mobility, technology and subsistence strategies in western France. *J. Archaeol. Sci.* 38, 1771–1783.
- Delagnes, A., Jaubert, J., Meignen, L., 2007. Les techno-complexes du Paléolithique moyen en Europe occidentale dans leur cadre diachronique et géographique. In: Vanderersch, B., Maureille, B. (Eds.), *Les Néandertaliens. Biologie et culture*. Editions du CTHS, Paris, pp. 213–229.
- Delpiano, D., Peresani, M., 2017. Exploring Neanderthal skills and lithic economy. The implication of a refitted Discoid reduction sequence reconstructed using 3D virtual analysis. *C. R. Palevol* 16, 865–877.
- Delpiano, D., Uthmeier, T., 2020. Techno-functional and 3D shape analysis applied for investigating the variability of backed tools in the Late Middle Paleolithic of Central Europe. *PLoS ONE* 15, e0236548.
- Delpiano, D., Heasley, K., Peresani, M., 2018. Assessing Neanderthal land use and lithic raw material management in Discoid technology. *J. Anthropol. Sci.* 96, 89–110.

- Delpiano, D., Zupancich, A., Peresani, M., 2019. Innovative Neanderthals: results from an integrated analytical approach applied to backed stone tools. *J. Archaeol. Sci.* 110, 105011.
- Demidenko, Y.E., Otte, M., Noiret, P. (Eds.), 2012. *Siuren I rock-shelter. From Late Middle Paleolithic and Early Upper Paleolithic to Epi-Paleolithic in Crimea*. 129. *Études et Recherches Archéologiques de L'Université de Liège*.
- Dendy, S., Austermann, J., Creveling, J.R., Mitrovica, J.X., 2017. Sensitivity of Last Interglacial sea-level high stands to ice sheet configuration during Marine Isotope Stage 6. *Quat. Sci. Rev.* 171, 234–244.
- Derevianko, A.P., Petrin, V.T., Rybin, E.P., 2000. The Kara-Bom site and the characteristics of the Middle-Upper Paleolithic transition in the Altai. *Archaeol. Ethnol. Anthropol. Eurasia* 2, 33–52.
- Derevianko, A.P., Shunkov, M.V., Agajanian, A.K., Baryshnikov, G.F., Malaeva, E.M., Uliyanov, V.A., Kulik, N.A., Postnov, A.V., Anokin, A.A., 2003. Paleoenvironment and Paleolithic Human Occupation of Gorny Altai. Institute of Archaeology and Ethnography, Siberian Branch of the Russian Academy of Sciences, Novosibirsk.
- Derevianko, A.P., Markin, S.V., Kulik, N.A., Kolobova, K.A., 2015. Lithic raw material exploitation in the Sibiryachikha facies, the Middle Paleolithic of Altai. *Archaeol. Ethnol. Anthropol. Eurasia* 43 (3), 3–16.
- Derevianko, A.P., Markin, S.V., Kolobova, K.A., Chabai, V.P., Rudaya, N.A., Viola, B., Buzhilova, A.P., Mednikova, M.B., Vasiliev, S.K., Zykina, V.S., Zykin, V.S., Zazhigin, V.S., Volvakh, A.O., Roberts, R.G., Jacobs, Z., Li, B., 2018. Multidisciplinary Studies of Chagyrskaya Cave—A Middle Paleolithic Site in Altai. Institute of Archaeology and Ethnography, Siberian Branch of the Russian Academy of Sciences, Novosibirsk (in Russian).
- Deschamps, M., 2017. Late Middle Palaeolithic assemblages with flake cleavers in the western Pyrenees: the Vasconian reconsidered. *Quat. Int.* 433, 33–49.
- Deschamps, M., Flas, D., 2019. Late Middle Paleolithic and Early Upper Paleolithic in Pyrenean context: lithic industries from Gatzarria cave (Ossas-Suhare, Pyrénées-Atlantiques) and their regional implications. In: Deschamps, M., Costamagno, S., Milcent, P.-Y., Pétilion, J.-M., Renard, C., Valdeyron, N. (Eds.), *La conquête de la montagne: des premières occupations humaines à l'anthropisation du milieu*. Éditions du CTHS, Paris, pp. 1–25.
- Di Modica, K., 2010. Les productions lithiques du Paléolithique moyen de Belgique: variabilité des systèmes d'acquisition et des technologies en réponse à une mosaïque d'environnements contrastés (Ph.D. thesis). Museum national d'histoire naturelle Paris & Université de Liège.
- Di Modica, K., Toussaint, M., Abrams, G., Pirson, S., 2016. The Middle Palaeolithic from Belgium: chronostratigraphy, territorial management and culture on a mosaic of contrasting environments. *Quat. Int.* 411, 77–106.
- Dibble, H.L., Bar-Yosef, O., 1995. *The Definition and Interpretation of Levallois Technology*. Prehistory Press, Madison.
- Dibble, H., McPherron, S., 2006. The missing Mousterian. *Curr. Anthropol.* 47, 777–803.
- Dobosi, V.T., 2011. Obsidian use in the Palaeolithic in Hungary and adjoining areas. *Nat. Resource Environ. Hum.* 1, 83–95.
- Dogandžić, T., Đuričić, L., 2017. Lithic production strategies in the Middle Paleolithic of the southern Balkans. *Quat. Int.* 450, 68–102.
- Douka, K., Grimaldi, S., Boschian, G., del Lucchese, A., Higham, T.F.G., 2012. A new chronostratigraphic framework for the Upper Palaeolithic of Riparo Mochi (Italy). *J. Hum. Evol.* 62, 286–299.
- Douka, K., Higham, T.F.G., Wood, R., Boscato, P., Gambassini, P., Karkanas, P., Peresani, M., Ronchitelli, A.M., 2014. On the chronology of the Uluzzian. *J. Hum. Evol.* 68, 1–13.
- Duran, J., Soler, N., 2006. Variabilité des modalités de débitage et des productions lithiques dans les industries moustériennes de la grotte de l'Arbreda, secteur alpha (Serinyà, Espagne). *Bull. Soc. Préhist. Fr.* 103, 241–262.
- Đuričić, L., 2006. A contribution to research on Bioče Mousterian. *Glas. Srp. Arheol. Društva* 22, 179–196.
- Eixea, A., 2018. Middle palaeolithic lithic assemblages in western Mediterranean Europe from MIS 5 to 3. *J. Archaeol. Sci. Rep.* 21, 643–666.
- Eixea, A., Villaverde, V., Roldán, C., Zilhão, J., 2014. Middle Palaeolithic flint procurement in central Mediterranean Iberia: implications for human mobility. *J. Lithic Stud.* 1, 103–115.
- Eixea, A., Villaverde, V., Zilhão, J., 2016. Not only flint: Levallois on quartzite and limestone at Abrigo de la Quebrada (Valencia, Spain). Implications for Neanderthal Behavior. *J. Anthropol. Res.* 72, 24–57.
- Eixea, A., Villaverde, V., Zilhão, J., 2018. L'évolution des assemblages lithiques des niveaux du Paléolithique moyen de l'Abrigo de la Quebrada (Valencia, Espagne). *L'Anthropologie* 122 (4), 654–678.
- Eixea, A., Oltra, I., Bergadà, M., Villaverde, V., 2020a. The reinterpretation of the Cova Negra archaeological and stratigraphical sequence and its implications in the understanding of the Middle Palaeolithic Iberian Peninsula. *Quat. Int.* 566–567, 98–112.
- Eixea, A., Chacón, M.G., Bargalló, A., Sanchis, A., Romagnoli, F., Vaquero, M., Villaverde, V., 2020b. Neanderthal spatial patterns and occupation dynamics: a focus on the central region in Mediterranean Iberia. *J. World Prehist.* 33, 267–324.
- Ekshtain, R., Barzilai, O., Inbar, M., Milevski, I., Ullman, M., 2012. Giv'at Rabi East: a new Middle Paleolithic knapping site in the Lower Galilee, Israel. *Paléorient* 37, 107–122.
- Ekshtain, R., Malinsky-Buller, A., Ilani, S., Segal, I., Hovers, E., 2014. Raw material exploitation around the Middle Paleolithic site of 'Ein Qashish. *Quat. Int.* 331, 248–266.
- Ekshtain, R., Ilani, S., Segal, I., Hovers, E., 2017. Local and nonlocal procurement of raw material in Amud Cave, Israel: the complex mobility of late middle paleolithic Groups. *Geoarchaeology* 32, 189–214.
- Ekshtain, R., Malinsky-Buller, A., Greenbaum, N., Mitki, N., Stahlschmidt, M.C., Shahack-Gross, R., Nir, N., Porat, N., Bar-Yosef Mayer, D.E., Yeshurun, R., Been, E., Rak, Y., Agha, N., Brailovsky, L., Krakovsky, M., Spivak, P., Ullman, M., Vered, A., Barzilai, O., Hovers, E., 2019. Persistent Neanderthal occupation of the open-air site of 'Ein Qashish, Israel. *PLoS ONE* 14, e0215668.
- Faivre, J.-P., Discamps, E., Gravina, B., Turq, A., Guadelli, J.-L., Lenoir, M., 2014. The contribution of lithic production systems to the interpretation of Mousterian industrial variability in south-western France: the example of Combe-Grenal (Dordogne, France). *Quat. Int.* 350, 227–240.
- Faivre, J.-P., Gravina, B., Bourguignon, L., Discamps, E., Turq, A., 2017. Late Middle Palaeolithic lithic technocomplexes (MIS 5–3) in the northeastern Aquitaine Basin: advances and challenges. *Quat. Int.* 433 (Part B), 116–131.
- Falguères, C., Ghaleb, B., Tombret, O., Ben Arous, E., Richard, M., Moigne, A.M., Saos, T., Frouin, M., Caparros, M., Barroso-Ruiz, C., 2019. ESR/U-series dates on *Equus* teeth from the Middle Pleistocene Acheulean site of Cueva del Angel, Spain. *Quat. Geochronol.* 49, 297–302.
- Féblot-Augustins, J., 1997. *La circulation des matières premières au Paléolithique. Synthèse des données, perspectives comportementales*. vol. 2 *Études et Recherches Archéologiques de l'Université de Liège*, 75, Liège.

- Féblot-Augustins, J., 1999. Raw material transport patterns and settlement systems in the European Lower and Middle Palaeolithic: continuity, change and variability. In: Roebroeks, W., Gamble, C. (Eds.), *The Middle Palaeolithic Occupation of Europe*. University of Leiden and European Science Foundation, pp. 193–214.
- Feray, P., Coutard, S., Créteur, Y., Debenham, N., Coquelle, B., Ladureau, P., 2013. Saint-Hilaire-sur-Helpe, Nord, la Grande Pièce, carrière des Ardennes: rapport de fouilles. (Rapport de fouilles).
- Fernandez, P., Legendre, S., 2003. Mortality curves for horses from the Middle Palaeolithic site of Bau de l'Aubesier (Vaucluse, France): methodological, palaeo-ethnological, and palaeo-ecological approaches. *J. Archaeol. Sci.* 30 (12), 1577–1598.
- Fernández Peris, J., Barciela, V., Blasco, R., Cuartero, F., Sañudo, P., 2008. El Paleolítico Medio en el territorio valenciano y la variabilidad tecno-económica de la Cova del Bolomor. *Treballs d'Arqueologia* 14, 141–169.
- Fernández-Peris, J., 2007. La cova de Bolomor (Tavernes de la Valldigna, Valencia). Las industrias líticas del Pleistoceno medio en el ámbito del Mediterráneo peninsular. *Trabajos Varios del S.I.P. 108* (Valencia).
- Fewlass, H., Talamo, S., Wacker, L., Kromer, B., Tuna, T., Fagault, Y., Bard, E., McPherron, S.P., Aldeias, V., Maria, R., Martisius, N.L., Paskulin, L., Rezek, Z., Sinet-Mathiot, V., Sirakova, S., Smith, G.M., Spasov, R., Welfer, F., Sirakov, N., Tsanova, T., Hublin, J.-J., 2020. A ¹⁴C chronology for the Middle to Upper Palaeolithic transition at Bacho Kiro Cave, Bulgaria. *Nat. Ecol. Evol.* 4, 794–801.
- Finkel, M., Gopher, A., Ben-Yosef, E., Barkai, R., 2018. A Middle Paleolithic and Neolithic/Chalcolithic flint extraction and reduction complex at Mt. Achbara, Eastern Galilee, Israel. *Archaeol. Res. Asia* 16, 14–33.
- Finlayson, C., Blasco, R., Rodríguez-Vidal, J., Giles Pacheco, F., Finlayson, G., Gutierrez, J.M., Jennings, R., Fa, D.A., Rosell, J., Carrión, J.S., Sánchez Marco, A., Finlayson, S., Bernal, M.A., 2014. Gibraltar excavations with particular reference to Gorham's and Vanguard Caves. In: Sala, R. (Ed.), *Pleistocene and Holocene Hunter-Gatherers in Iberia and the Gibraltar Strait: The Current Archaeological Record*. Fundación Atapuerca, Universidad de Burgos, pp. 506–514.
- Floss, H., 1994. Rohmaterialversorgung im Paläolithikum des Mittelrheingebietes. *Monographien des Römisch-Germanischen Zentralmuseums* 21. Habelt, Bonn.
- Floss, H., 2012. Lithische Rohmaterialien im Rheinland. In: Floss, H. (Ed.), *Steinartefakte—vom Altpaläolithikum bis in die Neuzeit*. Kerns, Tübingen, pp. 55–62.
- Fontana, F., Moncel, M.-H., Nenzioni, G., Onorevoli, G., Peretto, C., Combier, J., 2013. Widespread diffusion of technical innovations around 300,000 years ago in Europe as a reflection of anthropological and social transformations? New comparative data from the western Mediterranean sites of Orgnac (France) and Cave dall'Olio (Italy). *J. Anthropol. Archaeol.* 32, 478–498.
- Freund, G., 1963. Die ältere und mittlere Steinzeit in Bayern. *Jahresbericht der Bayerischen Bodendenkmalpflege* 4.
- Frick, J.A., 2020. Reflections on the term Micoquian in Western and Central Europe. Change in criteria, changed deductions, change in meaning, and its significance for current research. *Archaeol. Anthropol. Sci.* 12, 38.
- Friedman, E., Goren-Inbar, N., Rosenfeld, A., Marder, O., Burian, F., 1994. Hafting during mousterian times - further evidence. *J. Isr. Prehist. Soc.* 26, 8–31.
- Fu, Q., Li, H., Moorjani, P., Jay, F., Slepchenko, S.M., Bondarev, A.A., Johnson, P.L.F., Aximu-Petri, A., Prüfer, K., de Filippo, C., Meyer, M., Zwyns, N., Salazar-García, D.C., Kuzmin, Y.V., Keates, S.G., Kosintsev, P.A., Razhev, D.I., Richards, M.P., Peristov, N.V., Lachmann, M., Douka, K., Higham, T.F.G., Slatkin, M., Hublin, J.-J., Reich, D., Kelso, J., Viola, B.T.B., Pääbo, S., 2014. Genome sequence of a 45,000-year-old modern human from western Siberia. *Nature* 514, 445–449.
- Galván, B., Hernández Gómez, C.M., Francisco Ortega, M.I., 2008. Elementos Líticos Apuntados en el Musteriense Alcoyano El Abric Del Pastor (Alicante). *Veleia* 24–25, 367–383.
- Galway-Witham, J., Cole, J., Stringer, C., 2019. Aspects of human physical and behavioural evolution during the last 1 million years. *J. Quat. Sci.* 34, 355–378.
- García Moreno, A., Rios-Garaizar, J., Marín Arroyo, A.B., Ortíz, J.E., de Torres, T., López-Dóriga, I., 2014. La secuencia musteriana de la Cueva del Niño (Ayna, Albacete) y el poblamiento neandertal en el sureste de la Península Ibérica. *Trab. Prehist.* 72, 221–241.
- Gerasimenko, N.P., 2004. Vegetational history of Buran-Kaya III. In: Chabai, V., Monigal, K., Marks, A. (Eds.), *The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea 3. Études et Recherches Archéologiques de L'Université de Liège*. vol. 104, pp. 19–34.
- Gerasimenko, N.P., 2005. Vegetation evolution of the Kabazi II site. In: Chabai, V.P., Richter, J., Uthmeier, T. (Eds.), *Kabazi II: Last Interglacial Occupation, Environment & Subsistence. Palaeolithic Sites of Crimea*, vol. 1. Shlyakh, Simferopol - Cologne, pp. 25–49.
- Gerasimenko, N.P., 2007. Pollen study of Kabazi V. In: Chabai, V.P., Richter, J., Uthmeier, T. (Eds.), *Kabazi V: Interstratification of Micoquian and Levallois-Mousterian Camp Sites 3/1*. Shlyakh, Simferopol - Cologne, pp. 89–96.
- Gerasimenko, N., Haesaerts, P., Nigst, P., Liaschky, T., Kulakovska, L., Usik, V., 2016. The Late Pleistocene vegetational and climatic changes in the Middle Dniester area (Ukraine) based on the study of the Paleolithic sites Neporotovo VII and Doroshivtsi III. In: *Bridging Europe and Asia: Quaternary Stratigraphy and Paleolithic Human Occupation in Armenia and Southern Georgia*. Abstract Volume of the INQUA Section on European Stratigraphy Workshop, Yerevan (Armenia), pp. 38–39.
- Gilead, I., Grigson, G., 1984. Far'ah II: a Middle Palaeolithic open-air site in the Northern Negev, Israel. *Proc. Prehist. Soc.* 50, 71–91.
- Giraud, Y., Brugal, J.P., Jeannet, M., 1998. Un nouveau gisement mousterien en moyenne vallée du Rhône: la grotte Mandrin à Malataverne (Drôme). *Bull. Soc. Préhist. Fr.* 95 (1), 7–15.
- Glauberger, P., Gasparyan, B., Wilkinson, K., Frahm, E., Nahapetyan, S., Arakelyan, D., Raczynski-Henk, Y., Haydosyan, H., Adler, D.S., 2020. Late Middle Paleolithic technological organization and behavior at the open-air site of Barozh 12 (Armenia). *J. Paleolit. Archaeol.* 3, 1095–1148.
- Goder-Goldberger, M., Bar-Matthews, M., 2019. Novel chrono-cultural constraints for the Middle Paleolithic site of Rosh Ein Mor (D15), Israel. *J. Archaeol. Sci. Rep.* 24, 102–114.
- Goder-Goldberger, M., Crouvi, O., Caracuta, V., Kolska Horwitz, L., Neumann, F.H., Porat, N., Scott, L., Shavit, R., Jacoby-Glass, Y., Zilberman, T., Boaretto, E., 2020. The Middle to Upper Paleolithic transition in the southern Levant: new insights from the late Middle Paleolithic site of Far'ah II, Israel. *Quat. Sci. Rev.* 237, 106304.
- Golovanova, L.V., Doronichev, V.B., 2003. The middle paleolithic of the Caucasus. *J. World Prehist.* 17, 71–140.
- Gómez de Soler, B., Soto, M., Vallverdú, J., Vaquero, M., Bargalló, A., Chacón, M.G., Romagnoli, F., Eudald, C., 2020. Neanderthal lithic procurement and mobility patterns through a multi-level study in the Abric Romani site (Capellades, Spain). *Quat. Sci. Rev.* 237, 106315.

- Gómez-Olivencia, A., Sala, N., Núñez-Lahuerta, C., Sanchis, A., Arlegi, M., Rios-Garaizar, J., 2018. First data of Neandertal bird and carnivore exploitation in the Cantabrian Region (Axlor; Barandiaran excavations; Dima, Biscay, Northern Iberian Peninsula). *Sci. Rep.* 8, 10551.
- González-Molina, I., Jiménez-García, B., Mafillo-Fernández, J.-M., Baquedano, E., Domínguez-Rodrigo, M., 2020. Distinguishing Discoid and Centripetal Levallois methods through machine learning. *PLoS ONE* 15 (12), e0244288.
- Goren-Inbar, N., 1988. Too small to be true? Reevaluation of cores on flakes in Levantine Mousterian assemblages. *Lithic Technol.* 17, 37–44.
- Goren-Inbar, N., 1989. Typological characteristics of the Mousterian assemblage from Biq'at Quneitra. In: Bar-Yosef, O., Vandermeersch, B. (Eds.), *Investigations in South Levantine Prehistory*. BAR International Series 497, Oxford, pp. 125–146.
- Goren-Inbar, N., 1990a. The Lithic Assemblages. In: Goren-Inbar, N. (Ed.), *Quneitra - A Mousterian Site on the Golan Heights*. Institute of Archaeology, Jerusalem, pp. 61–167.
- Goren-Inbar, N., 1990b. The basalt component of the Mousterian assemblage from the Quneitra site (area A). *Cahiers du Quaternaire* 17, 581–584.
- Goring-Morris, A.N., Hovers, E., Belfer-Cohen, A., 2009. The dynamics of Pleistocene and early Holocene settlement patterns and human adaptations in the Levant—an overview. In: Shea, J.J., Lieberman, D.E. (Eds.), *Transitions in Prehistory: Essays in Honor of Ofer Bar-Yosef*. Oxbow Books for the American School of Prehistoric Research, Oxford, pp. 185–252.
- Goval, E., Hérissou, D. (Eds.), 2018. Les chasseurs des steppes durant le dernier glaciaire en France septentrionale. *Paléoenvironnement, techno-économie, approche fonctionnelles et spatiale du gisement d'Havrincourt*. Études et Recherches Archéologiques de l'Université de Liège.
- Goval, E., Hérissou, D., Claud, É., Loch, J., Antoine, P., Coutard, S., 2015. Hunting camp and the end of the Middle Paleolithic at Havrincourt "Les Bosquets" (Pas-de-Calais, France). In: Conard, N.J., Delagnes, A. (Eds.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age*. vol. IV. Tübingen Publications in Prehistory, Kerns Verlag, pp. 311–328.
- Gowlett, J.A.J., Carter, P.L., 1997. The basal Mousterian of Asprochaliko rockshelter, Louros Valley. In: Bailey, G. (Ed.), *Klithi: Palaeolithic Settlement and Quaternary Landscapes in Northwest Greece*. vol. 1. *Klithi in Its Local and Regional Setting*, McDonald Institute Monographs, pp. 441–458.
- Gravina, B., 2017. Intra-level technological change and its implications for Mousterian assemblage variability. The example of Le Moustier, layer G. *Quat. Int.* 433 (Part B), 132–139.
- Gravina, B., Discamps, E., 2015. MTA-B or not to be? Recycled bifaces and shifting hunting strategies at Le Moustier and their implication for the late Middle Palaeolithic in southwestern France. *J. Hum. Evol.* 84, 83–98.
- Green, R.E., Krause, J., Briggs, A.W., Maricic, T., Stenzel, U., et al., 2010. A draft sequence of the neandertal genome. *Science* 328, 710–722.
- Grimaldi, S., Lemorini, C., 1993. Retouche spécialisée et/ou chaîne de ravivage? Les "raclours" moustériens de Grotta Breuil (Monte Circeo, Italie). In: Anderson, P.C., Beyries, S., Otte, M., Plisson, H. (Eds.), *Traces et fonctions: les gestes retrouvés*. Colloque international de Liège. ERAUL 50, Liège, pp. 67–78.
- Gutiérrez-Zugasti, I., Rios-Garaizar, J., Marín-Arroyo, A.B., Rasines del Río, P., Maroto, J., Jones, J.R., Bailey, G.N., Richards, M.P., 2018. A chrono-cultural reassessment of the levels VI–XIV from El Cuco rock-shelter: a new sequence for the Late Middle Paleolithic in the Cantabrian region (northern Iberia). *Quat. Int.* 474, 44–55.
- Haesaerts, P., Borziak, I., Chirica, V., Damblon, F., Koulakovska, L., Van der Plicht, J., 2003. The East Carpathian Loess Record: a reference for the Middle and Late Pleniglacial stratigraphy in Central Europe. *Quaternaire* 14 (3), 163–188.
- Hardy, B.L., Moncel, M.-H., Daujeard, C., Fernandes, P., Béarez, P., Desclaux, E., Chacón Navarro, M.G., Puaud, S., Gallotti, R., 2013. Impossible Neanderthals? Making string, throwing projectiles and catching small game during Marine Isotope Stage 4 (Abri du Maras, France). *Quat. Sci. Rev.* 82, 23–40.
- Hardy, B.L., Moncel, M.-H., Kerfant, C., Lebon, M., Bellot-Gurlet, L., Mélard, N., 2020. Direct evidence of Neanderthal fibre technology and its cognitive and behavioral implications. *Sci. Rep.* 10, 4889.
- Harvati, K., Röding, C., Bosman, A.M., Karakostis, F.A., Grün, R., Stringer, C., Karkanas, P., Thompson, N.C., Koutoulidis, V., Mouloupoulos, L.A., Gorgoulis, V.G., Kouloukoussa, M., 2019. Apidima cave fossils provide earliest evidence of *Homo sapiens* in Eurasia. *Nature* 571, 500–504.
- Hauck, T.C., 2011. Mousterian technology and settlement dynamics in the site of Hummal (Syria). *J. Hum. Evol.* 61, 519–537.
- Hauck, T.C., Connan, J., Charrié-Duhaut, A., Le Tensorer, J.-M., al Sakhel, H., 2013. Molecular evidence of bitumen in the Mousterian lithic assemblage of Hummal (Central Syria). *J. Archaeol. Sci.* 40, 3252–3262.
- Haws, J.A., Benedetti, M.M., Talamo, S., Bicho, N., Cascalheira, J., Ellis, M.G., Carvalho, M.M., Friedl, L., Pereira, T., Zinsious, B.K., 2020. The early Aurignacian dispersal of modern humans into westernmost Eurasia. *Proc. Natl. Acad. Sci. U.S.A.* 117, 25414–25422.
- Hein, M., Weiss, M., Otcherednoy, A., Lauer, T., 2020. Luminescence chronology of the key-Middle Paleolithic site Khotylevo I (Western Russia). Implications for the timing of occupation, site formation and landscape evolution. *Quat. Sci. Adv.* 2, 100008.
- Henry, D.O., 2003. Human behavior and the stone tools from Tor Faraj, Neanderthals in the Levant: Behavioral Organization and the Beginnings of Human Modernity. *New Approaches to Anthropological Archaeology*, Continuum, London.
- Hérissou, D., Soriano, S., 2020. A view of the Lower to Middle Paleolithic boundary from Northern France, far from the Near East? *J. Hum. Evol.* 145, 102814.
- Hérissou, D., Brenet, M., Cliquet, D., Moncel, M.H., Richter, J., Scott, B., Baelen, A.V., Di Modica, K., de Loecker, D., Ashton, N., Bourguignon, L., Delagnes, A., Faivre, J.-P., Folgado-Lopez, M., Loch, J.-L., Pope, M., Raynal, J.P., Roebroeks, W., Santagata, C., Turq, A., Van Peer, P., 2016. The emergence of the Middle Palaeolithic in north-western Europe and its southern fringes. *Quat. Int.* 411, 233–283.
- Hershkovitz, I., Weber, G.W., Quam, R., Duval, M., Grün, R., Kinsley, L., Ayalon, A., Bar-Matthews, Valladas, H., Mercier, N., Arsuaga, J.L., Martínón-Torres, M., Bermúdez de Castro, J.M., Fornai, C., Martín-Francés, L., Sarig, R., May, H., Krenn, V.A., Slon, V., Rodríguez, L., García, R., Lorenzo, C., Carretero, J.M., Frumkin, A., Shahack-Gross, R., Bar-Yosef, D.E., Cui, Y., Wu, X., Peled, N., Groman-Yaroslavski, I., Weissbrod, L., Yeshurun, R., Tsatskin, A., Zaidner, Y., Weinstein-Evron, M., 2018. The earliest modern humans outside Africa. *Science* 359, 456–459.
- Hershkovitz, I., May, H., Sarig, R., Pokhraj, A., Grimaud-Hervé, D., Bruner, E., Fornai, C., Quam, R., Arsuaga, J.L., Krenn, V.A., Martínón-Torres, M., Bermúdez de Castro, J.M., Martín-Francés, L., Slon, V., Albessard-Ball, L., Viallet, A., Schüller, T., Manzi, G., Profico, A., Di Vincenzo, F., Weber, G.W., Zaidner, Y., 2021. A Middle Pleistocene *Homo* from Neshar Ramla, Israel. *Science* 372, 1424–1428.

- Higham, T., Douka, K., Wood, R., Bronk Ramsey, C., Brock, F., Basell, L., Camps, M., Arrizabalaga, A., Baena, J., Barroso-Ruiz, C., Bergman, C., Boitard, C., Boscato, P., Caparrós, M., Conard, N.J., Draily, C., Froment, A., Galván, B., Gambassini, P., García-Moreno, A., Grimaldi, S., Haesaerts, P., Holt, B., Iriarte-Chiapusso, M.J., Jelinek, A., Jordá Pardo, J.F., Mafillo-Fernández, J.M., Marom, A., Maroto, J., Menéndez, M., Metz, L., Morin, E., Moroni, A., Negrino, F., Panagopoulou, E., Peresani, M., Pirson, S., de la Rasilla, M., Riel-Salvatore, J., Ronchitelli, A., Santamaria, D., Semal, P., Slimak, L., Soler, J., Soler, N., Villaluenga, A., Pinhasi, R., Jacobi, R., 2014. The timing and spatiotemporal patterning of Neanderthal disappearance. *Nature* 512, 306–309.
- Holt, B., Negrino, F., Riel-Salvatore, J., Formicola, V., Arellano, A., Arobba, D., Boschian, G., Churchill, S.E., Cristiani, E., di Canzio, E., Vicino, G., 2019. The Middle-Upper Paleolithic transition in Northwest Italy: new evidences from Riparo Bombrini (Balzi Rossi, Liguria, Italy). *Quat. Int.* 508, 142–152.
- Hovers, E., 1990. The exploitation of raw material at the Mousterian site of Quneitra. In: Goren-Inbar, N. (Ed.), *Quneitra: A Mousterian Site on the Golan Heights*. Institute of Archaeology, Jerusalem, pp. 150–167.
- Hovers, E., 1998. The lithic assemblages of Amud Cave: implications for the end of the Mousterian in the Levant. In: Akazawa, T., Aoki, K., Bar-Yosef, O. (Eds.), *Neandertals and Modern Humans in Southwest Asia*. Plenum Press, New York, pp. 143–163.
- Hovers, E., 2001. Territorial behavior in the Middle Paleolithic of the Southern Levant. In: Conard, N. (Ed.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age*. Kerns Verlag, Tübingen, pp. 123–152.
- Hovers, E., 2006. Neandertals and Modern Humans in the Middle Paleolithic of the Levant: what kind of interaction? In: Conard, N. (Ed.), *When Neandertals and Modern Humans Met*. Kerns Verlag, Tübingen, pp. 65–86.
- Hovers, E., 2007. The many faces of cores-on-flakes: a perspective from the Levantine Mousterian. In: McPherron, S.P. (Ed.), *Cores vs Tools. Alternative Approaches to Stone Tool Analysis*. Cambridge Scholars Press, Newcastle, pp. 42–74.
- Hovers, E., 2009. *The Lithic Assemblages of Qafzeh Cave*. Oxford University Press, New York.
- Hovers, E., Belfer-Cohen, A., 2013. On variability and complexity: lessons from the Levantine Middle Paleolithic record. *Curr. Anthropol.* 54, S337–S357.
- Hovers, E., Belfer-Cohen, A., 2020. Are lithics and fauna a match made in (prehistoric) heaven? *J. Paleolit. Archaeol.* 3, 108–125.
- Hovers, E., Malinsky-Buller, A., Goder-Goldberger, M., Ekshtain, R., 2011. Capturing a moment: identifying short-lived activity locations in Amud Cave, Israel. In: Le Tensorer, J.-M., Jagher, R., Otte, M. (Eds.), *The Lower and Middle Palaeolithic in the Middle East and Neighbouring Regions. Proceedings of the Basel Symposium (mai 8-10 2008)*. ERAUL 126. University of Liège Press, Liège, pp. 101–114.
- Hublin, J.-J., Roebroeks, W., 2009. Ebb and flow or regional extinctions? On the character of Neandertal occupation of northern environments. *C. R. Palevol* 8, 503–509.
- Inizan, M.L., Roche, H., Tixier, J., 1992. *Technology of Knapping Stone*. CREP, Meudon.
- Jacobs, Z., Li, B., Shunkov, M.V., Kozlikin, M.B., Bolikhovskaya, N.S., Agadjanian, A.K., Uliyanov, V.A., Vasiliev, S.K., O’Gorman, K., Derevianko, A.P., Roberts, R.G., 2019. Timing of archaic hominin occupation of Denisova Cave in southern Siberia. *Nature* 565, 594–599.
- Jaubert, J., 2010. Les archéoséquences du Paléolithique moyen en Poitou-Charentes. In: Buisson-Catil, J., Primault, J. (Eds.), *Préhistoire entre Vienne et Charente, hommes et sociétés du Paléolithique*. Mémoire 38. Association des publications chauvinoises, Chauvigny, pp. 51–55.
- Jaubert, J., Bordes, J.G., Discamps, E., Gravina, B., 2011. A new look at the end of the middle Palaeolithic sequence in Southwestern France. In: Derevianko, A.P., Shunkov, M.V. (Eds.), *Characteristic Features of the Middle to Upper Paleolithic Transition in Eurasia*. Asian Palaeolithic Association, Novosibirsk, pp. 102–115.
- Jéquier, C., Peresani, M., Romandini, M., Delpiano, D., Joannes-Boyau, R., Lembo, G., Livraghi, A., López-García, J.M., Obradovic, M., Nicosia, C., 2015. The De Nadale Cave, a single layered Quina Mousterian site in the North of Italy. *Quartär* 62, 7–21.
- Jiménez-Arenas, J.M., Santonja, M., Botella, M., Palmqvist, P., 2011. The oldest handaxes in Europe: fact or artefact? *J. Archaeol. Sci.* 38, 3340–3349.
- Jöris, O., 2001. *Der Spätmittelpaläolithische Fundplatz Buhlen (Grabungen 1966–69)*. Stratigraphie, Steinartefakte und Fauna des oberen Fundplatzes. Universitätsforschungen zur Prähistorischen Archäologie 73, Habelt, Bonn.
- Jöris, O., 2004. Zur chronostratigraphischen Stellung der spätmittelpaläolithischen Keilmessergruppen: Der Versuch einer kulturgeographischen Abgrenzung einer mittelpaläolithischen Formengruppe in ihrem europäischen Kontext. *Bericht RGK*. vol. 84, pp. 49–153.
- Jöris, O., 2006. Bifacially backed knives (Keilmesser) in the central European Middle Palaeolithic. In: Goren-Inbar, N., Sharon, G. (Eds.), *Axe Age: Acheulian Tool-Making From Quarry to Discard*. Equinox Publishing Ltd, London, pp. 287–310.
- Jöris, O., 2012. Keilmesser. In: Floss, H. (Ed.), *Steinartefakte vom Altpaläolithikum bis in die Neuzeit*. Kerns Verlag, Tübingen, pp. 297–308.
- Jöris, O., 2014. Early Palaeolithic Europe. In: Renfrew, C., Bahn, P. (Eds.), *The Cambridge World Prehistory*. vol. III. University Press Cambridge, Cambridge, pp. 1703–1746.
- Jöris, O., Schunk, L., 2021. Händigkeit bei Neandertalern: Buhlen, Bocksteinschmiede, Balver Höhle/Handedness among Neandertals: Buhlen, Bocksteinschmiede, Balver Höhle. In: Gaudzinski-Windheuser, S., Jöris, O. (Eds.), *MONREPOS forscht. Römisch-Germanisches Zentralmuseum, Mainz*.
- Jöris, O., Uomini, N., 2019. Evidence for Neanderthal hand preferences from the late Middle Palaeolithic site of Buhlen, Germany: insights into Neanderthal learning behaviour. In: Nishiaki, Y., Jöris, O. (Eds.), *Learning Among Neandertals and Palaeolithic Modern Humans. Archaeological Evidence. Replacement of Neandertals by Modern Humans Series*. Springer Nature, Singapore, pp. 77–93.
- Jöris, O., Street, M., Terberger, T., Weninger, B., 2011. Radiocarbon dating the Middle to Upper Palaeolithic transition: the demise of the last Neandertals and the first appearance of anatomically modern humans in Europe. In: Condemi, S., Weniger, G.-C. (Eds.), *Continuity and Discontinuity in the Peopling of Europe: One Hundred Fifty Years of Neanderthal Study. Vertebrate Paleobiology and Paleoanthropology Series XXII*. Springer, New York, pp. 239–298.
- Kaminská, L. (Ed.), 2014. *Staré Slovensko 2. Paleolit a mezolit*. Archaeologica Slovaca Monographiae STASLO, Tomus 2. Archeologický ústav Slovenskej akadémie vied Nitra, Nitra.
- Karavanić, I., 2004. The Middle Paleolithic settlement of Croatia. In: Conard, N.J. (Ed.), *Settlement Dynamics of the Middle Palaeolithic and Middle Stone Age*. Tübingen Publications in Prehistory, Tübingen, Kerns Verlag, pp. 185–200.

- Karavanić, I., 2007. Le Moustérien en Croatie. *L'Anthropologie* 111 (3), 321–345.
- Karavanić, I., Kamenjarin, I. (Eds.), 2020. *Mujina Pećina. Geoarchaeology and lithic analysis.* Muzej Grada Kastela. FF-Press.
- Karavanić, I., Hellstrom, J., Rabeder, G., Vukosavljević, N., Banda, M., Smith, F.H., 2021. New U-Th Dates from Vindija, Velika pećina (Kličevica) and Mujina pećina and Their Implications for Chronology of the Middle Paleolithic in Croatia. *Coll. Antropol.* 1, 1–10.
- Kindler, L., Smith, G.M., García-Moreno, A., Gaudzinski-Windheuser, S., Pop, E., Roebroeks, W., 2020. The Last interglacial (Eemian) Lakeland of Neumark-Nord (Saxony-Anhalt, Germany). Sequencing Neanderthal occupations, assessing subsistence opportunities and prey selection based on estimations of ungulate carrying capacities, biomass production and energy values. In: García-Moreno, A., Hutson, J.M., Smith, G.M., et al. (Eds.), *Human Behavioural Adaptations to Interglacial Lakeshore Environments.* RGZM-Tagungen 37, Verlag des Römisch-Deutschen Zentralmuseums, Mainz, pp. 67–104.
- Kolesnik, A., 1994. Mousterian industries evolution of South East Ukraine. *Préhist. Eur.* 6, 175–186.
- Kolesnik, A.V., 2000. The technological analyzes of Middle Paleolithic flint industry from Kurdumovka (Southeastern Ukraine). *Archeol. Almanac* 9, 65–80 (in Russian).
- Kolesnik, A.V., 2003. The Middle Palaeolithic of Donbass. *Archeol. Almanac* 12 (in Russian).
- Kolobova, K.A., Chabai, V.P., Shalagina, A.V., Krajcarz, M.T., Krajcarz, M., Rendu, W., Vasiliev, S.K., Markin, S., Krivoshapkin, A.I., 2019a. Exploitation of the natural environment by Neanderthals from Chagyrskaya Cave (Altai). *Quartär* 66, 7–31.
- Kolobova, K.A., Shalagina, A.V., Chabai, V.P., Markin, S.V., Krivoshapkin, A.I., 2019b. The significance of bifacial technologies in Altai Middle Paleolithic. *Anthropologie* 123, 276–288.
- Kolobova, K.A., Shalagina, A.V., Markin, S.V., Krivoshapkin, A.I., 2019c. Identification of bifacial components in middle paleolithic techno-complexes (based on the Chagyrskaya Cave Assemblages). *Vestn. Novosib. Gos. Univ. Seriya: Istor. Filol.* 18 (7), 98–111.
- Kolobova, K.A., Roberts, R.G., Chabai, V.P., Jacobs, Z., Krajcarz, M.T., Shalagina, A.V., Krivoshapkin, A.I., Li, B., Uthmeier, T., Markin, S.V., Morley, M.W., O’Gorman, K., Rudaya, N.A., Talamo, S., Viola, B., Derevianko, A.P., 2020. Archaeological evidence for two separate dispersals of Neanderthals into southern Siberia. *Proc. Natl. Acad. Sci. U.S.A.* 117, 2879–2885.
- Kozłowski, J., 2014. Middle Palaeolithic variability in Central Europe: Mousterian vs Micoquian. *Quat. Int.* 326–327, 344–363.
- Krakovsky, M., 2017. Technological traditions at the end of the Middle Palaeolithic in the southern Levant? Point reduction sequences from Amud and Kebara caves as a case study (Unpublished M.A. thesis). The Institute of Archaeology, The Hebrew University of Jerusalem.
- Krause, J., Orlando, L., Serre, D., Viola, B., Prüfer, K., Richards, M.P., Hublin, J.J., Hänni, C., Derevianko, A.P., Paabo, S., 2007. Neanderthals in central Asia and Siberia. *Nature* 449, 902–904.
- Krivoshapkin, A., Shalagina, A., Baumann, M., Shnaider, S., Kolobova, K., 2018. Between Denisovans and Neanderthals: Strashnaya cave in the Altai mountains. *Antiquity* 92, 365.
- Krukowski, S., 1939–1948. *Paleolit. Prehistoria ziem polskich.* In: Krukowski, S., Kostrzewski, J., Jakimowicz, R. (Eds.), *Encyklopedia Polska*, t. 4, cz. 1, dział V. PAU, Warszawa-Kraków, pp. 1–117.
- Kuhn, S.L., 1990. *Diversity Within Uniformity: Tool Manufacture and Use in the ‘Pontinian’ Mousterian of Latium (Italy)* (Ph.D. dissertation). University of New Mexico.
- Kuhn, S.L., 1995. *Mousterian Lithic Technology: An Ecological Perspective.* Princeton Legacy Library. Princeton University Press.
- Lambeck, K., Purcell, A., Funder, S., Kjaer, K.H., Larsen, E., Møller, P., 2006. Constraints on the Late Saalian to early Middle Weichselian ice sheet of Eurasia from field data and rebound modeling. *Boreas* 35, 539–575.
- Lamotte, D., Goval, É., Locht, J.-L., Auguste, P., Bardel, D., Bostyn, F., 2010. Canal Seine-Nord Europe, R 1, Picardie, Oise, Catigny, Sermaize, Campagne: du Moustérien à l’époque mérovingienne: résultats des sondages profonds et surfaciques de la zone R1 à Catigny, Sermaize et Campagne (Oise) préalables aux travaux du canal à grand gabarit Seine-Nord Europe: rapport de diagnostic (rapport de diagnostic). INRAP.
- Langgut, D., Almogi-Labin, A., Bar-Matthews, M., Weinstein-Evron, M., 2011. Vegetation and climate changes in the South Eastern Mediterranean during the Last Glacial-Interglacial cycle (86 ka): new marine pollen record. *Quat. Sci. Rev.* 30, 3960–3972.
- Langgut, D., Almogi-Labin, A., Bar-Matthews, M., Pickarski, N., Weinstein-Evron, M., 2018. Evidence for a humid interval at ~56–44 ka in the Levant and its potential link to modern humans dispersal out of Africa. *J. Hum. Evol.* 124, 75–90.
- Lazuén, T., Delagnes, A., 2014. Lithic tool management in the Early Middle Paleolithic: an integrated techno-functional approach applied to Le Pucheuil-type production (Le Pucheuil, northwestern France). *J. Archaeol. Sci.* 52, 337–353.
- Le Tensorer, J.-M., 1981. *Le Paléolithique de l’Agenais.* Editions du CNRS, Paris.
- Lemorini, C., Peresani, M., Rossetti, P., Malerba, G., Giacobini, G., 2003. Techno-morphological and use-wear functional analysis: an integrated approach to the study of a discoid industry. In: Peresani, M. (Ed.), *Discoid Lithic Technology: Advances and Implications.* BAR International Series 1120, Oxford, pp. 257–275.
- Lemorini, C., Venditti, F., Assaf, E., Parush, Y., Barkai, R., 2015. The function of recycled lithic items at late Lower Paleolithic Qesem Cave, Israel: an overview of the use-wear data. *Quat. Int.* 361, 103–112.
- Lesage, C., Postnov, A.V., Krivoshapkin, A.I., Jaubert, J., 2020. Levallois reduction sequences in Altai: a view from the study of Ust’-Kanskaya Cave (Gorny-Altai, Russia). *Quat. Int.* 535, 104–116.
- Liu, W., Martínón-Torres, M., Cai, Y., et al., 2015. The earliest unequivocally modern humans in southern China. *Nature* 526, 696–699.
- Locht, J.-L., 2019. La fin du Paléolithique moyen dans le nord de la France. *Quaternaire* 30 (4), 335–350.
- Locht, J., Swinnen, C., 1994. Le débitage discoïde du gisement de Beauvais (Oise): aspects de la chaîne opératoire au travers de quelques remontages. *Paléo* 6, 89–104.
- Locht, J.-L., Coutard, S., Antoine, P., Sellier, N., Ducrocq, T., Paris, C., Guerlin, O., Kiefer, D., Defaux, F., Deschodt, L., Limondin-Lozouet, N., 2013. Données inédites sur le Quaternaire et le Paléolithique du Nord de la France. *Rev. Archeol. Picardie* 3, 5–70.
- Locht, J.-L., Hérison, D., Goval, E., Cliquet, D., Huet, B., Coutard, S., Antoine, P., Feray, P., 2016. Timescales, space and culture during the Middle Palaeolithic in northwestern France. *Quat. Int.* 411, 129–148.
- Luttrupp, A., Bosinski, G., 1967. Rörshain, Kreis Ziegenhain. *Fundber. Hessen* 7, 13–18.
- Machado, J., Molina, F.J., Hernández, C.M., Tarrío, A., Galván, B., 2017. Using lithic assemblage formation to approach Middle Palaeolithic settlement dynamics: El Salt stratigraphic unit X (Alicante, Spain). *Archaeol. Anthropol. Sci.* 9, 1715–1743.
- Mafessoni, F., Grote, S., de Filippo, C., Slon, V., Kolobova, K.A., Viola, B., Markin, S.V., Chintalapati, M., Peyrégne, S., Skov, L., Skoglund, P.,

- Krivoshapkin, A.I., Derevianko, A.P., Meyer, M., Kelso, J., Peter, B., Prüfer, K., Pääbo, S., 2020. A high-coverage Neanderthal genome from Chagyrskaya Cave. *Proc. Natl. Acad. Sci. U.S.A.* 117 (26), 15132–15136.
- Maíllo Fernández, J.M., 2005. La producción laminar en el Chatelperroniense de Cueva Morín: modalidades, intenciones y objetivos. *Trab. Prehist.* 62 (1), 47–64.
- Maíllo Fernández, J.M., 2007. Aproximación tecnológica del final del Musteriense de Cueva Morín (Villanueva de Villaescusa, Cantabria, España). *MUNIBE* 58, 13–42.
- Malinsky-Buller, A., Ekshtain, R., Hovers, E., 2014. Organization of lithic technology at 'Ein Qashish, a late Middle Paleolithic open-air site in Israel. *Quat. Int.* 331, 234–247.
- Malinsky-Buller, A., Ekshtain, R., Munro, N., Hovers, E., 2021. Back to base: re-thinking variations in settlement and mobility behaviors in the Levantine Late Middle Paleolithic as seen from Shovakh Cave. *Archaeol. Anthropol. Sci.* 13, 112.
- Mania, D., 1990. Auf den Spuren des Urmenschen: Die Funde aus der Steinrinne von Bilzingsleben. Deutscher Verlag der Wissenschaften, Berlin.
- Mańka, D., Milewski, M., Targosz, M., 2004. Neanderthal economy: recycling stone tools at Poland's Wytłone Shelter. *Antiquity* 78 (301). <http://antiquity.ac.uk/projGall/manka/index.html>.
- Marciani, G., Ronchitelli, A., Arrighi, S., Badino, F., Bortolini, E., Boscato, P., Boschini, F., Crezzini, J., Delpiano, D., Falcucci, A., Figus, C., Lugli, F., Oxilia, G., Romandini, M., Riel-Salvatore, J., Peresani, M., Spinapolice, E., Moroni, A., Benazzi, S., 2020. Lithic technocomplexes in Italy from 50 to 39 thousand years BP: an overview of lithic technological changes across the Middle-Upper Palaeolithic boundary. *Quat. Int.* 551, 123–149.
- Marcó, A., 2009. Raw material circulation during the Middle Palaeolithic period in northern Hungary. In: Pawlikowski, M. (Ed.), *Surowce naturalne w Karpatach oraz ich wykorzystanie w pradziejach i wczesnym średniowieczu*. Krosno, pp. 107–118.
- Marcó, A., Biró, K.T., Kasztovszky, Z., 2003. Szeletian felsitic porphyry: non-destructive analysis of a classical Palaeolithic raw material. *Acta Archaeol. Acad. Sci. Hung.* 54 (3–4), 297–314.
- Marcy, J.-L., Auguste, P., Fontugne, M., Munaut, A.-V., Van Vliet-Lanoë, B., 1993. Le gisement moustérien d'Hénin-sur-Cojeul (Pas-de-Calais). *Bull. Soc. Préhist. Fr.* 90, 251–256.
- Marín, J., Rodríguez-Hidalgo, A., Vallverdú, J., Gómez de Soler, B., Rivals, F., Ramón Rabuñal, J., Pineda, A., Chacón, M.G., Carbonell, E., Saladié, P., 2020. Neanderthal logistic mobility during MIS3: zooarchaeological perspective of Abric Romaní level P (Spain). *Quat. Sci. Rev.* 225, 106033.
- Marín-Arroyo, A.B., Rios-Garaizar, J., Straus, L.G., Jones, J.R., de la Rasilla, M., González Morales, M.R., Richards, M., Altuna, J., Mariezkurrena, K., Ocio, D., 2018. Chronological reassessment of the Middle to Upper Paleolithic transition and Early Upper Paleolithic cultures in Cantabrian Spain. *PLoS ONE* 13 (4), e0194708.
- Maroto, J., 1993. La cueva de los Ermitons (Sales de Llierca, Girona). Un yacimiento del Paleolítico medio final. *Espacio Tiempo Forma* 6, 13–30.
- Márquez, B., Baquedano, E., Pérez-González, A., Arsuaga, J.L., 2016. Microwear analysis of Mousterian quartz tools from the Navalmaíllo Rock Shelter (Pinilla del Valle, Madrid, Spain). *Quat. Int.* 424, 84–97.
- Martínez-Moreno, J., Mora Torcal, R., de la Torre, I., 2006. La Roca dels Bous en el contexto del Paleolítico Medio final del Noreste de la Península Ibérica. *Zona Arqueológica*. In: *Miscelánea en homenaje a Victoria Cabrera*. vol. 7, pp. 253–262.
- Martínez-Moreno, J., de la Torre, I., Mora, R., Casanova, J., 2010. Technical variability and change in the pattern of settlement at Roca dels Bous (southeastern Pre-Pyrenees, Spain). In: Conard, N.J., Delagnes, A. (Eds.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age*. vol. III. Kerns Verlag, Tübingen, pp. 485–507.
- Martín-Viveros, J.I., Ollé, A., Chacón, M.G., Romagnoli, F., Gómez de Soler, B., Vaquero, M., Saladié, P., Vallverdú, J., Carbonell, E., 2020. Use-wear analysis of a specific mobile toolkit from the Middle Paleolithic site of Abric Romaní (Barcelona, Spain): a case study from level M. *Archaeol. Anthropol. Sci.* 12, 16.
- Mathias, C., Bourguignon, L., 2020. Cores-on-flakes and ramification during the Middle Palaeolithic in Southern France: a gradual process from the early to Late Middle Palaeolithic? *J. Archaeol. Sci. Rep.* 31, 102336.
- Mayor, A., Hernández, C.M., Machado, J., Mallol, C., Galván, B., 2019. El estudio tecnológico de conjuntos líticos paleolíticos desde la perspectiva del episodio de ocupación humana: los casos de El Salt y El Pastor (Alcoi, Alacant). *Recerques de Museu d'Alcoi* 28, 7–26.
- Mayor, A., Hernández, C.M., Machado, J., Mallol, C., Galván, B., 2020. On identifying Palaeolithic single occupation episodes: archaeostratigraphic and technological approaches to the Neanderthal lithic record of stratigraphic unit Xa of El Salt (Alcoi, eastern Iberia). *Archaeol. Anthropol. Sci.* 12, 84.
- Meignen, L., 1995. Levallois lithic production systems in the Middle Palaeolithic of the Near East: the case of the unidirectional method. In: Dibble, H.L., Bar-Yosef, O. (Eds.), *The Definition and Interpretation of Levallois Technology*. Prehistory Press, Madison, WI, pp. 361–380.
- Meignen, L., 2019. The Mousterian lithic assemblages from Kebara Cave. In: Meignen, L., Bar-Yosef, O. (Eds.), *Kebara cave, Mt. Carmel, Israel. The Middle and Upper Paleolithic Archeology Part II*. Peabody Museum of Archeology and Ethnology. Harvard University, Cambridge, MA, pp. 1–126.
- Meignen, L., Bar-Yosef, O., 1992. Middle Paleolithic variability in Kebara Cave, Israel. In: Akazawa, T., Aoki, K., Kimura, T. (Eds.), *The Evolution and Dispersal of Modern Humans in Asia*. Hakusen-Sha, Tokyo, pp. 129–148.
- Meignen, L., Bar-Yosef, O., Speth, J.D., Stiner, M.C., 2006. Middle Paleolithic settlement patterns in the Levant. In: Hovers, E., Kuhn, S.L. (Eds.), *Transitions Before The Transition: Evolution and Stability in the Middle Paleolithic and Middle Stone Age*. Springer, New York, pp. 149–169.
- Meignen, L., Speth, J.D., Bar-Yosef, O., 2019. Changes in the use of Kebara Cave during the Middle Paleolithic. In: Meignen, L., Bar-Yosef, O. (Eds.), *Kebara Cave, Mt. Carmel, Israel. The Middle and Upper Paleolithic Archeology. Part II. The Peabody Museum of Archaeology and Ethnology*, Harvard University Cambridge, MA, pp. 413–455.
- Méndez-Quintas, E., Demuro, M., Arnold, L.J., Duval, M., Pérez-González, A., Santonja, M., 2019. Insights into the late stages of the Acheulean technocomplex of Western Iberia from the Arbo site (Galicia, Spain). *J. Archaeol. Sci. Rep.* 27, 101934.
- Méndez-Quintas, E., Santonja, M., Arnold, L.J., Cunha-Ribeiro, J.P., da Silva, P.X., Demuro, M., Duval, M., Gomes, A., Meireles, J., Monteiro-Rodrigues, S., Pérez-González, A., 2020. The Acheulean technocomplex of the Iberian Atlantic margin as an example of technology continuity through the Middle Pleistocene. *J. Paleolit. Archaeol.* 3, 918–943.
- Mihailović, D., 2020. Push-and-pull factors of the Middle to Upper Paleolithic transition in the Balkans. *Quat. Int.* 551, 47–62.

- Mihailović, D., Whallon, R., 2017. Crvena Stijena revisited: the Late Mousterian assemblages. *Quat. Int.* 450, 36–49.
- Minet, T., Deschamps, M., Mangier, C., Murre, V., 2021. Lithic territories during the Late Middle Palaeolithic in the central and western Pyrenees: new data from the Noisetier (Hautes-Pyrénées, France), Gatzarria (Pyrénées-Atlantiques, France) and Abautz (Navarre, Spain) caves. *J. Archaeol. Sci. Rep.* 36, 102713.
- Mitki, N., Yeshurun, R., Ekshtain, R., Malinsky-Buller, A., Hovers, E., 2021. A multi-proxy approach to Middle Paleolithic mobility: a case study from the open-air site of 'Ein Qashish (Israel). *J. Archaeol. Sci. Rep.* 38, 103088.
- Moncel, M.-H., 1996. Le Moustérien de la Baume d'Oullins (Ardèche). *Bull. Soc. Préhist. Fr.* 93 (2), 169–173.
- Moncel, M.-H., 1998. Les niveaux moustériens de la grotte de Saint-Marcel d'Ardèche (Ardèche, France), Fouilles René Gilles. Reconnaissance de niveaux à débitage discoïde dans la vallée du Rhône. *Bull. Soc. Préhist. Fr.* 95 (2), 141–171.
- Moncel, M.H., Daujeard, C., 2012. The variability of the middle palaeolithic on the right bank of the Middle Rhône Valley (southeast France): technical traditions or functional choices? *Quat. Int.* 247, 103–124.
- Moncel, M.-H., Lhomme, G., 2007. Les assemblages lithiques des niveaux du Paléolithique moyen de l'Abri des Pêcheurs (Ardèche, sud-est de la France). Des occupations néandertaliennes récurrentes dans un «fossé». *L'Anthropologie* 111, 211–253.
- Moncel, M.-H., Daujeard, C., Crégut-Bonnouère, E., Fernandez, P., Faure, M., Guérin, C., 2004. L'occupation de la grotte de Saint-Marcel (Ardèche, France) au Paléolithique moyen: stratégie d'exploitation de l'environnement et type d'occupation de la grotte. L'exemple des couches i, j et j'. *Bull. Soc. Préhist. Fr.* 101 (2), 257–304.
- Moncel, M.-H., Brugal, J.-P., Prucca, A., Lhomme, G., 2008. Mixed Occupation during the Middle Palaeolithic: case study of a small pit-cave site of Les Pêcheurs (Ardèche, south-eastern France). *J. Anthropol. Archaeol.* 27, 382–398.
- Moncel, M.-H., Puaud, S., Daujeard, C., Lartigot-Campin, A.-S., Millet, J.-J., Theodoropoulou, A., Crégut-Bonnouère, E., Gély, B., Vercoutère, C., Desclaux, E., Roger, T., Bourges, F., 2012. La Grotte du Figuier (Saint-Martin-d'Ardèche): Bilan des travaux récents sur un site du Paléolithique moyen et supérieur de la moyenne vallée du Rhône (Sud-Est de la France). *Bull. Soc. Préhist. Fr.* 109 (1), 35–67.
- Moncel, M.-H., Chacón Navarro, M.G., La Porta, A., Fernandes, P., Hardy, B., Gallotti, R., 2014. Middle Palaeolithic technical behavior in a rock shelter in southeastern France: the Abri du Maras. *Quat. Int.* 350, 180–204.
- Moncel, M.-H., Raynal, J.-P., Fernandes, P., Delvigne, V., Hardy, B., 2018. Les différentes phases d'occupation de la cavité: fonction(s) du site. 4.1. Le matériel lithique. In: Daujeard, C. (Ed.), *La Grotte des Barasses II (Balazuc): entre Néandertaliens, bouquetins et carnivores. Des occupations du Pleistocène supérieur en moyenne vallée de l'Ardèche*. DARA 46. Alpara, MOM Éditions, Lyon, pp. 109–128.
- Moncel, M.-H., Ashton, N., Arzarello, M., Fontana, F., Lamotte, A., Scott, B., Muttillio, B., Berruti, G., Nenzioni, G., Tuffreau, A., Peretto, C., 2020. Early Levallois core technology between Marine Isotope Stage 12 and 9 in Western Europe. *J. Hum. Evol.* 139, 102735.
- Moncel, M.-H., Chacón, M.G., Vettese, D., Courty, M.-A., Daujeard, C., Eixea, A., Fernandes, P., Allué, E., Hardy, B., Rivals, F., Béarez, P., Gallotti, R., Puaud, S., 2021. Late Neanderthals short-term and specialized occupations at the Abri du Maras (South-East France, level 4.1, MIS 3). *Anthropol. Archaeol. Sci.* 13, 45.
- Monigal, K., 2004. Introduction to the site of Buran-Kaya III. In: Chabai, V., Monigal, K., Marks, A. (Eds.), *The Paleolithic of Crimea*. The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea 3. *Études et Recherches Archéologiques de L'Université de Liège* 104, pp. 3–18.
- Monnier, G.F., 2006. The Lower/Middle Paleolithic periodization in Western Europe. An evaluation. *Curr. Anthropol.* 47, 709–744.
- Monnier, G.F., Ladwig, J.L., Porter, S.T., 2012. Swept under the rug: the problem of unacknowledged ambiguity in lithic residue identification. *J. Archaeol. Sci.* 39, 3284–3300.
- Mora, R., Martínez-Moreno, J., Roy, M., Benito-Calvo, A., Polo, A., Samper, S., 2018. Contextual, techno-typological and chronometric implications from Cova Gran to the Middle-to-Upper Palaeolithic debate in Northeastern Iberia. *Quat. Int.* 474, 30–43.
- Moroni, A., Boscato, P., Ronchitelli, A., 2013. What roots for the Uluzzian? Modern behaviour in Central-Southern Italy and hypotheses on AMH dispersal routes. *Quat. Int.* 316, 27–44.
- Moroni, A., Boschian, G., Crezzini, J., Montanari-Canini, G., Marciani, G., Capecechi, G., Arrighi, S., Aureli, D., Berto, C., Freguglia, M., Araujo, A., Scaramucci, S., Hublin, J.J., Lauer, T., Benazzi, S., Parenti, F., Bonato, M., Ricci, S., Talamo, S., Segre, A.G., Boschian, F., Spagnolo, V., 2019. Late Neanderthals in Central Italy. High-resolution chronicles from Grotta dei Santi (Monte Argentario—Tuscany). *Quat. Sci. Rev.* 217, 130–151.
- Moure Romanillo, J.A., García Soto, E., 1983. Cueva Millán y La Ermita. Dos yacimientos musterienses en el valle medio de Arlanza. *Bol. Semin. Estud. Arte Arqueol.* 49, 5–30.
- Munday, F.C., 1976. Intersite variability in the Mousterian of the Central Negev. In: Marks, A.E. (Ed.), *Prehistory and Paleoenvironments in the Central Negev, Israel*. Vol. I: The Avdat/Aqev Area, Part I. SMU Press, Dallas, pp. 113–140.
- Nabais, M., 2018. Neanderthal subsistence in Portugal: what evidence? *Archaeol. Int.* 21 (1), 95–100.
- Navazo Ruíz, M., Jordá Pardo, J.F., Burow, C., Kehl, M., Pastoors, A., Weniger, G.-C., Wood, R., 2020. Last Neanderthal occupations at Central Iberia: the lithic industry of Jarama VI rock shelter (Valdesotos, Guadalajara, Spain). *Archaeol. Anthropol. Sci.* 12, 45.
- Navazo Ruíz, M., Benito-Calvo, A., Alonso-Alcalde, R., Alonso, P., de la Fuente, H., Santamaría, M., Álvarez-Vena, A., Arnold, L.J., Iriarte-Chiapusso, M.J., Demuro, M., Lozano, M., Ortiz, J.E., Torres, T., 2021. Late Neanderthal subsistence strategies and cultural traditions in the northern Iberia Peninsula: insights from Prado Vargas, Burgos, Spain. *Quat. Sci. Rev.* 254, 106795.
- Negrino, F., Starnini, E., 2010. Dinamiche di sfruttamento e circolazione delle materie prime silicee per l'industria litica scheggiata in Liguria tra Paleolitico inferiore e Età del Rame. In: Odetti, G. (Ed.), *L'uomo e la terra ligure. Atti della Tavola Rotonda, Genova 10-11 febbraio 2005*, pp. 21–34.
- Nehoroshev, P.E., Vishnyatsky, L.B., 2000. Shlyakh—a new Late Middle Paleolithic site in the South Russian Plain. In: Orschiedt, J., Weniger, G.-C. (Eds.), *Neanderthals and Modern Humans—Discussing the Transition: Central and Eastern Europe From 50.000–30.000 B.P.* Wissenschaftliche Schriften des Neanderthal Museums 2. Neanderthal Museum, Mettmann, pp. 256–266.
- Neruda, P., 2011. Střední paleolit v moravských jeskyních. Middle Palaeolithic in Moravian Caves. *Dissertationes archaeologicae Brunenses/Pragensesque* 8, Masarykova Univerzita, Brno.
- Newcomer, M.H., Hivernel-Guerre, F., 1974. Nucléus sur éclat: technologie et utilisation par différentes cultures préhistoriques. *Bull. Soc. Préhist. Fr.* 71, 119–128.
- Nielsen, T.K., Benito, B.M., Svenning, J.-C., Sandel, B.S., McKerracher, L.J., Riede, F., Kjærsgaard, P.C., 2017. Investigating Neanderthal dis-

- persal above 55°N in Europe during the Last Interglacial Complex. *Quat. Int.* 431, 88–103.
- Nigst, P.R., Kulakovska, L., Usik, V., Pirson, S., Damblon, F., Gerasimenko, N., Haesaerts, P., 2019. Neanderthal occupation of the East European Plain: new data from the Middle Dniester valley (Ukraine). In: Bosken, J., Richter, J., Lehmkuhl, F. (Eds.), *International Workshop on Loess and Archeology*, 27-29th November 2019. Abstract Book, Aachen, pp. 43–44.
- Nishiaki, Y., Copeland, L., 1992. Keoue Cave, Northern Lebanon, and its place in the context of the Levantine Mousterian. In: Akazawa, T., Aoki, K., Kimura, T. (Eds.), *The Evolution and Dispersal of Modern Humans in Asia*. Hakusen-Sha, Tokyo, pp. 107–127.
- Nishiaki, Y., Kanjo, Y., Muhesen, S., Akazawa, T., 2012. The temporal variability of late Levantine Mousterian lithic assemblages from Dederiyeh Cave, Syria. *Eurasian Prehist.* 9, 3–27.
- Ollé, A., Mosquera, M., Rodríguez-Álvarez, X.P., García-Medrano, P., Barsky, D., de Lombera-Hermida, A., Eudald, C., 2016. The Acheulean from Atapuerca: three steps forward, one step back. *Quat. Int.* 411, 316–328.
- Ortega, I., Locht, J.L., Rios-Garaizar, J., Bourguignon, L., Blaser, F., Goval, É., Grigoletto, F., Sellier, N., 2013. La producción laminar en el Paleolítico Medio en el Norte y el Sur-Oeste de Francia: el aporte de la experimentación. In: Palomo, A., Piqué, R., Terradas, X. (Eds.), *Experimentación En Arqueología. Estudio y Difusión Del Pasado*. Museu d'Arqueologia de Catalunya, Girona, pp. 219–228.
- Ortiz Nieto-Márquez, I., Baena, J., 2017. Did stones speak about people? Flint catchment and Neanderthal behavior from Area 3 (Cañaveral, Madrid-Spain). *Quat. Int.* 435 (Part A), 144–163.
- Palma di Cesnola, A., 1996. Le Paléolithique inférieur et moyen en Italie. In: *Préhistoire d'Europa*, 1. Millon.
- Pastors, A., Tafelmaier, Y., 2010. Bladelet production, core reduction strategies, and efficiency of core configuration at the Middle Palaeolithic site Balver Höhle (North Rhine Westphalia, Germany). *Quartär* 57, 25–41.
- Pastors, A., Weniger, G.-C., Kegler, J.F., 2008. The Middle-Upper Palaeolithic transition at Yabroud II (Syria). A re-evaluation of the lithic material from the Rust excavation. *Paléorient* 34, 47–65.
- Păunescu, A., 1993. Ripiceni-Izvor. Paleolitic și Mezolitic. Editura Academiei Române, București.
- Pavlov, P., Roebroeks, W., Inge Svendsen, J., 2004. The Pleistocene colonization of northeastern Europe: a report on recent research. *J. Hum. Evol.* 47, 3–17.
- Péan, S., Puaud, S., Crépin, L., Prat, S., Quiles, A., van der Plicht, J., Valladas, H., Stuart, A.J., Drucker, D., Patou-Mathis, M., Lanoë, F., Yanevich, A., 2013. The Middle to Upper Paleolithic sequence of Buran Kaya III (Crimea, Ukraine): new stratigraphical, paleoenvironmental, and chronological results. *Radiocarbon* 55, 1454–1469.
- Pereira, T., Paixão, E., Carvalho, V., Gomes, T., 2017. Raw material diversity, availability and sourcing in the River Lis Basin, Central Portugal. In: Pereira, T., Terradas, X., Bicho, N. (Eds.), *The Exploitation of Raw Materials in Prehistory: Sourcing, Processing and Distribution*. Cambridge Scholars Publishing, pp. 15–29.
- Peresani, M. (Ed.), 2003a. *Discoid Lithic Technology. Advances and Implications*. BAR International Series 1120, Oxford.
- Peresani, M., 2003b. An initial overview of the middle Palaeolithic discoid industries in Central-Northern Italy. In: Peresani, M. (Ed.), *Discoid Lithic Technology. Advances and Implications*. BAR International Series 1120, pp. 209–223. Oxford.
- Peresani, M., 2011. The end of the Middle Paleolithic in the Italian Alps. In: Conard, N.J., Richter, J. (Eds.), *Neanderthal Lifeways, Subsistence and Technology. One Hundred Fifty Years of Neanderthal Study*. Springer Netherlands, pp. 249–259.
- Peresani, M., Romandini, M., Duches, R., Jequier, C., Nannini, N., Pastors, A., Picin, A., Schmidt, I., Vaquero, M., Weniger, G.-C., 2014. New evidence for the mousterian and gravettian at Rio Secco cave, Italy. *J. Field Archaeol.* 39, 401–416.
- Peresani, M., Boldrin, M., Pasetti, P., 2015. Assessing the exploitation of double patinated artifacts from the Late Mousterian: implications for lithic economy and human mobility in northern Italy. *Quat. Int.* 361, 238–250.
- Peresani, M., Cristiani, E., Romandini, M., 2016. The Uluzzian technology of Grotta di Fumane and its implication for reconstructing cultural dynamics in the Middle-Upper Palaeolithic transition of Western Eurasia. *J. Hum. Evol.* 91, 9136–9156.
- Peresani, M., Bertola, S., Delpiano, D., Benazzi, S., Romandini, M., 2019. The Uluzzian in the north of Italy. Insights around the new evidence at Riparo Broion Rockshelter. *Archaeol. Anthropol. Sci.* 11 (7), 3503–3536.
- Peretto, C., Arzarello, M., Coltorti, M., Bertolini, M., Cui, Q.-Y., de Curtis, O., Lebreton, V., Lembo, G., Marquer, L., Pieruccini, P., Ravani, S., Rufo, E., Sala, B., Talamo, S., Thun Hohenstein, U., 2020. Grotta Reali, the first multilayered mousterian evidences in the Upper Volturno Basin (Rocchetta a Volturno, Molise, Italy). *Archaeol. Anthropol. Sci.* 12, 67.
- Perhoč, Z., 2020. Rohmaterial für die Produktion von Steinartefakten im Spätjungpaläolithikum, Mesolithikum und Neolithikum Dalmatiens (Kroatien) (Ph.D. dissertation). Ruprecht-Karls-University of Heidelberg.
- Peyrony, D., 1920. Le Moustérien—ses faciès. *Association Française pour l'avancement des Sciences*, Strasbourg, pp. 1–2.
- Picin, A., Blasco, R., Arilla, M., Rivals, F., Chacón, M.G., Gómez de Soler, B., Talamo, S., Rosell, J., 2020a. Short-term Neanderthal occupations and carnivores in the North-east of Iberian Peninsula. In: Cascalheira, J., Picin, A. (Eds.), *Short-Term Occupations in Paleolithic Archaeology: Definition and Interpretation*. Interdisciplinary Contributions to Archaeology. Springer Cham, pp. 183–216.
- Picin, A., Chacón, M.G., Gómez de Soler, B., Blasco, R., Rivals, F., Rosell, J., 2020b. Neanderthals mobile toolkit in short-term occupations at Teixoneres Cave (Moia, Spain). *J. Archaeol. Sci. Rep.* 29, 102165.
- Picin, A., Moroni, A., Benazzi, S., 2022. The arrival of *Homo sapiens* in the Near East and Europe. In: Romagnoli, F., Rivals, F., Benazzi, S. (Eds.), *Updating Neanderthals. Understanding Behavioural Complexity in the Late Middle Palaeolithic*. Academic Press, Cambridge, pp. 321–347.
- Porraz, G., Peresani, M., 2006. Occupations du territoire et exploitation des matières premières: présentation et discussion sur la mobilité des groupes humaines au Paléolithique moyen dans le nord-est de l'Italie. In: Bressy-Leandri, C., Burke, A., Chalard, P., Martin, H. (Eds.), *Notions de territoire et de mobilité. Exemples de l'Europe et des premières nations en Amérique du nord avant le contact européen. Études et Recherches Archéologiques de Université de Liège*, pp. 11–21.
- Prieto, A., Yusta, I., Arrizabalaga, A., 2018. Defining and characterizing archaeological quartzite: sedimentary and metamorphic processes in the lithic assemblages of El Habario and El Arteu (Cantabrian Mountains, Northern Spain). *Archaeometry* 61 (1), 14–30.
- Prieto, A., Yusta, I., García-Rojas, M., Arrizabalaga, A., Baena Preysler, J., 2021. Quartzite procurement in conglomerates and deposits: geoarchaeological characterization of potential catchment areas in the central part of the Cantabrian Region, Spain. *Geoarchaeology* 2021, 1–21.

- Prüfer, K., Racimo, F., Patterson, N., Jay, F., Sankararaman, S., et al., 2014. The complete genome sequence of a Neanderthal from the Altai Mountains. *Nature* 505, 43–49.
- Ramos-Muñoz, J., Weniger, G.C., Cantalejo, P., Tafelmaier, Y., Becerra, S., Vijande-Vila, E., Kellberg Nielsen, T., Rotgänger, M., Fernández-Sánchez, D., Otto, T., Moreno-Márquez, A., Espejo, M., Bolín, V., Cabello, L., Kehl, M., Domínguez-Bella, S., Blumenröther, J., 2020. Ocupaciones de la Cueva de Ardales y Sima de las Palomas de Teba por sociedades neandertales. *Bajo Guadalquivir y Mundos Atlánticos* 2, 1–18.
- Ranhorn, K.L., Braun, D.R., Biermann Gürbüz, R.E., Greiner, E., Wawrzyniak, D., Brooks, A.S., 2019. Evaluating prepared core assemblages with three-dimensional methods: a case study from the Middle Paleolithic at Skhül (Israel). *Archaeol. Anthropol. Sci.* 11, 3225–3238.
- Real, C., Martínez-Varea, C.M., Carrión, Y., Badal, E., Sanchis, A., Guillem, P., Martínez-Valle, R., Villaverde, V., 2022. Could the central-eastern Iberian Mediterranean region be defined as a refugium? Fauna and flora in MIS 5–3 and their implications for Palaeolithic human behaviour. *J. Quat. Sci.* 37, 363–379.
- Renfrew, C., 1977. Alternative models for exchange and spatial distribution. In: Earle, T.K., Ericson, J.E. (Eds.), *Exchange Systems in Prehistory*. Academic, New York, pp. 71–90.
- Richard, M., Falguères, C., Pons-Branchu, E., Bahain, J.-J., Voinchet, P., Lebon, M., Valladas, H., Dolo, J.-M., Puaud, S., Rué, M., Daujeard, C., Moncel, M.-H., Raynal, J.-P., 2015. Contribution of ESR/U-series dating method to Late Middle Palaeolithic sites chronology of Middle Rhône valley, Southeastern France. *Quat. Geochronol.* 30, 493–497.
- Richter, J., 1997. *Sesselfelsgrötte III. Der G-Schichten-Komplex der Sesselfelsgrötte. Zum Verständnis des Micoquien*. Saarbrücker Druckerei und Verlag, Saarbrücken.
- Richter, J., 2012. Moustérien und Micoquien. In: Floss, H. (Ed.), *Steinartefakte vom Altpaläolithikum bis in die Neuzeit*. Tübingen Publications in Prehistory, Tübingen, pp. 267–272.
- Richter, J., 2013. Mittelpaläolithische Funde aus Coesfeld-Stevede. In: Baales, M., Pollmann, H.-O., Stapel, B. (Eds.), *Westfalen in der Altund Mittelsteinzeit*. Münster, pp. 72–73.
- Richter, J., 2016. Leave at the height of the party: a critical review of the Middle Paleolithic in Western Central Europe from its beginnings to its rapid decline. *Quat. Int.* 411, 107–128.
- Riel-Salvatore, J., Negrino, F., 2018. Human adaptations to climatic change in Liguria across the Middle-Upper Paleolithic transition. *J. Quat. Sci.* 33, 313–322.
- Rios-Garaizar, J., 2016. Experimental and archeological observations of northern Iberian Peninsula Middle Paleolithic Mousterian point assemblages. Testing the potential use of throwing spears among Neanderthals. In: Iovita, R., Sano, K. (Eds.), *Multidisciplinary Approaches to the Study of Stone Age Weaponry*. Springer Netherlands, Dordrecht, pp. 213–225.
- Rios-Garaizar, J., 2017. A new chronological and technological synthesis for Late Middle Paleolithic of the Eastern Cantabrian Region. *Quat. Int.* 433 (Part B), 50–63.
- Rios-Garaizar, J., 2020. Microlithic lithic technology of Neandertal shellfishers from El Cuco rock-shelter (Cantabrian Region, northern Spain). *J. Archaeol. Sci. Rep.* 102201.
- Rios-Garaizar, J., Eixea, A., 2021. Lithic technological choices of late Neandertals in a mountain environment south of the Ebro Valley, Iberian Peninsula (Peña Miel level e). *Archaeol. Anthropol. Sci.* 13, 123.
- Rios-Garaizar, J., García Moreno, A., 2015. Middle Paleolithic mobility patterns and settlement system variability in the Eastern Cantabrian Region (Iberian Peninsula): a GIS-based resource patching model. In: Conard, N., Delagnes, A. (Eds.), *Settlement Dynamics of the Middle Palaeolithic and Middle Stone Age*. vol. IV. Tübingen Publications in Prehistory, pp. 329–360.
- Rios-Garaizar, J., Eixea, A., Villaverde, V., 2015. Ramification of lithic production and the search of small tools in Iberian Peninsula Middle Paleolithic. *Quat. Int.* 361, 188–199.
- Rios-Garaizar, J., Mañillo-Fernández, J.M., Marín-Arroyo, A.B., Sánchez Carro, M.Á., Salazar, S., Medina-Alcaide, M.Á., San Emeterio, A., Martínez de Pinillos, L., Garate, D., Rivero, O., 2020. Revisiting Hornos de la Peña 100 years after. *J. Archaeol. Sci. Rep.* 31, 102259.
- Romagnoli, F., 2015. A second life: recycling production waste during Middle Palaeolithic in Southern Italy. The lithic assemblage of layer L at Grotta del Cavallo (Lecce, South Apulia). *Quat. Int.* 361, 200–211.
- Romagnoli, F., 2018. The socio-economic significance of Neanderthal shell technology. In: Borgia, V., Cristiani, E. (Eds.), *Palaeolithic Italy: Advanced Studies on Early Human Adaptations in the Apennine Peninsula*. Sidestone Press Academics, pp. 125–146.
- Romagnoli, F., 2021. Changes in raw material selection and use at 400,000 Years BP: a novel, symbolic relationship between humans and their world. Discussing technological, social and cognitive arguments. *Camb. Archaeol. J.* 31, 325–336.
- Romagnoli, F., Vaquero, M., 2019. The challenges of applying refitting analysis in the Palaeolithic archaeology of the twenty-first century: an actualised overview and future perspectives. *Archaeol. Anthropol. Sci.* 11, 4387–4396.
- Romagnoli, F., Bargalló, A., Chacón, M.G., Gómez de Soler, B., Vaquero, M., 2016a. Testing a hypothesis about the importance of the quality of raw material on technological changes at Abric Romaní (Capellades, Spain): some considerations using a high-resolution techno-economic perspective. *J. Lithic Stud.* 3 (2), 635–659.
- Romagnoli, F., Trenti, F., Nannini, L., Carmignani, L., Ricci, G., Lo Vetro, D., Martini, F., Sarti, L., 2016b. Raw material procurement and productive sequences in the Paleolithic of southern Italy: the Tyrrhenian and Ionian areas. In: Tomasso, A., Binder, D., Martino, G., Porraz, G., Simon, P., Naudinot, N. (Eds.), *Ressources lithiques, productions et transferts entre Alpes et Méditerranée. Séances de la Société préhistorique française* 5, Paris, pp. 185–206.
- Romagnoli, F., Baena, J., Sarti, L., 2016c. Neanderthal retouched shell tools and Quina economic and technical strategies: an integrated behaviour. *Quat. Int.* 407, 29–44.
- Romagnoli, F., Gómez de Soler, B., Bargalló, A., Chacón, M.G., Vaquero, M., 2018. Here and now or a previously planned strategy? Rethinking the concept of ramification for micro-production in expedient contexts: implications for Neanderthal socio-economic behavior. *Quat. Int.* 474, 168–181.
- Romagnoli, F., Rivals, F., Benazzi, S., 2022. Updating Neanderthals: Taking stock of more than 160 years of studies. In: Romagnoli, F., Rivals, F., Benazzi, S. (Eds.), *Updating Neanderthals. Understanding Behavioural Complexity in the Late Middle Palaeolithic*. Academic Press, Cambridge, pp. 1–15.
- Rosas, A., Bastir, M., García-Taberner, A., 2022. Neanderthals: Anatomy, genes, and evolution. In: Romagnoli, F., Rivals, F., Benazzi, S. (Eds.), *Updating Neanderthals. Understanding Behavioural Complexity in the Late Middle Palaeolithic*. Academic Press, Cambridge, pp. 71–87.
- Rots, V., 2016. Projectiles and hafting technology. In: Iovita, R., Sano, K. (Eds.), *Multidisciplinary Approaches to the Study of Stone Age Weaponry. Vertebrate Paleobiology and Paleoanthropology*. Springer, pp. 167–185.
- Roy, M., Mora, R., Plasencia, F.-J., Martínez-Moreno, J., Benito-Calvo, A., 2017. Quartzite selection in fluvial deposits: the N12 level of Roca dels Bous (Middle Palaeolithic, southeastern Pyrenees). *Quat. Int.* 435, 49–60.

- Rudaya, N., Vasiliev, S., Viola, B., Talamo, S., Markin, S., 2017. Palaeoenvironments during the period of the Neanderthals settlement in Chagyrskaya Cave (Altai Mountains, Russia). *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 467, 265–276.
- Rufà, A., Blasco, R., Rivals, F., Rosell, J., 2014. Leporids as a potential resource for predators (hominins, mammalian carnivores, raptors): an example of mixed contribution from level III of Teixoneres Cave (MIS 3, Barcelona, Spain). *C. R. Palevol* 13, 665–680.
- Rybin, E.P., Kolobova, K.A., 2004. The structure of lithic industries and functionality of Paleolithic sites in Altay Mountains. *Archaeol. Ethnol. Anthropol. Eurasia* 4 (20), 20–34 (in Russian).
- Rybin, E., Kolobova, K.A., 2005. Srednii paleolit Altaya: Variabelnost i evolyutsiya (Altai Middle Paleolithic: variability and evolution). *Stratum Plus* 1, 33–78 (in Russian).
- Sánchez de la Torre, M., Utrilla, P., Montes, L., Domingo, R., Le Bourdonnec, F.-X., Gratuze, B., 2020. Characterizing the lithic raw materials from Fuente del Trucho (Asque-Colungo, Huesca): new data about Palaeolithic human mobility in north-east Iberia. *Archaeometry* 63 (2), 247–265.
- Sankararaman, S., Mallick, S., Dannemann, M., Prüfer, K., Kelso, J., et al., 2014. The genomic landscape of Neanderthal ancestry in present-day humans. *Nature* 507, 354–357.
- Santamaría, M., Navazo, M., Benito-Calvo, A., Alonso, R., López, G.I., Carbonell, E., 2020. Atapuerca Neanderthal landscape at Fuente Mudarra site in Burgos, Spain, during Marine Isotope Stages 5–3. *Quat. Res.* 99, 248–269.
- Santonja, M., Pérez-González, A., Panera, J., Rubio-Jara, S., Méndez-Quintas, E., 2016. The coexistence of Acheulean and ancient Middle Palaeolithic techno-complexes in the Middle Pleistocene of the Iberian Peninsula. *Quat. Int.* 411, 367–377.
- Sarti, L., Romagnoli, F., Carmignani, L., Martini, F., 2017. Grotta del Cavallo (scavi L. Sarti): Tradizione e innovazione nella sequenza musteriana sulla base dell'indicatore litico. In: Radina, F. (Ed.), *Preistoria e Protostoria della Puglia. Studi di Preistoria e Protostoria* 4. Istituto Italiano di Preistoria e Protostoria, pp. 130–138.
- Schroëder, B., 1969. The Lithic Industries from Jerf Ajla and Their Bearing on the Problem of a Middle to Upper Paleolithic Transition. (Ph.D. dissertation). Columbia University.
- Sellier, N., Bostyn, F., 2005. Corbehem (Pas-de-Calais), rue de Gouy-RD 45. Rapport de diagnostic. Lille.
- Shalagina, A.V., Kharevich, V.M., Serge, M., Baumann, M., Krivoschapkin, A.I., Kolobova, K.A., 2020. Reconstruction of the bifacial technological sequence in Chagyrskaya cave assemblage. *Siberian Hist. Res.* 3, 130–151.
- Shea, J.J., 1988. Spear points from the Middle Paleolithic of the Levant. *J. Field Archaeol.* 15, 441–450.
- Shea, J.J., 1991. The Behavioral Significance of Levantine Mousterian Variability (Unpublished Ph.D. dissertation). Harvard University, MA.
- Shea, J.J., 1998. Reply to Plisson and Beyries. *Paléorient* 24, 17–18.
- Shipton, C., Clarkson, C., Bernal, M.A., Boivin, N., Finlayson, C., Finlayson, G., Fa, D., Giles Pacheco, F., Petraglia, M., 2013. Variation in lithic technological strategies among the Neanderthals of Gibraltar. *PLoS ONE* 8 (6), e65185.
- Shunkov, M.V., Kozlikin, M.B., Derevianko, A.P., 2020. Dynamics of the Altai Paleolithic industries in the archaeological record of Denisova Cave. *Quat. Int.* 559, 34–46.
- Siddall, M., Rohling, E., Almogi-Labin, A., Hemleben, C., Meischner, D., Schmelzer, I., Smeed, D.A., 2003. Sea-level fluctuations during the Last Glacial cycle. *Nature* 423, 853–858.
- Sitlivy, V., Zięba, A., 2006. Eastern and Central Europe before 30 kyr BP: Mousterian, Levallois and Blade industries. In: Chabai, V., Richter, J., Uthmeier, T. (Eds.), *Kabazi II: The 70,000 years since the last interglacial. Paleolithic Sites of Crimea 2. Simferopol - Cologne*, pp. 361–420.
- Sitlivy, V., Zięba, A., Sobczyk, K., 2008. Middle and Early Upper Palaeolithic of the Krakow Region: Piekary IIa. *Musées Royaux d'Art et d'Histoire, Bruxelles*.
- Sitlivy, V., Zięba, A., Sobczyk, K., 2009. Middle and Early Upper Palaeolithic of the Krakow Region: Księcia Józefa. *Musées Royaux d'Art et d'Histoire, Bruxelles*.
- Sitlivy, V., Zięba, A., Sobczyk, K., Kolesnik, A., 2014. The Middle-to-Upper Palaeolithic Księcia Józefa open-air site (Krakow, Poland): lithic technology and spatial distribution. In: *Universitätsforschungen zur Prähistorischen Archäologie* 250. Habelt, Bonn.
- Škrdla, P., Nikolajev, P., 2014. Preliminary comparison of Kulychivka (lower layer) and Moravian Bohunician. In: *Materials and Studies on Archaeology of Sub-Carpathian and Volhynian Area* 18, pp. 78–86.
- Škrdla, P., Sytnyk, O., Koropets'kyi, R., 2016. New observations concerning Kulychivka site, layer IV. In: *Materials and Studies on Archaeology of Sub-Carpathian and Volhynian Area* 20, pp. 15–25.
- Slimak, L., 1999. Pour une individualisation des Moustériens de type Quina dans le quart sud-est de la France? La Baume Néron (Soyons, Ardèche) et le Champ Grand (Saint-Maurice-sur-Loire, Loire), premières données. *Bull. Soc. Préhist. Fr.* 96, 133–144.
- Slimak, L., 2006. Les dernières expressions du Moustérien entre Loire et Rhône. *Bull. Soc. Préhist. Fr.* 103 (3), 614–617.
- Slimak, L., Svendsen, J.I., Mangerud, J., Plisson, H., Heggen, H.P., Brugères, A., Pavlov, P.Y., 2011. Late Mousterian persistence near the Arctic circle. *Science* 332, 841–845.
- Slimak, L., Svendsen, J.I., Mangerud, J., Plisson, H., Heggen, H.P., Brugères, A., Pavlov, P.Y., 2012. Response to “comment on late Mousterian persistence near the Arctic circle”. *Science* 335, 167.
- Slon, V., Hopfe, C., Weiß, C.L., Mafessoni, F., de la Rasilla, M., Lalueza-Fox, C., Rosas, A., Soressi, M., Knul, M.V., Miller, R., Stewart, J.R., Derevianko, A.P., Jacobs, Z., Li, B., Roberts, R.G., Shunkov, M.V., de Lumley, H., Perrenoud, C., Gušić, I., Kučan, Ž., Rudan, P., Aximu-Petri, A., Essel, E., Nagel, S., Nickel, B., Schmidt, A., Prüfer, K., Kelso, J., Burbano, H.A., Pääbo, S., Meyer, M., 2017a. Neandertal and Denisovan DNA from Pleistocene sediments. *Science* 356, 605–608.
- Slon, V., Viola, B., Renaud, G., Gansauge, M.T., Benazzi, S., Sawyer, S., Hublin, J.J., Shunkov, M.V., Derevianko, A.P., Kelso, J., Prüfer, K., Meyer, M., Pääbo, S., 2017b. A fourth Denisovan individual. *Sci. Adv.* 3, e1700186.
- Slon, V., Mafessoni, F., Vernot, B., de Filippo, C., Grote, S., Viola, B., Hajdinjak, M., Peyrégne, S., Nagel, S., Brown, S., Douka, K., Higham, T., Kozlikin, M.B., Shunkov, M.V., Derevianko, A.P., Kelso, J., Meyer, M., Prüfer, K., Pääbo, S., 2018. The genome of the offspring of a Neanderthal mother and a Denisovan father. *Nature* 561, 113–116.
- Solecki, R.L., Solecki, R.S., 1970. A new secondary flaking technique at the Nahr Ibrahim cave site. *Bull. du Mus. Beyrouth* 23, 137–142.
- Soressi, M., Rendu, W., Texier, J.P., Claud, E., Daulny, L., d'Errico, F., Laroulandie, V., Maureille, B., Niclot, M., Schwart, S., Tillier, A.M., 2008. Pech de l'Azé I (Dordogne, France): nouveau regard sur un gisement moustérien de tradition acheuléenne connu depuis le XIXe siècle. In: Jaubert, J., Bordes, J.G., Ortega, I. (Eds.), *Les Sociétés Du Paléolithique Dans Un Grand Sud-Ouest de La France: Nouveaux Gisements, Nouveaux Résultats, Nouvelles Méthodes. Mém. Soc. Préhist. Fr. Société Préhistorique Française*, pp. 95–132.

- Soriano, S., Villa, P., 2017. Early Levallois and the beginning of the Middle Paleolithic in central Italy. *PLoS ONE* 12, e0186082.
- Spindler, L., Comeskey, D., Chabai, V., Uthmeier, T., Buckley, M., Devièse, T., Higham, T., 2021. Dating the last Middle Palaeolithic of the Crimean Peninsula: new hydroxyproline AMS dates from the site of Kabazi II. *J. Hum. Evol.* 156, 102996.
- Starkovich, B.M., Elefanti, P., Karkanias, P., Panagopoulou, E., 2020. Site use and maintenance in the Middle Palaeolithic at Lakonis I (Peloponnese, Greece). *J. Paleolit. Archaeol.* 3, 157–186.
- Sytnyk, O., 2012. Middle Paleolithic of Podillia: results, perspectives, miscalculations. In: *Materials and Studies on Archaeology of Sub-Carpathian and Volhynian Area* 16, pp. 38–54 (in Ukrainian).
- Szmidt, C., Moncel, M.-H., Daujeard, C., 2010. New data on the late Mousterian in Mediterranean France: first radiocarbon (AMS) dates at Saint-Marcel Cave (Ardèche). *C. R. Palevol* 9 (4), 185–199.
- Texier, P.J., Renault-Miskovsky, J., Desclaux, E., de Lumley, M.A., Porraz, G., Tomasso, A., 2011. L'abri Pié Lombard à Tourrettes-Sur-Loup (Alpes-Maritimes): Anciennes fouilles, nouvelles données. *Bull. Mus. Anthropol. Préhist. Monaco* 51, 19–49.
- Thiébaud, C., 2005. Le Moustérien à denticulés: variabilité ou diversité techno-économique? (Ph.D. dissertation). vol. 2 Université de Provence.
- Torfstein, A., Goldstein, S.L., Stein, M., Enzel, Y., 2013. Impacts of abrupt climate changes in the Levant from Last Glacial Dead Sea levels. *Quat. Sci. Rev.* 69, 1–7.
- Tourloukis, V., Harvati, K., 2018. The Palaeolithic record of Greece: a synthesis of the evidence and a research agenda for the future. *Quat. Int.* 466, 48–65.
- Tuffreau, A., 1993. Rencourt-lès-Bapaume, Pas-de-Calais: un gisement du Paléolithique moyen. In: *Documents d'archéologie française*. Ed. de la Maison des sciences de l'homme, Paris.
- Turk, I. (Ed.), 1997. Mousterian « bone flute » and other finds from Divje Babe I cave site in Slovenia. *Opera Instituti Archaeologici Sloveniae* 2. Založba ZRC, Ljubljana.
- Turq, A., Roebroeks, W., Bourguignon, L., Faivre, J.-P., 2013. The fragmented character of Middle Palaeolithic stone tool technology. *J. Hum. Evol.* 65, 641–655.
- Turq, A., Faivre, J.-P., Gravina, B., Bourguignon, L., 2017. Building models of Neanderthal territories from raw material transports in the Aquitaine Basin (southwestern France). *Quat. Int.* 433 (Part B), 88–101.
- Urbanowski, M., 2003. Pradnik knives as an element of Micoquian technostylistic specifics (Ph.D. dissertation). Warsaw University.
- Usik, V., 2006. The problem of Levallois method in Level II/8 of Kabazi II. In: Chabai, V.P., Richter, J., Uthmeier, T. (Eds.), *Kabazi II: 70000 Years Since the Last Interglacial. Palaeolithic Sites of Crimea* 2. Shlyakh, Simferopol – Cologne, pp. 143–168.
- Uthmeier, T., 2000. Stone tools, “time of activity”, and the transition from the Middle to the Upper Palaeolithic in Bavaria (Germany). In: Orschiedt, J., Weniger, G.-C. (Eds.), *Neanderthals and Modern Humans—Discussing the Transition: Central and Eastern Europe From 50.000–30.000 B.P.* Wissenschaftliche Schriften des Neanderthal Museums 2. Neanderthal Museum, Mettmann, pp. 133–150.
- Uthmeier, T., 2012. The Transition from Middle- to Upper Palaeolithic at Buran Kaya III, Crimea (Ukraine): a case of conceptual continuity of lithic artefact manufacture? In: Pastoors, A., Peresani, M. (Eds.), *Flakes not Blades: The Role of Flake Production at the Onset of the Upper Palaeolithic.* Wissenschaftliche Schriften des Neanderthal Museums 5. Neanderthal Museum, Mettmann, pp. 239–260.
- Uthmeier, T., 2016. Neanderthal utilitarian equipment and group identity: the social context of bifacial tool manufacture and use. In: Haidle, M., Conard, N., Bolus, M. (Eds.), *The Nature of Culture. Vertebrate Paleobiology and Paleoanthropology*. Springer, Dordrecht, pp. 65–77.
- Uthmeier, T., 2019. Das Große im Kleinen—Regionale Perspektiven für eine Erforschung des Mittelpaläolithikums in Bayern. *Festschrift für Klaus-Joachim Kind*. vol. 327 *Universitätsforschungen zur prähistorischen Archäologie* Band, pp. 109–124.
- Uthmeier, T., Chabai, V., 2010. Neanderthal subsistence tactics in the Crimean Micoquian. In: Conard, N.J., Delagnes, A. (Eds.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age III*. Kerns Verlag, Tübingen, pp. 195–234.
- Uthmeier, T., Kels, H., Schirmer, W., Böhner, U., 2011. Neanderthals in the cold: Middle Palaeolithic sites from the open-cast mine of Garzweiler, Northrhine-Westfalia (Germany). In: Conard, N.J., Richter, J. (Eds.), *Neanderthal Lifeways, Subsistence and Technology*. Springer, Dordrecht, pp. 25–42.
- Utrilla Miranda, P., Mazo, C., 1996. Non-Flint raw materials in La Rioja: a tentative interpretation. In: Moloney, N., Raposo, L., Santonja, M. (Eds.), *Non-Flint Stone Tools and the Palaeolithic Occupation of the Iberian Peninsula*. *Tempus Reparatum*, Oxford, pp. 63–80.
- Utrilla, P., Mazo, C., Domingo, R., 2015. Fifty thousand years of prehistory at the cave of Abauntz (Arraiz, Navarre): a nexus point between the Ebro Valley, Aquitaine and the Cantabrian Corridor. *Quat. Int.* 364, 294–305.
- Vallin, L., Masson, B., Caspar, J.-P., Depiereux, É., 2006. L'outil idéal. Analyse du standard Levallois des sites moustériens d'Hermies (Nord de la France). *Paléo* 18, 237–272.
- Valoch, K., 1988. Die Erforschung der Kůlna Höhle 1961–1976. *Moravské Muzeum*, Brno.
- Van Peer, P. (Ed.), 1992. *The Levallois Reduction Strategy*. Prehistory Press, Madison.
- Vaquero, M., 2008. The history of stones: behavioural inferences and temporal resolution of an archaeological assemblage from the Middle Palaeolithic. *J. Archaeol. Sci.* 35, 3178–3185.
- Vaquero, M., Romagnoli, F., 2018. Searching for lazy people: the significance of expedient behaviours in the interpretation of Palaeolithic assemblages. *J. Archaeol. Method Theory* 25, 334–367.
- Vaquero, M., Chacón, M.G., Cuartero, F., García-Antón, M.D., Gómez de Soler, B., Martínez, K., 2012a. The lithic assemblage of level J. In: Carbonell, E. (Ed.), *High Resolution Archaeology and Neandertal Behavior: Time and Space in Level J of Abric Romaní (Capellades, Spain)*. *Vertebrate Paleobiology and Paleoanthropology Book Series*. Springer, Dordrecht, pp. 189–311.
- Vaquero, M., Chacón, M.G., García-Antón, M.D., Gómez de Soler, B., Martínez, K., Cuartero, F., 2012b. Time and space in the formation of lithic assemblages: the example of Abric Romaní Level J. *Quat. Int.* 247, 162–181.
- Vaquero, M., Bargalló, A., Chacón, M.G., Romagnoli, F., Sañudo, P., 2015. Lithic recycling in a Middle Paleolithic expedient context: evidence from the Abric Romaní (Capellades, Spain). *Quat. Int.* 361, 212–228.
- Vaquero, M., Fernández-Laso, M.C., Chacón, M.G., Romagnoli, F., Rosell, J., Sañudo, P., 2017. Moving things: comparing lithic and bone refits from a Middle Paleolithic site. *J. Anthropol. Archaeol.* 48, 262–280.
- Vaquero, M., Romagnoli, F., Bargalló, A., Chacón, M.G., Gómez de Soler, B., Picin, A., 2019. Lithic refitting and intrasite artefact transport: a view from the Middle Paleolithic. *Archaeol. Anthropol. Sci.* 11, 4491–4513.

- Veil, S., Breest, K., Höfle, H.-C., 1994. Ein mittelpaläolithischer Fundplatz aus der Weichsel-Kaltzeit bei Lichtenberg, Lkr. Lüchow-Dannenberg. *Germania* 72, 1–66.
- Vernot, B., Akey, J.M., 2014. Resurrecting surviving Neandertal lineages from modern human genomes. *Science* 343, 1017–1021.
- Veselsky, A., 2008. Kabazi V: bone and stone tools used for flint knapping. In: Chabai, V.P., Richter, J., Uthmeier, T. (Eds.), *Kabazi V: Interstratification of Micoquian and Levallois-Mousterian Camp Sites 3/2*. Shlyakh, Simferopol - Cologne, pp. 427–454.
- Vettese, D., Daujeard, C., Blasco, R., Borel, A., Cáceres, I., Moncel, M.H., 2017. Neanderthal long bone breakage process: standardized or random patterns? The example of Abri du Maras (Southeastern France, MIS 3). *J. Archaeol. Sci. Rep.* 13, 151–163.
- Villa, P., Soriano, S., Pollarolo, L., Smriglio, C., Gaeta, M., D’Orazio, M., Conforti, J., Tozzi, C., 2020. Neandertals on the beach: use of marine resources at Grotta dei Moscerini (Latium, Italy). *PLoS ONE* 15 (1), e0226690.
- Viola, B., 2022. Different species on the horizon: The Denisova hominins. In: Romagnoli, F., Rivals, F., Benazzi, S. (Eds.), *Updating Neandertals. Understanding Behavioural Complexity in the Late Middle Palaeolithic*. Academic Press, Cambridge, pp. 55–69.
- Weber, T., 2012. Artefakt-Rohstoffe in Ostdeutschland. In: Floss, H. (Ed.), *Steinartefakte vom Altpaläolithikum bis in die Neuzeit*. Kerns Verlag, Tübingen, pp. 45–54.
- Weiss, M., 2015. Stone tool analysis and context of a new late Middle Paleolithic site in western central Europe. *Quartär* 62, 23–62.
- Weiss, M., 2020. The Lichtenberg Keilmesser—it’s all about the angle. *PLoS ONE* 15 (10), e0239718.
- Weiss, M., Lauer, T., Wimmer, R., Pop, C.M., 2018. The variability of the Keilmesser-concept: a case study from central Germany. *J. Paleolit. Archaeol.* 1, 202–246.
- Wenban-Smith, F.F., Bates, M.R., Schwenninger, J.-L., 2010. Early Devensian (MIS 5d–5b) occupation at Dartford, southeast England. *J. Quat. Sci.* 25, 1193–1199.
- Wenzel, S., 1998. Die Funde aus dem Travertin von Stuttgart-Untertürkheim und die Archäologie der letzten Warmzeit in Mitteleuropa. *Universitätsforschungen zur Prähistorischen Archäologie* 52.
- Wilson, L., 2007. Understanding prehistoric lithic raw material selection: application of a gravity model. *J. Archaeol. Method Theory* 14, 388–411.
- Wiśniewski, A., 2014. The beginnings and diversity of Levallois methods in the early Middle Palaeolithic of Central Europe. *Quat. Int.* 326, 364–380.
- Wiśniewski, A., Adamiec, G., Badura, J., Bluszcz, A., Kowalska, A., Kufel-Diakowska, B., Mikołajczyk, A., Murczkiewicz, M., Musil, F., Przybylski, B., Skrzypek, G., Stefaniak, K., Zych, J., 2013. Occupation dynamics north of the Carpathians and Sudeten during the Weichselian (MIS 5d-3): the Lower Silesia (SW Poland) case study. *Quat. Int.* 294, 20–40.
- Wiśniewski, A., Lauer, T., Chłoiń, M., Pyżewicz, K., Weiss, M., Badura, J., Kalicki, T., Zarzecka-Szubińska, K., 2019. Looking for provisioning places of shaped tools of the late Neanderthals: a study of a Micoquian open-air site, Pietraszyn 49a (southwestern Poland). *C. R. Palevol* 18, 367–389.
- Wiśniewski, A., Chłoiń, M., Weiss, M., Pyżewicz, K., Migal, W., 2020. On Making of Micoquian Bifacial Backed Tools at Pietraszyn 49a, SW Poland. *J. Paleolit. Archaeol.* 3, 856–888.
- Wragg Sykes, R.M., 2017. Neanderthals in the Outermost West: technological adaptation in the Late Middle Palaeolithic (re)-colonization of Britain, Marine Isotope Stage 4/3. *Quat. Int.* 433, 4–32.
- Yravedra, J., Sesé, C., López-Cisneros, P., Linares-Matás, C.G., Pernas-Hernández, M., Arrizabalaga, A., Jordá Pardo, J.F., Álvarez-Alonso, D., 2019. Lagomorph exploitation during the Upper Palaeolithic in the Northern Iberian Peninsula. New evidence from Coímbrre Cave (Asturias, Spain). *Quat. Int.* 506, 59–68.
- Zanchetta, G., Giaccio, B., Bini, M., Sarti, L., 2018. Tephrostratigraphy of Grotta del Cavallo, Southern Italy: insights on the chronology of Middle to Upper Palaeolithic transition in the Mediterranean. *Quat. Sci. Rev.* 182, 65–77.
- Zavala, E.I., Jacobs, Z., Vernot, B., Shunkov, M.V., Kozlikin, M.B., Derevianko, A.P., Essel, E., de Filippo, C., Nagel, S., Richter, J., Romagné, F., Schmidt, A., Li, B., O’Gorman, K., Slon, V., Kelso, J., Pääbo, S., Roberts, R.G., Meyer, M., 2021. Pleistocene sediment DNA reveals hominin and faunal turnovers at Denisova Cave. *Nature* 595, 399–403.
- Zilhão, J., Cardoso, J.L., Pike, A.W.G., Weninger, C.-G., 2011. Gruta Nova da Columbeira (Bombarral, Portugal): site stratigraphy, age of the Mousterian sequence, and implications for the timing of Neanderthal extinction in Iberia. *Quartär* 58, 93–112.
- Zilhão, J., Ajas, A., Badal, E., Burow, C., Kehl, M., López-Sáez, J.A., Pimienta, C.M., Preece, R.C., Sanchis, A., Sanz, M., Weniger, G.C., White, D., Wood, R., Angelucci, D.E., Villaverde Bonilla, V., Zapata, J., 2016. Cueva Antón: a multi-proxy MIS 3 to MIS 5a paleoenvironmental record for SE Iberia. *Quat. Sci. Rev.* 146, 251–273.
- Zwyns, J., Roebroeks, W., McPherron, S.P., Jagich, A., Hublin, J.J., 2012. Comment on “Late Mousterian persistence near the Arctic circle”. *Science* 335, 167.

Updating Neanderthals

Understanding Behavioural Complexity in the Late Middle Palaeolithic

Provides an updated and synthetic overview of Late Pleistocene Eurasian populations

Edited by

Francesca Romagnoli

Universidad Autónoma de Madrid, Madrid, Spain

Florent Rivals

ICREA at Institut Català de Paleoecologia Humana i Evolució Social, Tarragona, Spain

Stefano Benazzi

Alma Mater Studiorum Università di Bologna, Bologna, Italy

Updating Neanderthals: Understanding Behavioural Complexity in the Late Middle Palaeolithic provides the most up-to-date and comprehensive knowledge of Neanderthals who lived throughout the European and Asian continents. Focusing on the last phase of Neanderthal settlements and behaviours in Europe, the Levant, and across Asian regions, the book synthesises historical information about the study of Middle Palaeolithic populations and presents the current debates about their biology, subsistence, technology, and social and cognitive behaviours.

Written by international experts on the Middle Palaeolithic, the book explores the diversity and variability of human adaptations and behaviours in the changing climate and environment of the Late Pleistocene, and the relationship between these behaviours, demography, and cognitive capabilities. The book also discusses theoretical issues and shows how novel methods have improved our knowledge of human evolution. It also explores the new findings about the Denisovans and the arrival of *Homo sapiens*. The complete multidisciplinary approach includes archaeology, palaeoecology, genetics, and palaeoanthropology, transcending a 'case study approach' to present Neanderthals in the most complete way.

This book is a vital reference for researchers, students, and advanced amateurs in prehistory, archaeology, human evolution studies, evolutionary psychology, palaeoecology, and cultural evolution.

Key Features

- Offers a comprehensive update on the variability and diversity of Neanderthal behaviours during the Late Pleistocene
- Presents an interdisciplinary reconstruction of Neanderthals by assessing archaeology, palaeontology, palaeoecology, palaeoanthropology, genetics, and cognition
- Critically reviews the reliability of archaeological data and the theoretical and methodological advances of the past 30 years



ACADEMIC PRESS

An imprint of Elsevier
elsevier.com/books-and-journals

ISBN 978-0-12-821428-2



9 780128 214282