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## 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.

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# Updating Neanderthals

Understanding Behavioural Complexity in the Late Middle Palaeolithic

Edited by

Francesca Romagnoli, Florent Rivals  
and Stefano Benazzi



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

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## 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

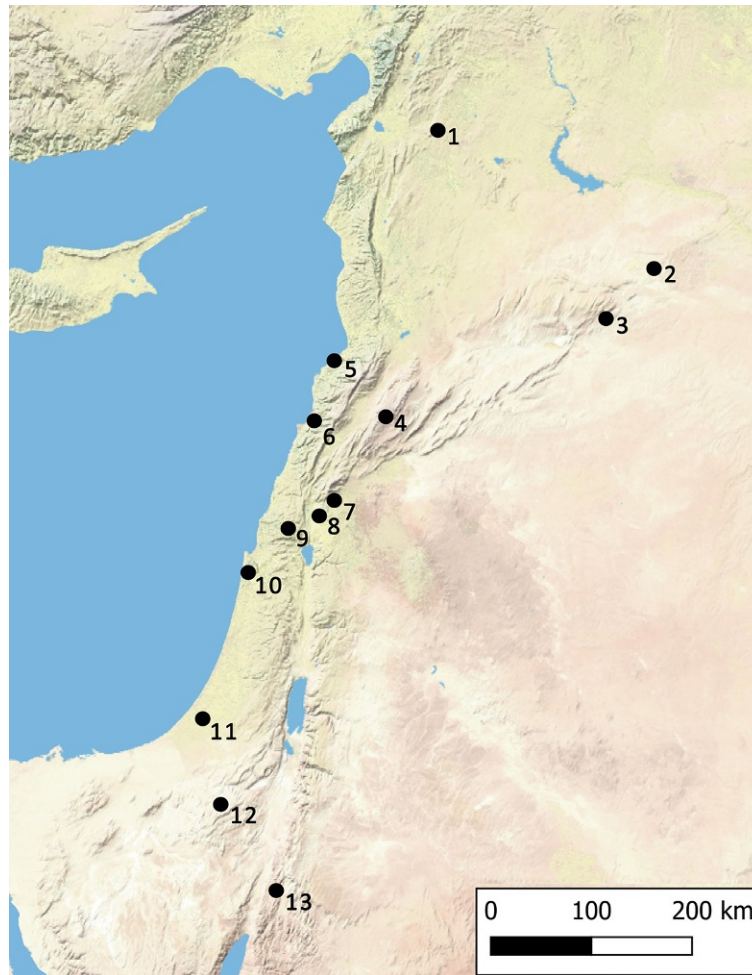
technology according to cyclical movements across the landscape, with retouched tools as a key element for reconstructing mobility strategies, particularly in relation to the concept of curation. Transported tools are characterised by longer duration of use, higher intensity of retouch, and large size (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 Mahanayem 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–gatherers 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).

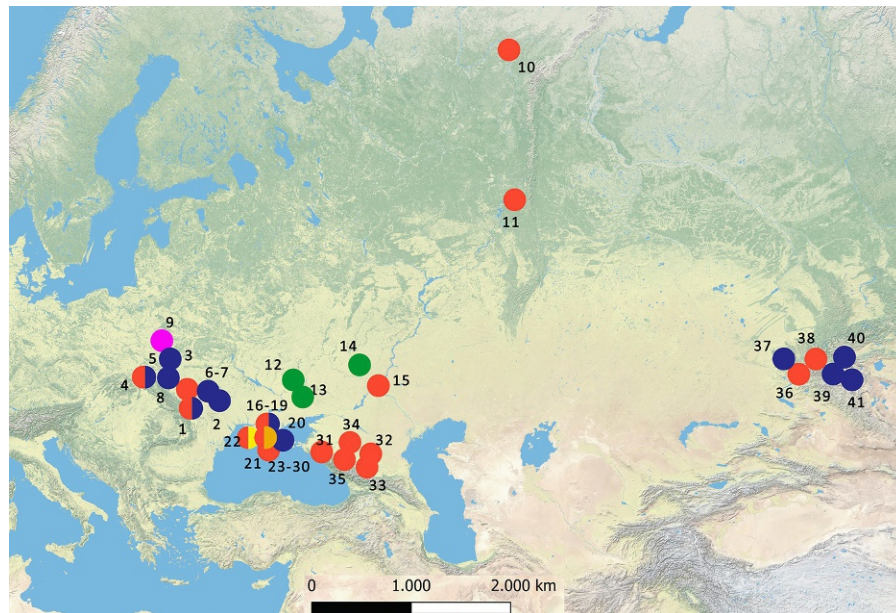
#### 4 The eastern regions: From the Altai to Eastern Europe

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; Krivoshepa 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

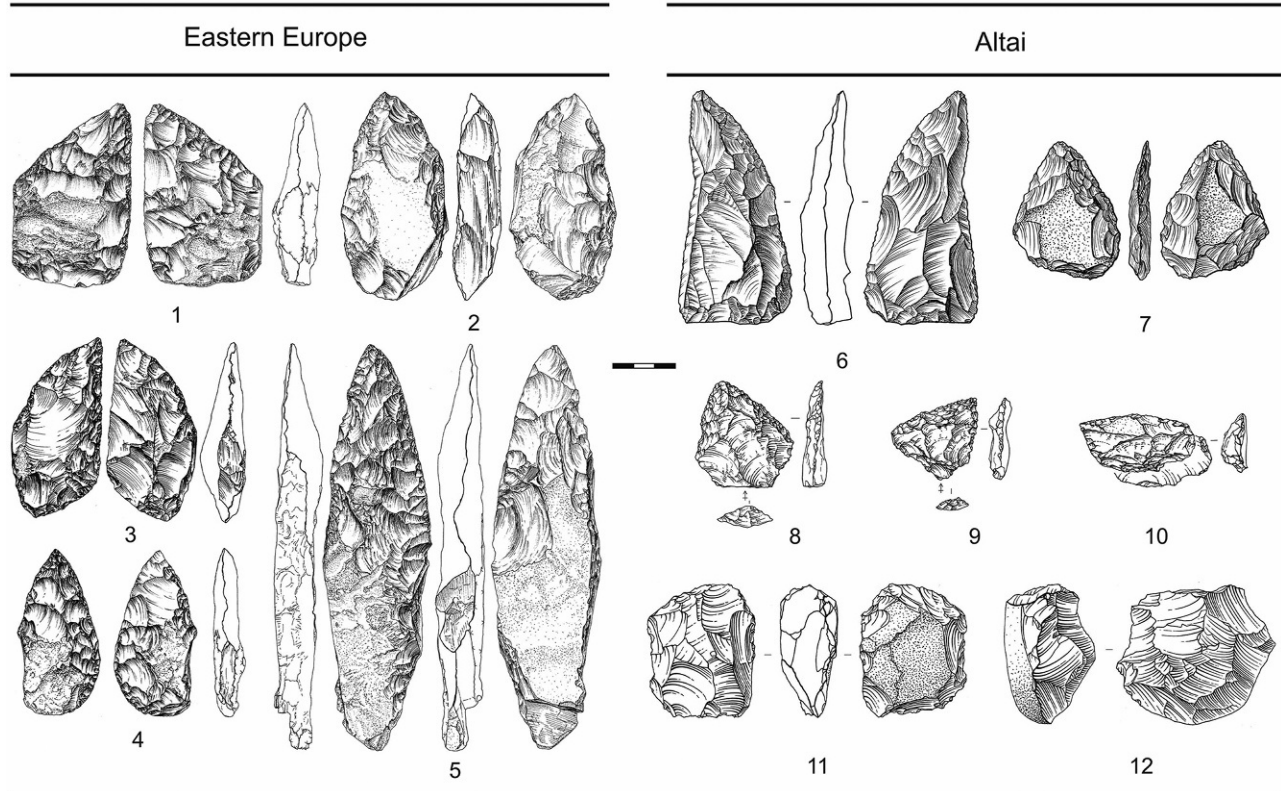
et al., 2007, 2008). In the Altai, no evidence of assemblage interstratification has been found. At the current state of research, no stratigraphic correlation between the Blade Mousterian and any other MP industry has been observed.

##### 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).

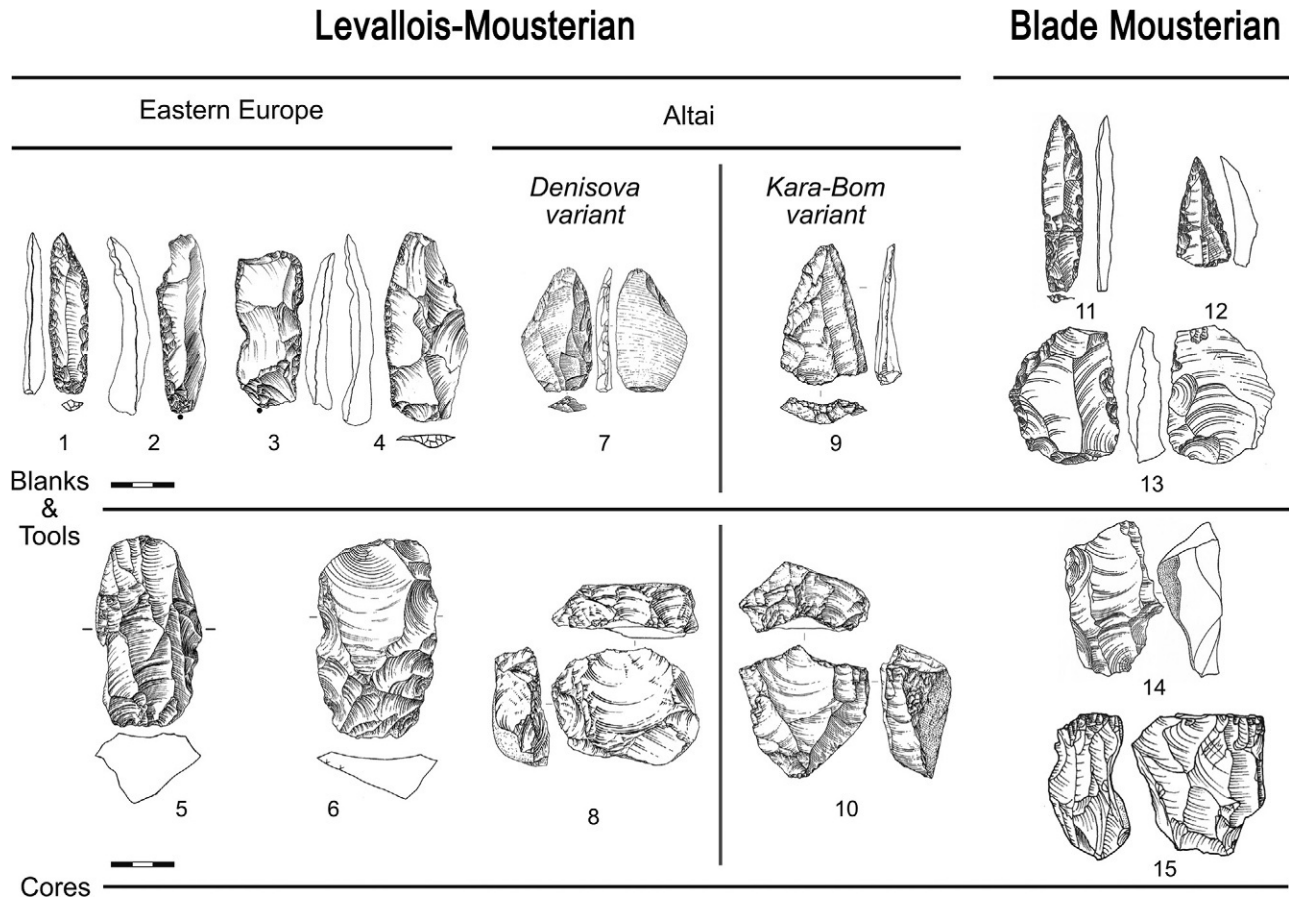
In western Ukraine, the appearance of a Levallois technology described as similar to that of the Emirian and Bohunician Kulychivka, layers III and IV (Fig. 10.2), is worth mentioning because it indicates the presence of a transitional industry between the Middle and the Upper Palaeolithic and is dated 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.*)

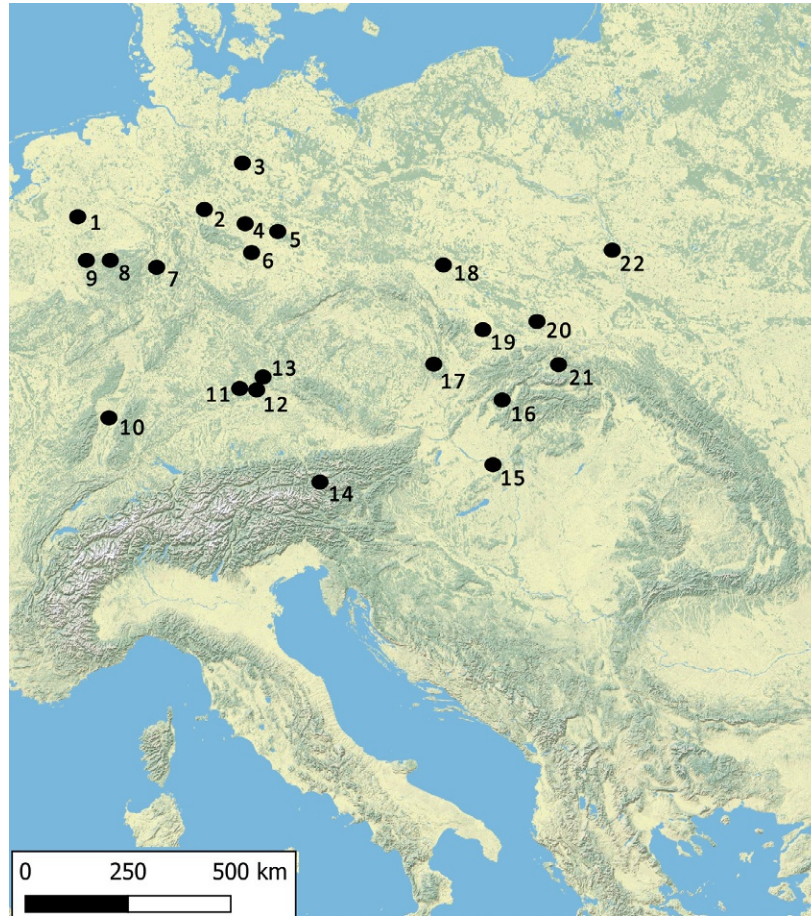
based on environmental studies, can be placed to the period between the beginning of the Early Glacial and the end of the lower Pleniglacial (approximately MIS 4). Core reduction usually took place on-site and involves local chert, which was preferred for nodules with a cylindrical shape.

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’ flint<sup>1</sup> 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.<sup>2</sup>

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 (SiO<sub>2</sub>). 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).

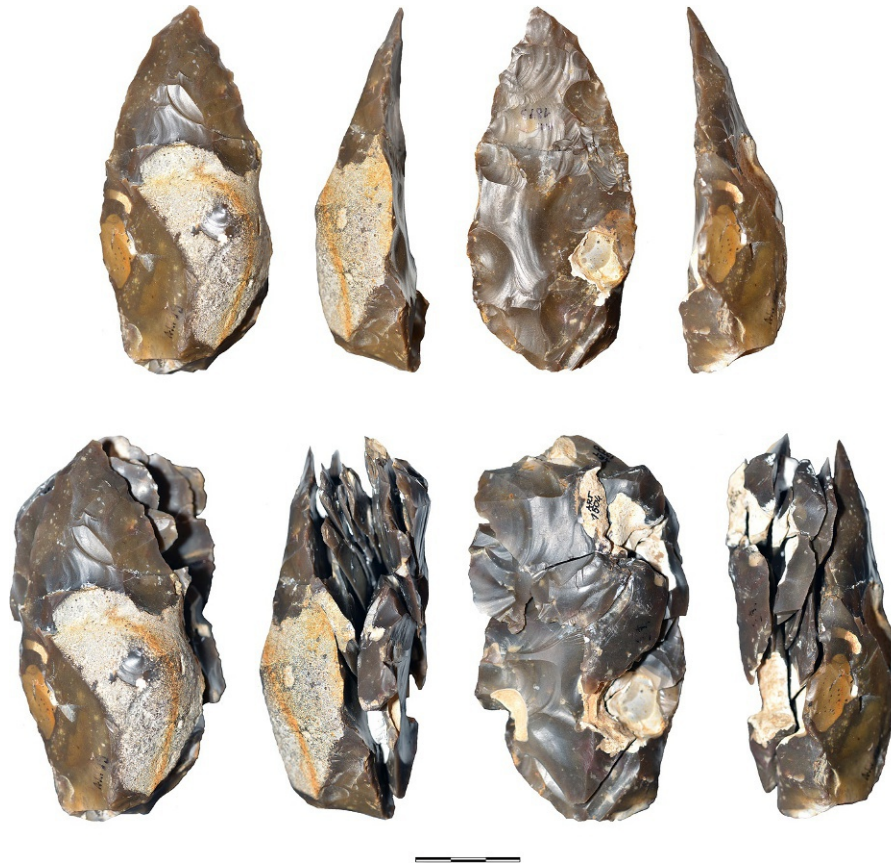


FIG. 10.6 Refit of a *Keilmesser* production sequence (bottom) and the resulting *Keilmesser* (top) from the site of Pietraszyn 49a. (Photos A. Wiśniewski.)

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 7c<sup>2</sup>).

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

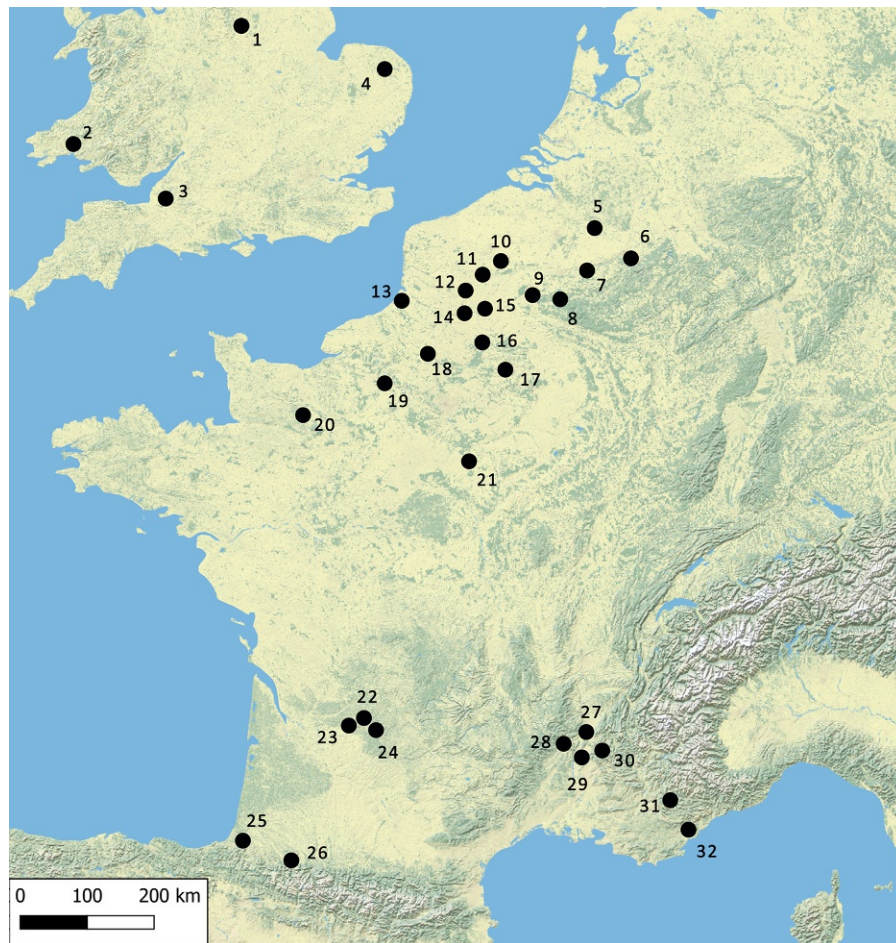
several central European KMG sites has documented a focus on the long-term maintenance of tool usability through different and often repeated phases of reduction and resharpening, leading to significant morphological transformation in shape and size (Buhlen: Jöris, 2001; Cienna: Krukowski, 1939–1948; 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; Coygan Cave; 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.

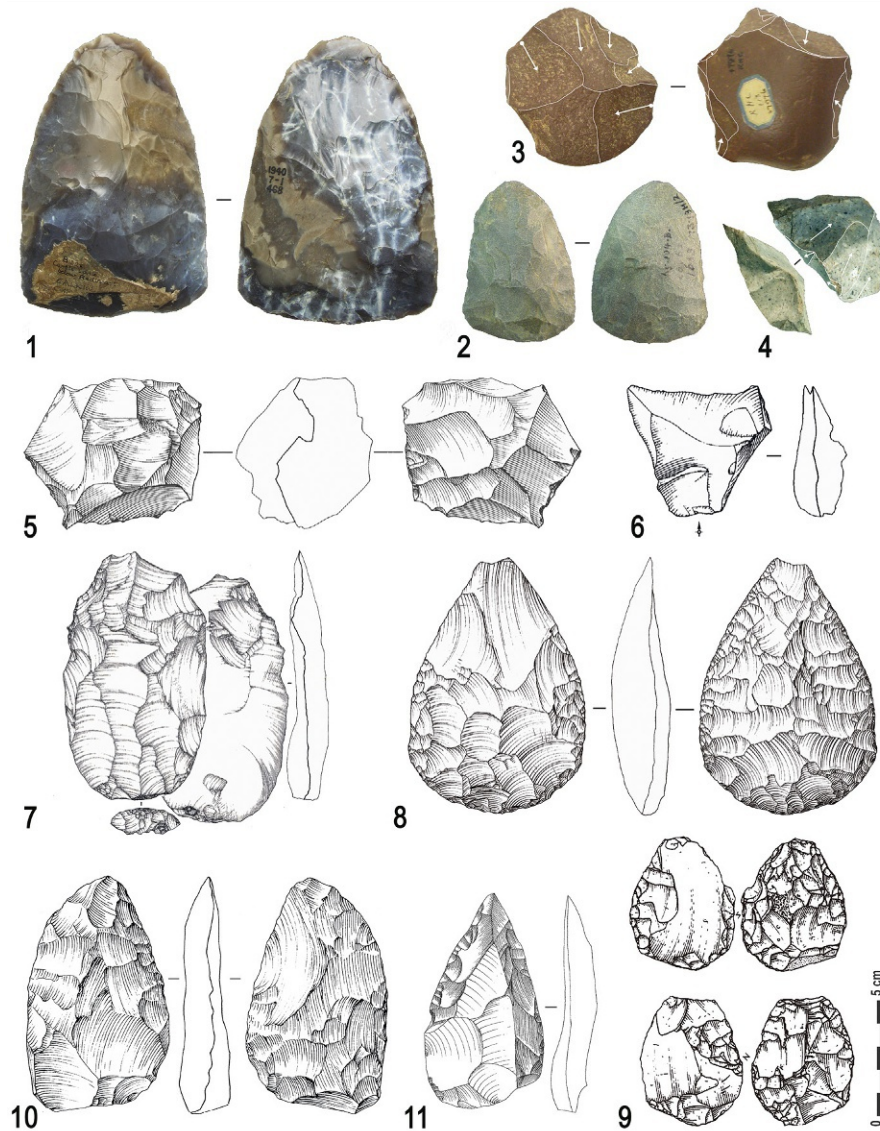
In south-western France, raw materials were generally transported less than 50 km. Their movement only rarely exceeds 100 km (see Turq et al., 2017, for a recent synthesis), with long-distance transport connecting areas rich in good-quality raw materials (i.e. the Périgord and Bergerac areas) with those 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: discoidal 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 (Feraÿ 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 Lautridou, 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 Loch, 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 Goyal, 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 Loch, 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.)

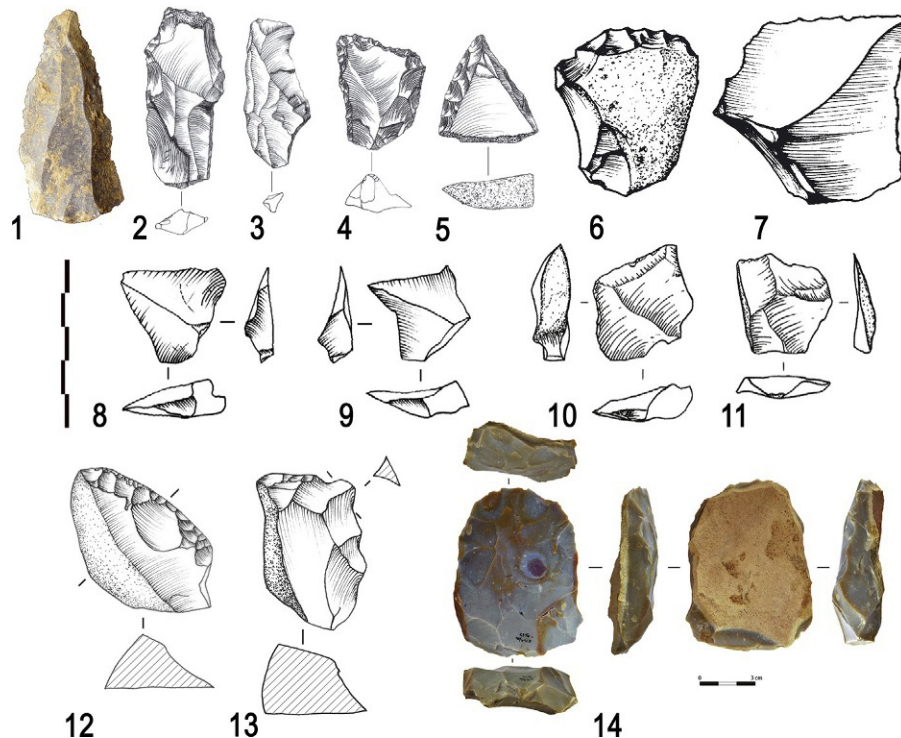
by an increase in multistratified archaeological sites (Faivre et al., 2014; Jaubert, 2010; Jaubert et al., 2011). In the south-east, a Quina facies has been identified at Grotte du Figuier based on the characteristics of retouch (Moncel et al., 2012). The Quina production system is observed at some 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 resharping, 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).

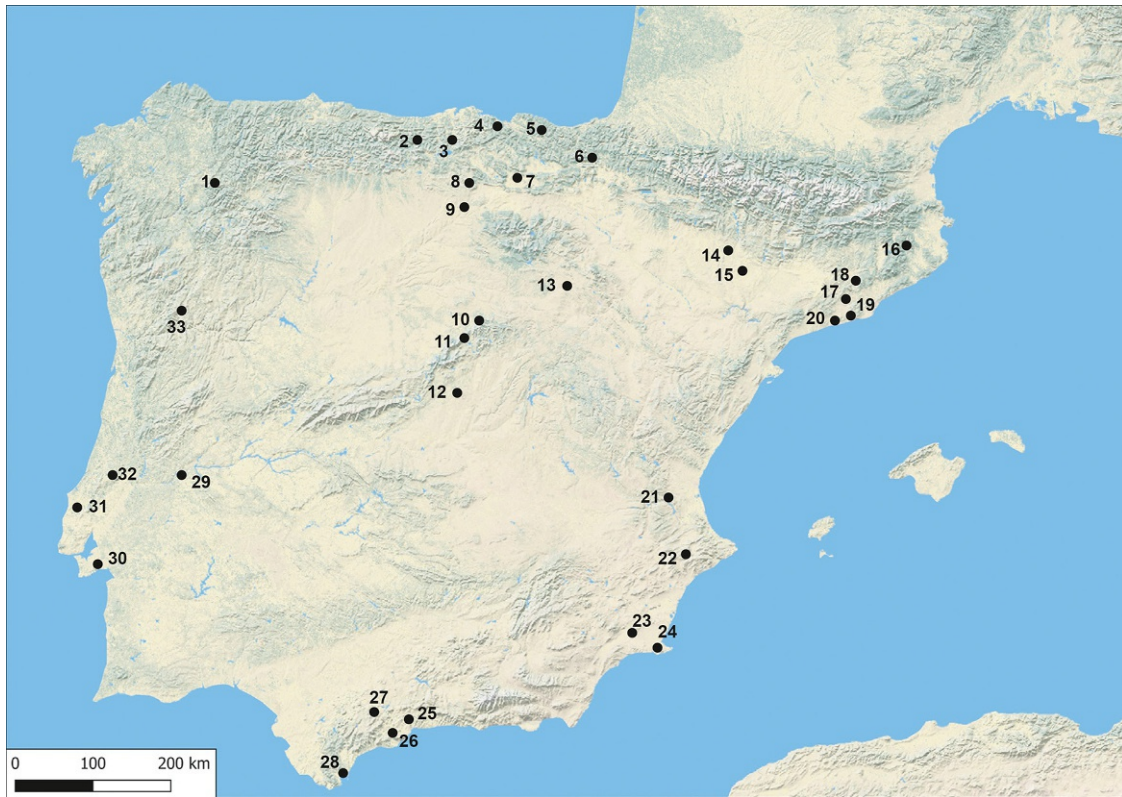
## 7 Mediterranean Europe

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.

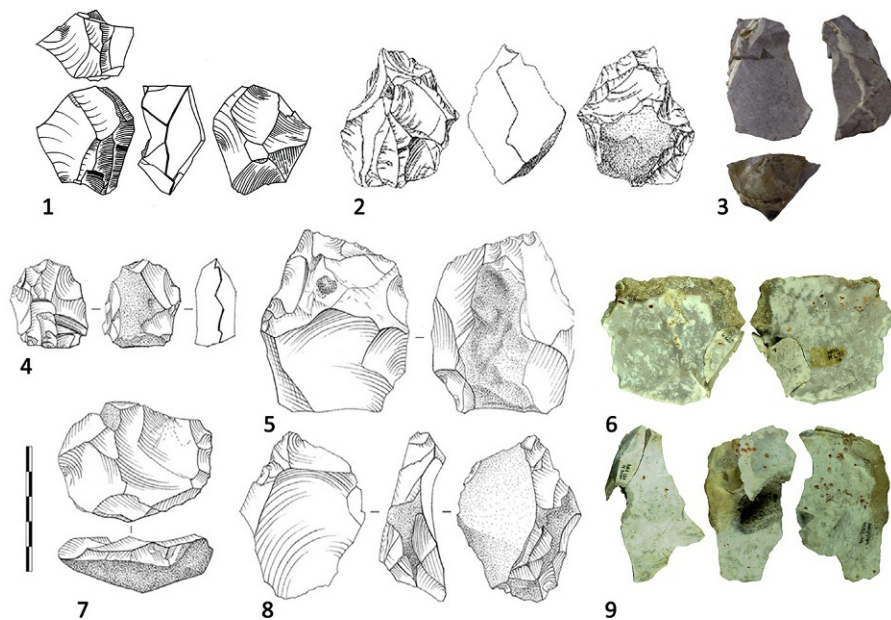
Despite the climatic fluctuations of MIS 3, the distribution of LMP sites in the Iberian Peninsula and catchment areas seems to have been more strongly affected by mobility strategies with a complex mosaic between long-term and short-term camps. Mobility patterns were most probably dependent on subsistence 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’Oscuruscuito; 3 Grotta di Castelcivita; 4 Grotta Reali; 5 Riparo Mochi, Grotta del Principe, Riparo Bombrini; 6 Madonna dell’Arma; 7 Grotta di Fumane, Riparo Tagliante; 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-

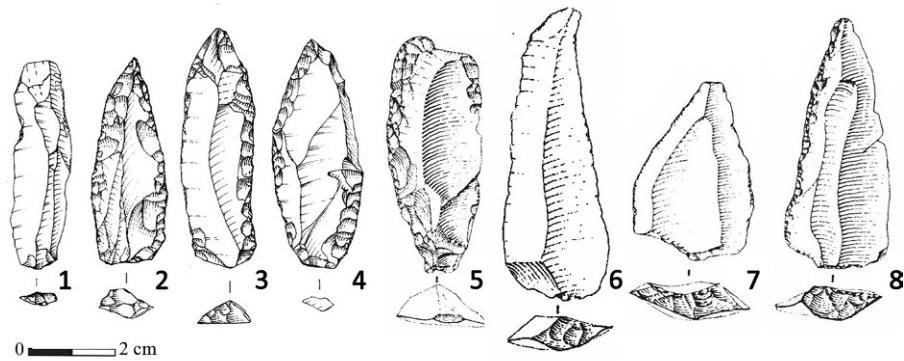
rectional and centripetal recurrent modalities. The main goal was the production of blades and flake blades with thin and regular edges, whereas the extraction of points had minor importance. The maintenance of the core convexities in the unidirectional modality was reduced to a minimum and prevalently 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  $\approx 170$  ka (Herskovitz 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; Herskovitz 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.

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# Updating Neanderthals

## Understanding Behavioural Complexity in the Late Middle Palaeolithic

*Provides an updated and synthetic overview of Late Pleistocene Eurasian populations*

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***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



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