Replacement of Neanderthals by Modern Humans Series

Yoshihiro Nishiaki
Takeru Akazawa *Editors*

The Middle and Upper Paleolithic Archeology of the Levant and Beyond

Springer

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The planned series of volumes will report the results of a major research project entitled "Replacement of Neanderthals by Modern Humans: Testing Evolutionary Models of Learning", offering new perspectives on the process of replacement and on interactions between Neanderthals and modern humans and hence on the origins of prehistoric modern cultures. The projected volumes will present the diverse achievements of research activities, originally designed to implement the project's strategy, in the fields of archaeology, paleoanthropology, cultural anthropology, population biology, earth sciences, developmental psychology, biomechanics, and neuroscience. Comprehensive research models will be used to integrate the discipline-specific research outcomes from those various perspectives. The series, aimed mainly at providing a set of multidisciplinary perspectives united under the overarching concept of learning strategies, will include monographs and edited collections of papers focusing on specific problems related to the goals of the project, employing a variety of approaches to the analysis of the newly acquired data sets.

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Preface

The aim of the Replacement of Neanderthals by Modern Humans project (RNMH2010–2014) was to make a contribution to one of the most intensely debated issues in paleoanthropology—the question of why replacement occurred between these two populations/species. In this respect, despite a long history of comparable research, the RNMH project is unique because it advocates the "learning hypothesis," the proposal that replacement occurred because of significant differences in adaptive technology due to innate variation in learning ability between Neanderthals and modern humans. Thus, a series of multi-disciplinary investigations were carried out for six years including the year of 2015 for synthesis under the auspices of the RNMH project in an attempt to verify this hypothesis.

Key outputs of the project have been published as individual journal articles as well as monographs in this Series, including conference proceedings. Results presented at the first international conference (RNMH2012) held in November 2012 in Tokyo, were published as Series 1 and Series 2; papers in these series discussed the dynamics of learning in Neanderthals and modern humans from cultural and cognitive perspectives, respectively. The second conference (RNMH2014) was held in December 2014, Hokkaido; in this case, outcomes were compiled according to specific disciplines and were combined with contributions from non-attending participants. In this second round of publication, Series 3, published in 2016, was devoted to developing an understanding of the evolution of learning ability via theoretical modeling, while Series 4, published in early 2017, comprised studies on the learning behavior of modern hunter-gatherers that were conducted by cultural anthropologists. This volume augments these earlier publications and contains a collection of papers that present archaeological evidence for the replacement of Neanderthals with modern humans with emphasis on the Levant and surrounding areas, the region where this transition is thought to have initially occurred in Eurasia.

Sessions at the RNMH2014 conference were held with the support of various individuals and institutions; we would like to extend our deep gratitude to Kenichi Aoki (Meiji University, Japan), Tomoya Aono (Date City Institute of Funkawan Culture, Japan), Ofer Bar-Yosef (Harvard University, USA), Tasuku Kimura (The University of Tokyo, Japan), Naomichi Ogihara (Keio University, Japan), Naoyuki Ohshima (Date City Institute of Funkawan Culture, Japan), Hiroki C. Tanabe (Nagoya University, Japan), Hideaki Terashima (Kobe Gakuin University, Japan), Motomitsu Uchibori (The Open University of Japan, Japan), and Minoru Yoneda (The University of Tokyo, Japan). In particular, we are very grateful to the Education Board of Date City, Hokkaido, and the Date Volunteer Society for Scientific Meetings, who prepared the venue for this international conference. We thank Christopher Bergman (AECOM, USA), Seiji Kadowaki (Nagoya University, Japan), Marcel Otte (University of Liège, Belgium), and Miho Suzuki (The University of Tokyo, Japan) for providing support and comments that were invaluable to the editing of this book.

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1 Archeological Issues in the Middle and Upper Paleolithic of the Levant and Its Neighboring Regions

Yoshihiro Nishiaki and Takeru Akazawa

Abstract

This chapter gives an introduction to the present volume, which presents overviews of the archeological data on the replacement of Neanderthals by modern humans in the Levant and its neighboring regions. The first part focuses on recent evidence from the Levant, the second part on the neighboring regions of the Caucasus, the Zagros, and South Asia. A total of 13 papers in this volume highlight the distinct nature of the cultural occurrences over the Middle and Upper Paleolithic periods of the Levant: they display a continuity and a mosaic of different lithic industries. This feature, hardly documented in the other regions discussed in this volume, reinforces the importance of the Levant as a special region in interpreting the RNMH phenomenon in West Asia.

Keywords

Neanderthals • Modern humans • Cultural interaction • Tabun model • Middle–Upper Paleolithic transition

1.1 Introduction

Studies of the replacement of Neanderthals by modern humans (RNMH) inevitably require an interdisciplinary research framework involving many disciplines, including archeology, physical anthropology, genetic anthropology, environmental sciences, and population biology, to mention but a few. The seven years since the launching of the RNMH research project have been enough to see a rapid increase in influential findings from these disciplines, notably from ancient genetic studies which represent one of the most rapidly developing research fields. Their overwhelming contributions include predictions of the timing of "Out-of-Africa" and the subsequent diversification of the modern human population groups in Eurasia (e.g. Fu et al. 2016; Malaspinas et al. 2016; Mallick et al. 2016; Pagani et al. 2016), the rates and timing of interbreeding between Neanderthals and modern humans (e.g. Viola and Pääbo 2013; Prüfer et al. 2014; Kuhlwilm et al. 2016), and the definition of a new indigenous hominin type in Paleolithic Eurasia, the Denisovans, whose morphological traits have not yet been fully defined with fossil records, and their interbreeding with the other hominins (e.g. Sawyer et al. 2015; Sankararaman et al. 2016; Slon et al. 2017). There have also been important findings in the fields of archeology. The discovery of different cultural traditions in the Middle Paleolithic of Central Asia, where Neanderthals and Denisovans have been identified in restricted geographic and chronological contexts, poses questions about possible cultural interactions between different hominin groups (Derevianko et al. 2013). In addition, the recognition of many of the behavioral traits long thought to be specific to modern humans within the archeological records of the Neanderthals has considerably blurred the

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behavioral distinction between those two populations (see Villa and Roebroeks 2014).

A consequence of these rapidly increasing findings is to encourage archeologists to recognize the replacement processes as being more complicated than previously thought, certainly rejecting a straightforward "replacement" model of one by the other. As interbreeding is suggested by genetic studies, cultural interactions should also be taken into consideration in identifying these processes with archeological data. Further, the possibility of regionally varied replacement processes, and hence region-specific mechanisms behind the replacement in each region, also needs to be taken into consideration. Accordingly, archeological research in this subject today requires more refined perspectives grounded in the interpretation of higher resolution data obtained through more rigorously controlled field methodology.

The archeology sessions at the RNMH2014 conference were organized on the basis of this recognition to survey the latest field information on the replacement processes across Eurasia. While the conference focused on verifying the "learning hypothesis" as an explanatory model for the replacement, it also aimed to collect fact-based reports from fieldwork, essential to test any theoretical hypothesis. The present volume is thus a compilation of selected papers from the sessions concerning the RNMH in the Levant and its neighboring regions, supplemented by a couple of non-participant contributions.

1.2 The Archeological Issues of the RNMH in the Levant

Situated at the junction of Africa, Europe, and Asia, the Levant has been recognized as a unique region in the RNMH research, displaying a set of evidence unseen in the other regions. Even in the early decades of the research history in the twentieth century, debates were sparked by the discovery of evidence of modern humans and Neanderthals in association with the Middle Paleolithic stone assemblages at the Mount Carmel sites in Israel (Garrod and Bate 1937; McCown and Keith 1939). Likewise, the occurrences of elongated blade elements, then thought to be a hallmark of the Upper Paleolithic, in Middle or even earlier Paleolithic contexts at Tabun Cave (Garrod and Bate 1937), Israel, and Yabrud (Rust 1950), Syria, puzzled Paleolithic archeologists (Bordes 1960). Furthermore, the curious mixture of Middle and Upper Paleolithic techno-typological traits in the lithic assemblages from Ksar Akil (Ewing 1947) and Abou Halka (Haller 1942–1943) in Lebanon also attracted much attention as they suggested transitions over these critical periods (Garrod 1951, 1955; for the research history see Marks and Rose 2014; Leder 2014).

One of the most significant breakthroughs in the pursuit of the replacement processes in the Levant is probably the introduction of developed radiometric dating methods for the key fossil and lithic remains in the 1980s. Those techniques, including thermo-luminescence (TL), electron spin resonance (ESR), and optically stimulated luminescence (OSL), placed the then-known early modern human fossils of Qafzeh (Valladas et al. 1988) and Skhul (Grün et al. 2005) bracketed in the MIS 5, ca. 120 to 90 ka, and the Neanderthal remains from Kebara Cave (Valladas et al. 1987) and Amud (Valladas et al. 1999; Rink et al. 2001) in the period ca. 70 to 50 ka, in the MIS 4 to 3. Given the existence of anatomically modern human fossils in the Initial Upper Paleolithic (IUP) in MIS3 (Bergman and Stringer 1989; also see Güleç et al. 2007), the chronological relationships suggested alternate occupations of the Levant by two groups of human populations, having turned each other over in different time periods (Shea 2008). This view apparently matched the chronological model proposed in the 1970s to 1980s for lithic assemblages, which surmised the successive occurrences of three different Levantine Mousterian industries, each defined as Tabun D-, C-, and B-type according to the long Middle Paleolithic stratigraphic sequence (Copeland 1975, 1981; Bar-Yosef 2000, 2002): associations were assumed between Tabun C and modern humans, and Tabun B and Neanderthals.

In the last decade, this sequential or turnover model has come to be reviewed by new discoveries and reanalyses of the extant finds. While the discovery of Neanderthal remains from Ein Qashish, OSL dated to 70 and 60 ka (Been et al. 2017), and the confirmation of the association between Neanderthal fossils and Tabun-B type lithic assemblages at Dederiyeh Cave, Syria (Nishiaki et al. 2012) has provided a supporting view, the discovery of an ostensibly modern human skull, with an U/Th date of 55 ka, at Manot Cave challenged this simple view (Hershkovitz et al. 2015). Moreover, morphological reevaluation of the fossil records of the Middle Paleolithic has suggested a large anatomical diversity within each group of fossils, casting doubt on the distinction even between the two hominin groups: "in place of the Neanderthal versus modern human model frequently proposed, the idea of a more complicated situation in the Levant cannot be rejected" (Tillier and Arensburg 2017).

The simple turnover model can also be reconsidered with new archeological evidence. Significant in this regard is the availability of more lithic evidence from the inland Levant today. Recent fieldwork in the Syro–Arabian Desert has revealed the distribution of Middle Paleolithic lithic assemblages unassignable to any of the three Tabun type-industries, for example, flake assemblages with bifacial foliates and those with the Nubian Levallois of methods (e.g. Armitage et al. 2011; Rose et al. 2011; Usik et al. 2013). Their techno-morphological features, almost identical with those of the

Middle Stone Age complexes, point to the existence of populations in the Arabian Peninsula closely linked with modern humans of northeast Africa. The reports of comparable materials from the Sinai Peninsula (Goder-Goldberger et al. 2016) suggest that those populations might have had cultural interactions with the Tabun groups in the Levant, just north of the desert (Rose and Marks 2014).

Understanding of the lithic industrial changes in the coastal region of the Levant also needs to be further defined in relation to the Tabun model. At the late Middle Paleolithic site of the Kebara Cave, which is often regarded as a typical Tabun B-type site, lithic assemblages with perfect Tabun B-type features appeared in the earlier layers, and those from the upper layers yielded assemblages with Levallois flakes produced from radially prepared cores (Meignen and Bar-Yosef 1992). A similar contrast has been also reported in the late Middle Paleolithic sequence of the Dederiyeh Cave, consisting of two phases: the occurrence of typical Tabun B assemblages was identified in its earlier phase, and it was overlain by assemblages with ad hoc flake and blade tools produced from unidirectionally flaked Levallois cores but with few short broad-based Levallois points of the Tabun B type (Nishiaki et al. 2012).

1.3 The Levantine Middle and Upper Paleolithic

Given the existence of modern humans and Neanderthals in the Middle Paleolithic of the Levant, major questions posited in this context for archeology may include the following: how archeological evidence can be used to define the population dynamics in the Middle Paleolithic, whether the evidence reflects the co-existence or turnover of different population (hominin) groups, and whether the Neanderthal cultures contributed to the formation of modern human cultures in the Upper Paleolithic of the Levant. Since the present volume is composed primarily of papers presented at the RNMH2014 conference, it does not fully cover all the related issues. Nevertheless, the papers presented in two parts contribute to our better understanding of these archeological issues from original perspectives.

Part I deals with archeological issues in the Middle Paleolithic (Chaps. 2, 3, 4 and 5) and the Initial/Early Upper Paleolithic (Chaps. 6, 7 and 8) of the Levant. As noted above, the widely accepted chronological model for the Levantine Middle Paleolithic presumes three phases: the early, middle, and late phases, each represented by the Tabun D-, C-, and B-type industries of the Levantine Mousterian, thought to correspond to the MIS 7 to 6 (ca. 250 ka to 130 ka), MIS 5 (130 ka to 75 ka), and MIS 4 to 3 (75 ka to 45 ka) respectively (e.g. Shea 2008, 2013). Chapter 2 reports on the discovery of a distinct lithic industry at the open-air site of Nesher Ramla, situated in the karstic environments of south Israel, OSL dated to ca. 160 ka to 120 ka. Contrary to the expectation of the presence of a blade-rich industry of the Tabun D-type in this period, the recovered lithic assemblages exhibit the dominant production of Levallois flakes, reminiscent of the Tabun C- or B-types. Moreover, the assemblages exhibited the frequent production of naturally backed flake-knives and the common practice of recycling side-scrapers by resharpening the edges with systematic lateral spall removal unknown in the other Levantine assemblages to date. The authors of this chapter interpreted these unique elements as "part of the cultural package of the Nesher Ramla hominins previously unknown."

Unique lithic evidence from the late Middle Paleolithic context is the subject of Chap. 3. The open-air site of Nahal Mahanyeem Outlet (NMO) on the banks of the Upper Jordan River, OSL dated to 60 ka, is considered a short-term late Middle Paleolithic occupation camp for hunting and butchering. Unlike many of the cave and rockshelter sites, where archeological data are available only in the form of palimpsests or as the sum of residues derived from an unknown number of activity floors, the floor records at NMO were regarded as representing uniquely high-resolution data from a very short-term activity of late Middle Paleolithic hominins. Careful technological study, based on refitted pieces, revealed the practice of platform abrasion for the production of elongated blanks, a technique rather reminiscent of the Upper Paleolithic. Together with the abundant occurrence of elongated points instead of the broad-based Levallois points of the Tabun B-type, the NMO assemblages can be regarded as displaying part of the cultural diversity during the late Middle Paleolithic of the southern Levant.

Chapter 4 also deals with the late Middle Paleolithic. As mentioned earlier, Manot Cave is of great interest because it yielded a modern human fossil, U/Th dated to 55 ka, whose chronological and geographical positions wholly overlap those of the Neanderthals in the Levant. While the Middle Paleolithic lithics that might have been associated with this fossil are only available from the Upper Paleolithic layers, this chapter reports an interesting lithic artifact in those derived assemblages. It is a Levallois core with engravings made by sharp tools on its cortical back, most likely on purpose. The best parallels are known from Qafzeh Cave (Hovers et al. 1997) and Quneitra (Marshack 1996), Israel, the former of which was recovered with modern human fossils. Although contextual data is absent to establish the association of this important artifact with the modern humans at Manot Cave, this engraved core suggests that the practice of symbolic behavior was not uncommon in the Levantine Middle Paleolithic.

The behavioral diversity of the Middle Paleolithic hominins can be defined with a variety of archeological records. Chapter 5 refers to the possible flint mining activities in the

Middle Paleolithic of the Levant. The abundant reports of lithic raw material quarrying sites through pit digging in the Middle Stone Age of the Lower Nile valley of North Africa (e.g. Vermeersch et al. 1995) suggest comparable practices in the Levant. One such candidate is the series of open-air sites in Mount Carmel, where Middle Paleolithic lithic artifacts occur among heaps of abundant limestone rocks originally interpreted as having been extracted to obtain flints embedded in-between. A critical evaluation in this chapter concludes, however, that these rocks were residues of limestone quarrying to obtain building materials in the historical period, irrelevant to the Middle Paleolithic. Considering that Middle Paleolithic flint mining sites, at least for surface quarrying, have been reported from other sites as well (Finkel et al. 2016), the practice of flint quarrying itself in the Levant would not be rejected. This chapter suggests a more cautious approach toward the interpretation of such records.

The next three chapters (Chaps. 6, 7, and 8) look at the cultural dynamics of the Levantine Upper Paleolithic. The earliest IUP assemblages are defined with a series of distinct techno-typological elements (Kuhn 2003), including chamfered pieces and Emireh points as two *fossiles directeurs* of this period, whose spatio-temporal distribution is discussed in Chap. 6. Their different geographic distribution pattern was known already in the 1950s: chamfered pieces were more commonly discovered in the northern Levant, and Emireh points more in the south (Garrod 1962). This pattern can now be examined with a much larger data set and demonstrates the unique position of the central Levant, where IUP sites with both types are concentrated, the Keoue Cave being one such site in Lebanon. Further, this chapter points out a temporal pattern as well: Emireh points were popular earlier, and chamfered pieces later, manufactured even after the disappearance of Emireh points. These patterns seem to correlate well with the current general consensus that the IUP developed earlier in the south, and then expanded to toward the north.

The next cultural entity appearing in the Levant is the Early Ahmarian, a fully developed Upper Paleolithic industry with the established use of the volumetric concept of cores for bladelet production and the common manufacturing of backed bladelets. These features are not fully seen in the IUP, which still contains Middle Paleolithic elements like Levallois core reduction and Levallois points. The traditional view that the Early Ahmarian originated from the local IUP of the Levant is reviewed in Chap. 7, with a conclusion that "it is impossible to tie in the origins of the Ahmarian directly with any of the known IUP variants in the Near East." The processes of the emergence of the full-fledged Upper Paleolithic in the Levant are thus yet to be determined. In fact, the possibility has even been suggested that the Proto-Aurignacian of southeast Europe, which shares a number of techno-typological features with the Early Ahmarian, might have emerged earlier than the Ahmarian (Kadowaki et al. 2015). The development processes of Early Ahmarian also constitute a matter of further study. With reference to the new data from the Wadi Kharar 16R site, the middle Euphrates of Syria, Chap. 8 argues that the Early Ahmarian of the northern Levant exhibits a mixture of techno-typological elements of Early Ahmarian proper and Levantine Aurignacian. As with its initial stages, discussed in the previous chapter, the emerging regional variability in the Early Ahmarian also appears to have been a complex phenomenon which might have involved contacts with different cultural groups.

1.4 The Middle and Upper Paleolithic of the Caucasus, the Zagros, and South Asia

In Part II of this volume we turn our attention to the neighboring regions of the Levant, i.e., the Caucasus, the Zagros, South Asia, and further. As in Part I, the main concern is when and how the Upper Paleolithic started. However, the chapters here tend to consider the possibility of external as well as internal origins, acknowledging that the Upper Paleolithic emerged earlier in the Levant than elsewhere in West Asia.

The overview starts in Chap. 9 by providing the latest data from the Caucasus. In spite of the rapid increase in the number of field investigations, mainly in Georgia and Armenia, no IUP assemblages have ever been reported from the Caucasus. In this regard, the Upper Paleolithic site of Aghitu-3 Cave, Armenia, is an invaluable source of information as the site with the oldest radiometric dates in the region, ca. 39 ka. The associated lithic assemblages no doubt represent a fully developed UP industry, comparable to Early Ahmarian, characterized by bladelet production with volumetric cores and the manufacturing of baked bladelets. What is emphasized in this chapter is the complete lack of any link between this earliest UP and local Middle Paleolithic industries, suggesting a rather abrupt replacement of the Middle by the Upper Paleolithic in the Caucasus. This chapter also points outs an intriguing pattern in the regional distribution of lithic industries over these periods. The industrial contrast seen between the northern and the southern Caucasus during the Middle Paleolithic disappeared in the Upper Paleolithic, when a single bladelet industry was widely distributed across the mountains. The authors of this chapter suggest a rapid and widespread dispersal of modern humans and the development of a new social network in the Upper Paleolithic, probably arising from a far more mobile settlement pattern than before.

Chapters 10 and 11 are concerned with evidence from the Zagros, where some authors suggest an industrial continuity between the Middle and the Upper Paleolithic, although admittedly with some reservations (see Olszewski and Dibble 1994, 2006; Olszewski 2007). Moreover, even suggestions on a link between the European Aurignacian and the Zagros Upper Paleolithic have also been presented (Otte and Kozlowski 2009). A critical review of the archeological records from relevant sites including Warwasi and Yafteh Caves is provided in Chap. 10. The conclusion is that the available evidence is insufficient to verify the Middle–Upper Paleolithic continuity in the Zagros, and this chapter suggests two alternative interpretations of the admixture of Middle and Upper Paleolithic elements at certain sites like Warwasi: a stratigraphic or taphonomic mixing, and the possibility of its indicating visits by different human populations to the same site at short intervals. As a matter of fact, the admixture of Middle and Upper Paleolithic elements in the Zagros Upper Paleolithic is seen in the form of the presence of Middle and Upper Paleolithic-type artifacts in the same assemblages, while in the Levant they are seen on the same artifacts, for example, the manufacturing of Upper Paleolithic-type tools on Middle Paleolithic-type blanks, which has not been documented in the Zagros.

The next chapter, Chap. 11, investigates behavioral characteristics of the Upper Paleolithic populations in the southern Zagros. On the basis of the excavation of the Ghār-e Boof Cave and a general survey of its surroundings, the Dasht-e Rostam-Basht region of the southern Zagros, a local EUP lithic industry or "Rostamian" has been proposed (Conard and Ghasidian 2011). This chapter discusses how this distinct industry (see a different view in Chap. 10), characterized by significant bladelet production and backed pieces, emerged from an ecological point of view. Combining the lithic data and other data like faunal records, the author suggests a combination of the highly mobile settlement pattern and the raw material constraints in the local environments as the main factors leading to the emergence of this industry. Comparably mobile settlement patterns are also pointed out for the Early Upper Paleolithic of the Caucasus, and interestingly, the consequent lithic industry of the Caucasus is similarly characterized by the common production of bladelets and bladelet tools (Chap. 9).

The third region for review in Part II is South Asia. Chapter 12 focuses on the geographic distribution of Levallois artifacts in the Middle Paleolithic contexts in South Asia. The dense distribution of Levallois-dominated assemblages in the mountain foothills of Pakistan and the northwest part of the Indian continent is demonstrated, although mainly as surface finds. The absence of comparable assemblages further to the east requires an adequate interpretation from both cultural and biological viewpoints. Another interesting issue from the data shown in this chapter is that the techno-typological features of those Levallois industries do not necessarily correspond to those of the Zagros Mousterian distributed to the west. Do the Levallois-dominated assemblages in South Asia reflect the range expansion of Neanderthals from the Zagros, or modern humans coming through the Arabian Desert, or others? The key information should be provided from future research in the southern Zagros, a focal region for understanding the relationship to the hominins of Arabia, where very little has been known on the Middle Paleolithic. The discovery of lithic assemblages containing Nubian Levallois cores, allegedly reported from Pakistan (Blinkhorn et al. 2013), also remains to be tested with stratigraphic data.

The last article, Chap. 13, looks at the available archeological evidence from a different viewpoint, namely employing a computer simulation method to infer the expansion routes of modern humans from the Levant to northern Eurasia. Lithic assemblages more-or-less comparable to those of the Levantine IUP have been widely recovered in northern Eurasia from Central Europe, East Europe, and the Altai Mountains of east Central Asia, or even further to the east, suggesting the distribution is due to modern human dispersals from the Levant (Škrdla 2013; cf. Kuhn and Zwyns 2014). Supposing the southern Levant as a starting point of modern human expansion in Eurasia, this chapter predicts possible expansion routes based on a computer-based niche probability model, which allows the identification of the least-cost paths to the above target regions. This simulation assumes that the regions with environmental conditions (temperature, precipitation, altitude, and others) most comparable to those of the southern Levant were favored as priority regions to be passed through by the early IUP immigrants. The model then suggests routes to Central Europe via Anatolia and the Danube Valley, to the Russian Steppe of East Europe through the east coast of the Black Sea, and to the Altai region along the southern foothills of the Zagros and the Afghanistan plateau. It is interesting to see that the suggested routes to East Europe are more or less comparable to those postulated from the evidence in archeological records (Conard and Bolus 2003), and the bypasses to the Russian plain and Central Asia avoiding the Caucasus and the Zagros Mountains also match the archeological data (Chaps. 9 and 10). In further testing the suggested model with archeological data, it is important to note that the model does not incorporate the presence of indigenous populations like Neanderthals in the regions to be occupied by the IUP groups. This should be considered in interpretation when the actual expansion routes do not match the suggested least-cost paths.

1.5 Conclusion

The chapters of this volume highlight the unique status of the Levantine records in the RNMH research of West Asia. This is partly due to the rich data from the long and intensive research history in the Levant, incomparable with those of other regions dealt with in this volume. At the same time, it may also reflect the unique events that actually occurred in the Levant: the possible co-existence of Neanderthals and modern humans for a much longer period than elsewhere, either by way of turnover in different periods, contemporaneously in different environmental settings, or overlapping in both time and place. If there were periods of co-existence, complex cultural interactions and replacement processes would probably have taken place. Comparable patterns may have occurred in the Caucasus, the Zagros, and South Asia, but the absence of the IUP or the transitional phenomena in these regions suggest different processes.

Archeological records as reviewed in this volume, far more abundant than the fossil records, should play a vital role in this attempt to elucidate how the replacement processes took place (see Shea 2017). Disentangling the complex cultural events in the Levant continues to be a major challenge for archeologists now equipped with much more refined field methodologies and radiometric dating techniques. New data, especially from previously less investigated regions like the Arabian Desert and Anatolia, which will help further characterize the Levantine situation, be especially welcome.

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Part I

The Levant

2 An Open-Air Site at Nesher Ramla, Israel, and New Insights into Levantine Middle Paleolithic Technology and Site Use

Yossi Zaidner, Laura Centi, Marion Prevost, Maayan Shemer, and Oz Varoner

Abstract

A recently discovered site at Nesher Ramla, Israel (170–80 ka BP) is an open-air, eight-meter-thick Middle Paleolithic sequence situated in a deep karst sinkhole that acted as a sedimentary basin in which colluvial deposition was intermittent with *in situ* human activities. Presence of combustion features, excellent preservation of lithic artifacts and animal bones, and distinct concentrations of bones, lithics, and manuports point to the *in situ* human activities in the sinkhole.

The lithic assemblage from Nesher Ramla is the largest and best-preserved in the Levant dating to the latter half of MIS 6 – early MIS 5 (160–120 ka BP), offering a great opportunity to investigate changes and variations in human lifestyles and the exploitation of open landscapes for a period during which evidence for human occupation in the Levant is meager. The systematic production of naturally backed knives, the specialized tool-kit dominated by invasively and carefully retouched side-scrapers, and systematic lateral spall removal from retouched edges are unique characteristics of the Nesher Ramla industry setting it apart from other Middle Paleolithic industries in the Near East. We hypothesize that rather than a reflection of the function of the site in the land-use and mobility patterns, these features have a cultural origin and may indicate that Nesher Ramla hominins possessed discrete technological tradition that emerged in the region during late MIS 6 – early MIS 5. The unique context of the site, the size of the lithic assemblages, the excellent preservation of the finds and unique features of the lithic assemblages offer novel perspectives on various aspects of the MP hominin behavior during MIS 6–5.

Keywords

Middle Paleolithic • Levant • Open-air sites • Lithic technology • Site formation processes

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2.1 Introduction

Middle Paleolithic (MP) human occupation in the Levant (250–45 ka BP) is known from two major contexts: caves and open-air sites on riverbanks, small lake margins, and springs. Deeply-stratified Levantine cave sites yielded remains of both anatomically modern humans and Neanderthals together with large assemblages of lithic and faunal remains that accumulated over tens of thousands of years. The cave sites have been interpreted as repeatedly-occupied habitation localities to which lithic, faunal, and other resources were transported (Bar-Yosef and Meignen 2007; Garrod and Bate 1937; Hovers 2001, 2009; Jelinek 1977, 1982; Meignen et al. 2006; Speth 2004, 2006; Speth and Clark 2006; Stiner 2005; Yeshurun et al. 2007). Open-air sites in the Levant have been found on lake margins, flood plains, mountain/hill slopes, shallow terrestrial depressions, and karst depressions related to active springs in the Syrian Desert. Only the last type of sites was repeatedly used and preserves thick stratigraphic sequences (Boëda et al. 2001; Le Tensorer 2004; Hauck 2010, 2011). The majority of the MP open-air sites yielded shallow stratigraphic sequences and constrained lithic and faunal assemblages (Crew 1976; Fleisch 1970; Goren-Inbar 1990a; Hovers et al. 2008; Marks 1976, 1977; Munday 1977; Gilead and Grigson 1984; Ronen 1974; Sharon et al. 2010).

The open-air sites in the Levant are interpreted as either ephemeral campsites (Gilead 1980; Gilead and Grigson 1984; Hovers et al. 2014), residential camps (mostly in arid and semi-arid zones: Boëda et al. 2001; Hauck 2010, 2011; Henry 2012; Marks 1976, 1977), hunting/butchering stations (Davis et al. 1988; Hovers 1986; Goren-Inbar 1990a; Rabinovich 1990; Sharon et al. 2010; Sharon and Oron 2014), or raw material acquisition localities (Barkai and Gopher 2009; Barkai et al. 2006; Ekshtain et al. 2012; Gopher and Barkai 2011; Ronen 1974). However there are still many uncertainties in interpretation of open-air sites function (Sharon et al. 2014). For instance, three Levantine MP sites (NMO, Quneitra and Umm el Tlel VIIa0) that are interpreted as hunting/butchering localities exhibit prominent differences in the composition of lithic and faunal assemblages (Goren-Inbar 1990a; Griggo et al. 2011; Sharon and Oron 2014).

The problem of understanding the function of open-air sites and their place within land use and subsistence strategies adopted by MP hominins is further exacerbated by the shortage of published radiometric dates (e.g., Bar-Yosef 1998; Hovers 2009; Sharon et al. 2014), which are available for only a few MP open-air sites in the Levantine Mediterranean zone, all yielding ages of the later part of the MP (90–45 ka BP; Boëda et al. 2008a, b; Kalbe et al. 2014; Greenbaum et al. 2014; Schwarcz et al. 1979; Schwarcz and Rink 1998; Ziaei et al. 1990). This is in contrast to the data from cave sites which indicate that the Levant was continuously occupied throughout the Middle Paleolithic with a possible gap between 160–120 ka BP for which we lack large and well-dated assemblages (Bar-Yosef 1998; Hovers 2009). The emerging picture of the MP open-air occupation in the Levant is thus partial and, for most of this 200,000-year-long period, is entirely missing. In particular, we know very little about the open-air adaptations of the anatomically modern humans that inhabited the Levant during the latter part of MIS 6 and MIS 5 (Mercier et al. 1993; Mercier and Valladas 2003; Stringer et al. 1989; Schwarcz et al. 1988; Valladas et al. 1988).

A recently discovered site at Nesher Ramla (170–80 ka BP) promises to fill some of these gaps in our knowledge of the MP human occupation of the Levant. It is an open-air, eight-meter-thick Middle Paleolithic sequence that is situated in a significantly different geomorphological context than the open-air sites described above. The site was found in a deep karst sinkhole that acted as a sedimentary basin in which colluvial deposition was intermittent with *in situ* human activities (Zaidner et al. 2016). Several lines of evidence point to the *in situ* human activities in this sinkhole: micromorphological study of the sediments; presence of *in situ* combustion features; excellent preservation of lithic artifacts and animal bones (often preserving anatomic articulation); and distinct concentrations (heaps) of bones, lithics, and manuports (Friesem et al. 2014; Tsatskin and Zaidner 2014; Weissbrod and Zaidner 2014; Zaidner et al. 2014). The excellent state of preservation of these finds is likely to be a consequence of the unique context of the site which, like caves, is closed and protected by surrounding walls, while at the same time not being subjected to the strong diagenesis characteristic of Levantine caves (e.g., Karkanas et al. 2000). Another probable reason for the excellent state of preservation of the site was the rapid burial of its archaeological remains (Friesem et al. 2014; Zaidner et al. 2016). The archaeological sequence of Nesher Ramla was dated by optically stimulated luminescence method (OSL) to 170±12–78±6 ka BP, placing the Mousterian hominin occupation at Nesher Ramla to the MIS 6 and 5 (Zaidner et al. 2014).

A history of tens thousands of years of human occupation demonstrates that Nesher Ramla was an important location within the mobility system of nomadic groups that chose to return to this place time after time. Clear diachronic fluctuations in the material density, lithic and faunal characteristics, the use of fire and manuports' transport, suggest that the mode of occupation changed over time (Zaidner et al. 2014). Nesher Ramla thus offers an opportunity to investigate changes and variations in human lifestyles and the exploitation of open landscapes over a long time span, including a few tens thousands of years (ca 160–120 ka) during which evidence for human presence in the Levant is meager. In the current paper, we will present the site, its formation processes, and discuss some of the unique features of the Nesher Ramla lithic assemblage.

2.2 The Nesher Ramla Site

2.2.1 General Description

The open-air Middle Paleolithic site of Nesher Ramla lies on the western slopes of the Judean hills bordering the Mediterranean coastal plain of Israel (Fig. 2.1). The site is located in a limestone and chalk quarry and was discovered by the Israel Antiquities Authority (IAA) in the course of preparation of the area for quarrying. During the cleaning of the chalk bedrock from the surface soils and clays, a deep depression within the chalk surface was discovered. After removal of 12 m of the clays (from ~ 120–108 masl) with heavy machinery, lithic artifacts and animal bones were discovered.

The Nesher Ramla depression has a funnel-like shape and is 34 m deep (120–86 masl) and 40–50 m wide at its top. In the upper part of the depression the slopes are relatively moderate (35–55°), but they become significantly steeper (70–90°) between 102 and 86 masl. The diameter of the depression at the level where the archaeological remains were discovered is approximately 20 m (Fig. 2.1). Nesher Ramla is one of several depressions recently discovered in the area (Fig. 2.2). These depressions have been interpreted as karst sinkholes formed by gravitational subsidence of the bedrock into underground voids (see below; Frumkin et al. 2015). Some sinkholes are relatively shallow and large in diameter (up to 200 m), while others are small (20–50 m in the diameter), with more vertical shear walls. These sinkholes are entirely filled with sediments, and were only initially revealed during preparation of the area for quarrying.

The site was excavated during 12 months of intensive salvage excavation in 2010 and 2011. In total, more than 450 m^3 of the sediments were excavated, representing the entire volume of the archaeological deposits at the site. The hominin occupation layers were found at an elevation of 107.5–99.5 masl, with sterile infill extending both above and below these deposits. The archaeological finds were concentrated in the center, while near the walls artifacts and bones were exceptionally rare or entirely absent.

2.2.2 Sediments and Stratigraphy

The eight-meter-hick archaeological sequence is composed of homogeneous brown, gravel-rich clay and can be roughly divided into Upper and Lower Sequences. The upper 5.5 m of the deposits (the Upper Sequence) lacks clear macro- and micro-stratigraphy (Fig. 2.3). The gravels that are composed of Nari, a calcrete crust developed on chalk bedrock in the site area, comprise 30–40% of the sediment volume. The fine-grained material is apparently derived from erosion of surrounding soils and formation of pedosediments, i.e., transported soil materials (Tsatskin and Zaidner 2014). On the basis of subtle differences in the field and laboratory measurements, especially the degree of pedogenic reworking (Tsatskin and Zaidner 2014; Zaidner et al. 2014), the Upper Sequence was divided into Unit I and Unit II (Fig. 2.1). In addition, a sharp increase in the density of bones and lithics and repeated occurrences of manuports (limestone and chert pebbles and boulders) at around 104.5 masl, allowing us to subdivide Unit II into Unit IIa (105.5–104.5 masl) and Unit IIb (104.5–102.7 masl).

The lower 3 m of the deposits (the Lower Sequence) consist of similar, brown-gravelly clay; however, they are well-bedded and include two dense layers rich in artifacts, bones, manuports, and burnt materials (Units III and V; Fig. 2.1), separated by low-density bed IV. The lowermost unit VI, is another layer with low densities of artifacts and bones.

2.2.3 Main Archaeological Characteristics

Units IIb–V of the site are characterized by the presence of concentrations ("heaps") composed of animal bones, limestone boulders (anvils, hammerstones, manuports) and lithics. About 60 such "heaps" were identified in Units IIb, III, and V. The heaps vary in shape, size, thickness, composition, and density, but clearly differ from the surrounding sediments in the density of finds (Fig. 2.4). The majority of the heaps are 0.5–1 m long, but there are some larger concentrations reaching lengths of 2–3 m. Manuports consist of pebbles, boulders and stone blocks of hard limestone and chert, which are absent in the vicinity of the site. More than 200 kg of stones had been transported to Unit V alone, including boulders weighing up to 16 kg.

The site shows clear diachronic changes, with pulses of intensive occupation manifested by increases in artifact density and an increase in the number of lithic-bone-limestone 'heaps'. The lower part of the sequence includes the two most prominent phases of occupation (Units III and V). Both of these units are thin anthropogenic layers (ca 20–30 cm thick in the center of the depression) extending over an area of 50–60 m^2 with large numbers of lithic-bone-limestone concentrations, as well as combustion features. Two types of combustion features have been identified so far, one representing *in situ* hearths, the other ash pile/midden formed following hearth rake-out activities (Friesem et al. 2014).

Unit IIb exhibits a different intensity and organization of occupation and is characterized by the presence of small,

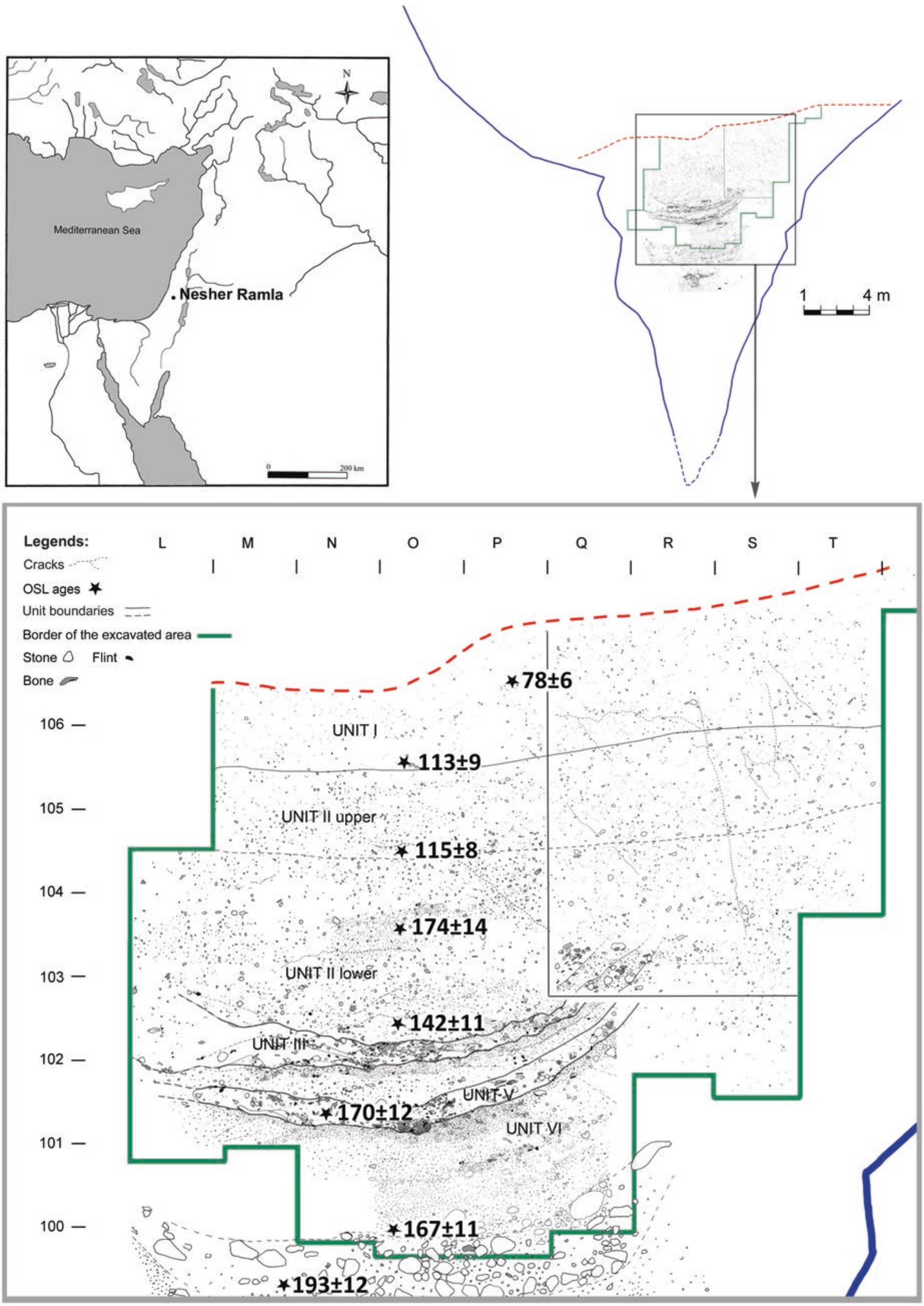


Fig. 2.1 Location of the site and composite stratigraphic section

Fig. 2.2 Different types of surface depressions found in the site area

spatially unconnected "heaps" rather than the continuous surfaces seen in Unit III and V. The densities of the lithics suggest several occupation peaks interspersed with phases of lower occupation intensity (Zaidner et al. 2014). Units IIa and I are characterized by low densities of animal bones and lithics. No remains of combustion features or charcoal were found in Units I and IIa, although the relatively high frequency of burnt flints suggests that fire had been used.

2.3 The Formation and Sedimentary Development of the Nesher Ramla Sinkhole

The history of the formation and sedimentary development of the sinkhole is presented in Fig. 2.5. The sinkholes are located within Late Cretaceous carbonate rocks. The surrounding bedrock is ca 40 m thick Senonian Age chalk of the 'En Zetim Formation that is underlain by ca 100 m thick Turonian Age limestone of the B'ina Formation. The study area is located in the western basin of the Mountain Aquifer, known as the Yarkon-Tanninim Aquifer (Frumkin and Gvirtzman 2006). The groundwater level in the aquifer fluctuated between 10 and 20 masl in course of the twentieth century. The aquifer in the study area is associated with hundreds of karstic caves extending from the low B'ina Formation to ca 60 masl in the mid-B'ina Formation (Fig. 2.5b). The morphological features of the caves are associated with dissolution under water-filled conditions by slow-moving rising hydrothermal water typical of artesian karstic system. The voids have no natural entrances and no genetic relationships to the land surface (Frumkin and Gvirtzman 2006). The sinkholes were formed due to the gravitational deformation, subsidence and collapse of the bedrock into these karstic caves (Fig. 2.5c; Frumkin et al. 2015).

The minimum age of two sinkholes was determinate by OSL dating of the sediments, placing them to the late Middle Pleistocene and Upper Pleistocene (Frumkin et al. 2015; Zaidner et al. 2014). Yet a catastrophic collapse event recorded in 1979 in the nearby village of Azarya formed a deep surface depression, indicating that similar processes still occur today (Frumkin and Gvirtzman 2006).

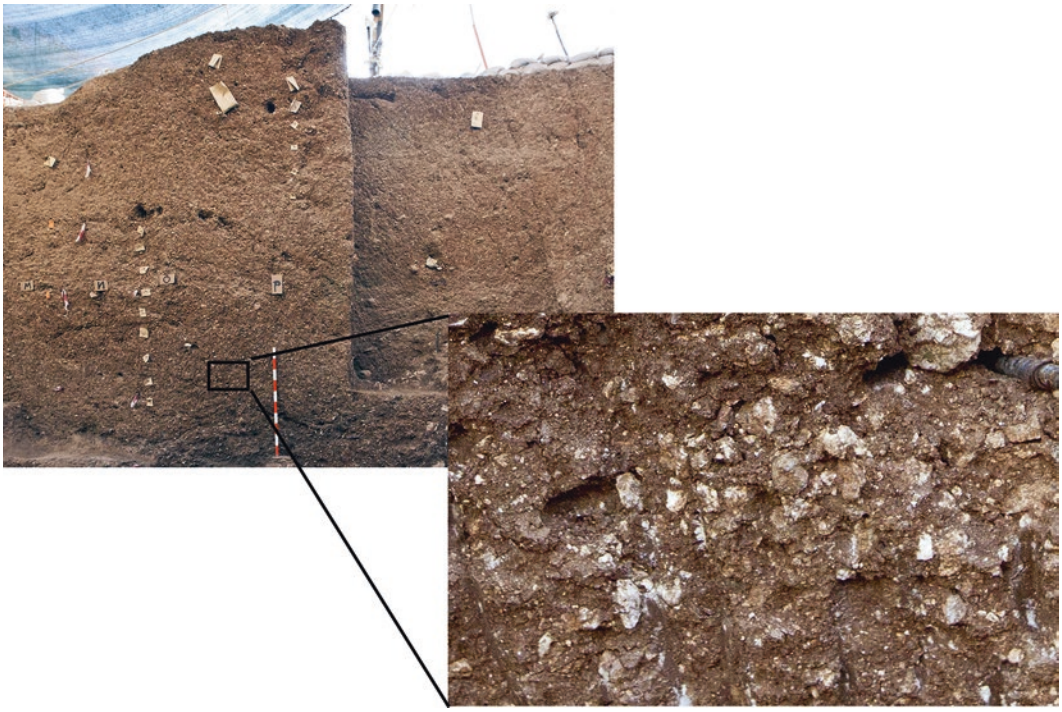
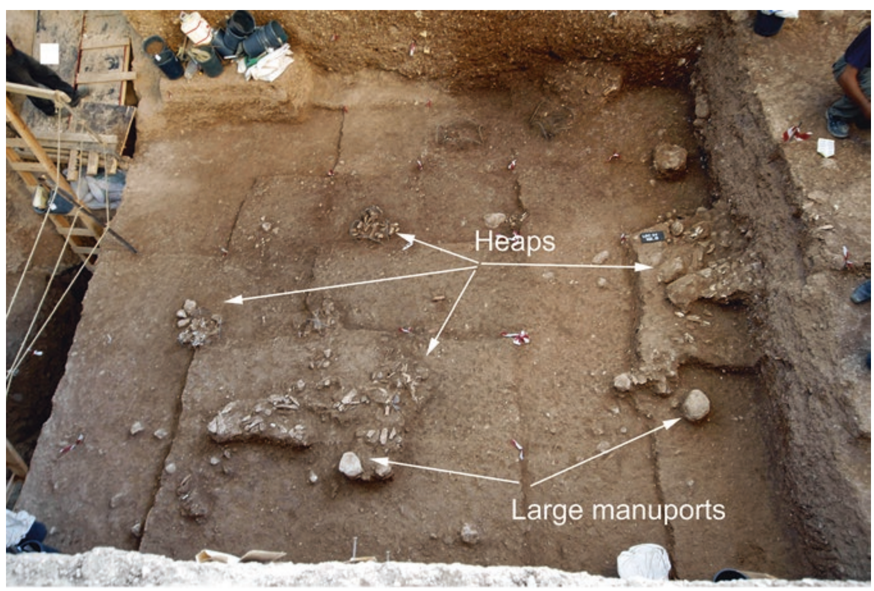


Fig. 2.3 The section (southern wall, squares L–P/17, Q–T/16) and the sediments

Fig. 2.4 A surface excavated in Unit III with a number of isolated features ('heaps' of manuports, bones and lithics)



The sinkholes are closed basins that, during and after their formation, act as depositional basins, trapping sediments from the surrounding slopes (Fig. 2.5d). The initial stages of sediment accumulation in the Nesher Ramla depression could be coeval with the bedrock subsidence. The sedimentation was probably unstable and involved frequent slope failures and catastrophic collapses. In the lower part of the infill from 85 to 99.50 masl, the sediments contain numerous large blocks of chalk and Nari (up to 100 cm in size). At the eastern wall some large blocks of Nari are found as far up as 103 masl. However, these massive slope failures are evident only in the lower part of the infill, prior to the hominin occupation of the site, while the archaeological sediments lack evidence for such catastrophic events. The lower stratigraphic units, III–V, are well-bedded and appear as continuous lens-like horizons without evidence of faults or disconformities (Fig. 2.1), suggesting that the central part of the site was not disturbed by postdepositional deformation,

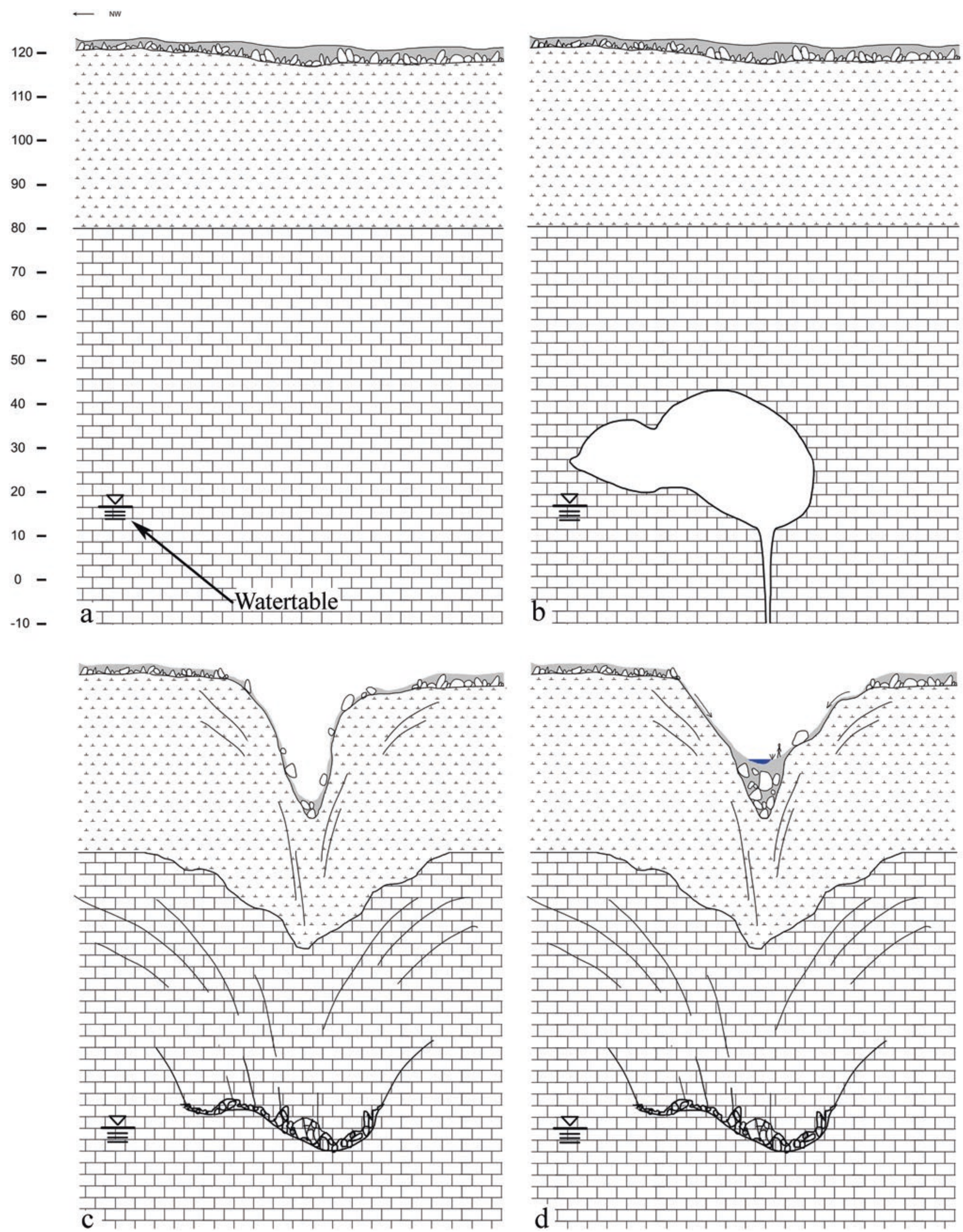


Fig. 2.5 The formation of the Nesher Ramla site. (**a**). The stratigraphic section of the area. (**b**). Dissolution and formation of the cave by slow-moving rising hydrothermal water. (**c**). Sagging and deformation of the bedrock and formation of surface depression. (**d**). During the human occupation the sinkhole had it present-day form and served as depositional basin. The site formation represented a continuous cycle of soil erosion, waterlogging, in situ pedogenesis and human occupation

and that the major features of karst sinkhole were shaped prior to human occupation. Nevertheless, it is likely that during deposition, soft chalky bedrock was eroded from the edges of the sinkhole, thereby widening its upper part.

Site formation during the accumulation of the archaeological deposits was a system composed of four major processes: deposition, waterlogging, pedogenesis and human occupation (Fig. 2.5d). The depression was filled with surrounding soils eroded from hill slopes along with chalk and Nari. The pedosediments indicate that soil cover was basically similar to that of the present day, including brown Rendzina and vertisols (Tsatskin and Zaidner 2014).

The *in situ* pedogenic processes were identified throughout the Upper Sequence (Units I–II). In the Lower Sequence (Units III–VI) traces of *in situ* pedogenesis were not found. Pedogenic processes were apparently short-lived and did not developed soil profiles with A, B, C horizonation. The lack of microstratigraphy in the upper 5.5 m of sequence should probably be attributed to the eradication of bedded features by post-depositional pedogenesis.

In units I and II, waterlogging is indicated by abundant tiny opaque Fe/Mn punctuations and shrink-swell processes (Tsatskin and Zaidner 2014). In particular, Unit I and Unit IIa clearly show conspicuous vertic and hydromorphic characteristics, suggesting higher seasonal waterlogging.

The evidence from the Upper Sequence indicates that accumulation of the pedosediments and Nari ceased and was followed by relatively stable episodes of low sedimentary input. This is indicated by evidence for incipient *in situ* pedogenisis, fluctuations in stoniness, skeletal fraction, magnetic susceptibility, and soil microfabric. Such indicators are expected only if the deposition and site formation were not uniform, but rather were characterized by episodes of higher and lower sediments input (Tsatskin and Zaidner 2014). This system of deposition and site formation at Nesher Ramla was consistent throughout the accumulation of the Upper Sequence, while lack of evidence for pedogenesis in the Lower Sequence may indicate some change at the boundary between Units III–II that is not yet fully comprehended.

2.4 Lithic Assemblages

The lithic industry of Nesher Ramla exhibits noticeable variations in the quantity of artifacts and in the presence of different technological and typological groups throughout the stratigraphy of the site (Fig. 2.6; Table 2.1). In general, the number of artifacts clearly increases with depth, from 10 to 20 artifacts per 0.1 m^3 in Unit I to 200–250 per 0.1 m^3 in Unit III (the lithic assemblages from units IV-VI are still under study). The density curve in Fig. 2.6 indicates that the increase in the quantity of artifacts is characterized by several peaks followed by drops in artifact densities. Some of these density peaks correlate

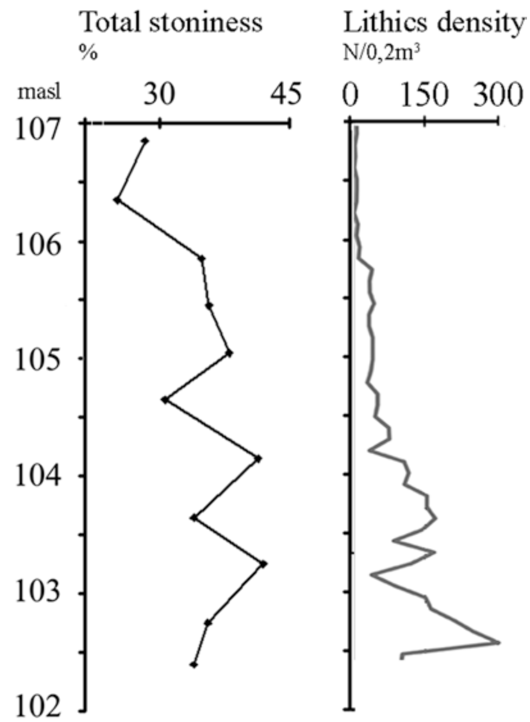


Fig. 2.6 Total stoniness and lithic density curves. Density of artifacts shows inverse correlation with frequency of gravel. When frequency of gravel drops, density of the artifacts increases indicating changes in the rate and intensity of deposition

with reduced stoniness of the sediments. For example, between the depths of 106–105 masl in Unit IIa, gravel constitutes about 40% of the total volume of sediments, but at a depth of 104.8 masl it drops to less than 30%. The amount of Mousterian artifacts nearly doubles at this depth (Fig. 2.6). A similar inverse correlation was also recorded at depths of 103.60–80 masl and ca 102.50 masl. The decreased amount of gravel washed into the sinkhole may indicate changes in the depositional regime towards lower energy erosion and slower sediment accumulation, thereby providing better conditions for use of the sinkhole by hominins.

Hierarchical core reduction strategies in which a surface, rather than a volume of the core was exploited, dominate the lithic assemblages of Nesher Ramla. These include classical Levallois methods, a specific method for production of naturally-backed knives and methods of core-on-flake reduction, which are quite reminiscent to the Levallois reduction strategy. The industry lacks true laminar and elongated Levallois components and is dominated by short and broad Levallois flakes. The assemblages studied for this publication (27,185 artifacts representing six assemblages from stratigraphic Units III, IIb, IIa and I) show that the frequencies of Levallois products are generally low, fluctuating between 8.8 and 18% (Table 2.1). In contrast, Levallois cores dominate all the studied assemblages except that of Unit III (Fig. 2.7). Levallois cores were knapped using both recurrent

Table 2.1 General breakdown of the studied assemblages

Blanks	III		II B 102.5–103		II B 103.4–103.9		II B/II A 104.3–104.6		II A Rino layer		I 105.8–105.95		I Vertebra layer	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Débitage														
Levallois products	641	8%	509	12%	774	12%	348	16%	185	11%	48	18%	55	9%
Levallois points	73	1%	12	0%	49	1%	22	1%	23	1%	8	3%	4	1%
Flakes	2900	34%	1058	26%	1818	29%	628	29%	590	36%	70	27%	240	37%
Blades	160	2%	61	1%	89	1%	31	1%	23	1%	1	0%	26	4%
Naturally backed knives	720	8%	272	7%	396	6%	126	6%	171	10%	24	9%	53	8%
CTE	687	8%	345	8%	677	11%	149	7%	45	3%	19	7%	21	3%
Kombewa flakes	124	1%	90	2%	141	2%	60	3%	21	1%	2	1%	11	2%
Pseudo-Levallois points	12	0%	13	0%	30	0%	1	0%	1	0%	0	0%	0	0%
Primary elements	1300	15%	833	20%	1307	21%	462	22%	316	19%	41	16%	104	16%
Lateral spalls	237	3%	85	2%	67	1%	1	0%	3	0%				
Cores														
Levallois cores	146	2%	85	2%	62	1%	31	1%	22	1%	2	1%	7	1%
Cores	139	2%	35	1%	50	1%	12	1%	12	1%	0	0%	6	1%
Preferential surface cores	42	0%	16	0%	13	0%	8	0%	4	0%	1	0%	4	1%
Cores on flakes	87	1%	27	1%	45	1%	18	1%	16	1%	1	0%	4	1%
Nahr Ibrahim	77	1%	20	0%	13	0%	2	0%	1	0%	0	0%	0	0%
		0%						0%		0%		0%		0%
Retouched pieces	815	10%	549	13%	632	10%	212	10%	120	7%	35	13%	47	7%
Chunk	314	4%	112	3%	167	3%	26	1%	87	5%	12	5%	60	9%
Total studied sample	**8474**	100%	**4122**	100%	**6330**	100%	**2137**	100%	**1640**	100%	**264**	100%	**642**	100%

and preferential methods. The cores are small and exhibit a low degree of standardization and poor preparation (Figs. 2.8: 2; 2.9: 2; 2.11:1, 4). The tools were made using the largest and most regular Levallois blanks (Figs. 2.9: 4, 5; 2.10: 4, 5; 2.12: 3, 5–7, 9; 2.13: 6, 7). Scar patterns on the dorsal faces of Levallois flakes and points indicate that both unipolar convergent and centripetal methods were used (Figs. 2.9: 8, 9; 2.10: 2, 3, 6; 2.12: 1, 2, 8; 2.13: 2, 5). The majority of core trimming elements (CTEs) fall into a category of Levallois preparation flakes, including *débordant* flakes and some platform and debitage surface rejuvenation flakes.

Hierarchical core reduction strategy was also employed for production of naturally-backed knives (NBK). NBKs make up between 6 and 12% of the lithic assemblages (Table 2.1; Fig. 2.14; Fig. 2.9: 3; 2.10: 1; 2.13: 1). At Nesher Ramla, NBK's occur throughout the archaeological sequence, always in substantial numbers regardless the size of the assemblage. NBK's often exhibit signs of edge damage that could be a result of use. In addition, use of NBK's as blanks for production of side-scrapers is also quite common. The NBK's were struck from specific type of cores (henceforth preferential-surface cores; Figs. 2.8: 1, 3, 4; 2.11: 2). Preferential-surface cores were identified in all studied assemblages (Fig. 2.7).

The preferential-surface cores exhibit Levallois-like volumetric conception with two hierarchical surfaces, one used for flaking and other as a striking platform. The fracture plane of the flakes detached from the debitage surface is parallel to the plane of intersection between debitage and striking surfaces. However, the evidence for predetermination and preparation of the debitage surface is dubious, and this seems to be the major deviation of the preferential-surface cores from the Levallois concept. The detached flakes usually removed the lateral, cortical edges of the core. Only rarely were flakes removed from the center of the debitage surface. The cores do not exhibit signs of the preparation of convexities. The striking surface exhibits only minimal and discontinuous preparation on the limited area from which the flakes were removed.

No other organized reduction methods were systematically used at Nesher Ramla. The category of cores (Table 2.1; Fig. 2.7) is composed of indeterminate core

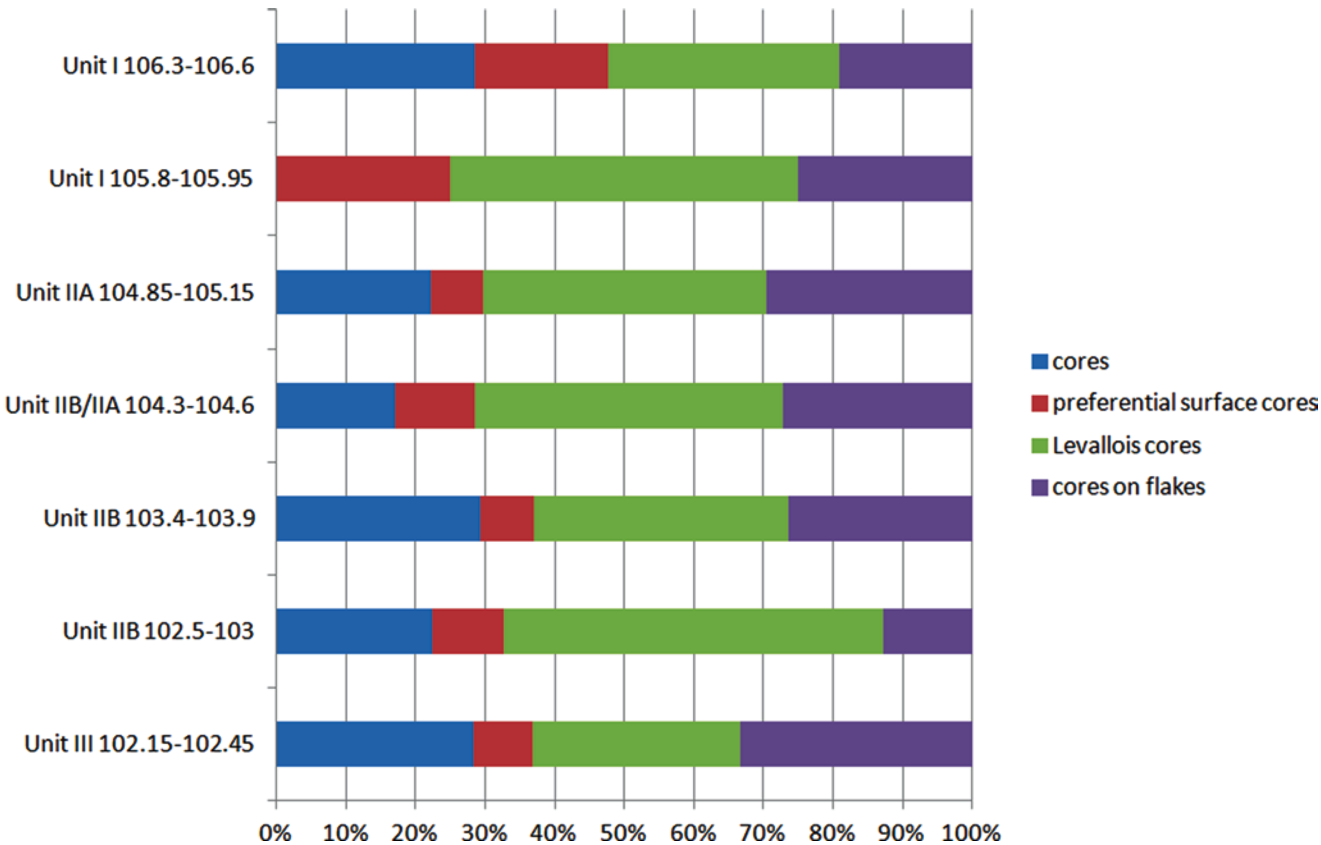


Fig. 2.7 Frequencies of the core types in studied assemblages

fragments, single platform cores, globular cores, cores with a few removals, and a very few discoidal cores. Cores-on-flake are the second largest group within the core assemblages, except for Unit III where they are the dominant category (Table 2.1; Fig. 2.7). Cores-on-flake exhibit Levallois-like hierarchical surfaces morphology, with convex ventral faces of the flakes used as debitage surfaces and striking platforms shaped on the dorsal faces (Fig. 2.9: 1; 2.11: 3).

Apart from NBKs production, the other distinctive feature of the Nesher Ramla lithic industry is highly specialized toolkit dominated by carefully and intensively retouched side-scrapers and side-scrapers shaped by removal of lateral longitudinal spall from retouched edge (long sharpening flakes, or "*coup de tranchet* lateral"; Zaidner et al. 2014; Zaidner and Grosman 2015). The side-scrapers were made on the largest, most regular and carefully prepared blanks, and were retouched by an intensive, regular and invasive retouch, mostly along the entire length of the edge (Figs. 2.9: 6, 7; 2.10: 4, 5, 7; 2.12: 3, 4, 7, 9; 2.13: 3, 4, 6). There seems to be a chronological trend in the proportion of side-scrapers among the artifacts, from almost 80% in Unit III to 30–50% in the upper assemblages (Fig. 2.15). In the upper units, the importance of the expediently retouched flakes and types 42–46 of Bordes' typology rises considerably. Among other tool types, the most interesting category is that of the retouched points which are almost entirely absent from Unit III, but are relatively abundant in other assemblages.

The removal of a lateral longitudinal spall from the retouched edge of the scraper at Nesher Ramla (Fig. 2.13: 8, 9) is technically similar to "long sharpening flakes removal" (LSF; Cornford 1986), "*coup de tranchet* lateral" (Bourguignon 1992), or Prądnick technique common in Keilmesser group of the central Europe (Jöris 2006). The process started with the preparation of a small truncation on the ventral surface. The truncation served as striking platform for the spall removal. An initial analysis of the spalls and parent scrapers demonstrates that the angle of the edge formed by spall removal is significantly sharper than that of the original (Zaidner and Grosman 2015). This was achieved by directing and angling the blow so that it removed a higher volume of material from the dorsal surface compared to that removed from the ventral surface of the parent tool.

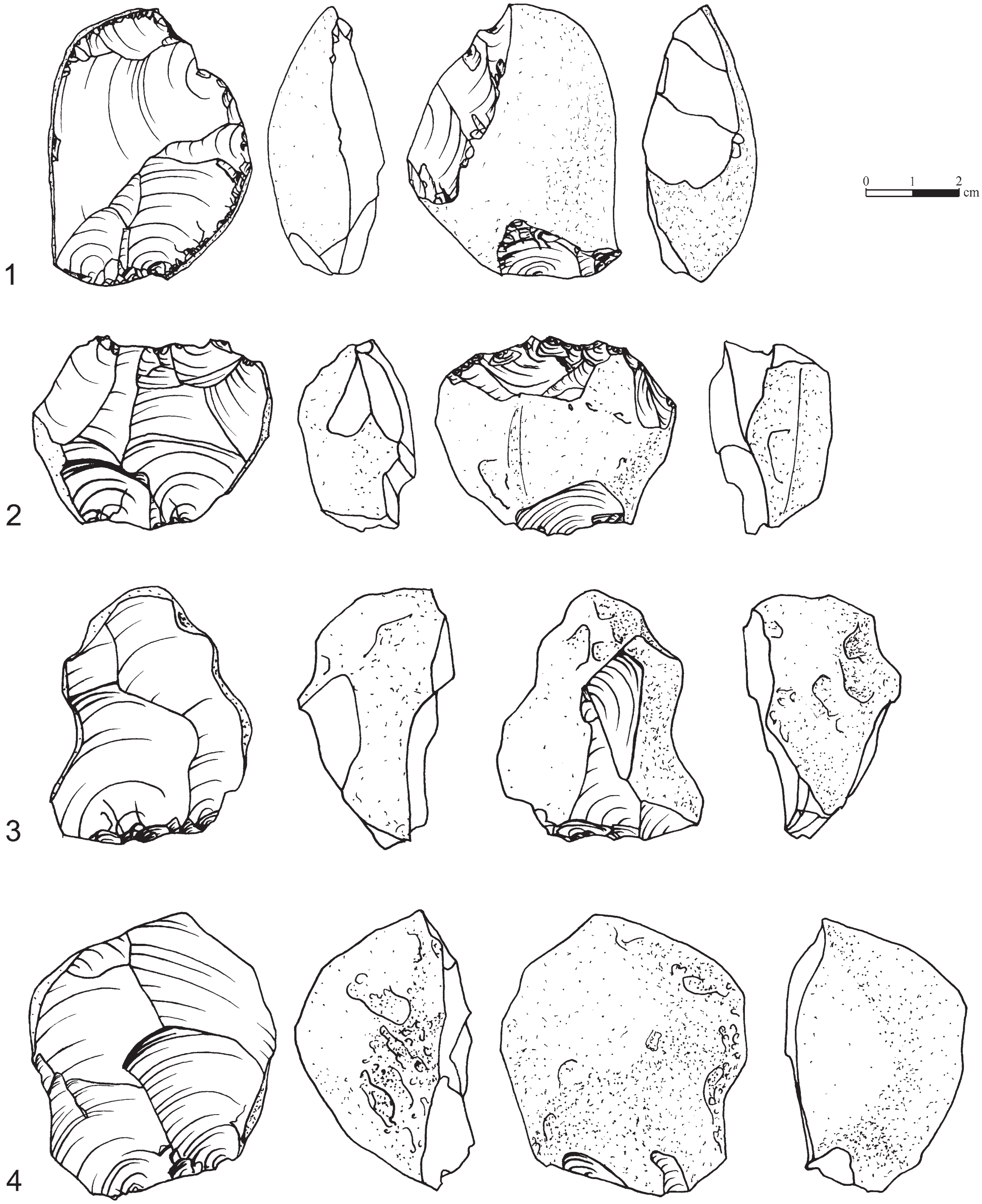


Fig. 2.8 'Preferential-surface cores' – *1*, *3*, *4*; Levallois core – *2*

Both tools with the scar of the spall removal and spalls are abundant throughout the Nesher Ramla sequence, providing a rare opportunity to reconstruct the life history of these specific tools. The spalls often removed relatively sharp, regular and lightly retouched edges. The scar of the spall removal usually extends over a part of the retouched edge, forming an edge that is partially retouched and partially not. A majority of the parent tools (73%; Zaidner and Grosman 2015) were not retouched after a spall was removed. Therefore, it is likely that the main goal in removing a spall was formation of an edge that is partially retouched and partially raw. The spall removal, thus, was probably employed as technique for the edge finishing and manufacture of a specific tool-type.

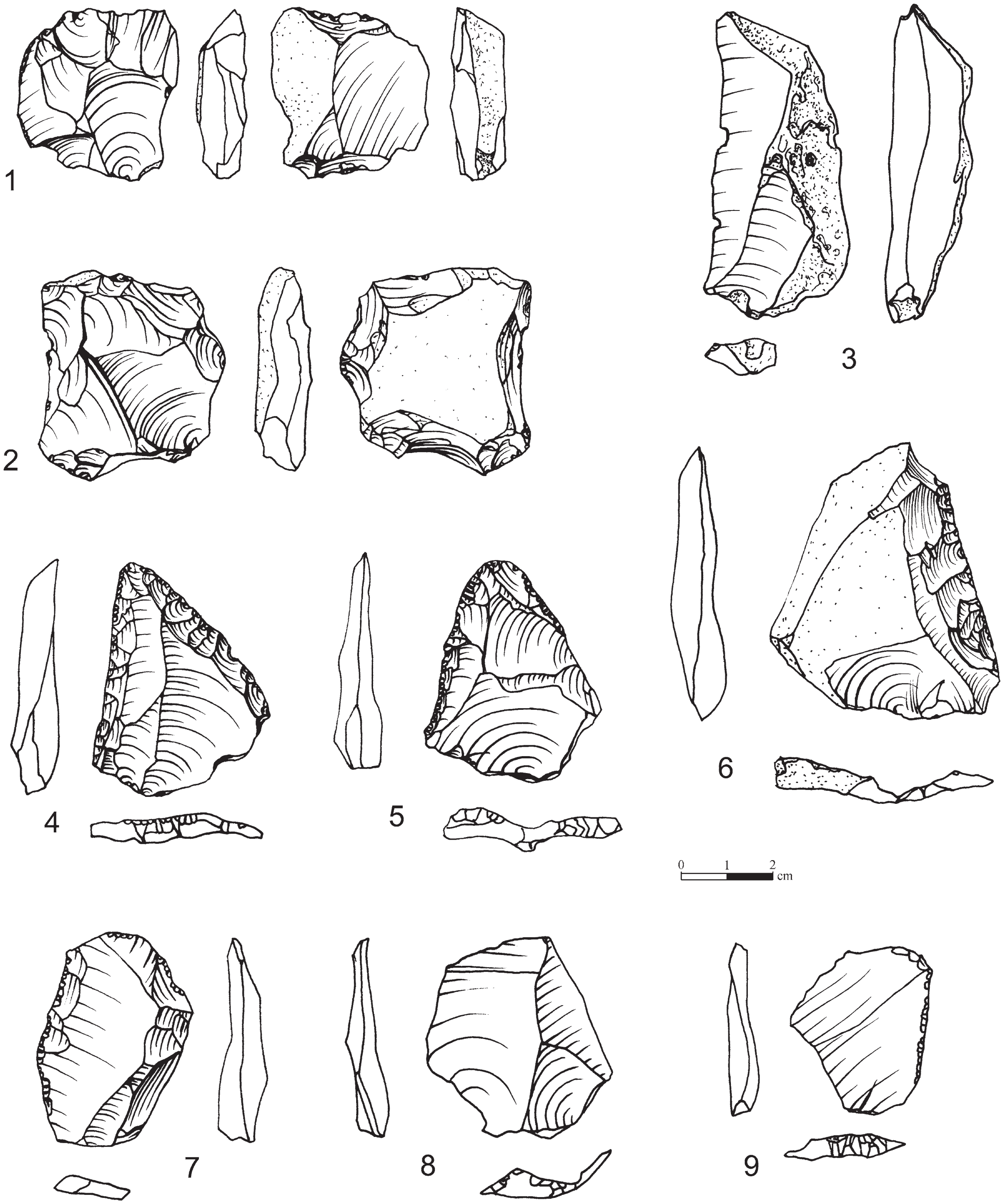


Fig. 2.9 Core-on-flake – *1*; Levallois core – *2*; Naturally backed knife – *3*; Retouched points – *4*, *5*; Side-scrapers – *6*, *7*; Levallois flake – *8*; *Raclette – 9*

2.5 Discussion

The 200,000 year-long sequence of the Levantine MP is generally characterized by the dominance of the Levallois technology, relatively frequent occurrences of core-on-flakes, and a scarcity of heavily-retouched scrapers (Bar-Yosef 1998, 2000; Hovers 2009; Shea 2003). The presence of Levallois products is often high in cave sites (20–60% of the assemblage) but low in open-air sites (5–20%). The lithic assemblages of open-air sites also notable for their high typological diversity and more expedient tool production in comparison to the caves (Gilead 1995; Gilead and Grigson 1984; Goren-Inbar 1990b; Hovers et al. 2008; Hovers 2009; Munday 1977; Ronen 1974). It has been suggested that these

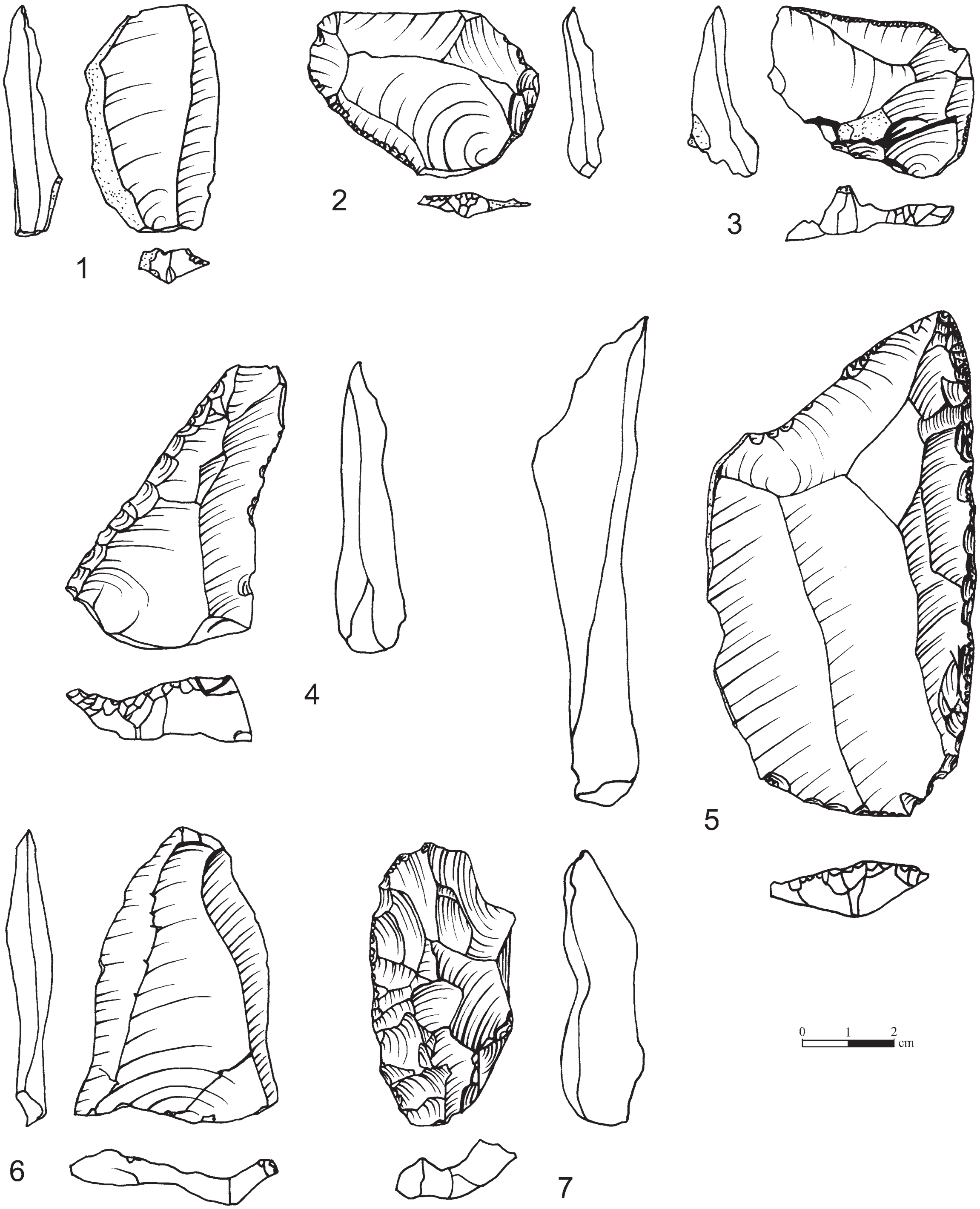


Fig. 2.10 Naturally backed knife – *1*; *Raclette* – *2*, *3*; Side-scrapers – *4*, *5*, *7*; Levallois point – *6*

differences are the result of specific site functions, more intensive lithic reduction, and the higher expediency of the lithic technology in open-air sites (Gilead 1995; Hover 1990, 2009; Jelinek 1982; Meignen et al. 2006; Ronen 1974; Sharon et al. 2010).

Nesher Ramla shares some general characteristics with other Levantine sites, especially the use of the Levallois method for production of flakes, use of core-on-flakes and production of the Levallois points. However, it should be noted that these characteristics are universal and occur in many MSA and MP contexts throughout Africa, Europe and Asia (e.g. Douze and Delagnes 2016; Groucutt et al. 2015; Moncel et al. 2009; Petraglia et al. 2010). Along with these classic MP features, a number of distinctive traits were

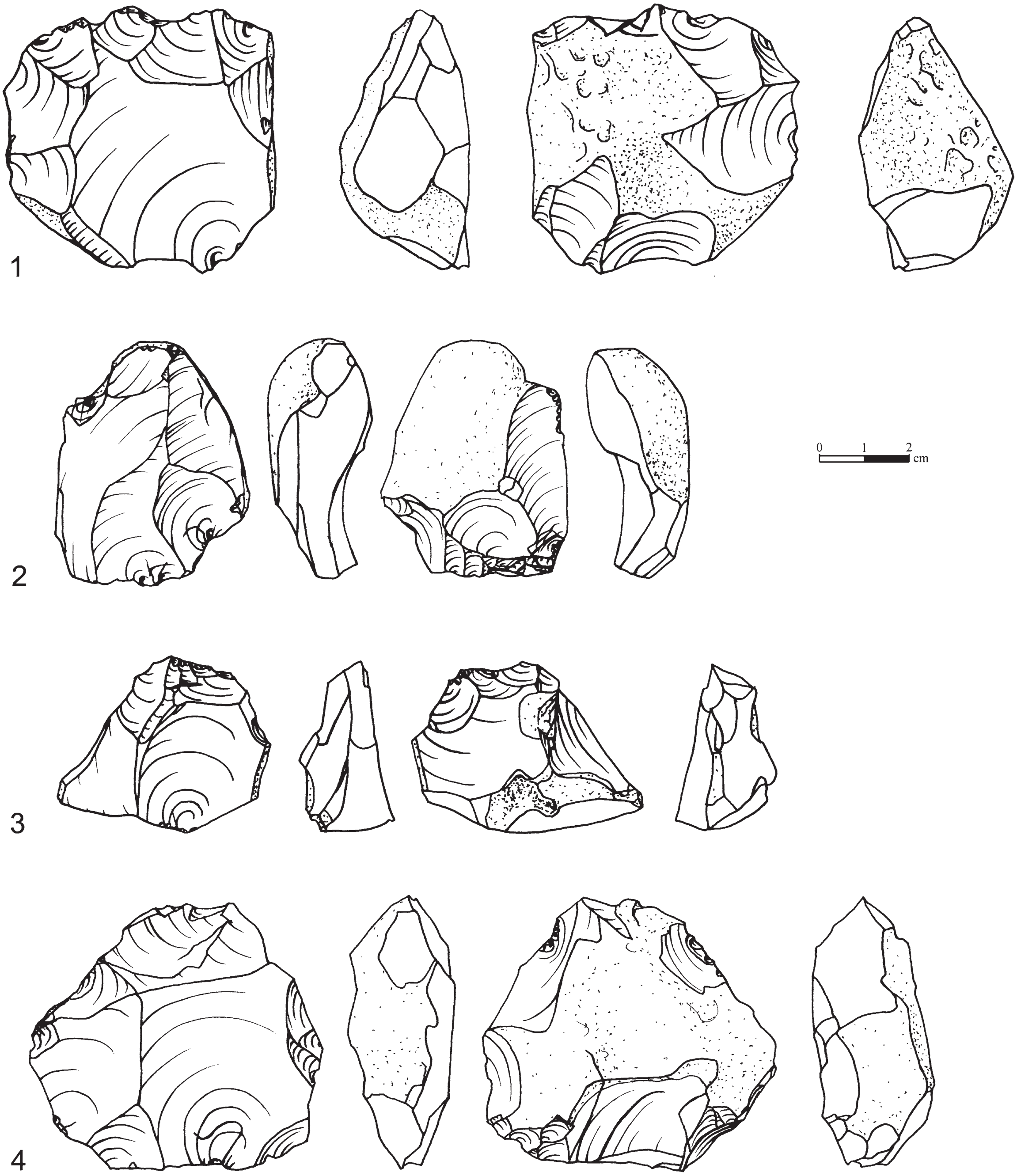


Fig. 2.11 Levallois cores – *1*, *4*; 'Preferential-surface core' – *2*; Core-on-flake – *3*

recorded. One of these is the specific reduction sequence for NBKs production. None of the Levantine sites yielded NBKs in high numbers like those at Nesher Ramla, and a specific reduction sequence for NBK production has never been identified. In general, NBK's in the Levantine MP sites rarely exceed 2–3% of the total assemblage (Table 2.2) and they are usually interpreted as CTEs removed for shaping the core and maintaining lateral (and sometimes distal) convexities (Henry 2003; Hovers 2009; Meignen 1995; Pagli 2013). The only case in which NBKs are considered as end-products is the site of Nahal Mahanayeem Outlet (Sharon and Oron 2014).

The retouched toolkits of the Levantine MP are usually quite heterogeneous and include a variety of tool types, with side-scrapers often contributing a substantial portion, but rarely exceeding 30–35% of the assemblage. The assemblages fromv the lower part of the stratigraphic sequence at Nesher Ramla exhibit an unprecedented predominance of side-scrapers and scrapers with lateral spall removal (Fig. 2.15). Intensive and invasive retouch is also an uncom-

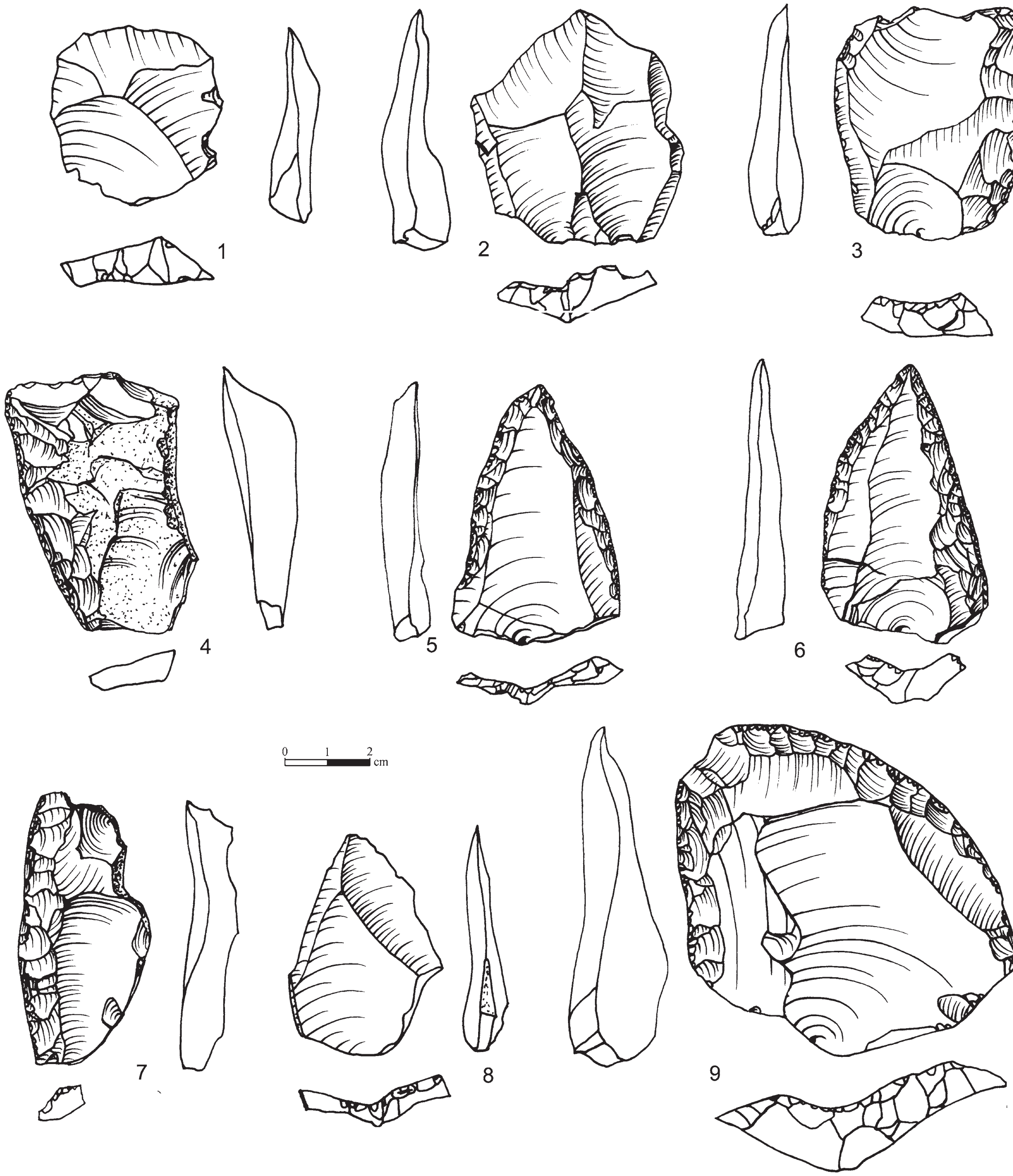


Fig. 2.12 Levallois flakes – *1*, *2*; Side-scrapers – *3*, *4*, *7*, *9*; Retouched Levallois point – *5*; Mousterian point – *6*; Levallois point – *8*

mon feature at MP sites, as the majority of the Levantine side-scrapers were only lightly retouched (Hovers 2009). The upper assemblages of Nesher Ramla display slightly different picture, with lower occurrences of side-scrapers in conjunction with the presence of lightly-retouched flakes, notches, and denticulates, making them more similar to other Levantine sites. The most interesting assemblage in the Upper Sequence derives from Unit I (105.95–105.8 masl). This is the only assemblage to have been studied thus far which is dominated by retouched Levallois and Mousterian points. The varying prevalence of different technological and typological types identified along the Nesher Ramla stratigraphy probably indicates changes in the site's mode of occupation. This impression is reinforced by the varying investment in the transport of large and heavy manuports, and the varying densities and taphonomic characteristics of faunal remains along the site's stratigraphy (Friesem et al. 2014; Zaidner 2014; Zaidner et al. 2014).

The systematic lateral spall removal from scraper-like retouched edges further distances Nesher Ramla assem-

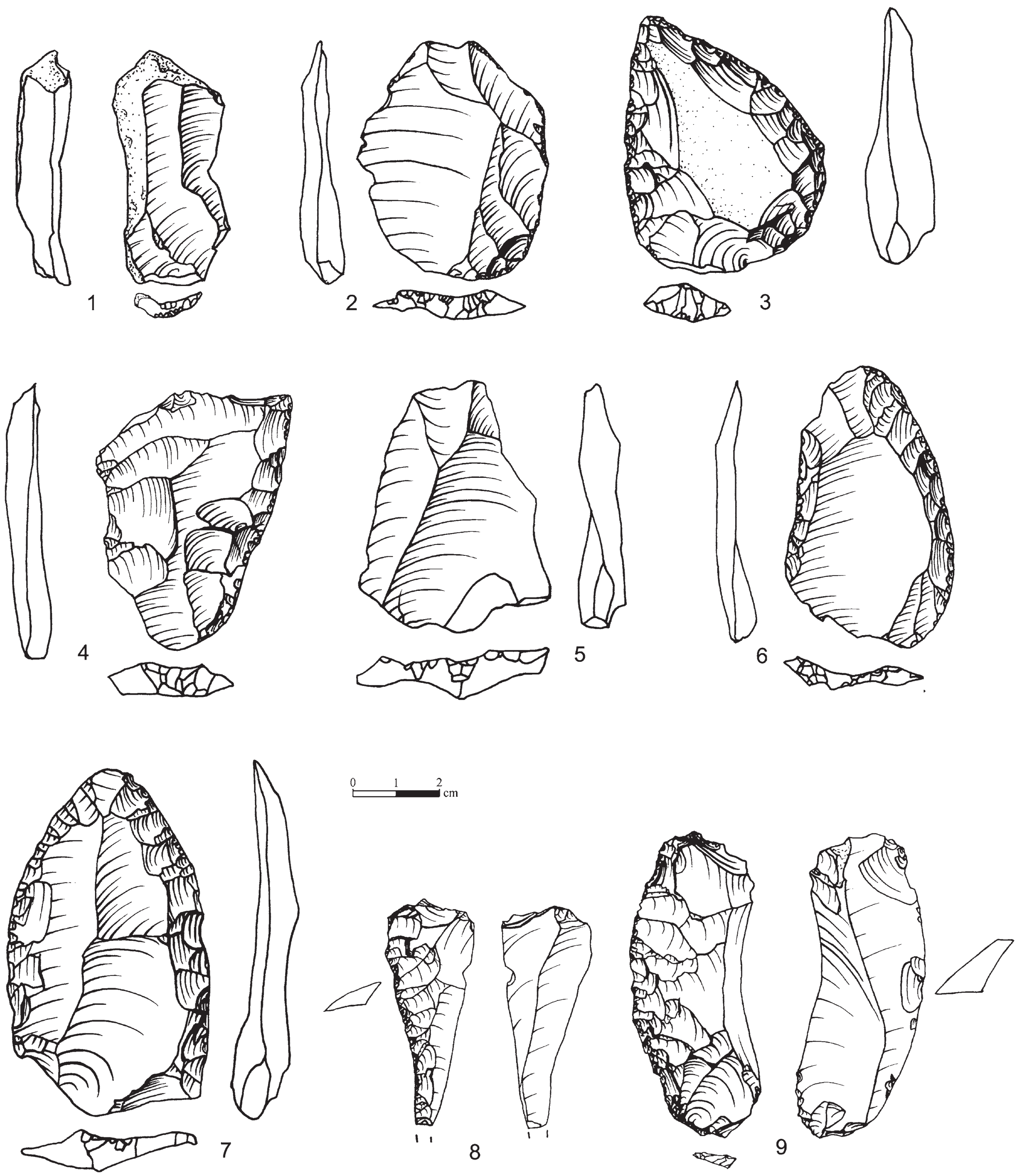


Fig. 2.13 Naturally backed knife – *1*; Levallois flakes – *2*, *5*; Side scrapers - *3*, *4*, *6*, *7*; Long sharpening flakes – *8*, *9*

blages from the general technological trends in the Levant. The removal of lateral spalls is a rare phenomenon, having been reported from the late Lower and Middle Paleolithic in Europe and from Middle Stone Age in Africa (e.g. Bourguignon 1992; Cornford 1986; Douze 2014; Jöris 2006; Roebroeks et al. 1997), but not from Middle Paleolithic assemblages in the Near East. Although sparsely interspersed across broad chronological and geographical ranges, the lateral spall removal technique represents a singular, well-structured technical process. In Central and Eastern Europe, this technical process became a cultural marker that defines the Prądnick and the Keilmesser group of sites (Jöris 2006). The spalls were removed from the variety of retouched tools including side-scrapers, points, bifacial tools and backed knives. The aim of the removal ranges from primary finishing and shaping of the edge to tool maintenance, re-sharpening and recycling. The site of La Cotte de Saint Brelade, British Isles, is one of the few localities in which lateral spall removal was systematically employed. Cornford (1986) has suggested that spalls were removed in order to

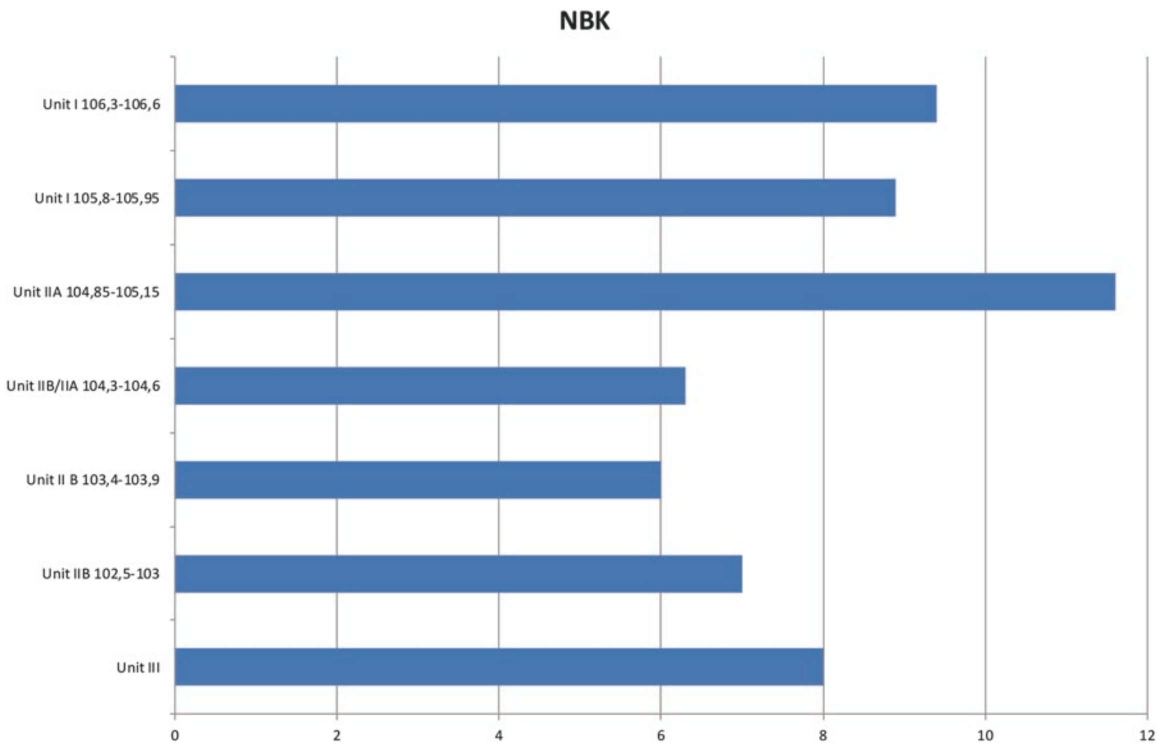


Fig. 2.14 Frequencies of naturally backed knives (NBK) in the studied assemblages

produce raw sharp edges. Her view was based on the assumptions that butchering was one of the main activities at La Cotte de Saint Brelade and that raw edges are most appropriate for butchering and meat cutting. Cornford also suggested that the increased occurrence of spalls in some layers of La Cotte de Saint Brelade correlates with diminishing supply of flint at the site. In other words, the growing shortage of fresh blanks with suitably long edges resulted in the need to reuse existing retouched tools for making these edges. This, however, is an unlikely explanation for Nesher Ramla, given that sources of raw material were readily available in the close vicinity of the site. Alternatively, the goal of the spall removal in Nesher Ramla is more likely to be a manufacture of a specific tool type, making it more similar to the Central European MP Keilmesser group, where the spall removal was embedded within the original sequence of the tool manufacture and aimed at finishing the working edge (Jöris 2006).

A technique similar to that used at Nesher Ramla for the lateral edge spall removal was occasionally employed in other Middle Paleolithic sites for the preparation of truncated-faceted pieces (Schroeder 1969, 2007; or Nahr Ibrahim technique, Solecki and Solecki 1970). In rare cases, the removal of a lateral spall at Nesher Ramla is also associated with additional 'truncated-faceted'-like removals on the dorsal surface (Prevost and Zaidner 2016). In case of Nesher Ramla the 'truncated-faceted'-like removals assisted in preparation of the edge, either by serving as a "guide" for following removal of the lateral spall, or by flattening the convex dorsal surface and improving the edge angle after the spall removal.

Other artifact types shaped by a similar technique are sinew frayers from Upper Paleolithic assemblages of Gamble's cave in Kenya (Leakey 1931), and European Kostienki knives that occur in a number of Middle and Upper Paleolithic European sites (e.g, Delagnes 1992; Efimienko 1958; Escutenaire 1997; Otte 1980; Turq and Marcillaud 1976). Along with dorsal scars similar to the Nahr Ibrahim technique, Kosteinki knives sometimes exhibit the scar of a lateral spall removal (*coup de tranchet lateral*; Bourguignon 1992). The most common interpretation for the dorsal removals on Kostienki knives is thinning of the blank as part of the tool preparation (Delagnes 1992; Turq and Marcillaud 1976). At Nesher Ramla the phenomenon of lateral spall removal is almost exclusively associated with removing the scraper-like retouched edge, which is not the case for Kostienki knives or truncated-faceted pieces.

2.6 Conclusions

The Nesher Ramla MP open-air site is located in a karst sinkhole that was largely formed prior to its MP hominin occupation and acted as closed depositional basin. The site formation during the accumulation of the archaeological deposits consisted of four major processes: deposition of eroded soils,

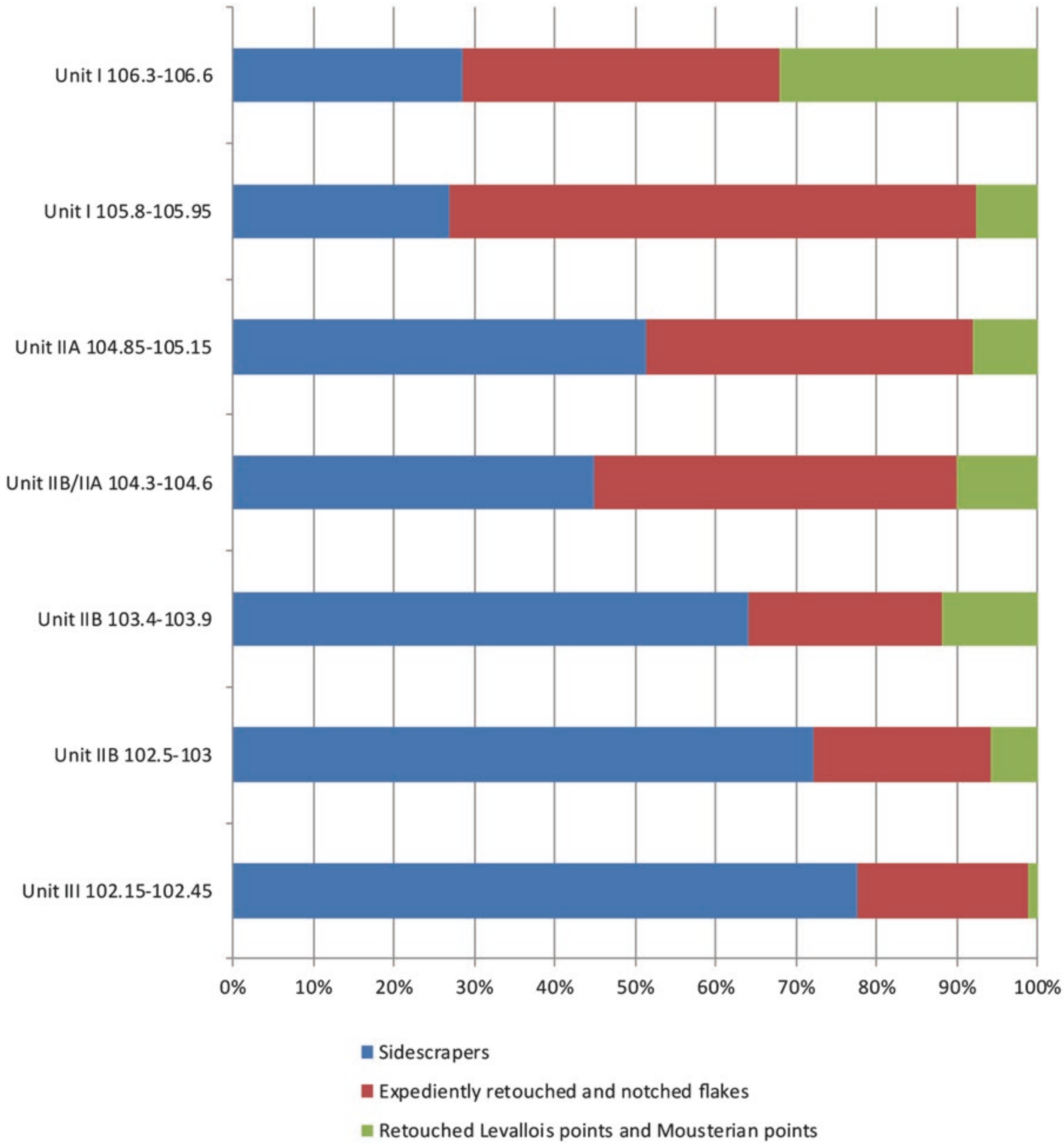


Fig. 2.15 Frequencies of the main retouched tool categories in the studied assemblages

waterlogging, pedogenesis and human occupation. It is likely that these processes often acted quasi-simultaneously, but the evidence suggests that some of them were more dominant than others during different stages of the site formation. The periods of intensive human use of the site were likely to be associated with stable episodes of low sedimentary input, which provided better conditions for exploitation of the sinkhole by hominins. The intensity and mode of the occupation fluctuated throughout the use of the site as attested by sharp changes in the densities of lithics, bones, anvils, hammerstones and manuports; changes in composition of the lithic assemblages and varying degree of fragmentation of the animal bones.

The lithic assemblage of Nesher Ramla is the largest and best-preserved excavated so far in the Near East dating to the latter half of MIS 6 (160–130 ka BP). The layers dated to MIS 6 contain evidence for intensive human use (combustion features, large faunal and lithic assemblages, lithic-bone-limestone concentrations, large occupation surfaces) comparable with much later Middle Paleolithic cave sites (e.g., Kebara Cave, Amud Cave, the upper levels of Qafzeh Cave), or with some rare occurrences in the Early Middle Paleolithic (250–160 ka BP; e.g., Misliya Cave; Weinstein-Evron and Zaidner 2017; Zaidner and Weinstein-Evron 2014). Nesher Ramla, thus, filling the gap between Early Middle Paleolithic and later sites

Table 2.2 NBK and side-scrapers in different MP sites in the Levant

Type of site	Site	Layer	Total assemblage	NBK %	Total retouched tools (restricted)	Sidescrapers (%)	References
	Nesher Ramla	I 106.6–106.3	642	8	47	17	
		I 105.95–105.8	264	9	35	20	
Open-air -		IIa 105.15–104.85	1640	10	120	31.7	
Karst sinkhole		IIb/a 104.6–104.3	2137	6	212	31.6	
		IIb 103.9–103.4	6330	6	632	55.4	
		IIb 103–102.5	4122	7	549	64.5	
		III 102.45–102.15	8474	8	618	68	
	Amud Cave	B2	1253	1.7	58	20.7	Akazawa and Ohnuma (1998)
		B4	418	1.9	11	0	
	Qafzeh Cave	III	198	6.6	8	25	Hovers (2009)
		IV	218	2.8	13	23	
		V	657	1.5	14	21.4	
		VI	433	1.6	30	43.3	
		VII	354	1.9	31	19.3	
		VIIa	599	5	48	22.9	
		VIIb	313	1.9	35	11.4	
		VIII	101	1	11	27.3	
		IX	1123	2.3	94	30.8	
		X	606	1.6	60	28.3	
		XI	846	3	77	37.7	
		XII	498	1.8	86	24.4	
		XIII	2243	2.5	231	36.8	
		XIV	495	1.4	84	3.6	
Caves and rock-shelters		XV	6109	3.7	342	13.1	
		Xva	1602	2.7	66	18.2	
Mediterranean zone		XVb	311	5.1	10	10	
		XVf	1572	3.2	31	6.5	
		XVII	867	1.3	109	18.3	
		XIX	515	1	55	16.4	
		XXI	309	1.3	38	7.9	
		XXII	182	1.6	20	10	
	Emanuel cave	II–VII	503	0.6	20	40	Goder-Goldberger et al. (2012)
		VIII–X	323	0.6	27	37	
	Yabrud I	6	632	7.4	159		Pagli (2013)
		5	998	6.6	131		
		4	1102	7.7	295		
		3	692	9.7	137		
		2	547		118		
	Ksar'Akil	XXVIII	605	8.8	70		Pagli (2013)
		XXVIIIA	717	6.1	125		
		XXVIIB	785	5.2	165		
		XXVIIA	359	1.4	58		

(continued)

Table 2.2 (continued)

Type of site	Site	Layer	Total assemblage	NBK %	Total retouched tools (restricted)	Sidescrapers (%)	References
		XXVIB	439	4.6	88		
		XXVIA	275	1.8	120		
Rock-shelter	Ain Difla		1562	1.3	55	0	Lindly and Clark (1987)
arid and semi-arid	Tor Faraj	floor 1	1223		123	3.2	Henry (2003)
zone		floor 2	1903		225	4	
	Quneitra	AREA A	2330	0.2	964	23.4	Goren Inbar (1990b)
Open-air sites		AREA B	5868	0.4	2269	32.1	
Mediterranean	NMO		694	4.7	172	9.3	Sharon and Oron (2014)
zone	EinQashish		2265	0.3	189	20.6	Malinsky-Buller et al. (2014)
	NahalAqev	1	840	2.1	34	20.6	Munday (1977)
		2	448	1.6	15	13.3	
		3a	1107	0.2	43	11.6	
		3b	913	1.2	28	17.9	
		3c	946	0.5	33	15.1	
Open-air sites		3d	1286	0.5	64	9.4	
arid and semi-arid		3e	1510	1	96	21.8	
zone		3f	742	0.5	37	8.1	
		3 g	875	1.2	41	2.4	
	Rosh EinMor		44,460	0.7	2667	8.2	Crew (1976)
	Hummal	5AII	138	2.9	13	30.8	Hauck (2010)
		5AIV	384	2	19	36.8	
		5a1	684	0.1	9	33.3	
		5a2	584	0.3	27	48.1	
		5a3	518	1	27	37	
		5a4	269	1.1	14	50	
		5b1	107	0	10	60	
		5b2	149	0.7	10	30	
		5b3	679	0.6	43	18.6	
		5b5	345	0.6	7	14.3	
		5b7	107	0	4	25	
		5E	211	0.5	14	42.9	
`	Umm El Tlel	V2 π b	1348	6.5	117		Pagli (2013)
		V2 π a	175	13.7	10		
		V2 Δ a patinated	746	3.6	37		
		V2 Δ a non patinated	361	3.3	40		

Only assemblages with more than 100 artifacts are included in the list

dated to late MIS 5 and 4. This is important for understanding cultural and technological development during the Middle Paleolithic, especially in light of the disappearance of Early Middle Paleolithic laminar technologies during MIS 6.

The systematic production of NBKs, a specialized toolkit dominated by invasively and carefully retouched sidescrapers and modification of scraper-like edge by lateral spall removal are unique characteristics of the Nesher Ramla industry, setting it apart from other Middle Paleolithic industries in the Near East. On the background of constant changes in the intensity and modes of occupation, the recurrent and systematic occurrence of distinctive technological and typological features throughout the site's stratigraphy is striking. We hypothesize that rather than a reflection of the function of the site in the land-use and mobility patterns, these features have a cultural origin and may indicate that Nesher Ramla hominins possessed discrete technological tradition that emerged in the region during late MIS 6 – early MIS 5.

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3 A Week in the Life of the Mousterian Hunter

Gonen Sharon

Abstract

Eight excavation seasons at the Mousterian site of Nahal Mahanyeem Outlet (NMO) on the banks of the Upper Jordan River offer a glimpse into the life ways of MP people during a hunting expedition in the Northern Dead Sea Rift. This open-air site, OSL dated to ca. 60ky BP, is interpreted as recording a series of short-term hunting events. The NMO horizons, with their small number of lithic artifacts, unique typological composition and evidence for task specific hunting and butchering activity fit within Binford's definition of a "task location". Many of the models suggested to describe site pattern and mobility activity, such as the foraging and logistical models, are based primarily upon theoretical consideration and ethnographic evidence. NMO gives us the opportunity to test such models based on archaeological evidence.

Keywords

Mousterian • Upper Jordan River • Task-specific • Short-term • Open-air

3.1 Introduction

Eight seasons of excavation at the Late Middle Paleolithic (MP) site of Nahal Mahanayeem Outlet (NMO) exposed a short-term, open-air hunting camp on the east bank of the Jordan River in the Upper Jordan Rift Valley. The framework for the cultural characteristics of the Final MP in the Levant was established well before the excavation of NMO. The primary data for this period spanning the final 20,000 years of human occupation prior to the emergence of the Upper Paleolithic industries ca. 50 ky before present (BP) was retrieved from large cave sites in the region. D. Garrod first described the final, or late stage of the MP cultural framework according to the final stage of the Tabun Cave sequence (Garrod and Bate 1937) and Copeland (Copeland 1975) later defined it as the Tabun B stage. This stage is characterized primarily by a relative abundance of broad-based, short Levallois points (see overview in Hovers 2009). The primary cave sites from which the data were collected are Kebara Cave in Mount Carmel (Bar-Yosef et al. 1992; Bar-Yosef et al. 2007; Meignen and Bar-Yosef 1992; Speth and Tchernov 2003), Amud Cave in the Lower Galilee (Valladas et al. 1999; Hovers et al. 1995; Suzuki and Takai 1970) and Dederiey Cave in Syria (Griggo et al. 1999). From the study of the lithic assemblages found in the relevant layers of these caves, we know that Neanderthals were the common type of human inhabiting them. An important contribution to our understanding of the Late MP comes from the open-air site of Quneitra in the Golan Heights (Goren-Inbar 1990; Oron and Goren-Inbar 2013). Similar to other open-air sites, the cultural sequence demonstrated by the lithic assemblage from Quneitra is different from all of the "typical" Late Mousterian cave assemblages.

The common features of all these sites, whether cave or open-air, are their high intensity of occupation. Archaeological horizons at cave sites represent considerable time averaging and document a large variety of tasks and activity. Cave site layers are also subject to complex

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post-depositional processes and, therefore, provide a wealth of information but have a relatively low resolution of observation (for overview see Sharon et al. 2014). In contrast, the site of NMO yielded information at a uniquely high resolution, enabling us to explore questions that rarely can be asked for Late MP sites in the Levant. The first section of this paper outlines the preliminary results of the NMO excavation and the second discusses their significance for our understanding of the life ways and subsistence of the final Mousterian hunter-gatherers of the Southern Levant.

3.2 The Site of NMO

3.2.1 Geology and Stratigraphy

The Hula Valley is a pull-apart basin that formed at the northern segment of the Dead Sea Fault plate boundary (Schattner and Weinberger 2008). A shallow lake covered much of the basin during the entire Pleistocene. The Jordan River is the primary drainage system through which the Hula Lake water flows, dropping from its level of ca. 70 meters above sea level (masl) today to the Sea of Galilee basin at −215 masl, only some 15 km to the south (Fig. 3.1a). It was recognized long ago that Hula Lake water level is dictated primarily by the depth of the Jordan River channel at its outlet southward, and the trench has been subjected to repeated deepening since the 1860s (for references see Sharon et al. 2002). As a result, the Jordan River flows today in a completely artificial channel, a few meters below its natural course at the beginning of the twentieth century. The site of NMO was discovered on the east bank of the Jordan River at the Mahanayeem Stream outlet c. 1.8 km north of the Benot Ya'aqov Bridge as a result of the last drainage operation that took place during the winter of 1999 (Sharon et al. 2002).

The Jordan River at this vicinity cuts through sediments ranging from the Early Pleistocene to the Holocene (Kalbe et al. 2014). The Upper Jordan Valley here is characterized by massive tectonics and massive volcanism that together formed a highly complex regional stratigraphy (e.g. Belitzky 2002). Nevertheless, the local sequence of the site containing the archaeological layers is well established and clear (Sharon and Oron 2014). The general stratigraphy of the NMO site was described in detail by Kalbe et al. (2014) and is summarized here as follows (Fig. 3.1c):

At the base of the stratigraphic sequence of the site is a layer of large basalt boulders and cobbles of fluvial origin (Layer 5; Sharon and Oron 2014). The basalt layer was formed in the shape of a hill with its highest point at the southwest portion and slanting to the north and dropping dramatically to the east. When or how (fluvial, tectonic, or a combination of these agents) this layer was formed is unclear. Stratigraphic, sedimentological and archaeological evidence suggest, however, that the people who occupied NMO during the Late Pleistocene found the basalt in its current form, that of a hill standing some 2–2.5 m above the surrounding landscape (Fig. 3.2). This basalt hill of Layer 5 is covered on its eastern, northern and southern sides by fine, silty, dark mud. This mud accumulated rapidly on the bank of a shallow, low energy water body, probably the southernmost edge of the Paleo-Hula Lake. At the contact between the basalt and the covering of dark mud is the archaeologically rich layer of the site, Layer 4 (Fig. 3.1c). The layer is comprised of flint tools, animal bones and botanical remains lying on the basalt floor of Layer 5 and continuing into the mud above it, forming a layer up to 40 cm thick. Layer 4 is dated to ca. 60 k years BP by a series of OSL dates (Kalbe et al. 2014). Above the archaeological layer is a sequence of additional mud layers (Layer 3), some showing a clear nonconformity with the layers below. Into this sequence of mud layers cut channels of streams and rivers (possibly the Paleo Jordan or the Paleo Mahanayeem Stream coming from the west), depositing sand with many mollusks and small limestone, basalt and flint pebbles. These channels (Layer 2) are dated to historical times by the presence of ceramics, coins and other such finds.

The data from Layer 4, the archaeologically rich layer, suggests that it represents a short-term event or, more precisely, a series of two or even more short events of occupation. The archaeological finds were found in fine mud. There is no evidence of layering or other processes indicating slow formation, and sedimentological observation suggests a rapid accumulation rate for this layer (Kalbe et al. 2014). Additional evidence for the rapid covering of the archaeological horizons is the excellent preservation of the bones and the flint tools at the site. It is evident that none of these finds were exposed to atmospheric conditions for a long period. The preservation of botanical remains in the site provides further evidence of short duration. Such preservation due to the waterlogged condition of the soils is well-known at the prehistoric sites on the banks of the Jordan River in this vicinity (e.g. Goren-Inbar et al. 2002a, b Melamed 2003; Melamed et al. 2011). A large number of wood remains, as well as fruits and seeds were recovered from the sediments of Layer 4. The actual presence of botanical remains within the layer indicates that they could not have been exposed on the surface for a long period of time.

Further evidence for the short duration of occupation can be seen in the presence of a significant number of refitted artifacts scattered throughout the site. These artifacts resulted from at least three reduction sequences connecting the different sections of the site into a single event (Sharon and Oron 2014). It is suggested that at least some of the artifacts in the archaeological layers were discarded by the site inhabitants directly into the mud or shallow water of the lake surrounding the basalt hill of Layer 5. The stone tool assemblage of

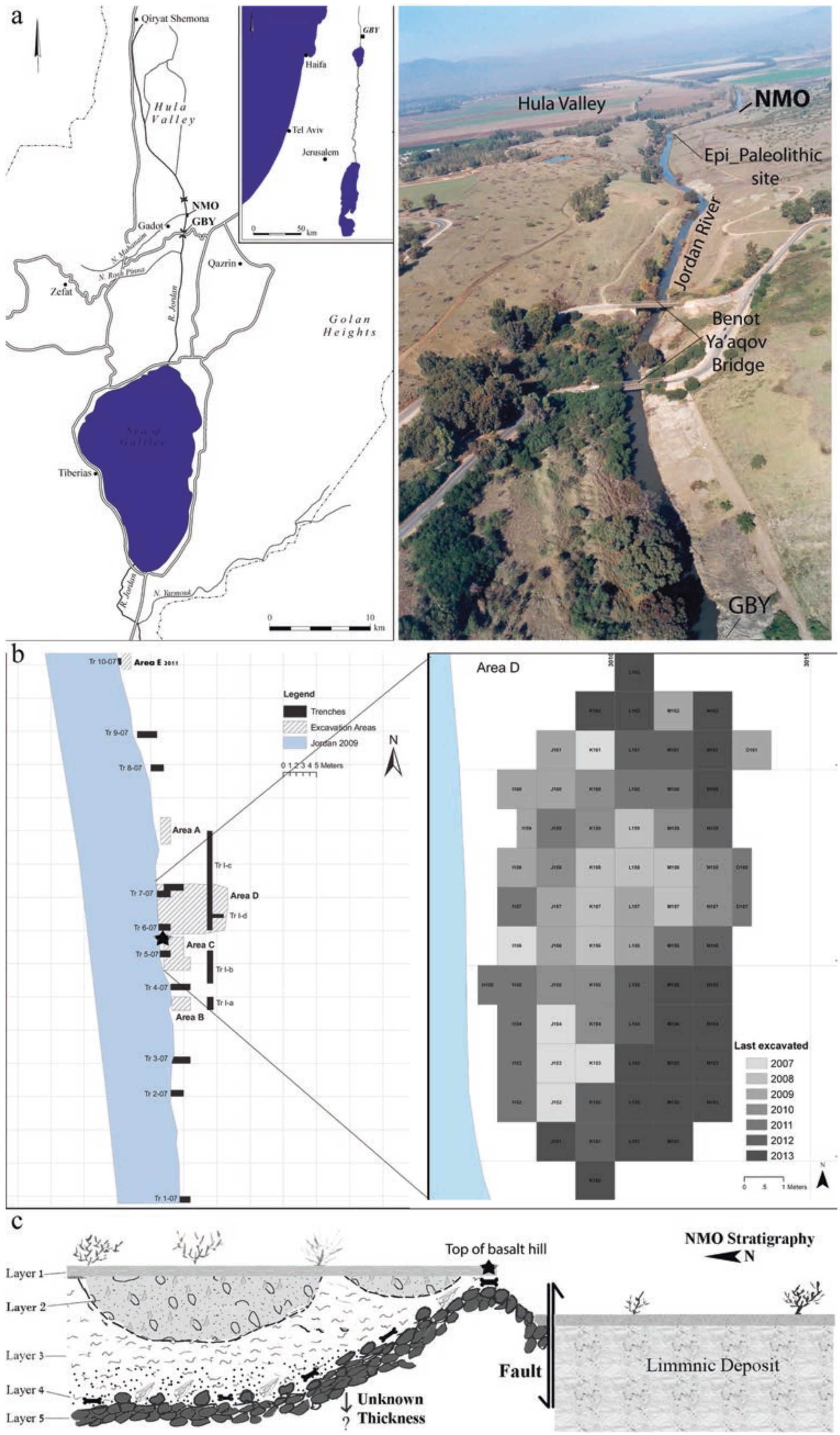

Fig. 3.1 (**a**) Location map and Aerial Photo of the NMO site and vicinity; (**b**) Excavation map with Area D excavated squares by year of excavation; (**c**) General reconstruction of the site's stratigraphy of the site looking from the west

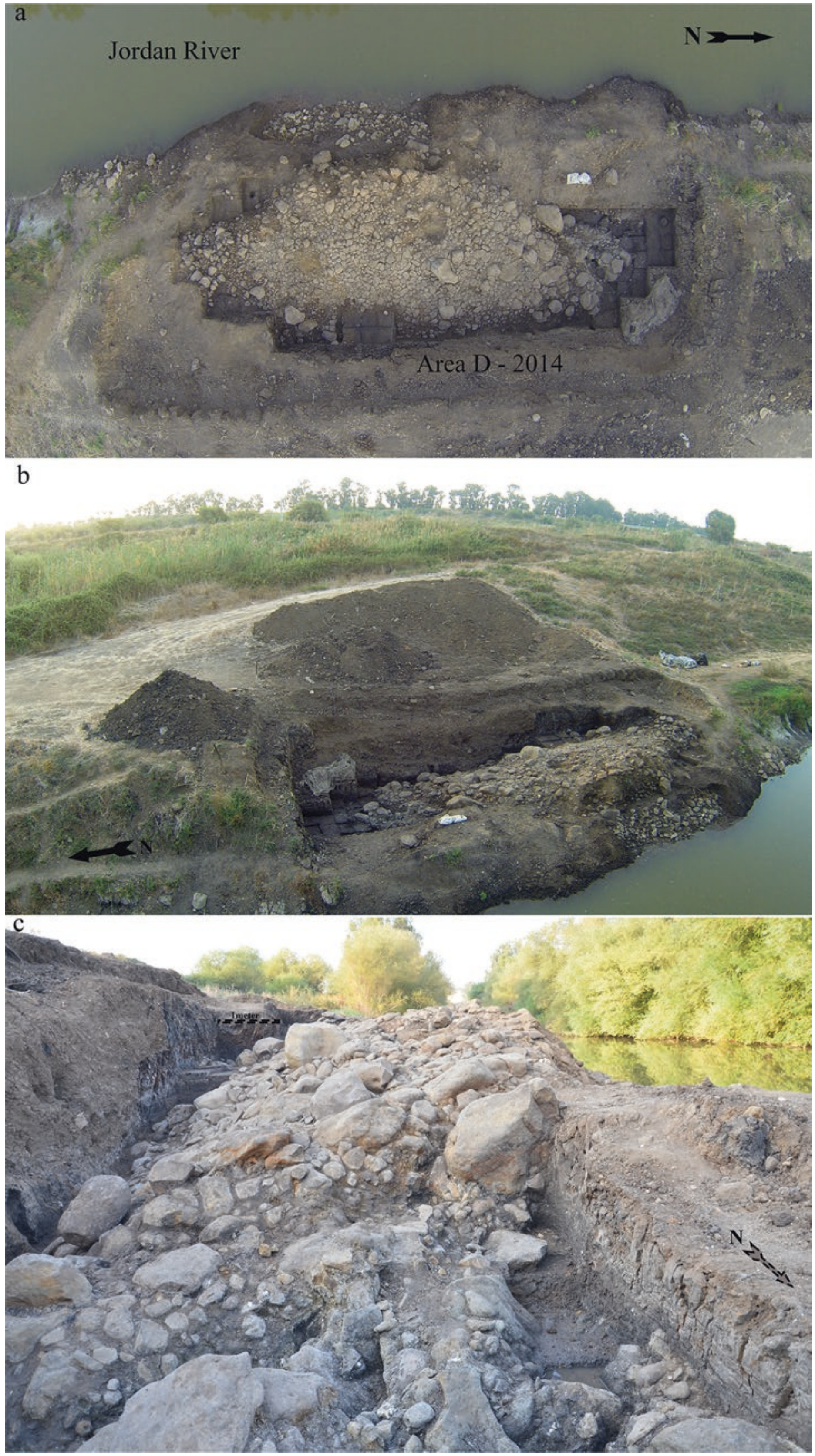

Fig. 3.2 Layer 5 "The basalt hill". (**a**) Aerial photo; (**b**) a view from the north-west; (**c**) the basalt hill from north – rising up to c. 2.5 m above surrounding surface

the site also strengthens the argument for a short occupation. The number of artifacts excavated per excavation unit at the site is exceptionally low when compared to any other MP site in the Levant. At most cave sites the density of the finds is extremely high, but the NMO density is very low even when compared to other open-air sites in the Levant (Goren-Inbar 1990; Oron and Goren-Inbar 2013). The low number of NMO stone tools clearly indicates a low intensity rate for the site and makes it highly unlikely that it represents an area of long-term activity.

The accumulation history of the site has been reconstructed as follows (Fig. 3.3): In the first stage, the basalt hill of Layer 5 was surrounded by shallow muddy water. The inhabitants of the site were active for a relatively short time (possibly only a few days) on the basalt surface and discarded their stone tools and processed bones on the basalt as well as in the mud surrounding it. At the next stage, the water level in the lake rose and covered a larger, higher section of the basalt hill. At this stage there was an additional, short phase of human occupation, possibly a hunting expedition. The remains of this second occupation phase were found in the mud at a somewhat higher level than the previous occupation and in the upper part of the basalt hill. Analysis of the finds demonstrates that the assemblage from the upper part of the basalt hill may have resulted from more than a single occupation event while the assemblage from the lower part of the hill documents only the first, earlier event. This scenario of short occupation events repeats itself at least 3 times (possibly more) as illustrated in Fig. 3.3. The last phase of occupation documented at the site took place when the entire pile of basalt was already covered by mud. The poor preservation state of bones excavated from this stage suggests that they were possibly exposed on the surface for a longer period.

3.2.2 Flora and Fauna

Organic remains are extremely rare in Levantine MP Sites. The botanical remains from the NMO site include wood pieces, bark, seeds and fruits as well as excellently preserved pollen. The wood pieces range in size from large branches (over 1 m in length with a diameter of over 10 cm) to small twigs a few mm in length. Some of the wood pieces are burned and some were found in clear association with stone tools. No clear hearth was identified in the field but preliminary study of the spatial distribution of burned elements suggests that concentrations can be observed. Among the wood species that were identified are species bearing edible fruits, including almond, oak, and palm (identified by Prof. E. Werker). It is interesting to note that the species of oak identified at NMO, the Cyprus Oak (*Quercus boissieri*) grows today only above 500 masl. This may indicate the involvement of human agency in its presence at the site. The fruits and seeds also include edible species of both dry land and water plants. The pollen data from the site were described in detail elsewhere (Aharonovich et al. 2014).

The fauna of the site is rich and includes animals ranging in size from rhinoceros to crabs and birds. At the current stage of research significant conclusions cannot be drawn regarding the fauna and its bearing on human behavior. Yet, preliminary observations can be suggested regarding the site's function and the hunters' behavior. The primary animal excavated at the site is the giant cow weighing over 1000 kg (*Bos primagenius;* Fig. 3.4). More than one cow was butchered by the site inhabitants during the short events documented in the site layers. Clear association was observed between the bones and the stone tools at the site. Stone tools are found in immediate proximity to the bones, sometimes touching each other. Cut marks and hack marks are clearly evident on many of the bones. It is interesting to note that many of the large bones were unearthed complete (Fig. 3.4). This is very different from any other MP site in the Levant where bones typically were found heavily fragmented due to human activity (e.g. Rabinovich 2002; Rabinovich and Tchernov 1995; Stiner 2005).

In addition to cows, the inhabitants of the site exploited the bones of other large animals including wild boar, deer, and gazelle. Small animal finds include tortoise and turtles. Although geologists determined that the site was located on the banks of a paleo-lake and that an additional substantial water body was clearly evident in the vicinity, fish remains at the site are very scarce.

3.2.3 Lithic Assemblage

Analysis of the NMO lithic assemblage, the primary tool for studying human behavior at the site, resulted in significant observations (for preliminary observations see Sharon and Oron 2014). Probably the most significant characteristic of the NMO assemblage is its small size. After eight seasons of excavation at the almost 50 square meters of Area D, we have fewer than 1000 flint artifacts (>2 cm.) excavated in situ. This is an extremely low density, incomparable to any other MP site in the Levant (Goren-Inbar 1990; Hovers 2009; Shea 2003b).

3.2.3.1 Typology

The other unique characteristic of the assemblage is its typological composition. The percentage of tools within the assemblage is very high, currently about 30% (Sharon and Oron 2014). This is not an exceptional frequency for an open-air site in the Levant, whose frequency is typically very high in comparison to cave sites of the region (Goren-Inbar 1990; Hovers et al. 2008; Malinsky-Buller et al. 2014). However, the typological composition of the assemblage is

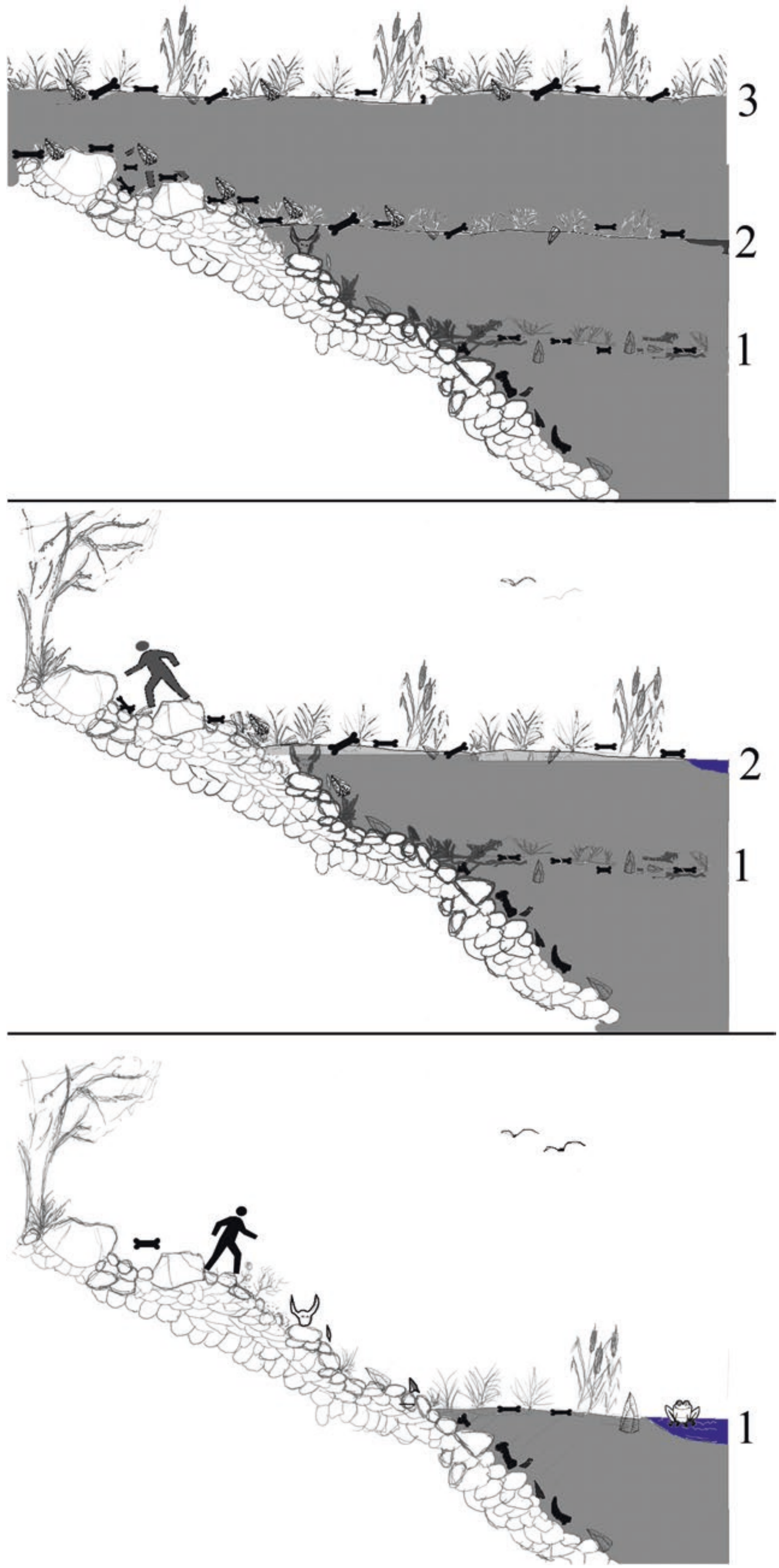

Fig. 3.3 Suggested reconstruction of the formation of the NMO archaeological horizons

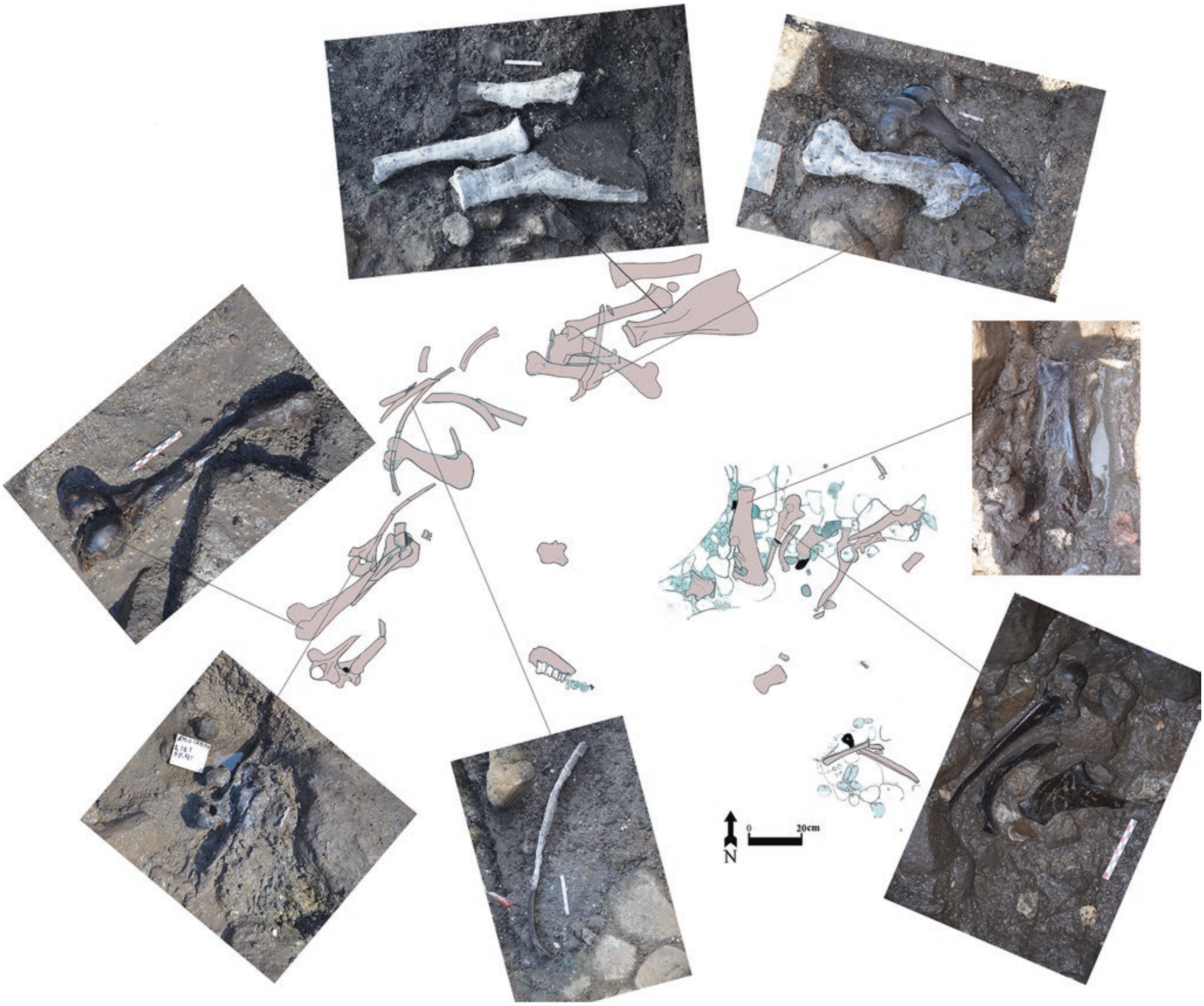

Fig. 3.4 Bovid large and complete bones and their spatial distribution in the northern sector of Area D

very different from both open-air and cave sites: the assemblage is dominated by two groups of artifacts defined as cutting tools and pointed elements, many of them made of high quality flint. Sharon and Oron (2014) demonstrated that as much as 10% of the assemblage can be classified as pointed elements, while an additional 9% of the artifacts studied can be classified as knives or present a long, straight cutting edge suitable for slicing meat (the percentages are preliminary as the analysis of the lithic assemblage is ongoing).

Moreover, the NMO assemblage is unique among other MP assemblages not only for its frequency of cutting tools and pointed elements, but also in the absence of other tool types typically present in significant numbers in such assemblages. There are very few scrapers in the assemblage, and the same is true for other tool types such as burins, awls, end scrapers, and many others such as notches and denticulates (for discussion of the typical tools in Levantine MP assemblages see Goren-Inbar 1990; Hovers 2009; Meignen and Bar-Yosef 2000; Shea 2003a). Lastly, cores are nearly absent from the excavated assemblage and the number of knapping waste elements is extremely low, indicating that a minimal amount of onsite knapping was done. Nevertheless, some knapping was done onsite, as evidenced by the presence of a tested nodule of flint (from which only two large flakes were removed before abandonment; Fig. 3.5) and refitted sequences (see below).

As discussed in detail below, it can be suggested that this unique typological composition resulted from the functional selectivity of the site inhabitants. The primary task that took place at the site was the butchering of large, hunted game. Pointed elements and cutting tools, the tools dominating the assemblage, were brought into the site for this purpose. This theory also explains why other tool types normally used for different tasks are so scarce in the assemblage.

Fig. 3.5 Refitted reduction sequence. Plain and wide striking platforms highlighted

3.2.3.2 Lithic Technology

Notwithstanding its small size, the analysis of the lithic assemblage of NMO yielded significant observations. Again, preliminary results were presented previously by Sharon and Oron (2014). Notable results of this preliminary study include:

Levallois Technology While present within the assemblage, the Levallois core method was applied to produce only a very small minority of the NMO flakes and blades. Of the 683 artifacts recorded to date as excavated from a reliable context in Area D, the primary excavation area of the site, only 24 (3.5%) were recorded as detached from a Levallois core (see Sharon and Oron 2014 for details). An additional 57 flakes (8.3%) were classified as possibly Levallois, meaning that they bear some features that may have resulted from the application of the Levallois core method, yet these features were insufficiently typical to classify the artifact as Levallois. This is a very low percentage for a Levantine site (Hovers 2009).

Reduction Technology The lithic assemblage cannot be classified as blade dominant but many of the tools have elongated proportions (Sharon and Oron 2014). Furthermore, it was demonstrated that the morphology of numerous pointed elements in the assemblage can be explained by the application of a "blade core" reduction sequence in their manufacture. They were produced from the elongated face of the core, with the knapper using the ridges between the previous scars (arris) to dictate the morphology of the resulting flake. The results are typical, pointed elements that do not meet the Bordesian criteria for points and hence are classified (in the traditional typological system) simply as blades (Fig. 3.6a). They are, however, the product of a systematic and predetermined reduction sequence. These pointed elements were selected by the NMO tool users to be used at the site.

Additional technological features characterizing the NMO tools are frequent thick and plain striking platforms. Of special interest is the presence of abrasion and micro-flaking marks on the dorsal face of the striking platforms (Fig. 3.6c). These are the result of striking platform preparation prior to the flaking of the tool by the knapper. Such "blade preparation marks" were identified on the striking platforms of 64 (9.4%) of the Area D flakes and blades. This abrasion and preparation was noted as one of the markers of the advanced core technology applied by the Upper Paleolithic knappers of the Ahmarian lithic tradition (Goring-Morris and Belfer-Cohen 2003). Its pronounced presence in the NMO assemblage can be seen as a herald of things to come in the lithic technology of the region.

Refitting The small assemblage of NMO yielded a significant number of refitted sequences that provided important information regarding both the lithic technology and flint economy of the site inhabitants. The artifacts refitted to date (Sharon and Oron 2014) enabled us to reconstruct the following: while many of the artifacts excavated at the site were most likely brought in as knapped tools, the knappers that inhabited the site also brought with them medium-sized nodules of flint to be used as raw material for the production of tools on site. These chunks of flint (in the shape of river cobbles or nodules) were knapped on site using a simple, yet highly efficient core method for the production of elongated blades, including naturally backed knives and other thick blades. The objective seems to have been the production of a long cutting edge for butchering tasks. The production was executed by applying the blows to a thick, plain, unprepared striking platform following the circumference of the core. After a series of blades was detached, an additional series of blades was removed from the same platform, again following the outer course of the core. This is a typical, simple and efficient method that produces numerous flakes without any preparation of the core and striking platforms.

3.3 The Significance of NMO for the Reconstruction of Human Behavior in the Late Middle Paleolithic

Eight seasons of excavation at the Middle Paleolithic site of NMO resulted in the exposure of a unique site within the Levantine MP. The small assemblage of stone tools and its typological and technological composition, together with the excellently preserved and exceptional faunal and botanical assemblages, suggest a short-term, task-specific nature for the site. The arguments for the short duration of the NMO occupation (or occupations) were presented above. It is also clear that the occupation intensity is exceptionally low in comparison to all other excavated MP sites in the Levant (Hovers 2009; Sharon and Oron 2014). The small assem-

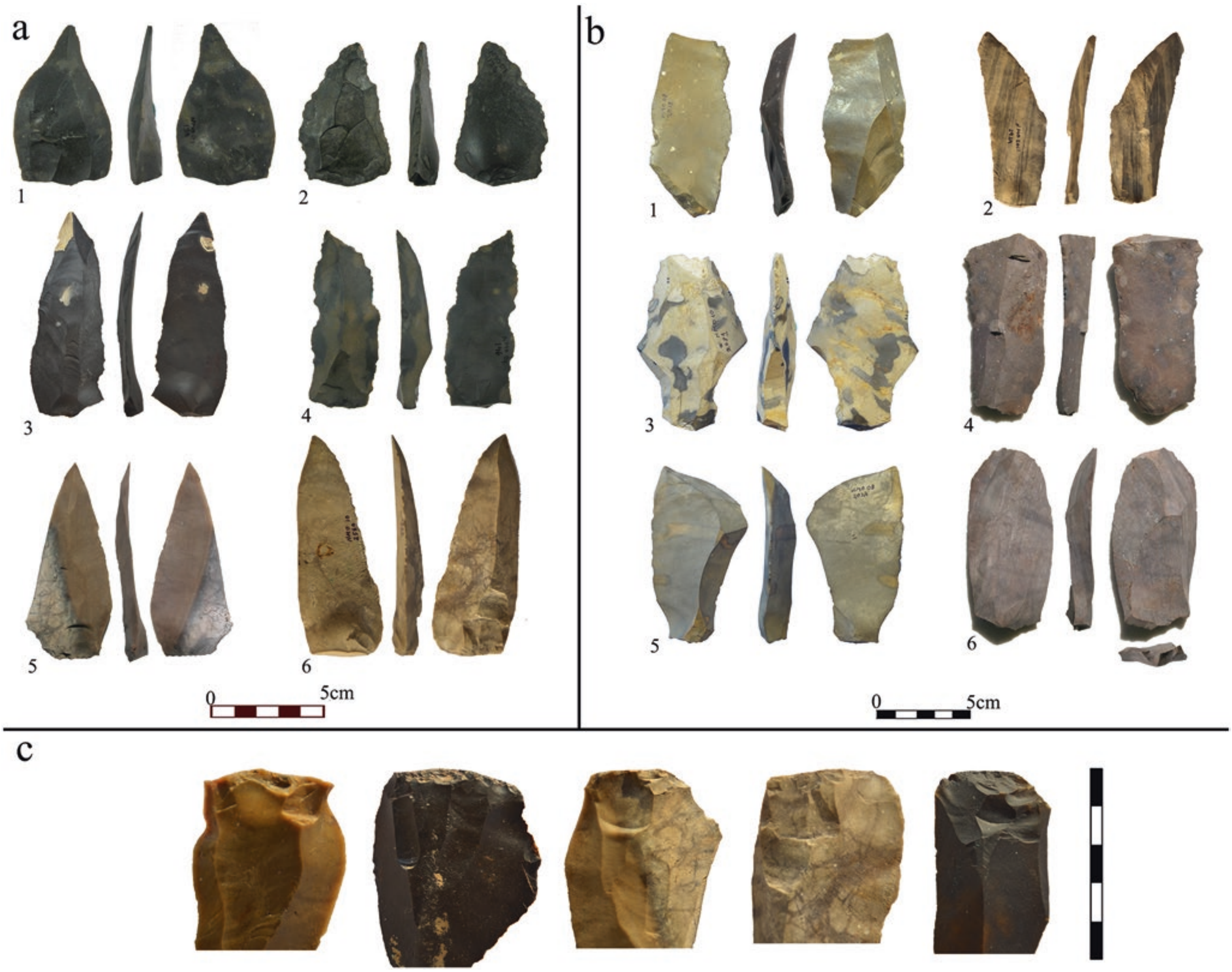

Fig. 3.6 NMO flint tools. (**a**) Pointed element; (**b**) cutting tools; (**c**) abrasion marks on dorsal edge of striking platforms

blage, the short duration of occupation and the preservation of the finds enable a high resolution exploration of the site, a resolution level that rarely can be achieved for an MP site in the Levant or beyond. While the study of the NMO finds is ongoing, observations at this stage can shed new light on existing models explaining human behavior during the MP.

The site of NMO is OSL dated to 60 k years BP. This date places it near the upper limit of the Late Levantine MP. The emergence of the Upper Paleolithic lithic traditions is just around the corner. Some important Levantine MP sites share this dating with NMO. These include the caves of Amud (Valladas et al. 1999) and Kebara (Bar-Yosef et al. 2007) as well as the open-air sites of Quneitra (Goren-Inbar 1990) and Fa'ara II (Gilead 1995; Gilead and Fabian 1990; Gilead and Grigson 1984). This is the end of MIS 4 and the beginning of MIS 3, characterized by glacial environmental conditions in Europe. The effect, however, of glaciation on the Levantine environment is debatable (for recent overview see Frumkin et al. 2011). Significantly, evidence from NMO suggests that no dramatic shift can be observed between glacial and inter-glacial environmental conditions in the Hula Valley (Aharonovich et al. 2014). The taxonomic classification of the humans occupying NMO is unknown. It has been widely accepted that Neanderthals were the dominant species during the final MP in the Levant (Hovers et al. 1995), but recent data from the Manot Cave suggest the coexistence of anatomically modern humans in the Levant (Hershkovitz et al. 2015). The debate over the presence of Neanderthals in the Levant (Arensburg and Belfer-Cohen 1998) is far beyond the scope of this paper. In the context of the question of Neanderthal replacement by modern humans, analysis shows that the material culture of the NMO people is situated well within MP boundaries. Yet, its features are modern, if you like, representing a significant advance (see below).

3.3.1 Hunting Large Game

NMO is interpreted as a hunting locality (terminology after Binford 1980) where a group of hunters butchered giant cows. The ability of Late MP Levantine groups to hunt large game is well established (Rabinovich and Hovers 2004; Speth and Tchernov 1998). Yet the enormous size of the wild cows hunted calls for appreciation of the skills of the NMO hunters. Their actual hunting gear is unknown as, unfortunately and notwithstanding our hopes given the excellent preservation of botanical remains, no hafted implement or spear-like piece of wood was recovered at NMO. Yet the very high percentage of pointed elements, over 10% of the assemblage, enables us to suggest a reconstruction of the hunters' tool arsenal (Sharon and Oron 2014; Shea 1988, 2003a, b). Pointed elements are associated with hunting activity (Yaroshevich et al. 2010) and the presence of impact fractures on some of the NMO pointed elements, combined with broken tips of points among the site's micro-artifacts support this assumption.

The bone assemblage excavated at NMO is unique in the Levantine MP. Bones in MP Levantine sites typically have been found greatly fragmented, especially in cave sites (Rabinovich and Hovers 2004; Stiner 2005). At NMO, many of the large bovid bones were found whole with their marrow intact (Fig. 3.4). The unbroken bones were not articulated when found. They were found in immediate proximity to flint tools and have cut marks. These factors clearly indicate that human agency was responsible for their accumulation at the site. The presence of bone marrow is somewhat unusual. One explanation for the fact that the hunters did not extract the bone marrow may be the enormous amount of meat acquired in the hunt. Each cow is estimated to have weighed over 1000 kg, obviating the effort to extract marrow. Recently, Speth (2010) raised questions regarding the efficiency and purpose of big-game hunting. We do not know how frequently the Mousterian hunters hunted large game and what was the praxis or size of their hunting party. The presence of many additional species of animals in the NMO layers, including deer, gazelle, wild boar and even carnivores, including the skull and femur of a lion (Sharon et al. 2008), suggest that we are looking at complex hunting behavior beyond that necessary to employ at a kill site of a single species (Binford 1980; Delagnes and Rendu 2011; Moncel and Rivals 2011). While additional study is required before a complete interpretation can be offered to explain the uniqueness of the NMO bone assemblage, the data paint a picture very different from that observed for cave sites and has great potential to shed new light on MP hunting behavior.

3.3.2 Stone Tools as Cultural Markers

As noted above, the NMO lithic assemblage is unique among all Levantine MP assemblages for its exceptionally small number of artifacts, its technology, and its typological composition. These differences are pronounced in comparison to both cave layer assemblages and open-air sites (Goren-Inbar 1990; Hovers 2009). The technology of the assemblage is unique because the use of the Levallois method is rare and broad-based Levallois points are absent. Many features of the assemblage are technologically advanced. A significant number of the blades and elongated pointed elements were produced using a blade core concept and evidence for careful preparation of the platforms by abrasion is seen clearly on the striking platforms (Fig. 3.6c). Researchers maintain that such characteristics indicate the emergence of Upper Paleolithic core technology in the Levant (Goring-Morris and Belfer-Cohen 2003). The dating of the NMO assemblage suggests that such technological innovations do not signify a transitional tradition as seen in the Early Ahmarian or Final Mousterian (Goring-Morris and Belfer-Cohen 2003), but were part of the Mousterian lithic technology earlier than previously recorded. Preliminary observation indicates that these features are present in other Levantine MP sites such as Amud Cave (A. Malinsky-Buller, personal communication). The small size and unique typology of the NMO assemblage enabled these features, which were somewhat overlooked in other assemblages, to stand out.

3.3.3 The Tool Arsenal and Flint Economy

The typological composition of the NMO assemblage is highly selective. It is very different not only in its high percentage of tools to waste, but also in the dominancy of pointed elements and cutting tools and in the near absence of many tool types that dominate other assemblages, including scrapers and denticulates. It is suggested that the composition of the assemblage represents a functional selection of the tools (Sharon and Oron 2014). The inhabitants of NMO brought with them only the tools for tasks they expected to execute at the site. The dominance of pointed elements and cutting tools suggests that the intended tasks were the hunting and processing of large game carcasses.

Under the traditional typological classification system, many of the pointed elements at NMO would be classified simply as either blades or flakes. The Bordesian (Bordes 1961) typological list consists of only Levallois (and pseudo-Levallois) and Mousterian points. Pointed elements that were not produced using the Levallois method or shaped by retouch (as Mousterian points) would fall outside the definition of pointed elements in this system. Nevertheless, the artifacts excavated at NMO are clearly pointed elements and, as evident from the impact fractures observed on some of them, were probably used as projectiles. Interestingly, some of the pointed elements of NMO, primarily the elongated ones (Fig. 3.6), closely resemble the Australian macroblades (Newman and Moore 2013). Some of the Australian pointed macroblades were hafted by aboriginal tool users into short handles and were used as knives rather than projectile tips (Newman and Moore 2013, Figs. 3.2 and 3.5). This example provides a plausible interpretation for use of the NMO pointed elements.

The tools excavated at NMO are, of course, the discarded objects left behind by its inhabitants (Fig. 3.6). While some were found broken, as expected for discarded tools, others were found whole and unweathered. It is hard, from our modern perspective, to understand why these prefect tools were left behind. Clearly, a simplistic model of discard of broken and unused tools cannot explain the pattern observed at NMO. A more complex tool economy is needed to explain this behavior.

Many models have been suggested to explain MP assemblage composition variability. Most of the models were developed from data at late prehistoric sites in the new world and from ethnographic observation. The models use theoretical considerations to predict the expected nature of lithic assemblages from different sites (see discussion and references in Hovers 2009). Variability in the typological and technological characteristics of the different assemblages is explained using models of changing environmental conditions, raw material provisioning strategies, variation in stone tool tradition and site function (e.g. Kuhn 1995). For example, Hovers (2009) summarizes the predicted nature of an assemblage from a task-specific, open-air site:

"If personal gear and curated artifacts were utilized in task-specific sites, they should be characterized archaeologically by the occurrence of later-stage reduction debris and low proportions of waste flakes. Used flakes and small resharpening flakes should occur in high proportions, but tools may be absent, as they would have been removed by users from the sites to other locales (Binford 1979). If the site was the last locale at which tools were used, small, exhausted, and heavily retouched implements are expected. Distal segments of broken artifacts, not salvaged after being broken during use, will be left on site." (Hovers 2009, p. 160).

It is now possible to test this prediction against the data from NMO. While many later stage artifacts and a low number of waste products were found, most of the other predicted characteristics are refuted by the NMO data. No evidence for recycling was uncovered at NMO nor was a significant number of "core on flakes" identified. The percentage of tools is very high and it seems that they were not removed from the site but rather left behind. The picture emerging from the NMO assemblage is very different from the one predicted by the model presented here.

The study of the flint assemblage from NMO, combined with the refitted sequences obtained from the site, allows us to explore the flint economy of the NMO tool makers and users. While some of the tools were clearly brought to the site as completed tools, the NMO knappers brought with them chunks of raw material that were knapped on site. The on-site core method employed was simple yet highly efficient. Evidence for raw material transportation into sites is, of course, not new to Levantine MP archaeology. Data include the presence of "tested" nodules and high frequency of cortical elements (for a summary of the evidence from Kebara Cave and Tot Faraj in Jordan see Hovers 2009, p. 220). However, the high resolution of the NMO data allows us to explore flint economy and mobility for a single occupation event. We are able to estimate the amount of raw material brought into the site, reconstruct the technology applied on site, and better control for theories regarding the mobility of artifacts imported and exported from the site. Preliminary observations suggest that only a few blocks, possibly three or four, were brought to the site as raw material. In one case, a cobble was tested and rejected after two blows. Other cobbles were efficiently knapped onsite to produce elongated blades and knives. The fact that little raw material was brought likely indicates careful and meticulous preplanning of the resources carried to the site by the hunting group members.

3.3.4 Implications for Band Size and Group Behavior and Territoriality

The NMO data also enables us to assess hunting behavior and group behavior and territoriality more precisely. If we reconstruct the observed data as reflecting short events of hunting expeditions camping on the shore of the Paleo-Hula Lake we can argue for the following behavior patterns:

The NMO data suggest repeated visits to the same locality by the hunting groups. The pile of basalt boulders may have been a landmark on the bank of the lake. The hill, rising over 2 m above the muddy shore of the lake (Fig. 3.2) could have been used as a "meeting point" for the hunting party or possibly as a good ambush location or, even more likely, as a "dry spot" where carcasses could be processed outside of the surrounding mud. This suggests a good knowledge of the environment as well as "place memory" of the group of hunters.

NMO is a short occupation site with low occupation intensity (see definition and discussion in Hovers 2009). Such behavior fits the logistical model of a home base site surrounded by satellite localities as suggested by Kuhn (1995). When we look for potential home bases for the hunting expeditions camping at NMO, sites such as Amud Cave can be suggested. Amud Cave is located only 21 km from NMO as the crow flies, meaning within a day's journey. The Amud Cave was occupied when the NMO site was active and many of the NMO lithic features are found within the Amud assemblage. This is not to claim that Amud was the home base for NMO. Other, closer sites exist but have not yet been excavated. Nonetheless, the Amud Cave, located within a short trek from the site, demonstrates the viability of the home base-satellite localities model for NMO.

3.4 Conclusion

Eight seasons of excavation at the open-air Mousterian site of NMO unearthed a short-term, task-specific, low occupation intensity hunting locality. The site's layers document repeated visits to a hill of basalt located on the bank of the Paleo-Hula Lake. The unique lithic assemblage, the excellent preservation of bones and botanical remains, together with the site stratigraphy, allow for high resolution reconstruction that is rare for Levantine MP sites. The study of the site finds is ongoing, yet preliminary observations have already exposed the potential of the site to shed light on our understanding of the behavior and subsistence of Late MP groups in the Levant.

The evidence suggests advanced hunting behavior of the groups of hunters occupying the NMO layers. They had excellent knowledge of their environment. They had sophisticated hunting and butchering skills; they possessed knowledge of lithic technology that was previously attributed only to later Upper Paleolithic knappers. The NMO hunters carried with them only the tools needed for their specific tasks, enabling us to reconstruct the tool arsenal of the Mousterian hunter. They applied sophisticated raw material economy that involved preplanning and good knowledge of the environment and its resources.

The NMO data provide the opportunity to test models explaining variability among lithic assemblages and to evaluate their predictions regarding the nature of open-air, short-term task-specific sites. The data also contribute to our understanding of mobility patterns, group size and territorial behaviors of Late Pleistocene MP groups in the Levant.

The replacement of Neanderthals by anatomically modern humans in the Levant is debatable. The NMO data help define and understand the behavior and abilities of the final Mousterian groups at the brink of the emergence of modern people in the Levant.

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4

Chrono-cultural Considerations of Middle Paleolithic Occurrences at Manot Cave (Western Galilee), Israel

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Abstract

Manot Cave is situated within the Levantine Mediterranean region. The site has an extensive Upper Paleolithic sequence, also manifesting the presence of a Middle Paleolithic occupation. This study will present the Middle Paleolithic assemblage from the cave. One of the Levallois centripetal cores from the assemblage exhibits, what seems to be non- utilitarian engravings on its cortex covered dorsal face. These incisions were performed prior to the last removals from the flaking surface. The Levallois techno-typological traits of the artifacts indicate their resemblance to other mid-late Middle Paleolithic techno-complexes present in the region.

Keywords

Manot cave • Levallois technology • Engraved artifact • Mediterranean • Levant

4.1 Introduction

The Mediterranean region was extensively occupied during the Middle Paleolithic, with a probable increase in population size in the later part of the period (Lieberman and Shea 1994; Hovers 2001; Shea 2003; Meignen et al. 2006). The lithic technologies varied from unidirectional convergent methods with short Levallois points (Bar-Yosef and Meignen 1992) to similar reduction strategies exploited to produce elongated Levallois points (Hovers 1998; Henry 2003; Groucutt 2014; Sharon and Oron 2014). Industries exhibiting more of a bidirectional and centripetal method of Levallois production are also present (Gilead 1980; Gilead and Grigson 1984; Marks and Volkman 1986; Hovers 2009; Malinsky-Buller et al. 2014). Behavioral variability among Middle Paleolithic people of the Mediterranean is also expressed via the high diversity of hunting areas exploited (Hartman et al. 2015), varied subsistence strategies utilized (Malinsky-Buller et al. 2014), and use of shells, ochre and other symbolic artifacts (Bar-Yosef Mayer et al. 2009; Hovers et al. 1997, 2003). It has been postulated that the differences between human groups in the Middle Paleolithic, reflected in their technological skills and preferences,

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allowed for the growth of technological innovations in the Initial and Early stages of the Upper Paleolithic (Hovers 1998; Belfer-Cohen and Goring-Morris 2007, 2009; Belfer-Cohen and Hovers 2010).

The recent discovery and dating of Manot 1 calvaria is an important contribution to the ongoing debates concerning modern human dispersalsout of Africa and their contemporaneous inhabitants of the Levantine Mediterranean region with Neanderthals (Hershkovitz et al. 2015). The crusts on the skull were dated by U/Th to a minimum age of 54.7 ± 5.5 ka (arithmetic mean ±2 standard deviations) (Hershkovitz et al. 2015). The partial skull was found in a side chamber of the cave resting on a flowstone ledge. Thus, the minimum age closely reflects the true age of the skull. The Manot 1 calvaria date places it close to the supposed transition between the Middle and Upper Paleolithic periods (Rebollo et al. 2011; Bosch et al. 2015). The current contribution focuses on the Middle Paleolithic artifacts found at different locations in the cave. The aim of the paper is to characterize (technologically and typologically) the Middle Paleolithic industry at Manot Cave and discuss its reference in comparison to other assemblages from the Mediterranean region.

4.2 The Site and Its Setting

Manot is an almost sealed karstic cave, located 5 km east of the current Mediterranean shoreline, some 40 km north east of Qafzeh Cave, and almost 50 km northwest of the Mt. Carmel sites (Fig. 4.1). Manot Cave is situated on the southern slope of a limestone hill at 220 m asl and >100 m above the local water table. Today, the surrounding landscape presents Mediterranean woodland, with mean annual precipitation of 600–700 mm.

Seven excavation seasons took place at the site (2010–2016) and 12 areas were excavated (Fig. 4.2; Areas A-L; Barzilai et al. 2012, 2014, 2016; Marder et al. 2013, 2017). During the excavation, in some of the areas, a few Levallois artifacts were encountered in Upper Palaeolithic contexts (Areas A, C, D, E and G). The majority of Middle Paleolithic artifacts originate from Areas C and D. The assemblage presented was retrieved from the 2011–2014 excavation seasons including 70 artifacts of which 11 are cores.

In this study we present one aspect of the overall lithic assemblage from Manot Cave, focusing on artifacts that complied with the definition of the Levallois technology

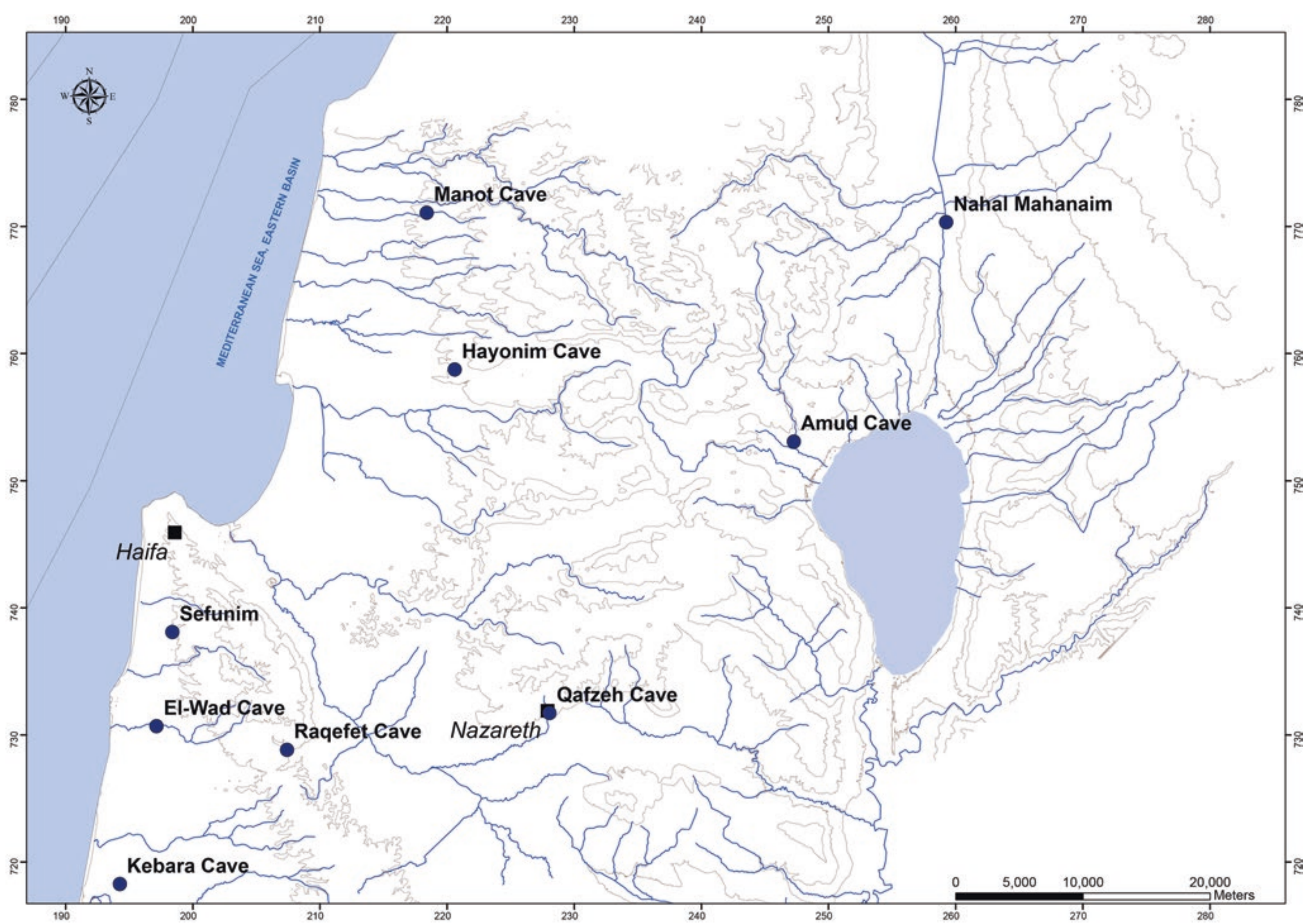

Fig. 4.1 Location map of sites mentioned in the text

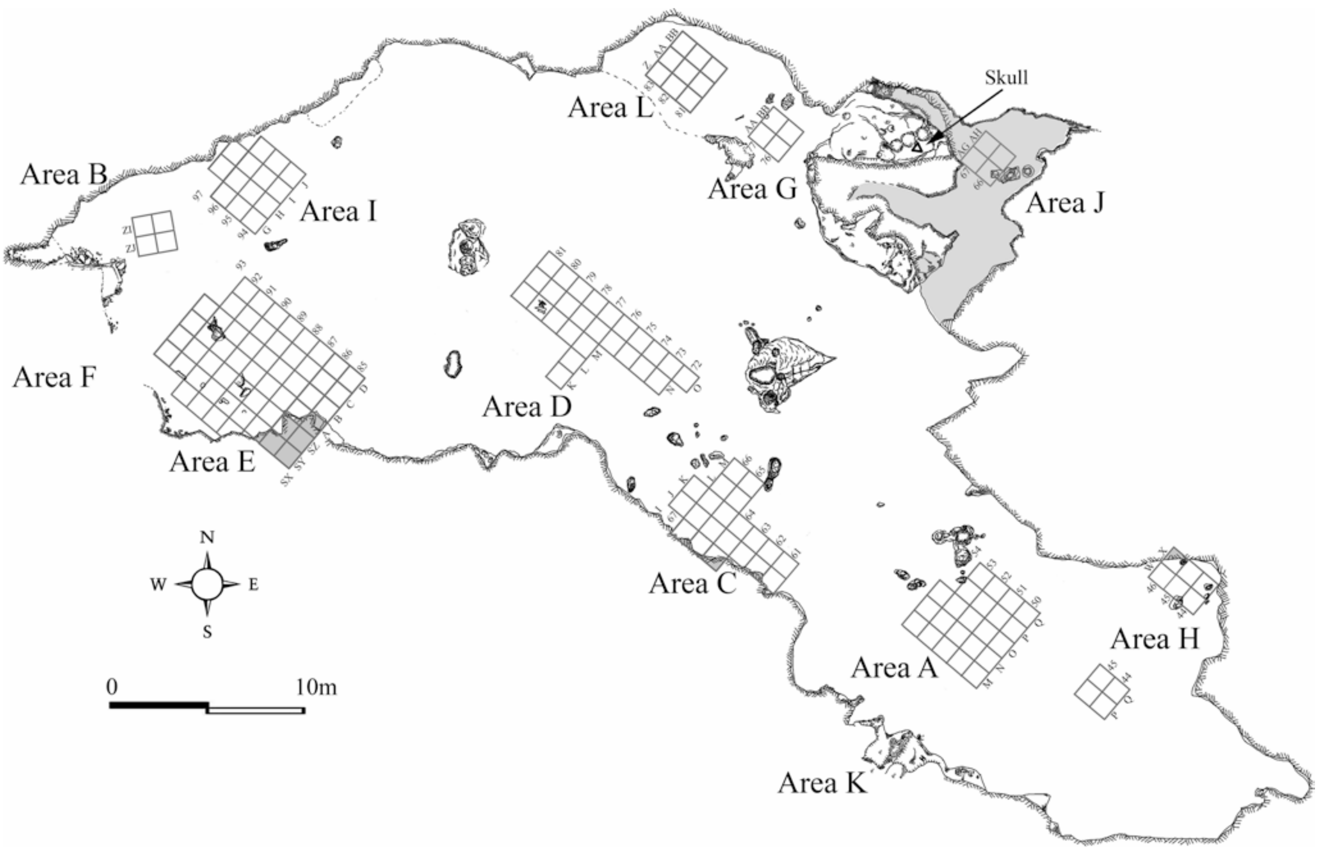

Fig. 4.2 Manot Cave excavation areas

(Boëda 1988, 1995). Debitage artifacts, which are usually found within Middle Paleolithic assemblages but are not Levallois, were not included in this study as it was difficult to securely differentiate between them and those of the Upper Paleolithic assemblages. Tools that may be assigned to the Middle Paleolithic due to their morphology and retouch, such as specific side scrapers, were included with reservations. These sidescrapers differ by raw material used, blank selection, type of retouch and platform preparation from the Aurignacian retouched blades found at the site.

4.2.1 Area C

This excavation area is located at the base of the western talus. To date, eight stratigraphic units (assigned numbers: 1–8) were recognized (Fig. 4.3). These units are rich in archaeological finds, including large amounts of flint artifacts, animal bones, bone tools, charcoals, ochre and several groundstones made of basalt.

All Area C units are comprised of dark brown to reddish brown sediments of loose clay to silty clay loam. Several Middle Paleolithic artifacts (N=33) were identified within Units 4–8. The upper units (Units 1–4), contain few pebble size angular stones whereas the lower units (Units 5–8) present a large number of limestone pebbles, cobbles and even boulders (Fig. 4.3). Units 6 and 7 are separated by a thin (~1 cm thick) unconformity layer, that divides the units sedimentologically, stratigraphically and culturally (Tejero et al. 2016). The archaeological assemblages from Units 2–4 are dominated by an Aurignacian lithic component, while Units 7–8 are composed almost exclusively by an Ahmarian component. The archaeological assemblages from Units 5 and 6 include both Ahmarian and Aurignacian elements (Tejero et al. 2016; Marder et al. 2017). A large group of Middle Paleolithic artifacts were found in Units 7 and 8 (Table 4.1) and are most abundant in Unit 8 (Fig. 4.4). These artifacts are well preserved in comparison to other Middle Paleolithic finds found at the site.

4.2.2 Area D

This area is located at the centre of the western talus (Fig. 4.5), where 28 square meters were excavated from north-west to south east along the talus (Barzilai et al. 2014).

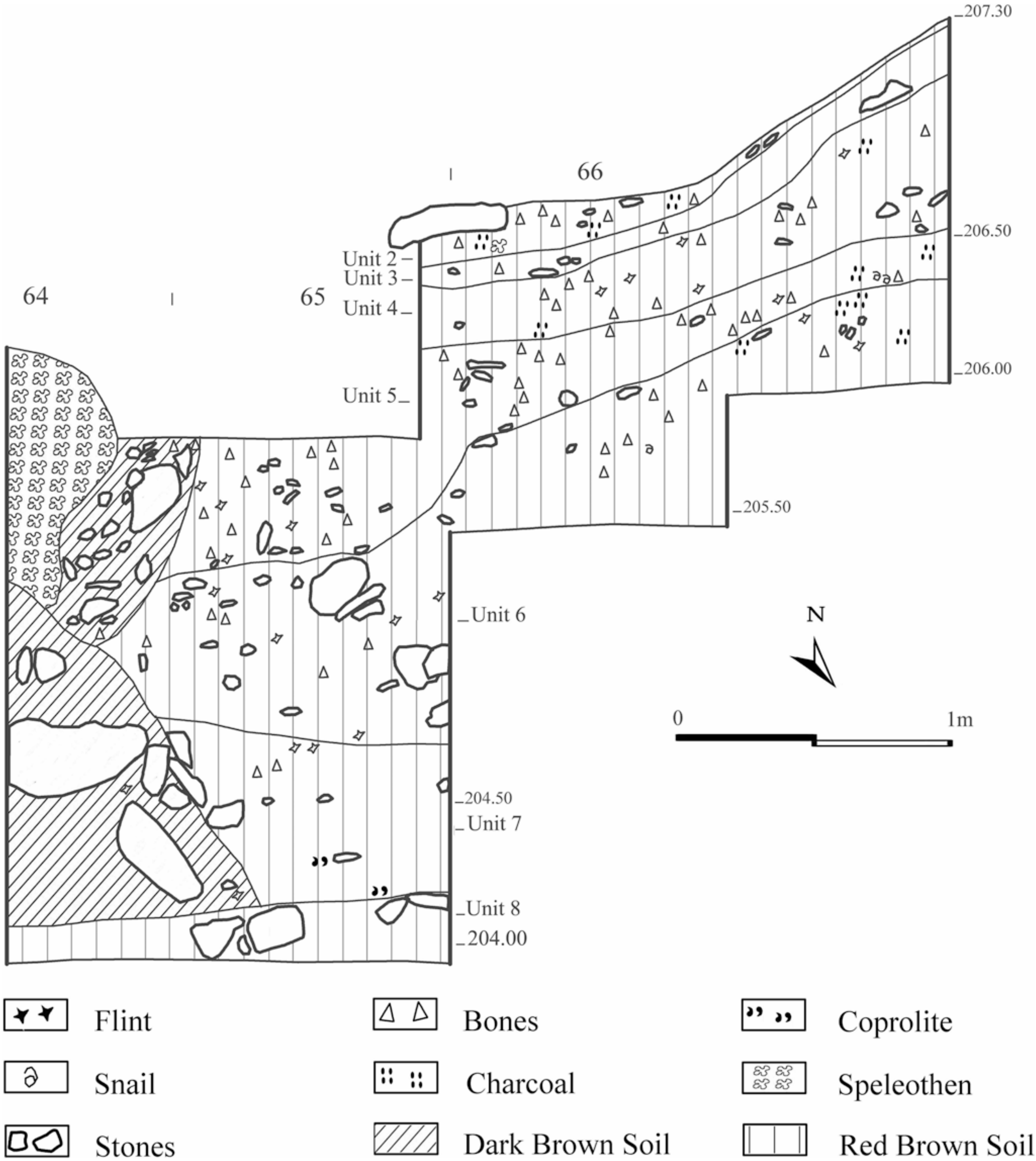

Fig. 4.3 Area C, western talus, section I64–66, Unit 1 does not appear in this section

Seven sedimentological units were identified (Fig. 4.5). These units are mainly composed of dark brown to reddish brown, loose clay to silty compact clay loam. In the northern section the sediments were highly disturbed as a result of post depositional digenesis processes and other agencies, i.e., rodents activity, presence of bats, and penetration of tree roots.

Area D contains large numbers of flint artifacts, biogenic material (bones and coprolites), bone tools and basalt groundstones (none of which were found in primary con-

Table 4.1 Area C; Complete assemblage of artifacts >2 cm from squares J65 and J66 and the number of artifacts attributed to the Levallois technology

Unit	Assemblage >2 cm (N)	Levallois (N)
4	968	2
5	3598	5
6	2156	5
7	1399	11
8	130	8

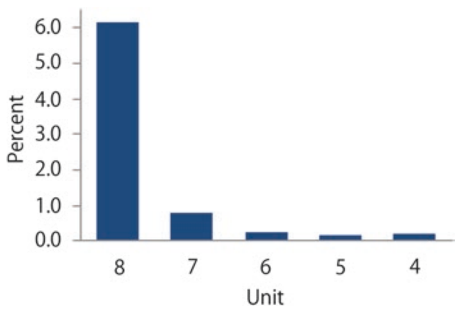

Fig. 4.4 Area C, percent of Levallois artifacts in each unit (from the complete assemblage >2 cm) in squares J65 and J66

text). The lithic assemblage includes mainly Aurignacian and Ahmarian components. Several Middle Paleolithic artifacts were found within Units 4–7 (N=33), the majority of which derive from Units 5–6 (N=22).

Unit 5 is composed of sediments varying from thick loose clay to compact silty clay loam, reddish brown in color (60–70 cm). Embedded within this unit is a lens of angular limestone fragments (3–15 cm long), a relic of an old channel (Fig. 4.5). This unit is rich in coprolites and animal bones, with relatively few flint artifacts. Unit 6 is characterized by a thick horizontal breccia (ca. 40 cm) situated along the southern part of the talus, and is rich in flint artifacts and large bones. This unit terminates at the cave center (Fig. 4.5). Unit 7 consists of a thin layer of amorphic compact orange clay (ca. 20 cm) with small angular nodules directly above the bedrock (Fig. 4.5). It is the most ancient sedimentological unit found at the cave center (F. Berna personal communication). Noticeably, few Middle Paleolithic artifacts (N = 5) were found just above the bedrock.

4.2.3 Dating of the Archaeological Assemblages

A series of ^{14}C dates suggest intensive occupation of the cave during the Early Upper Paleolithic period. Based on archaeological assemblages from Area C and Area E, and their dating (Hershkovitz et al. 2015; Tejero et al. 2016; Barzilai et al. 2016), three archaeological phases were identified; a post-Aurignacian industry thought to be younger than 34 kcalBP, a Levantine Aurignacian industry dated between 38–35 kcalBP, and an Early Ahmarian one dated between 46–42 kcalBP. One date of 49 kcalBP was retrieved from the lowest unit in Area C, together with the U-Th dates of Manot 1 suggesting that an earlier occupation exists in the cave (Hershkovitz et al. 2015; Barzilai et al. 2016).

4.3 The Lithic Collection

The majority of artifacts at Manot Cave were made from a fine-grained flint, very homogeneous and almost free of inclusions. They range in colour from pale yellow to pale brown, using the Munsell chart as reference. Few artifacts display a brown to light black color, and have a glossy shine to them. Two of the artifacts are burnt. The flint sources used by the caves inhabitants are yet to be defined.

4.3.1 Technology

Amongst the cores (Table 4.2), several Levallois reduction methods were recognized, the centripetal (Fig. 4.6: 1,3,5; Fig. 4.7: 1) the unidirectional and unidirectional convergent (Fig. 4.6: 2; Fig. 4.8: 1, 2), of which one is a core on flake (Fig. 4.7: 2). The presence of these reduction strategies at the cave is also indicated by the scar patterns (Table 4.3A) on tools, debitage and core trimming elements (Fig. 4.8: 3). The Levallois cores are mostly flat (thickness range 11.5–29.7 mm) and small (length range 28.0–68.9 mm; width range 24.1–65.0 mm), and were exploited in the recurrent (Fig. 4.6: 1, 3, 4; Fig. 4.7:1, 2; Fig. 4.8: 1) and preferential modes (Fig. 4.6: 2, 5; Fig. 4.8: 2). This core collection resembles Middle Paleolithic assemblages from Tabun B (e.g. Garrod and Bate 1937, Plates XXXIII: 9, 10 and XXXIV: 9, 10), Qafzeh (e.g. Hovers 2009, Plates 11: 4, and 21: 9), and Ein Qashish (Malinsky-Buller et al. 2014, Fig. 2: 1, 3).

4.3.2 Levallois Flakes and Points

This collection of artifacts presents a wide range of variability including Levallois broad based points (Fig. 4.9: 2, 3), elongated points (Fig. 4.9: 6), a retouched point (Fig. 4.11: 7) as well as blades and flakes (Fig. 4.9: 4, 5,7–10, Fig. 4.10). Of the eight Levallois points, six have a unidirectional convergent scar pattern (Table 4.3a), while amongst the flakes

Fig. 4.5 Area D, central talus, section M78–81

Table 4.2 Middle paleolithic core types and flaking methods from Manot Areas C and D

	Centripetal	Unidirectional	Unidirectional convergent	Undefined
Levallois cores for flakes preferential	1	2		
Levallois cores for flakes recurrent	3			2
Levallois cores for points			1	
Core on flake for flakes			1	
Levallois core for flakes				1
Total	4	2	2	3

(N=26), less than half have a unidirectional convergent scar pattern (showing both unidirectional and bidirectional patterns). Two of the flakes and one Levallois point have *Chapeau de gendarme* striking platforms (Table 4.3B). The points resemble those from Kebara Cave (e.g. Bar-Yosef and Meignen 1992, Fig. 12.5: 1–3; Meignen 1995, Fig. 25.7: 4, 5), as well as those from Qafzeh Cave (e.g. Hovers 2009, Plates 26: 1–6).

4.3.3 Tools

The tool assemblage consists of sidescrapers, endscrapers, burins and a notch (Table 4.3C). Sidescrapers (N = 11) comprise the largest group of tools, made on a variety of blanks (Fig. 4.11: 1–3, 5, 6). Three of the sidescrapers portray a *Racloir* like retouch (Fig. 4.11: 1–3). Sidescrapers with *Racloir* like retouch are known from Tabun Cave (e.g. Garrod and Bate 1937, Plate XXXIV: 1, 2, 7), Qafzeh Cave (e.g. Hovers 2009, Plates 31: 1 and 37: 9) and Quneitra open-air site (e.g. Goren-Inbar 1990, Fig. 45: 4 and Fig. 46: 3). Two of the sidescrapers are worth mentioning: one is a convergent sidescraper with an impact fracture on the tip (Fig. 4.11: 6), the other is double patinated, reflecting a single sidescraper which was subsequently retouched down the right lateral edge, converting it into a convergent sidescraper (Fig. 4.11: 3). Another tool with double patina is an endscraper (Fig. 4.11: 4); suggesting that a Levallois blade was recycled and transformed through abrupt retouch into an endscraper.

4.3.4 Engraved/Incised Artifact

A unique find found in Unit 6 of Area C is an engraved Levallois centripetal recurrent core (Fig. 4.7: 1 and Fig. 4.12). The raw material from which the core is made of differs from that of other Middle Paleolithic artifacts at the site and is characterized by a very dark greyish-green color. The core dimensions (53 × 47 × 17 mm) are within the range of other

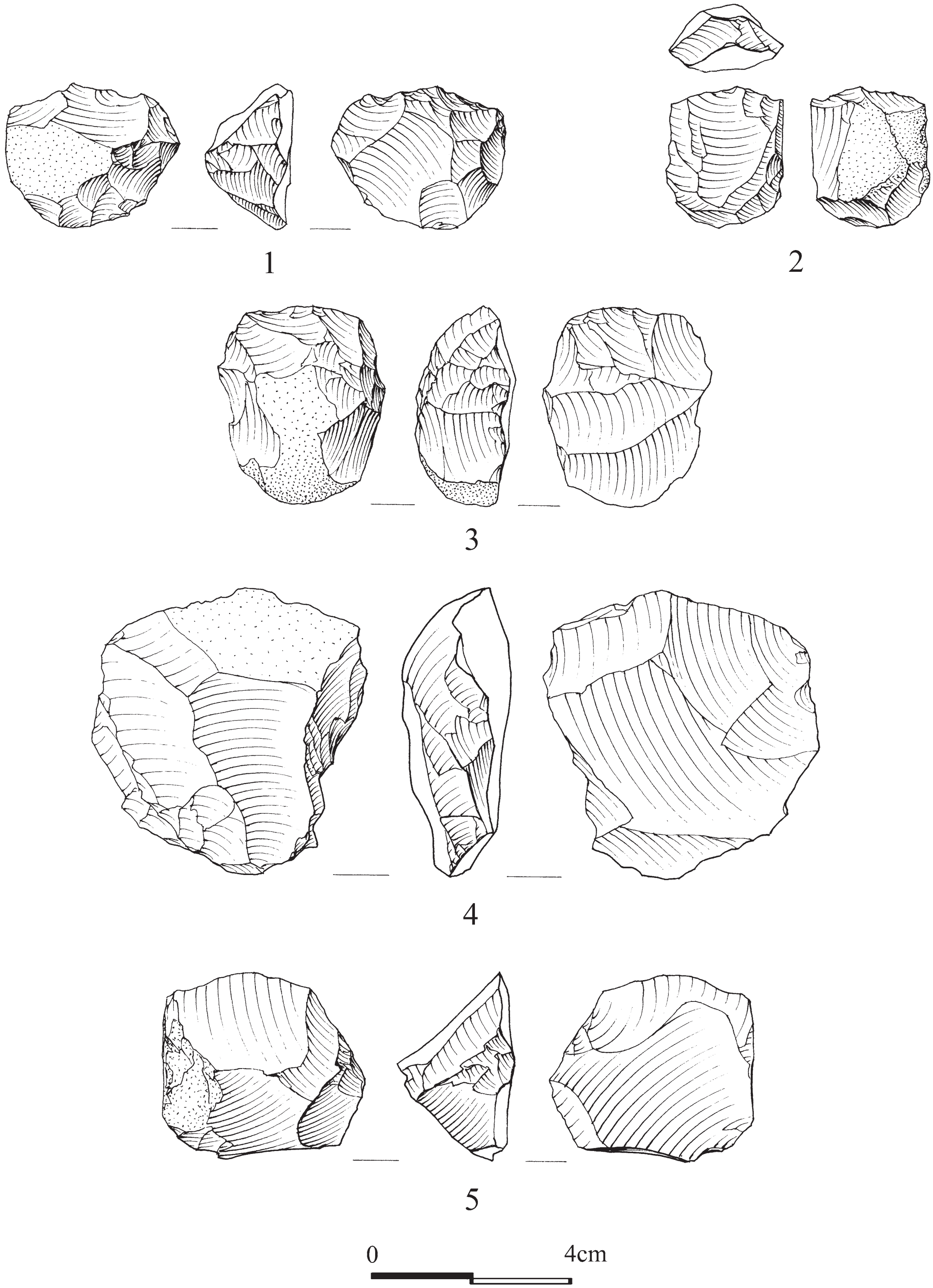

Fig. 4.6 Levallois cores – Area C, *1*,*3*, centripetal; *2*, unidirectional; Area D – *4*, undefined; *5*, centripetal

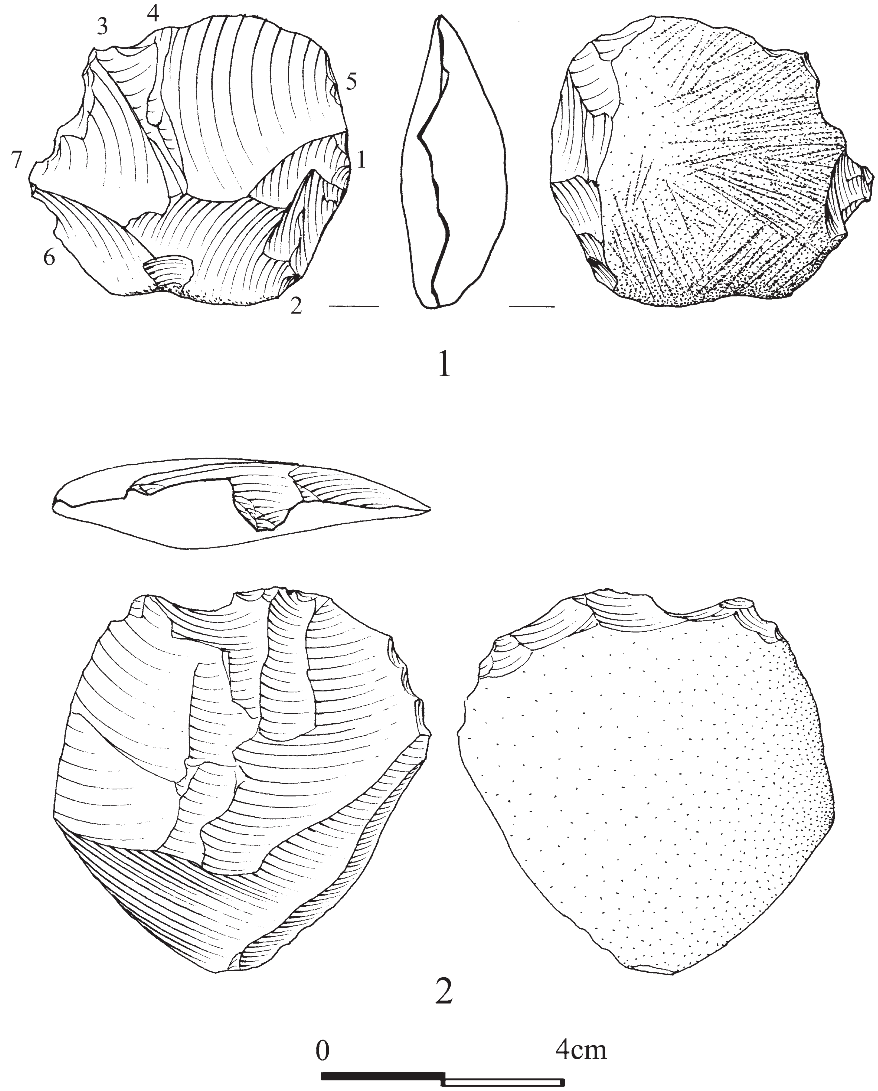

Fig. 4.7 Levallois cores – Area C, *1*, centripetal; *2*, core on flake, unidirectional convergent

Levallois cores. Most of the preparation surface is covered by cortex with one dominant striking platform. The incisions, covering most of the surface, are small and flat superficially incising the cortex in a super-positional structure without cutting through it. Their size and shape suggest that they were made by a delicate tool. The initial incisions radiate in a fan-shape from the centre of the core outward (Fig. 4.7: 1, 12) (N = 50). The second set of incisions run from the left lateral edge of the core towards the proximal (N = 14) and distal edge (N = 13) cutting through the first set of incisions.

The reduction sequence consists of several independent stages: initial knapping removed at least four flakes from the striking platform and the right side of the core (Fig.4.7: 1 removals 1–4). Several small flakes may also have been struck from the striking platform at this stage. Subsequently, a relatively large hinged flake (Fig. 4.7: 1 removal 5) was removed from the cores striking platform cutting previous removals. Prior to the cores discard, a small striking platform was prepared on the distal edge from which two hinged flakes were knapped (Fig. 4.7: 1 removals 6, 7). While detaching these two flakes some of the cortical incisions were removed from the preparation surface, suggesting that the incisions were made during the Middle Paleolithic and do not result from Early Upper Paleolithic (Aurignacian) recycling activities as observed on isolated Upper Paleolithic tools from Areas C, D and E. Recycling of Middle Paleolithic artifacts during the Early Upper Paleolithic is known from other assemblages in the Levant (Belfer-Cohen and Bar-Yosef 2015 for a detailed discussion).

Table 4.3 Technological and typological attributes of Middle Paleolithic artifacts from Manot Areas C and D

A. Scar pattern for all artefacts

	Unidirectional	Bidirectional	Convergent	Centripetal	Indeterminate	Cortical	Total
Levallois flakes[a]	7	6	9	2	1		25
Levallois blades		1			1		2
Levallois points[b]			6	1	1		8
Sidescrapers		1	5		2	1	9
Endscrapers			2				2
Burin		2					2
Notch				1			1
Retouched flake		1					1
CTE		1	1		1		3
Total	7	12	23	4	6	1	53

B. Striking platform of all artifacts

	Plain	Facetted	Dihedral	*Chapeau de gendarme*	Cortical	Indeterminate	Total
Levallois flakes[a]	4	18	1	2			25
Levallois blades	1	1					2
Levallois points[b]	1	4	1	1		1	8
Sidescrapers	2	3	3			1	9
Endscrapers	2						2
Burin	1		1				2
Notch		1					1
Retouched flake		1					1
CTE		1			1	1	3
Total	11	29	6	3	1	3	53

C. Middle Paleolithic artifact composition

Artifact type	Area C	Area D
Typical Levallois flake	9	4
Atypical Levallois flake	10	1
Levallois point	3	2
Retouched Levallois point	1	1
Pseudo Levallois point		1
Single straight sidescraper		1
Single convex sidescraper		3
Double straight convex sidescraper		2
Double convex sidescraper		1
Double concave-convex sidescraper		1
Convergent straight scraper		2
Convergent convex scraper		1
Typical endscraper		1
Atypical endscraper		1
Atypical burin	1	1
Notch		1
Core Trimming Elements (CTE)	1	2
Retouched flake	1	2
Retouched blade		1
Cores	7	4
Total	33	33

[a]Including Pseudo Levallois point
[b]Including both retouched and unretouched

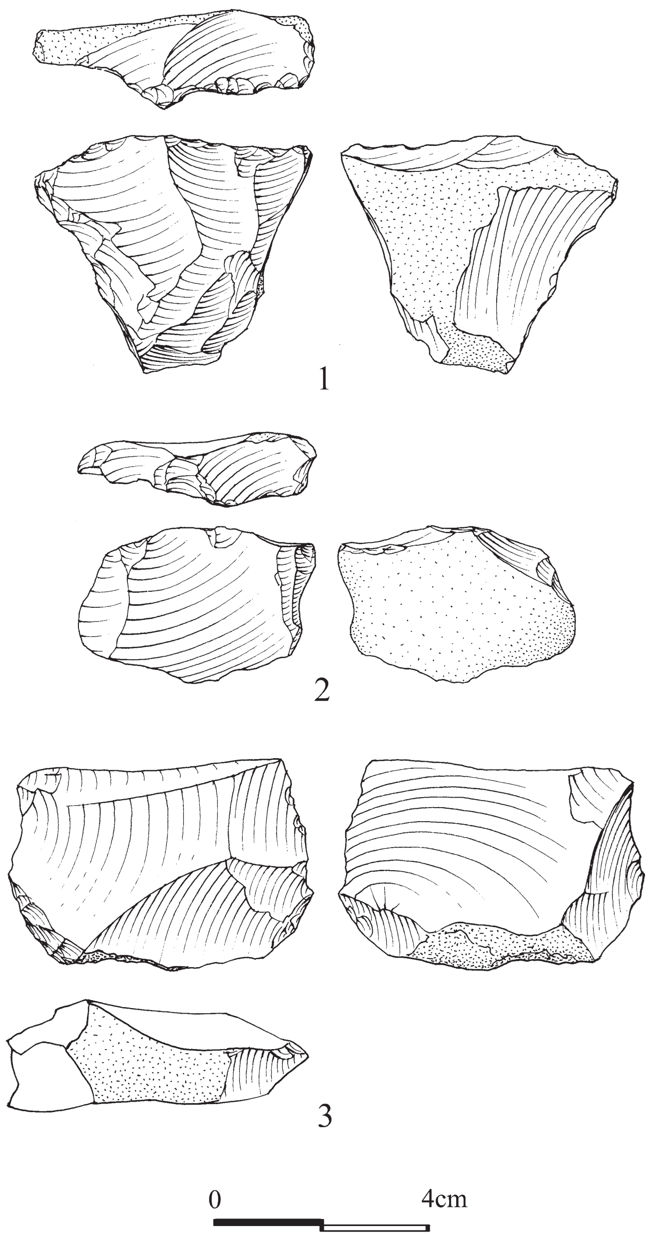

Fig. 4.8 Levallois cores and Core Trimming Elements – Area C, *1*, undefined; *2*, unidirectional convergent; Area D – *3*, Core Trimming Element

4.4 Discussion

The Middle Paleolithic artifacts assembled in Manot Cave represent a biased collection as most of them were found in Upper Paleolithic contexts. The majority of artifacts retrieved originate from the lower units in Areas C and D, with the largest group from Area C originating from the lower most unit. These artifacts were selected for study either because they complied with the Levallois definition (Boëda 1988, 1995) or they belonged to one of the predominant tool types of the Middle Paleolithic period (Bordes 1961).

The Middle Paleolithic artifacts demonstrate the use of both the Levallois unidirectional convergent and centripetal reduction strategies, alongside the presence of both broad based and elongated Levallois points. It is also clear from the analysis that there are no artifacts that can be associated with the Early Middle Paleolithic lithic industry (i.e. "Tabun D type"). The Levallois centripetal flaking mode, is most abundant in sites dating to ~120–90 ka, such as Qafzeh (layers XXIV–XV) (Valladas et al. 1988; Hovers 2009, pp. 267–273), Skhul (Garrod and Bate 1937, p. 111) and Nesher-Ramla (Zaidner et al. 2014). However, it is also present in significant quantities in younger sites dating to 70–50 ka, usually appearing alongside the Levallois unidirectional convergent mode including Quneitra, Amud, Kebara and 'Ein Qashish (Goren-Inbar 1990; Ziaei et al. 1990; Bar-Yosef and Meignen 1992; Hovers 1998, 2004, 2009, pp. 267–273; Valladas et al. 1999; Malinsky-Buller et al. 2014).

The unique engraved Levallois core from Manot cave cannot be interpreted as an anvil or cutting board based on the size and convexity of the incised surface. At the same time, it is unlikely that it represents an act of recycling during the Upper Paleolithic. In contrast to the incised objects from Quneitra and Qafzeh (Marshack 1996; Hovers et al. 1997), it seems that the core chosen to be incised at Manot Cave was not of a unique size or shape. The center point location from which the radial incisions diverge suggests that the artist was aware of the cores roundness and the knapping organization of the flaking surface. The incisions were engraved in between different knapping stages. The core shares some similarity with the object from Qafzeh in the incisions superimposition and evidence for several cycles of manipulation prior to its discard. This core adds to the growing evidence for symbolic behaviour among hominins during the Middle Paleolithic (Marshack 1996; Hovers et al. 1997, 2003; Bar-Yosef Mayer et al. 2009; Zilhão et al. 2009).

The techno-typological analysis of the artifacts from Manot Cave is consistent with technologies observed in other mid-late Middle Paleolithic sites. This study shows that the site was inhabited during the Middle paleolithic although the small size of the collection does not permit a precise chrono-cultural attribution.

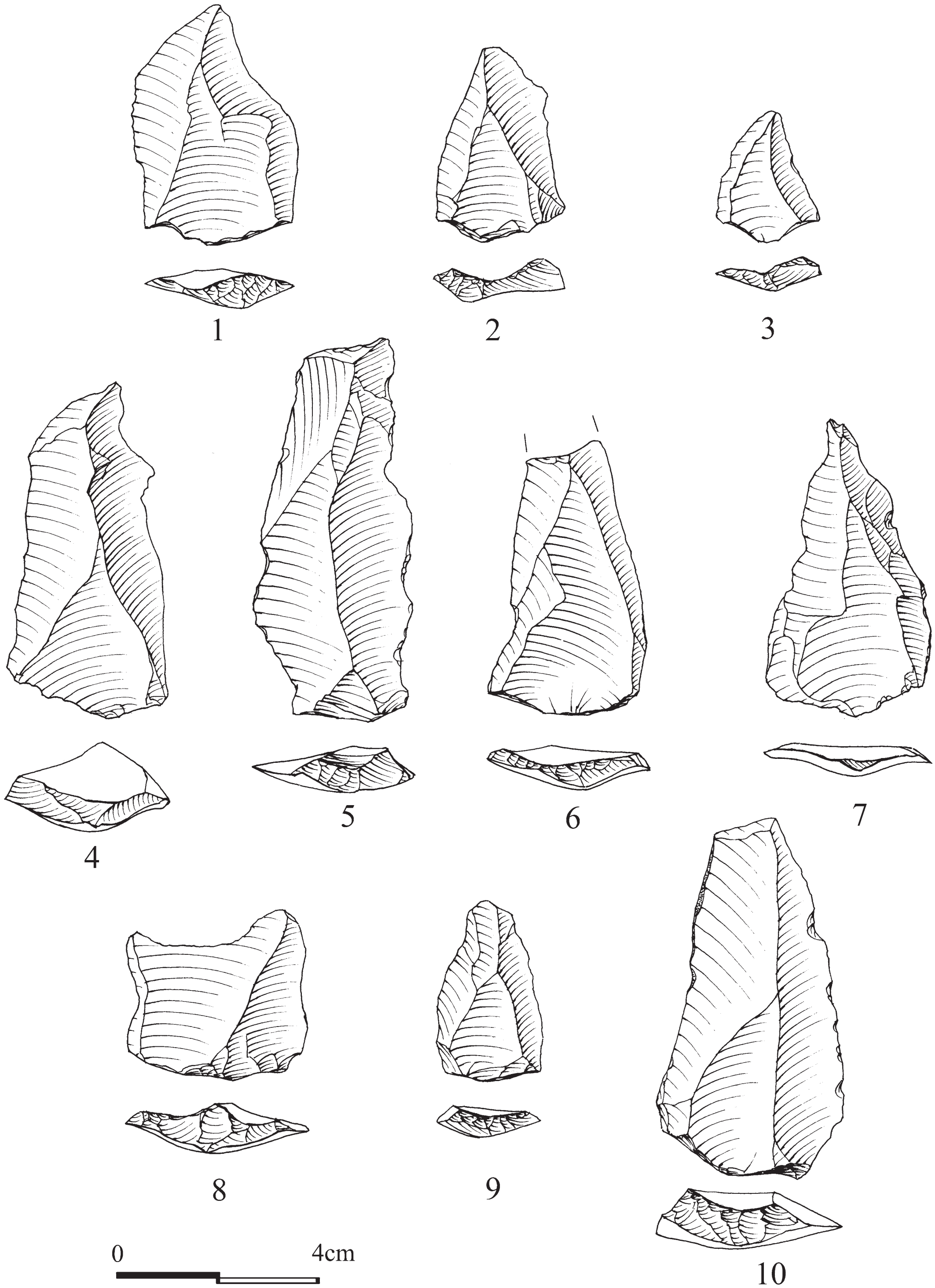

Fig. 4.9 Debitage – Area C – *1*,*4*,*6*,*8–10*, Levallois flakes; *2*,*3*,*7*, Levallois points; *5*, Levallois retouched blade

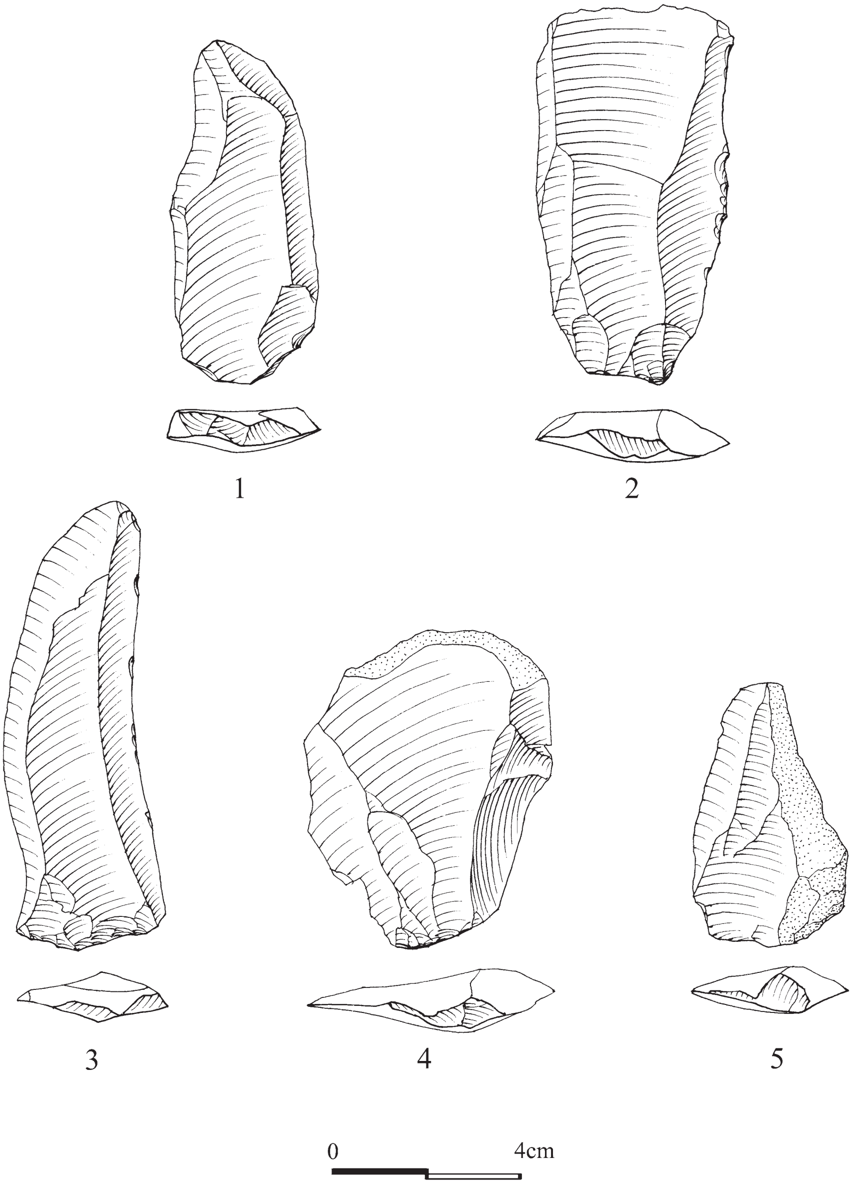

Fig. 4.10 Debitage – Area D – *1*,*3*, Levallois blade; *2*,*4* Atypical Levallois flakes; Area C – *5* Atypical Levallois flake

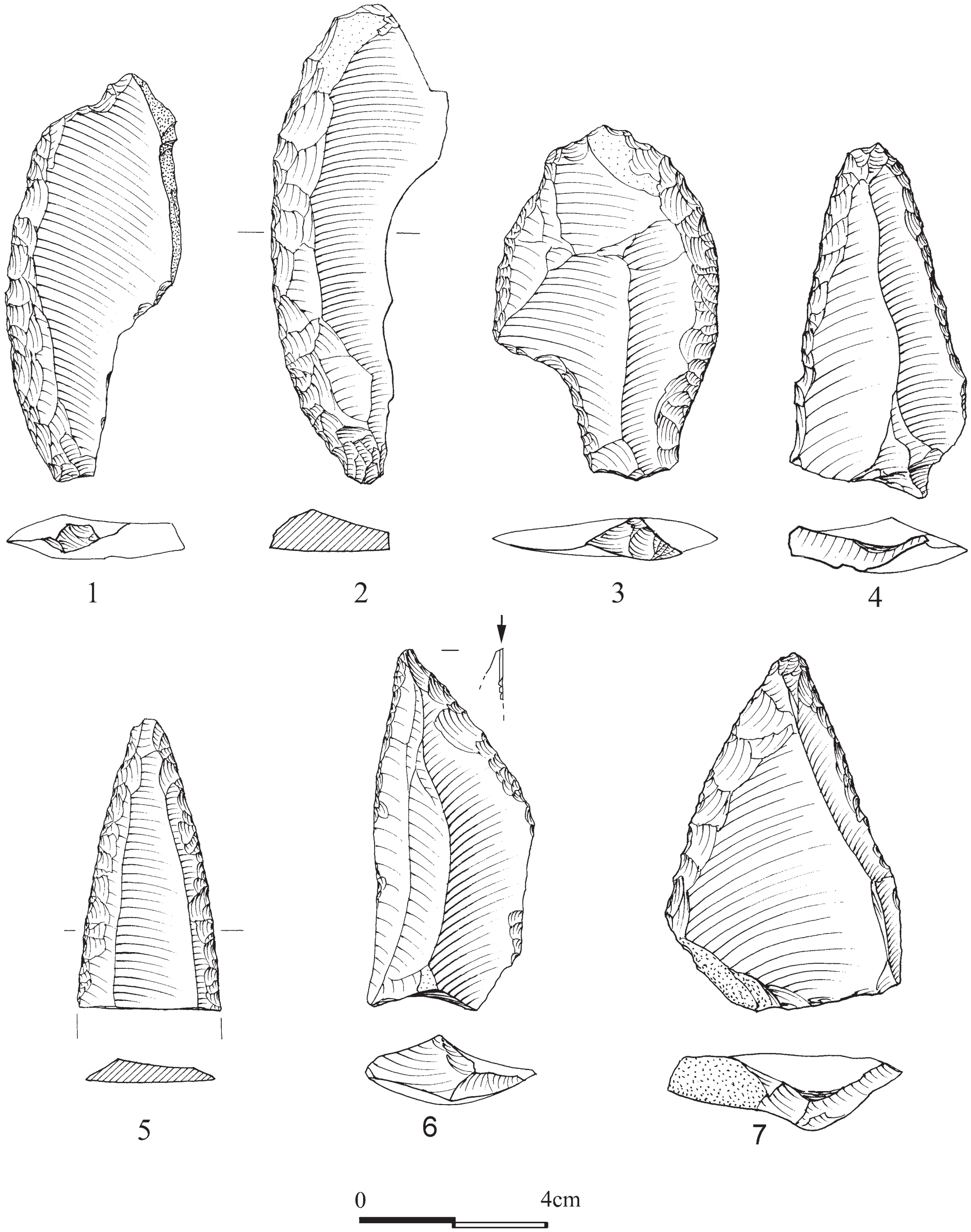

Fig. 4.11 Tools – Area D – *1*,*2*, Single sidescraper; *3*, Double sidescraper, retouch on right side occurred at a later stage creating a double patina; *4*, Endscraper; *5*, Convergent sidescraper; *6*, Convergent sidescraper with impact fracture on tip; *7*, Retouched Levallois point

Fig. 4.12 Levallois centripetal core with incisions

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Middle Palaeolithic Flint Mines in Mount Carmel: An Alternative Interpretation

5

Avraham Ronen

Abstract

Numerous heaps of limestone fragments mingled with occasional Middle Palaeolithic flint artifacts were found on Mount Carmel. They were interpreted as Middle Palaeolithic quarries for the extraction of fresh flint nodules and as flint knapping workshops (Nadel et al. 2011). This interpretation is questioned here due to the virtual absence of concentrations of knapping residues – nodules, cores, flakes and fragments, among the limestone heaps. An alternative interpretation of the limestone heaps is offered here, namely that they were in all likelihood raw material prepared for lime production during the last centuries.

Keywords

Flint mines • Knapping workshops • Piles of limestone • Debris • Lime kilns • Middle Palaeolithic • Mount Carmel

5.1 Introduction

There are abundant concentrations of stone fragments on the surface of Mount Carmel (Fig. 5.1). The concentrations are of two types: the first occurs on vast areas literally covered by rounded and heavily patinated stone debris. These objects were initially believed to be Early Palaeolithic artifacts, and as such were registered during the thorough Archaeological Survey of the 242 square km of Mount Carmel carried out between 1964 and 1969 (Olami 1984, pp. 43–46). The Archaeological Survey has focused solely on human-related features. These gravel beds turned out, however, to be natural deposits of Neogene/Early Pleistocene drainage systems much bigger and largely different from the present one (Clark 1961; Avnimelech 1965).

The second type are smaller, well defined concentrations of angular stone debris mingled with some flint fragments. Typically ca 10 m in diameter and 0.5–1.0 m thick at the center, these piles were initially considered as natural accumulations and unfortunately they were not registered by the Archaeological Survey. In addition, these piles were never subjected to a scientific investigation and their formation is due to unknown causes. “Debris formed in the Last Glacial Maximum“, was one geologist’s hunch.

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5.2 Hypothesis 1

In some areas of Mount Carmel, bedrock consists of alternating series of limestone beds 10–20 cm thick intersected by flint beds 10–15 cm thick. Piles of angular stone fragments are found in these areas. It was suggested that the fragments result from quarrying a limestone bed in order to expose the fresh flint underneath (Nadel et al. 2011). Quarrying a limestone bed with an underlying hard flint layer created step-like “extraction surfaces” or “quarrying fronts” (Nadel et al. 2011, p. 60). The angular debris (Fig. 5.2) have accumulated at the feet of those quarrying fronts. As is well known, freshly extracted flint nodules constitute a better raw material for tool production than nodules collected on the surface, battered by the elements and desiccated under intense sunshine. One large, elongated concentration of angular

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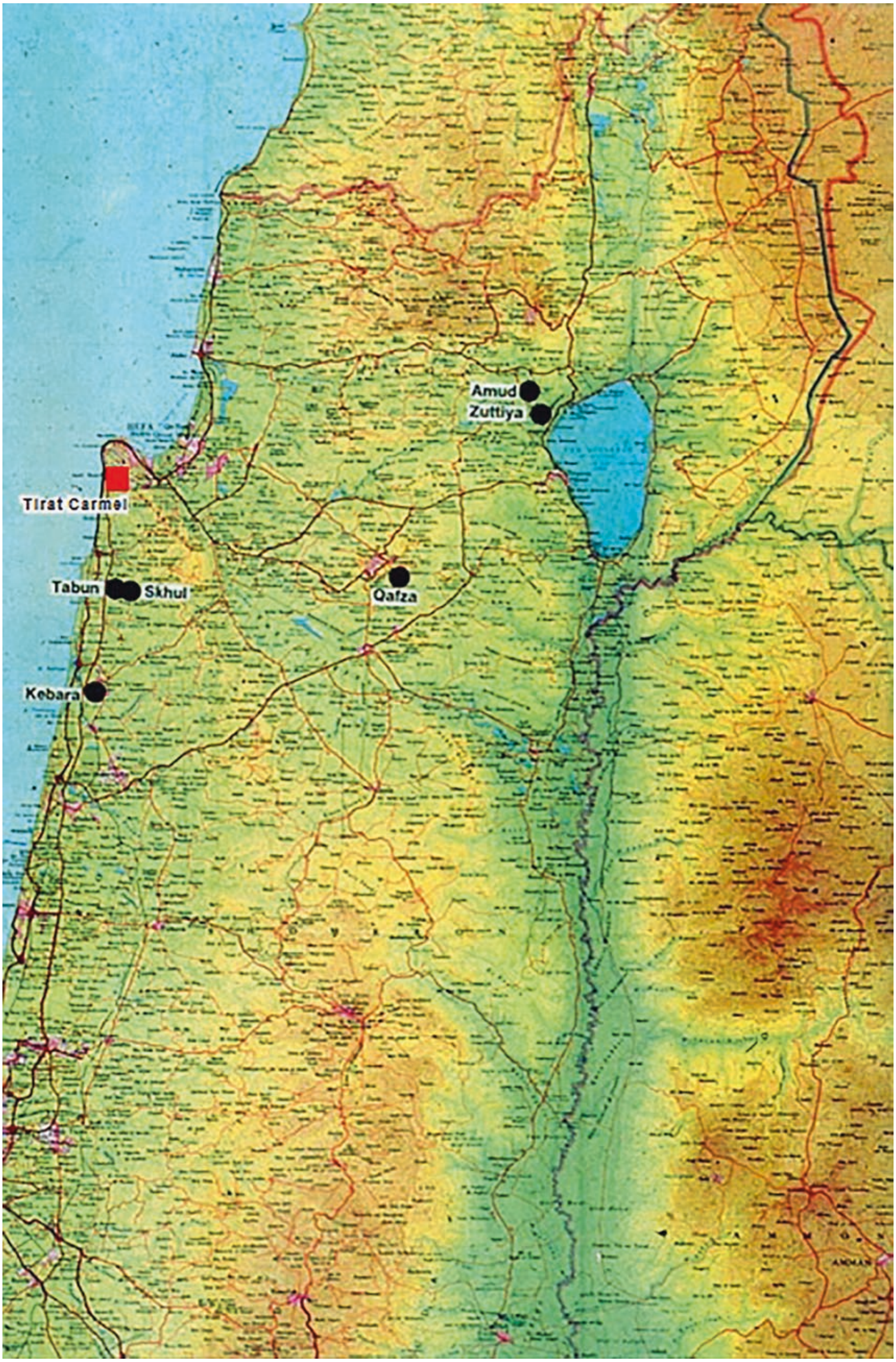

Fig. 5.1 Location map of the study area (red square) among MP burial sites

Fig. 5.2 A pile of limestone fragments in Mount Carnel (Photo, A. Ronen)

limestone debris along Nahal (river) Galim in north-western Mount Carmel was studied in detail (Nadel et al. 2011). Middle Palaeolithic-type flint artifacts were found on top and inside the concentration and these were taken to date the quarry.

Middle Palaeolithic peoples, experts of the Levallois method, would no doubt have the technical ability to break a limestone bed to pieces. Some of the newly exposed flint nodules bear flake scars. These were taken to be "test scars" (Fig. 5.3) indicating knapping activities. Hence the Middle Palaeolithic Nahal Galim flint quarry became a knapping workshop as well. This hypothesis holds far reaching consequences on the social organization of Middle Palaeolithic hominins in the Levant. The society would have the means to assemble individuals for the tedious task of quarrying flint (perhaps even individuals not in immediate need of flint). A mechanism to mobilize individuals for a communal effort intended for future needs reflects a central ruling authority, a level of social organization unexpected of Levantine Middle Palaeolithic society.

Some observations render, however, the Mount Carmel Middle Palaeolithic quarry/workshop hypothesis problematic. First, a very low density of lithic products was found among the limestone piles. The ratio of worked flints to limestone fragments is 0.043 and 0.064 respectively (Nadel et al. 2011, p. 64). Second, the virtual absence of clearly delineated concentrations of knapping residues – nodules, cores, flakes and debris is not compatible with a flint workshop hypothesis. Unquestioned knapping workshops (Neolithic, for example) consist of well defined, rich concentrations of knapping residues (Ronen and Davies 1970; Taute 1994).

5.3 Hypothesis 2

An alternative interpretation of the Mount Carmel limestone piles is offered here. This interpretation does not question the anthropogenic origin of the stone piles (considered of natural origin during the Archaeological Survey). This interpretation questions, however, both the function and the age of the limestone piles. Rather than waste products of flint quarries, according to the new interpretation the piles consist of debris prepared to be burnt for lime production. And rather than Middle Palaeolithic, the piles would date to the last centuries (Sasson 2002). Middle Palaeolithic flint artifacts are abundantly scattered on the surface of Mount Carmel (Olami 1984). Washed down slope, those artifacts could have easily mingled in the limestone piles. Indeed, the Middle Palaeolithic flint products at Nahal Galim occur mainly on the pile's surface, not inside the pile (Nadel et al. 2011, p. 60). Thus, the Middle Palaeolithic age attributed to the Nahal Galim pile is untenable. The "test scars" seen on some

Fig. 5.3 Flint nodules knapped

nodules are here interpreted as a random outcome of the quarry activities rather than a deliberate knapping.

Lime was a very important element in the traditional Levantine house building (Peled 2010). Building required large quantities of lime: mixed with sand, the lime served as mortar to bind the building stones while mixed with clayey earth, it served as plaster to be applied on the surface of the walls and the roof to repel moisture (Canaan 1933). Building a house actually started by building a lime kiln (Fig. 5.4) at the site (Canaan 1933). A round pit of the circumference of the planned kiln was dug to a depth of 1–2 m. The kiln walls began at the bottom of the pit. Rising above ground level, the walls terminate in a vault. The stone structure is covered by earth to ensure its being hermetically sealed (Canaan 1933, p. 20). The kiln had two openings at the bottom: one for feeding fuel and the other for ventilation. The kiln had to be fed with fuel day and night for 3–6 days, depending on the size of the kiln, until the stones turned lime. This procedure echoes lime production in biblical times: "And the peoples shall be as the burnings of lime: as thorns cut up shall they be burned in the fire" (Is. 33, 12). Trees were scarce in the Levant and thistles, especially *Sarcopoterium spinosum (L.)* constituted the main source of domestic fuel. Women and men collected a sufficient quantity of thistles during weeks before lime production began and stored it near the kiln. Burning lime in a small kiln required 700–1000 single person's loads of thistles. A large kiln took 2000–3000 loads (Canaan 1933, p. 21). Then the kiln was left to cool for 4–6 days before the lime could be removed and used. Hence it took some 10 days on average for a kiln to be re-loaded. In the

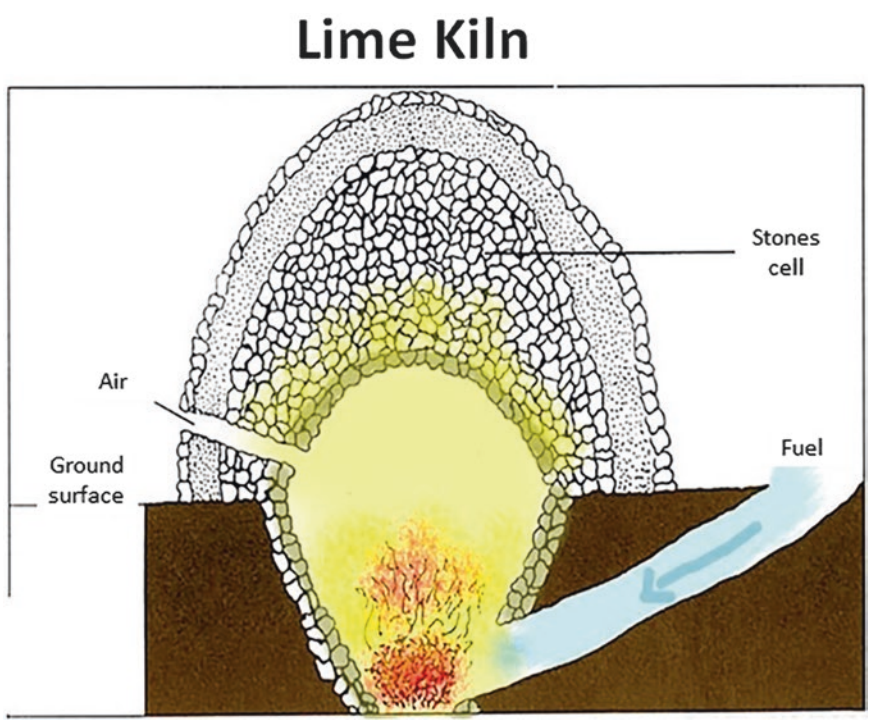

Fig. 5.4 Cross section of a lime kiln (From Sasson 2002)

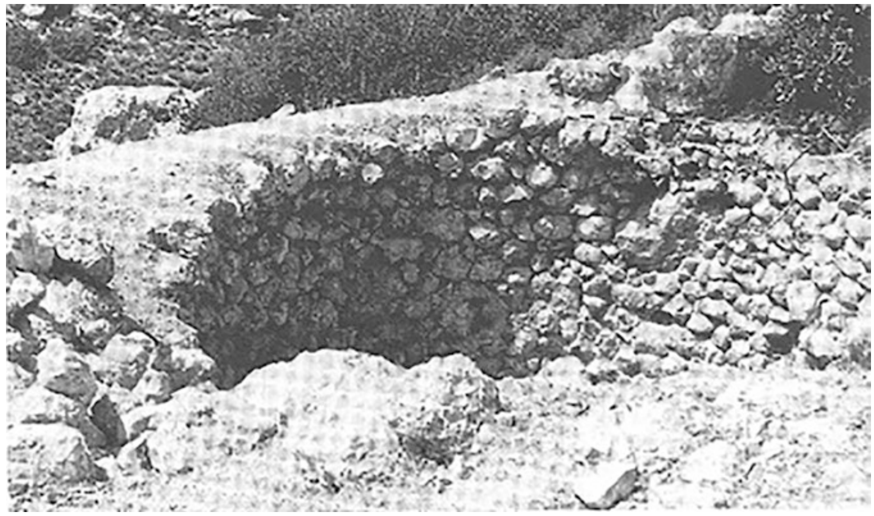

Fig. 5.5 Remains of a lime kiln in Mount Carmel (From Olami et al. 2003)

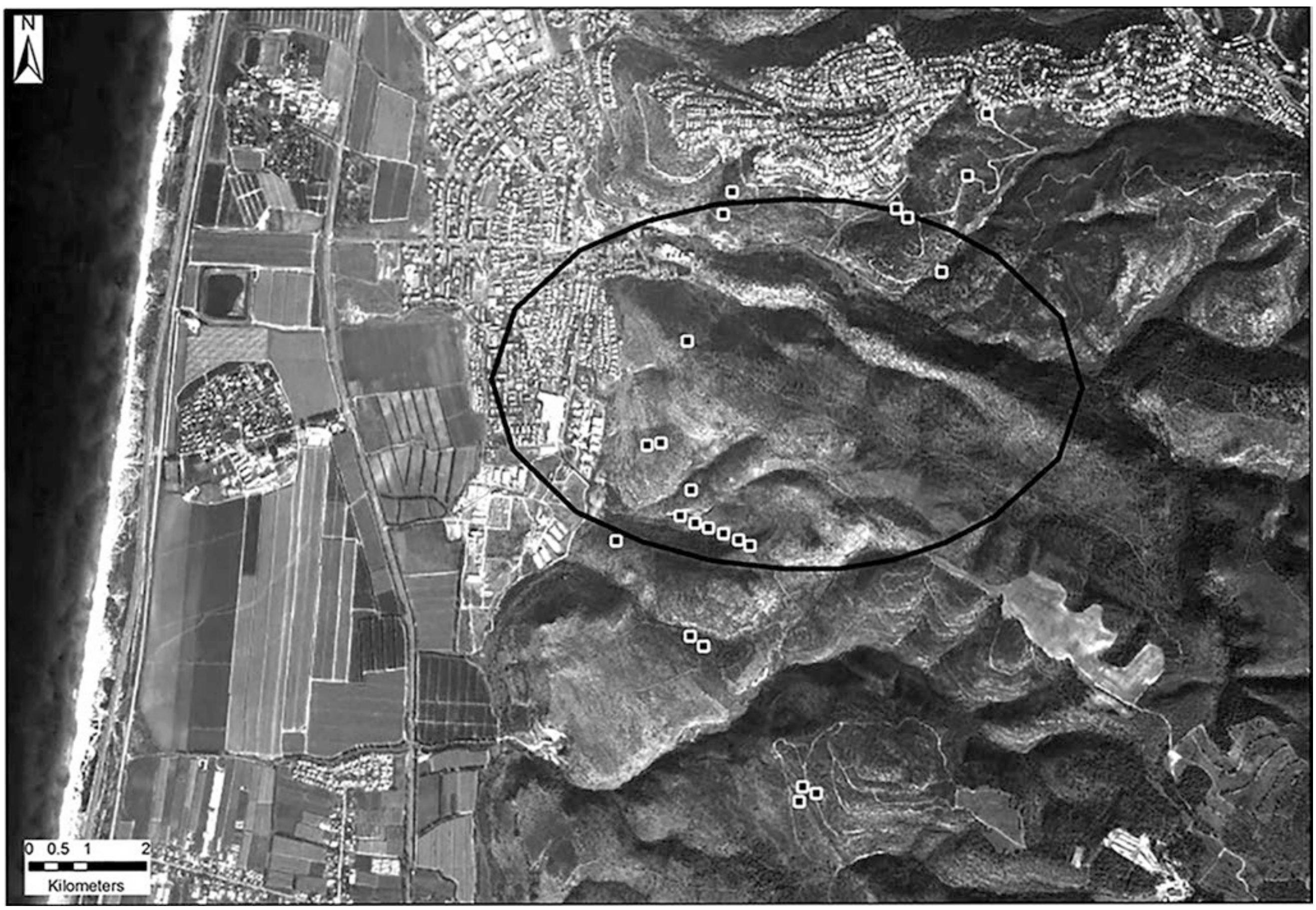

Fig. 5.6 Area of the Nahal Galim stone piles (circle) and location of lime kilns (squares)

immediate area of the stone piles discussed here, around Nahal Galim, the remains of some 20 lime kilns were revealed by the Archaeological Survey of Mount Carmel (Figs. 5.5 and 5.6) (Ronen and Olami 1978; Olami et al. 2003). Each kiln was fed ca. 4–5 tons of limestone fragments 10–15 cm in size (Sasson, pers. Comm.). For comparison, 98% of the limestone fragments reported by Nadel et al. in the Nahal Galim concentration are less than 20 cm long (Nadel et al. 2011, figs. 13 and 15). With 4–5 tons of debris in a kiln, the 20 kilns in the research area would have used some 100 tons of stone debris every 10 days, i.e. approximately 10 tons per day.

Women participated in the building activities (Peled 2010, p. 72). They carried water in various containers from the source to the building place, they hauled building stones for the walls and even to the roof and they were responsible for applying mortar to the walls and plaster to the walls and the roof. The proverb says that "There is no joy like the joy of roofing (one's house)" (Canaan 1933, p. 82).

5.4 Conclusion

Nadel et al. (2011) believed to have discovered Middle Palaeolithic flint quarries, but in reality they have identified the method of obtaining stone debris for lime production in the Carmel area. The method consisted of attacking a limestone bed above a hard flint bed and breaking it into fragments 10–15 cm long. In conclusion, the Nahal Galim limestone piles are not flint quarries and knapping workshops, nor are they of Middle Palaeolithic age. They are in all likelihood stone debris prepared for lime production during recent historical times.

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Initial Upper Paleolithic Elements of the Keoue Cave, Lebanon

6

Yoshihiro Nishiaki

Abstract

The Keoue Cave, located in Lebanon, is a Middle Paleolithic site excavated by a University of Tokyo team in 1970. Studies in the subsequent decades assigned its lithic assemblages to the Levantine Mousterian industry of Tabun-B type, dated from the late Middle Paleolithic. Interestingly, those studies revealed the existence of a chamfered piece and a couple of Emireh point pieces in the assemblage from the latest layer, which are the hallmarks of the Initial Upper Paleolithic (IUP) of the Levant. Their association with a Tabun-B type assemblage at the Keoue Cave is, if tested, intriguing in regard to the interpretation of the processes of the Middle-Upper Paleolithic transition. However, this issue has not been studied to date. In this paper, the occurrence of the IUP elements at the Keoue Cave is examined from stratigraphic and techno-typological viewpoints. Results confirmed the presence of at least one typical chamfered piece and one typical Emireh point, but revealed that those elements were derived from a secondary stratigraphic context. Therefore, the evidence from this cave cannot be used to verify the association of either the chamfered piece or Emireh point with the Tabun-B type industry; alternatively, the possibility that an IUP occupation layer once existed at the Keoue Cave is suggested. Despite the uncertainty in the stratigraphic context, the IUP elements' occurrence at the Keoue Cave is an important addition to our currently small dataset that will aid in understanding the chrono-spatial variability of the IUP cultural processes in the Levant.

Keywords

Middle-Upper Paleolithic transition • Initial Upper Paleolithic • Levantine Mousterian • Chamfered piece • Emireh point

6.1 Introduction

Keoue Cave is a small Middle Paleolithic site situated about 10 km southwest of Tripoli, northern Lebanon (Fig. 6.1). Discovered in 1967 (Suzuki and Kobori 1970), one season of excavations was carried out by a University of Tokyo team in 1970 under the direction of Hitoshi Watanabe (Watanabe 1970). The excavations yielded stratified lithic assemblages from several layers, which were all interpreted to represent the Levantine Mousterian industry of Tabun-B type, which was widely distributed in the late Middle Paleolithic (Nishiaki and Copeland 1992; Nishiaki 1995). Since the Tabun-B type industry has been often recovered with Neanderthal remains, Keoue Cave has also been regarded as a Neanderthal site. However, curiously, the lithic assemblage of the latest layer (Layer I) of this cave contained at least one chamfered piece and a few Emireh or Emireh-like points (Nishiaki and Copeland 1992, pp. 116–117). These tools are *fossiles directeurs* of the Middle-Upper Paleolithic transitional period or the beginning of the Upper Paleolithic of the

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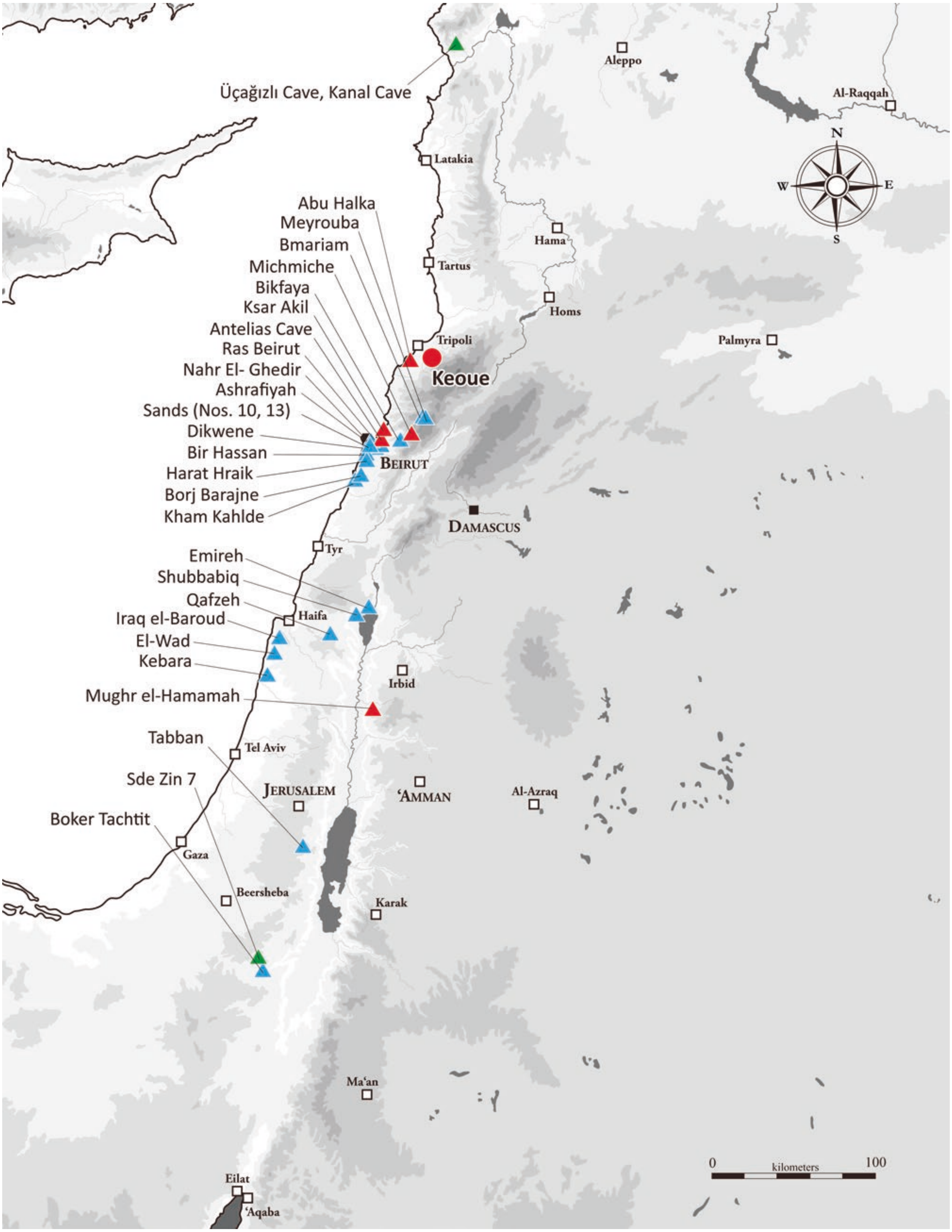

Fig. 6.1 Map showing the sites with chamfered pieces and/or Emireh points in the Levant. Green: chamfered pieces, Blue: Emireh points, Red: Both

Levant, collectively termed the Initial Upper Paleolithic (IUP) (Kuhn 2006). This association, if confirmed, is quite intriguing in regard to the interpretation of the relationship between the late Middle Paleolithic, when Neanderthals were present in the Levant, and the IUP, likely to be occupied by modern humans. Copeland (2000, p. 80) suggests a possible link between the Keoue industry and that of the well-known IUP site of Abu Halka, which is only about 10 km away from Keoue Cave; however, detailed investigations have not been carried out to date.

When Copeland and I studied the lithic materials from Keoue Cave in the 1980s and the early 1990s, information on their stratigraphic contexts was limited. This situation changed in the 2000s, as the detailed excavation records were discovered in the Hitosshi Watanabe archives (Nishiaki 2007). I examined the stratigraphic contexts; results indicated, rather disappointedly, that there was a stratigraphic mixing at the top of the cave deposits. Therefore, the association of the IUP elements with the Tabun-B type industry was not confirmed at Keoue Cave, nor was the presence of any IUP layers identified in the stratigraphy. Despite the lack of a secure stratigraphic context, however, the occurrence of the IUP elements is significant. It is an important addition to the small database of excavated IUP sites whose analysis is vital to our understanding of the emergence of modern humans in this part of Eurasia (e.g., Marks and Rose 2014). This paper aims to present the unpublished excavation records of this cave site with an emphasis on its stratigraphy. Additionally, it intends to present a detailed description of the IUP elements in question, as well as discuss the implications of their presence at the Keoue Cave.

6.2 The 1970 Excavations of Keoue Cave

The Keoue Cave is located on the left bank of the Wadi el-Keoue, about 10 km southwest of Tripoli and 120 km north of Beirut, in northern Lebanon (Fig. 6.1). The surrounding landscape consists of marly limestone plateau at an altitude of about 280 m, encompassing karstic features such as dolinas and springs, along with wadis including the Wadi el-Keoue. While referred to as a cave, it is indeed a U-shaped rockshelter, with a narrow overhang roof extending 3 m at most (Fig. 6.2). The ground floor of this "cave" has two terraces: the upper terrace closer to the cave wall and the lower terrace closer to the wadi. At the junction of the two, a modern artificial stone wall is set up, creating a step about 70 cm high (Fig. 6.3). The ground floor of the lower terrace is only about 4 m higher than the wadi bed, suggesting that the surviving Paleolithic cultural deposits are thin. Accordingly, the upper terrace was chosen for excavations.

Two areas comprise the upper terrace; the area closer to the cave wall shows a gentle downslope, while the farther area is almost flat. The excavation grid of 1 m by 1 m, designated by the combination of two numbers representing the east-west and the north-south squares, was set up to cover both areas. An east-west long trench of Squares 5-3/4 to 8-3/4 (8 m^2) was opened in the sloped area close to the wall,

Fig. 6.2 Keoue Cave as seen from the north (Photo: Y. Nishiaki)

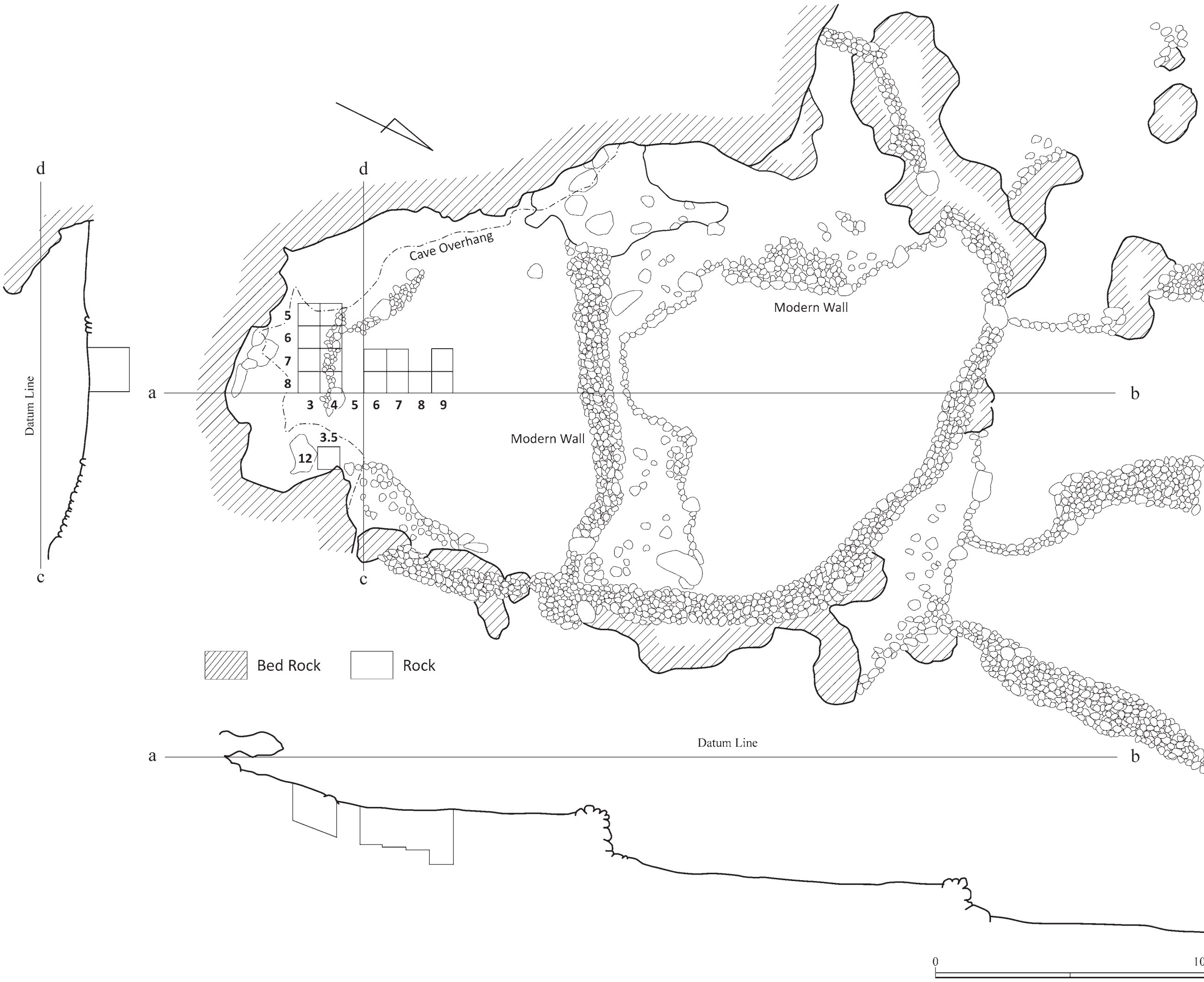

Fig. 6.3 Plan and section of the Keoue Cave showing the location of the excavation trenches

and a north-south trench of Squares 7-6/7 to 8-6/7 (7 m^2) was excavated in the flat area, with an unexcavated area 1 m wide (Fig. 6.3). Most of the squares were excavated about 1.5 to 1.9 m down from the surface, but Square 8-9 of the flat area was subjected to deep sounding down to 2.45 m below the surface (Fig. 6.4). However, bedrock was not reached.

The excavations were conducted based on a combination of the geological stratigraphy and artificial stratigraphic units. As a result, six geological layers were defined; Layers I to III were excavated in all squares, and Layers IV to VI were revealed in Square 8-9 only. When digging each of these layers, deposits were removed following the artificial horizontal units that were each 10 cm thick.

Watanabe's preliminary report (1970, p. 209) states that the stratigraphy and sedimentological features are to be published separately, but they have not appeared to date. However, stratigraphic descriptions provided by Kunihiko Endo and Masami Fukuda, geologists who joined the excavations in 1970, were found in the Hitoshi Watanabe archive (HW. F135, 137 of Nishiaki 2007). The summary description for each layer is presented below. The photographs shown in Figs. 6.5, 6.6, 6.7 and 6.8, as well as the drawings in Figs. 6.3 and 6.4, were prepared by Watanabe for a report submitted to the Directorate-General of Antiquities and Museums in Lebanon, and the captions for those figures in this paper were also taken from Watanabe's archives.

Layer I: This is a loose brown loam layer, 5–50 cm in thickness, which includes limestone rubbles (Fig. 6.4). Endo and Fukuda write that this layer has been "probably disturbed recently." In fact, they state that it bears many angular limestone gravels, which are weathered less than those of the underlying layers. Moreover, Watanabe (1970, p. 211) mentions that "this layer yielded potsherds as well as lithic artifacts. The lithic assemblage, however, has nothing to do with the potsherds culturally. The lithics were probably derived from the underlying Palaeolithic layers."

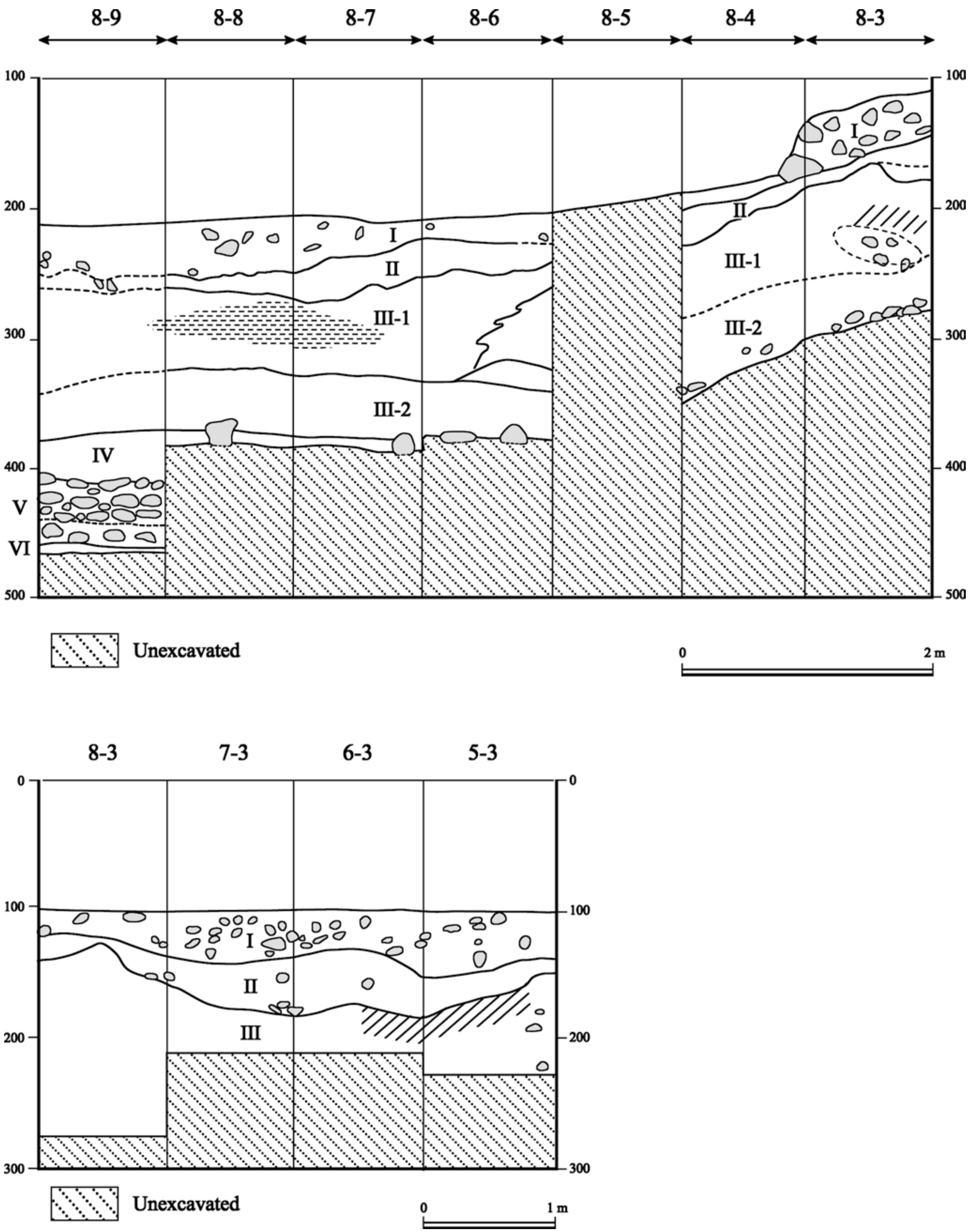

Fig. 6.4 Stratigraphy of the excavated areas of the Keoue Cave. Top: East wall of Squares 8-3–8-9; Bottom: South wall of Squares 5-3–8-3

Fig. 6.5 General view of the excavation areas. "Taken from the top side wall of the cave. It shows part of the overhanging wall of the cave and the upper (right above) and the lower (left below) areas excavated in the 1970 season. The surface of the upper area is sloping but that of the lower area is horizontal"

Fig. 6.6 Excavations at the Keoue Cave in progress. "It shows the cutting and digging down of Layer 3 at the 7-6/7-7 areas. A square area, which is seen at the top corner end, forms a little higher platform that is part of the surface of Layer 3 which was peeled and exposed before the digging down of the surrounding areas shown in the photo. Below the surface (boundary between Layer 2 and Layer 3), excavation was carried out on the basis of horizontal arbitral level system (10 cm) due to the lack of clear stratification and horizontal bedding of sediments until Layer 4 was reached"

Fig. 6.7 Excavations of Layers IV–VI of the Keoue Cave. "Large white pebbles of limestone and big animal bones distributed in concentrations in association with the pebbles in the 8–9 area at the bottom of the trench that was reached in this season. The most interesting point is the unusually high frequency of bear bones"

Fig. 6.8 Features of Layers VI at the Keoue Cave. "Large limestone slab nearly horizontally embedded and broken in pieces. The flat stone was met at the end of the excavation in the unit areas 7-6/7-7 (mostly in 7-7), a little below the surface of Layer 4, within reddish brown clayey loam. Soils covering a corner (lowest) were especially reddish." "Digging down below this feature was intentionally avoided because of shortage in time and money"

Layer II: The second layer is hard brown loam, 10–30 cm in thickness. Contrary to Layers I and III, it rarely contains limestone rubble.

Layer III: This is a very hard brown loam layer, 110–135 cm in thickness, bearing limestone rubbles and concretions. Besides being hard, the distinguishing characteristics of this layer include that it is rich in small white patches of calcium carbonates and weathered limestone gravel. The abundant concretions are also characteristic, indicating the active transportation of calcium. This layer includes lenses of dark brown loam with a small amount of humus (dotted areas in Fig. 6.4) and fragments of charcoal in parts. Although the excavators do not specify, these features may indicate the presence of occupation floors with features like fireplaces. The stratigraphic drawing prepared by Endo and Fukuda recognizes the subdivision of this layer (Fig. 6.4; Layers III-1 and III-2). However, Watanabe's notes indicate the subdivision of Layer III to be difficult (see caption for Fig. 6.6). Another notable feature is a stratigraphic anomaly identified in Squares 8–6 (Fig. 6.4). This anomaly apparently extended to the neighboring squares, and while the formation processes are unknown, it was mentioned as a "pit" in the other squares.

Layer IV: This is a reddish brown clayey loam layer, 25–40 cm in thickness. From this layer down, the excavation area was reduced because of the distribution of numerous large limestone rocks (Fig. 6.7). Large stones are particularly numerous in Squares 7-6/7 and 8-7/8. Further digging was thus conducted only in Square 8-9. Reflecting the small excavation area, a small number of lithic artifacts were recovered (Watanabe 1970).

Layer V: The fifth is an olive-green silty clay layer, 45–50 cm in thickness, containing limestone rubbles. This layer is especially rich with weathered limestone boulders.

Layer VI: The lowest layer reached during the 1970 season consists of brown silty clay sediments containing limestone rubbles, more than 5–10 cm in thickness. Plenty of white limestone pebbles and large animal bones characterize this layer. Watanabe's archive notes an "unusually high frequency of bear bones" (Fig. 6.7). No lithic artifacts were recorded from this layer.

Accordingly, six geological layers were defined in the 1970 season. Our data show that all of the chamfered and Emireh pieces were recovered from Layer I (Nishiaki and Copeland 1992, p. 118). As clearly written in the field notes in Watanabe's archive, it is very much likely that Layer I is derived from a secondary deposition. The nature of the limestone gravel in this layer, more angular and less weathered than in the underlying layers, and the mixing of potsherds reinforce this interpretation. Therefore, the presence of IUP elements in the otherwise Tabun-B-like lithic assemblage of

Layer I has no secure stratigraphic evidence. The Layer I assemblage could have even been comprised of more than one industry.

6.3 Emireh Points and a Chamfered Piece from Keoue Cave

The co-occurrence of a chamfered piece with a few Emireh points, two well-known *fossiles directeurs* of the IUP, is of interest despite their disturbed context. In order to explore its significance, those elements were examined more closely to verify their designation. In addition to the techno-typological characteristics, use-wears were also examined.

6.3.1 Emireh Point

The Emireh point was originally defined by Garrod (1951, p. 124) as a "triangular flake which has the bulbar end thinned by always directed from chipping on both faces, the thinning retouch being from the base of the flake and never from the lateral edges." The association of this tool type with the IUP assemblages was re-evaluated after a quarter century with firm stratigraphic evidence from Boker Tachtit, Israel, where more than 20 Emireh points *sensu stricto* were recovered from the Middle-Upper Paleolithic transitional contexts. Volkman and Kaufman (1983, p. 40), who carefully examined those specimens, propose a definition of this tool type to indicate a Levallois point produced by an opposed-platform Levallois point core preparation, and state "the only distinction is that Emireh points have the bifacial basal thinning absent from the other opposed-platform Levallois points." In other words, they narrowed the Garrod's definition by adding an important criterion concerning the blank, i.e., which should be bi-directionally flaked Levallois points. This is a rather strict definition by which they dismissed some of the "Emireh points" previously reported so because of their manufacture on blanks from single-platform cores.

On the other hand, after examining the Lebanese examples, Copeland (2000, p. 84) widens the definition: "a triangular point, Levallois or not, elongated or of moderate length, struck from a bipolar (or more rarely a unipolar) core after which all of the striking-platform and most of the bulb of percussion were removed by lamellar bifacial retouch (i.e., carried out on both faces of the proximal end) forming a bevel, V-shaped in profile and straight or slightly wavy in cross-section. The piece would most often have a Y-arete pattern on the distal dorsal face and either a straight or convex profile." She further writes that not every specimen referred to as an Emireh point conforms perfectly to her definition; "each may lack one or other of the criteria noted above but this is acceptable unless a piece is deficient in more than one respect, or has no bevel on the base."

There is a typical Emireh point in the Keoue collection (KE8-9-35), listed in Table 8.8 of Nishiaki and Copeland (1992) but not described in detail (Fig. 6.9: 1). It is a nearly complete point measuring 37.4 mm long, 27.2 mm wide, and 6.8 mm thick; some thermal damages are present at the base, especially on the dorsal surface. The blank is a Levallois point manufactured with bi-directional core preparation, displaying a reverse Y-shaped ridge at the tip. The basal part is prepared by bifacial retouch that forms a beveled ridge, forming an acute angle of 45–50 degrees. Therefore, this specimen exhibits techno-typological features perfectly matching the strict definition provided by Volkman and Kaufman (1983), without a necessity to consider the definition *sensu lacto* provided by Copeland (2000). Thus, this specimen can be labeled as a typical Emireh point.

Figure 6.10 compares the sizes of this point and Emireh points known from other Lebanese sites. The Keoue specimen is placed at the smallest end of the size range of known Emireh points. This result is in accord with the small size of the lithic artifacts in general at the Keoue Cave: many of them are between 3 and 4 cm in length, probably reflecting the size of locally available flints (Nishiaki and Copeland 1992, p. 110). This in turn suggests that the Emireh point in question can be a local product rather than a point brought in from somewhere else.

The bifacial retouch at the base of Emireh points is considered a device for hafting to serve as a projectile (Copeland 2000, p. 86). Our microscopic use-wear observations of the point revealed typical impact fractures at the distal tip (Katsuhiko Sano, personal communication). A flute-like fracture is observed on the dorsal side (Fig. 6.11: 1A), while the ventral surface of the tip shows a lateral fracture (Fig. 6.11: 1B). Further, the lateral fracture continues to the dorsal side, on which a spin-off fracture is visible (Fig. 6.11: 1C). These traces indicate that this point was in fact utilized as a projectile. Besides the impact fractures, no other type of use-wear was identified. This is due to the extensive traces of post-depositional surface modification (PDSM), which might well have made any other use-wear invisible. The occurrence of the extensive PDSM itself is in accord with the interpretation of the secondary depositional context of this artifact.

6.3.2 Emireh-like Point

The Layer I assemblage contains a specimen (KE7-9-45) reported as "Emireh-like point" in Nishiaki and Copeland (1992, p. 116). The blank is an elongated Levallois flake 46.7 mm long, 23.8 mm wide, and 7.3 mm thick, manufactured

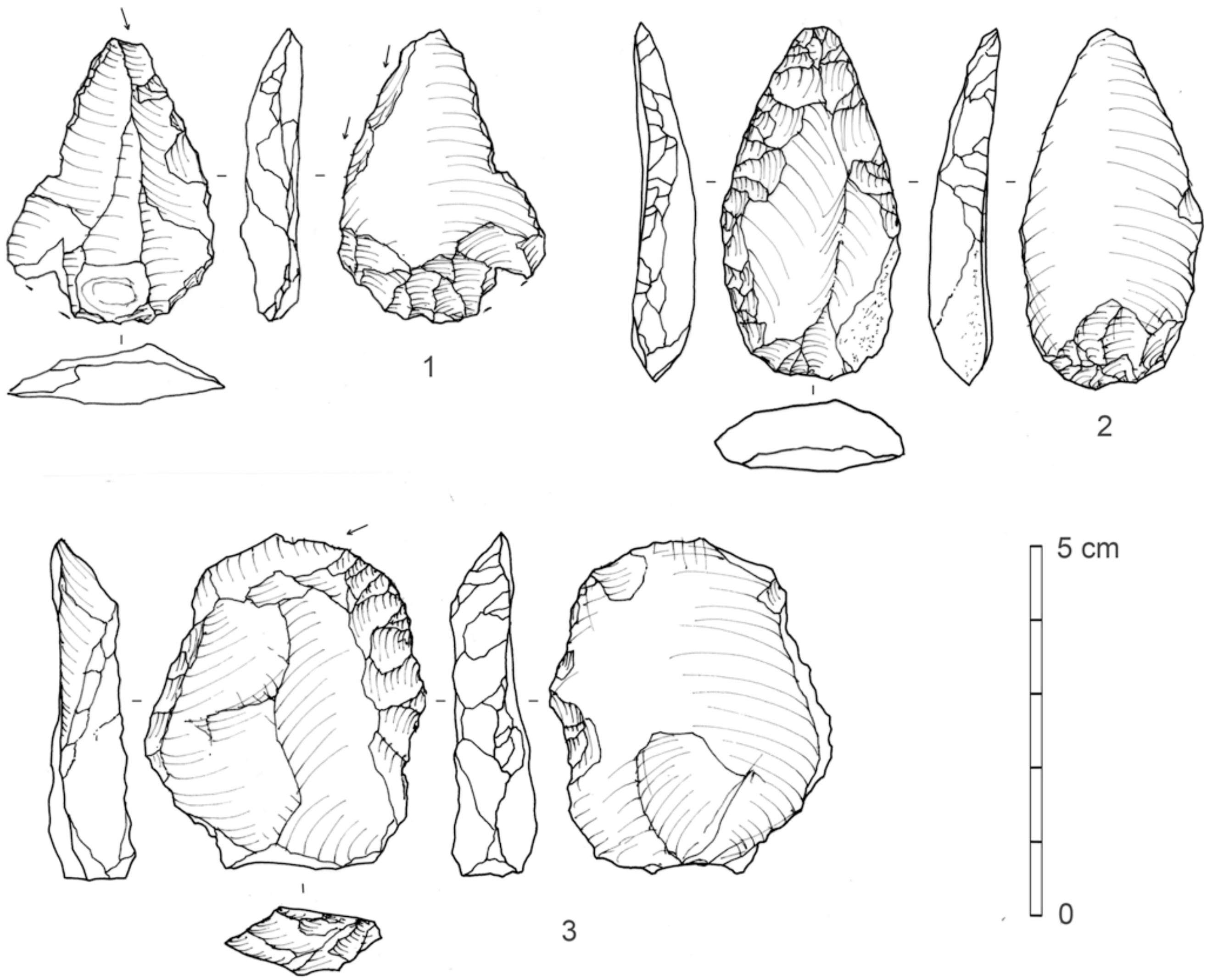

Fig. 6.9 Chamfered piece and Emireh points from the Keoue Cave. *1*: Emireh point, *2*: Emireh-like point, *3*: Chamfered piece

from a single-platform core (Fig. 6.9: 2). While the base is bifacially retouched to form a V-shaped beveled edge, approximately at an angle of 55 degrees, the lateral edges are entirely retouched by direct retouch. Because it is made on a single-platform blank, one of the criteria for the Emireh point *sense stricto* is absent. The question then becomes whether or not this specimen is made on a pointed blank; however, the original plan is unknown due to the extensive retouch along the lateral edges. The Emireh-points in the strict definition rarely exhibit extensive retouches along the lateral edges. Therefore, this specimen can also be called a convergent side-scraper with a bifacial basal retouch. However, its V-shaped beveled base is so distinct, showing a different morphology from that of ordinary tools occasionally with a retouched base (see Suzuki and Kobori 1970, p. 74; Nishiaki 1985). Accordingly, it has been reported as an Emireh-like point. Microscopic examination identified no impact fractures at the tip (Fig. 6.11: 2D1). Other use-wears were not identified either, due to the extensive PDSM observed on this artifact as well (Fig. 6.11: 2D2).

6.3.3 Chamfered Piece (KE8-6-8)

Chamfered pieces or chanfreins have been uncovered in the IUP contexts since the first discovery at Abou Halka by Haller (1942–1943). The definition employed in this paper follows that of Newcomer (1970), who carried out an extensive analysis of up to 590 chamfered pieces from various levels of Ksar Akil. He defines the chamfered piece as a flake or blade that shows evidence of the use of chamfer blow. The chamfer blow denotes a variation of a transverse burin blow, which creates an oblique facet inclining to the dorsal surface. The blow involves the preparation of an abrupt retouched platform at a lateral edge of the distal end (Newcomer 1970, pp. 180–181).

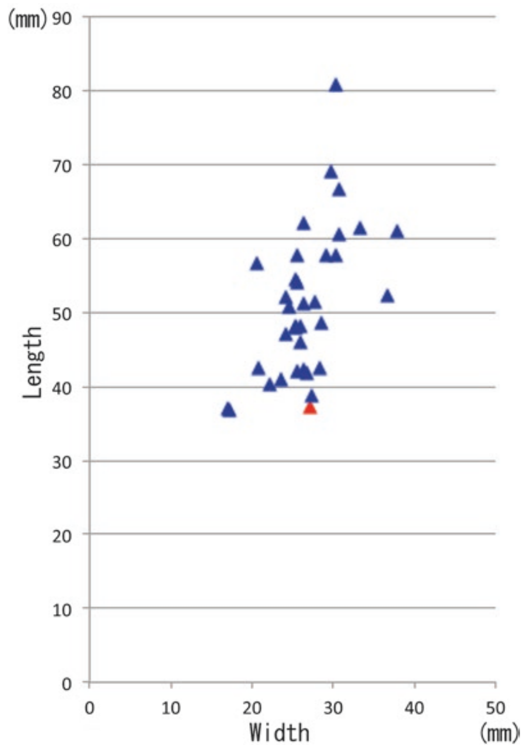

Fig. 6.10 Length and width of Emireh points from Lebanon. Red: Keoue Cave (KE KE8-9-35); Blue: Emireh points reported in Copeland (2000)

The Layer I assemblage of the Keoue Cave includes one typical chamfered piece, whose techno-morphological features wholly match the above definition (Fig. 6.9: 3). It is made on a Levallois flake with centripetal dorsal scars and a neatly faceted butt. The size is 44.2 mm long, 35.6 mm wide, and 9.1 mm thick. The direct retouch is made along the right lateral edge, and a chamfer blow is delivered from the right side using the retouched edge as its platform. The chamfer facet is extended onto the ventral surface nearly reaching to the basal part of the blank. It is noted that the left lateral edge shows a series of retouch scars also cut by the extensive chamfer facet. This retouch may represent the platform for a previous chamfer blow from the left lateral edge. Resharpening of chamfered pieces from the opposite lateral edge was not uncommon at Ksar Akil (Newcomer 1970, p. 183). The angle between the chamfer facet and the ventral surface ranges from 45 to 55 degrees, comparable to the mean angle of 53 degrees for the Ksar Akil samples (Newcomer 1970, p. 184). A use-wear analysis was also performed (Fig. 6.11: 3E, 3F); however, no use-wear was identified because of the extensive PDSM.

When this tool was first reported, the presence of a double patina was noted, suggesting the use of an old flake as a blank (Nishiaki and Copeland 1992, p. 116). However, the different patination color is visible only in the deeper part of the chamfer facet negative, which shows the interior color of this flint material. Therefore, "double patina" does not imply that the chamfer blow was made on a blank manufactured in a different period.

6.4 Discussion

6.4.1 The Layer I Lithic Assemblage from Keoue Cave

As described above, there is one typical Emireh point and one typical chamfered piece in the Levantine Mousterian assemblage of Layer I at Keoue Cave. One Emireh-like point is also present. While the Emireh point and chamfered piece are regarded as hallmarks of the IUP, it is not yet known if they were exclusively manufactured in this period. A handful of Middle Paleolithic sites in the southern Levant such as Kebara, El-Wad, and Qafzeh have yielded Emireh points, for instance. The stratigraphic contexts and typological statuses of Emireh points have received much discussion, and it is now generally agreed that a certain number of the "Emireh points" reported from the Middle Paleolithic are dismissed because of either their stratigraphic uncertainty (Bar-Yosef and Vandermeersch 1972) or techno-typological problems (Volkman and Kaufman 1983). The only feasible examples are from Boker Tachtit, where three Emireh points have been recovered from the Middle Paleolithic assemblage from Level 1. However, this assemblage is not an ordinary Late Middle Paleolithic like the Tabun-B industry, but is a terminal Middle Paleolithic displaying unique techno-typological characteristics reminiscent of the IUP (Volkman 1983). Another set of possible examples from unmixed context is from Shubbabiq (Binford 1966). In this case, however, the typological identification has not been confirmed with the current definitions (Volkman and Kaufman 1983, p. 45). Similarly, repeated reports of Emireh points from the Middle Paleolithic surface sites in the northern Levant such as Sands of Beirut and Michmiche in Lebanon lack stratigraphic contexts (see Copeland 2000; Leder 2011).

There have been even fewer reports of chamfered pieces from the Middle Paleolithic contexts. The report from the Amud Cave in the 1960s is dubious (see below), with more plausible reports from the site of Ksar Akil. Newcomer (1970, p. 182) reports one each from Levels XXX, XXVIIIa, XXVIIIb and XXVIa of Ksar Akil. However, Marks and Volkman (1983, p. 15) consider only those from XXVIIIa and XXVIa as "possible chamfered pieces," and dismiss the others. They caution that such a small number of pieces may have come out of the sidewalls of the upper strata during the excavations.

Supposing the Emireh points and chamfered pieces association with the IUP contexts, the possibility that there used to be IUP occupations at Keoue Cave must be then

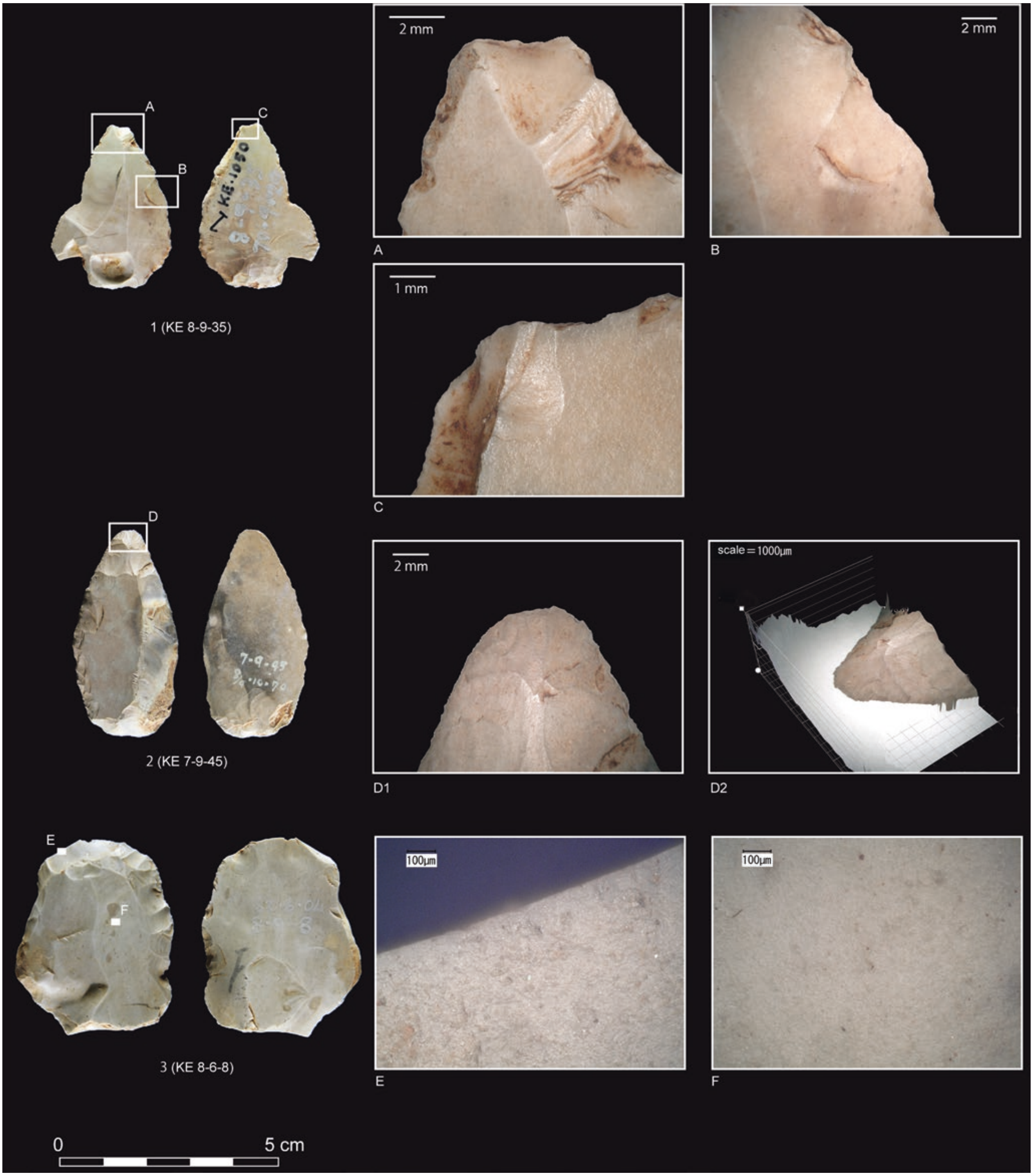

Fig. 6.11 Microphotographs of the lithic artifacts from Layer I of the Keoue Cave. *1*: Emireh point KE8-9-35 (*A*. a flute-like fracture, *B*. a lateral fracture, and *C*. a spin-off); *2*: Emireh-like point KE7-9-45 (*D1*. deliberate retouch without any use-wear traces, and *D2*. 3D reconstruction of the tip); *3*: Chamfered piece KE8-6-8 (*E* and *F*. microphotographs). All specimens indicate post-depositional surface modification (PDSM). No use-wears are identified on artifacts *2* and *3*

considered. Then, what other IUP elements might have been included in the Layer I assemblage? The IUP assemblages of the Levant, occurring in a period roughly between about 47 ka and 40 ka, are generally characterized in two ways: technologically, along with the use of Levallois cores, the introduction of volumetric cores for narrow elongated Levallois points and blade through unidirectional core-flaking, and replacing bi-directionally flaked Nubian-like cores; and typologically, with the increasingly common production of Upper Paleolithic tool types such as end-scrapers and burins, as well as a distinct tool group of Emireh points and chamfered pieces (Kuhn 2006; Marks and Rose 2014; Rose and Marks 2014). A recent intensive study of the available data from the coastal Levant by Leder (2014, 2017) has demonstrated that the IUP assemblages cannot be regarded as representing a single, monolithic industry. Instead, they may comprise spatially and chronologically different industries, which may be termed as Bokerian, Emiran, Baskintian, Tlelian, and others (Leder 2017). Although the Layer I assemblage has been thus far assigned to the Late Levantine Mousterian of the Tabun-B type, it must be re-evaluated to determine whether it contains any of such variants of the IUP industry.

Unfortunately, due to stratigraphic disturbance, examination of the entire picture of the possible existence of IUP industry/industries at Keoue Cave is not an easy task. Our previous study shows that the Layer I assemblage exhibits techno-typological features very similar to those of the underlying non-disturbed assemblages of Layers II and III, which do not contain any Emireh points or chamfered pieces (Nishiaki and Copeland 1992). The cores are highly Levallois-oriented, with the common use of unidirectional convergent flaking, as well as centripetal core reduction. Opposed-platform cores, which could have yielded blanks for Emireh points, do exist but are rare. Only three of the 109 cores retain opposed-platforms: two Levallois (Fig. 6.12: 1, 2) and one non-Levallois core. Moreover, volumetric cores, like those popular in the Meyroubian industry in northern Lebanon (Leder 2011), are virtually absent. Those once reported as "one-axis, unipolar cores," in fact consist of Levallois point or blade cores (Fig. 8.3: 6, 7 in Nishiaki and Copeland 1992). A globular core may have been used at a certain stage of its reduction sequence for producing narrow blanks from a single platform (Fig. 6.12: 3), but this core use is far from the volumetric cores increasingly becoming popular in this time period.

The blank forms of the Keoue Cave Layer I assemblage show the common occurrence of flake blanks. The laminar index is moderately high at 25.7, but the same is seen in the underlying layers. Points comprise 25.8% of the Levallois components, nearly 90% of which are short and broad-based Levallois points. Further, there are only two bidirectionally-flaked Levallois points. Side-scrapers of the Middle Paleolithic type are the dominant tool type in the retouched category: the IRes of the Bordesian system (Bordes 1961) is 51.9 and Group IIes index is 61.7. Group IIIes index for Upper Paleolithic tools is 12.3. Despite the quantity, the typological details of these Upper Paleolithic type tools are far different from those at known IUP sites such as Ksar Akil and Abou Halka (Fig. 6.12: 4, 5).

It is important to note that these general techno-typological characteristics are shared by the assemblages in Layers II and III, which have no IUP elements. The Layer I assemblage contains a significant increase in blades among Levallois blanks, which sets this layer apart from the others; specifically, 17.2% of the Levallois blanks in Layer I, while there is 12.5% in Layer II and 11.5% in Layer III. However, these are non-pointed blanks. Elongated Levallois points, popular in many IUP assemblages such as those from Abu Halka (Azoury 1986) and Ksar Akil (Ohnuma 1988), are very rare at the Keoue Cave: 3.2% in layer I, 3.1% in Layer II, and 2.0% in Layer III. The manufacturing of some of these blades may have been accomplished using the "partially faceted butt" technology for overhang removals, known to be popular in the IUP assemblages of Ksar Akil (Ohnuma and Bergman 2013; Kadowaki 2017), but are rare at the Keoue Cave. At the current stage of research, accordingly, the majority of the Layer I assemblage is considered to consist of the late Levantine Mousterian industry. Occupations at the cave during the IUP are highly possible, but lithic implements of this period have rarely survived in the excavation areas.

6.4.2 Spatio-temporal Distribution of the Emireh Points and Chamfered Pieces

In the meantime, what can be safely assumed is the existence of typical IUP elements at the Keoue Cave in northern Lebanon. From the early stages of research on the IUP, the existence of regionally different cultural processes was suggested: the northern facies characterized by the manufacturing of chamfered pieces, and the southern one by Emireh points (Garrod 1951, 1955). With the increasing number of discoveries made in the last several decades, the geographically separable pattern of these two tool types has been reinforced, as shown in Fig. 6.1.

The reports of chamfered pieces outside of the northern Levant are sparse. Chamfered pieces were once reported from Yabrud II, Syria (Bakdach 1982); however, a recent re-examination has failed to identify those pieces (Pastoors et al. 2008). In the southern Levant, Watanabe (1964) reported chamfered pieces in quantity at Amud Cave, Israel, claiming that an IUP cultural process comparable to that of the north took place in the south as well. However, later

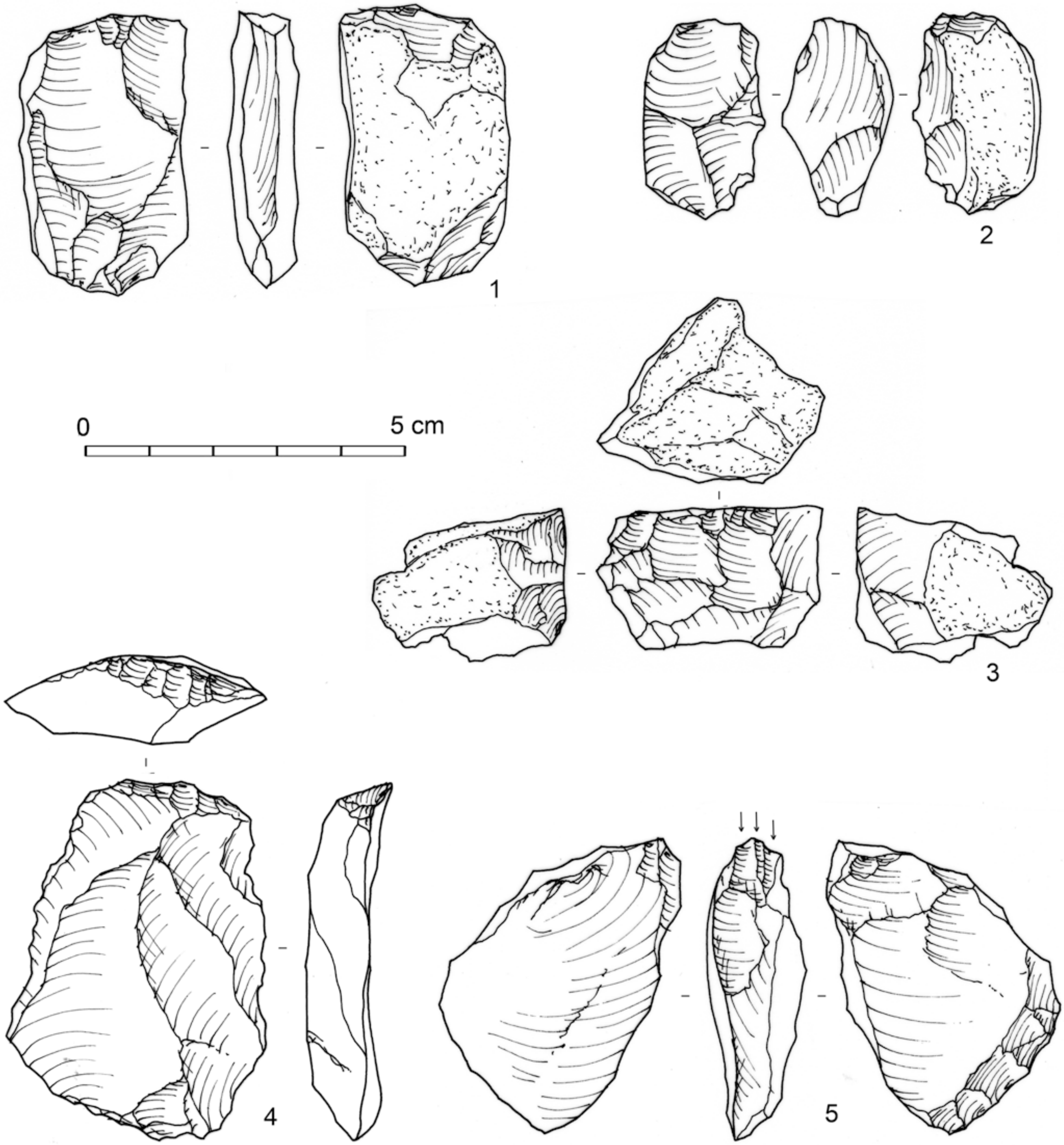

Fig. 6.12 Selected lithic artifacts from Layer I of the Keoue Cave. *1–2*: Opposed-platform Levallois cores; *3*: Globular core; *4*: End-scraper on a Levallois flake; *5*: Angle burin on a Levallois flake with scraping retouches

studies have not confirmed their typological status (Hovers 1998). More recently, one flake spall from the supposed manufacturing of a chamfered piece has been reported from Mughr el-Hamamah, Jordan (Stutz et al. 2015); yet, if any, chamfered pieces should have been very rare at this site. Further to the south, a surface collection of five chamfered pieces is known from the open-air site of Side Zin 7, not far from Boker Tachit (Goring-Morris and Rosen 1989). As described in the original report, the associated lithic assemblage indicates the early Upper Paleolithic rather than the IUP (Goring-Morris and Rosen 1989, p. 38). Those chamfered pieces, all made on regular blades, could also represent a variant of transversal burins. Further broadening the survey, if we accept the occurrence of chamfered pieces even in North Africa (McBurney 1967; cf. Iovita 2009), one would expect more discoveries in the region between the northern Levant and North Africa; however, this is not the case. In addition, the reported number of examples from the south is also ostensibly different from the north. Hundreds of chamfered pieces have been reported from Lebanon, such as nearly 300 specimens from Ksar Akil XXIII (Newcomer 1970; Azoury 1986; Ohnuma 1988).

As for the distribution of Emireh points (Fig. 6.1), they are more widely spread across the Levant, but apparently have not reached the site of Ucaağızlı at the northern end. It is also interesting to note that Emireh points are far less in number than chamfered pieces. The largest collection of Emireh points from a single site is that of Boker Tachtit, containing a few dozens of pieces at best, which is incomparable to the occurrence of hundreds of chamfered pieces at the site of Ksar Akil situated in the same region. The difference in the discovery contexts is also noteworthy; compiling the data known from Lebanon, Copeland (2000, p. 87) states that "chanfreins have been found only in habitation sites while most Emireh points occur in the open." Assuming that many of the Emireh points were projectiles for hunting, and that such usage cannot be expected for chamfered pieces, this contrast in site setting could reflect the different functions of these tool groups.

Chronological distributions could also differ between Emireh points and chamfered pieces. Aside from the site of Mughr el-Hamamah, whose data requires further testing, sites yielding both tool types are confined to the coastal region of Lebanon (Fig. 6.1). Ksar Akil and Abou Halka are the best examples, where chamfered pieces were more popular in the lower layers (Azoury 1986; Ohnuma 1988). Stratigraphic information has not been available from other sites like Antelias, Michmiche and Bakstina, where these tool groups have been collected from surface contexts.

The earlier occurrence of Emireh points than the chamfered piece fits with the general consensus of the chronology. Most researchers agree that the oldest IUP assemblages in the Levant are from Boker Tachtit, where a continuous transition from the latest Middle Paleolithic (Phase 1) to the earliest IUP (Phases 2 and 3) was documented (Volkman 1983; Rose and Marks 2014). Placing this as a starting point, the development of the IUP industries in Lebanon, such as at Ksar Akil, Abou Halka, and Antelias, has been repeatedly discussed in relation to the sequence of Boker Tachtit (see Marks and Rose 2014). Not only are earlier dates comparable to those of Boker Tachtit (ca. 47 ka) absent from Lebanon, but the technological features also suggest a later chronological position of the Lebanese sites. The most comprehensive techno-typological study, conducted by Leder (2014, p. 243), models three stages of evolutions over the interface period of the Middle and Upper Paleolithic in the Levant. The three stages are described using the term *Bokerian,* defined after the data at Boker Tachtit is discussed:

Bokerian A: This stage is represented by the lithic assemblages from Boker Tachtit 1–3 and Antelias VII–V. The blank production technology of this stage is characterized by the common manufacturing of preferential convergent blades from one-axis cores, and the typological features include the presence of Emireh points and (near) absence of chamfered pieces except at Antelias.

Bokerian B: The next stage, represented by Abou Halka IVf/IVe, Ksar Akil XXV–XXII, Ucaağızlı I, is distinguished by the introduction of the recurrent convergent blade production using convergent along-axis cores. The typological characteristics of this stage include the abundant chamfered pieces and the disappearance of Emireh points (after Ksar Akil XXV).

Bokerian C: Industries belonging to this stage are from Ksar Akil XXI–XVIII, Tor Sadaf A and B, and Ucaağızlı H–F. Blank production was practiced with the common use of volumetric blade cores together with along-axis cores, and chamfered pieces and Emireh points are completely absent.

Following this framework, the possible IUP occupations at the Keoue Cave can be derived from a period before Ksar Akil XXIV, or more generally, the beginning of *Bokerian B* and earlier. The presence of an Emireh point, which is one of the northernmost occurrences, suggests an early date for the IUP of Keoue; similarly, the single occurrence of a chamfered piece, even in northern Lebanon, also suggests an early date before this tool group became popular. The IUP occupations at Keoue Cave, which are no longer identified with stratigraphic evidence, should have been sparse anyway. The presence of a chamfered piece suggests the practice of habitation activities for a short period, while the short visit of the cave for hunting is indicated by the occurrence of Emireh points. Further speculation would be unwise with the present evidence.

6.5 Conclusions

This paper reports results of a re-examination of the excavation records and the techno-typological features of the IUP elements recovered from Keoue Cave, Lebanon. The techno-typological analysis shows that the Levantine Mousterian assemblage of Layer I at Keoue Cave contains at least one typical Emireh point and one chamfered piece, *fossiles directeurs* of the IUP. Their association with the otherwise Tabun-B like assemblage was probably caused by the stratigraphic disturbance. Microscopic observations of the lithic artifacts from this layer showed strong PDSM, supporting the secondary nature of these artifacts. Therefore, the question of whether the small number of chamfered pieces and Emireh points were indeed part of the Tabun-B type industry has not been solved with the evidence from Keoue Cave.

Alternatively, the presence of a few IUP elements at the Keoue Cave itself is evident. The spatio-temporal distribution of chamfered pieces and Emireh points was examined; their different distribution patterns in the southern and northern Levant support the existence of at least two regionally different cultural processes in the IUP period, where those in the south are apparently earlier than those in the north. The Keoue Cave is one of the rare sites with both tool types. Although the current data do not specify the precise picture of the IUP occupations that likely existed at this cave, the importance of their further investigations would not be dismissed. Further research of the extant lithic collections and exploration of the unexcavated areas of the site would lead to provide additional data to understand the IUP processes.

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The Ahmarian in the Context of the Earlier Upper Palaeolithic in the Near East

7

Nigel Goring-Morris and Anna Belfer-Cohen

Abstract

There is a general consensus that the Ahmarian techno-complex represents an endemic Upper Palaeolithic entity that emerged in south-western Asia. Its entrenchment in the region is apparent over a long chronological span and a wide geographic range, as is most especially apparent in the Levant. Notwithstanding diachronic and synchronic variability, its basic parameters have been widely recognized since it was first defined over 30 years ago. The Ahmarian characterization is based on certain intrinsic features as well as on the absence of hallmarks of other Upper Palaeolithic entities identified in the region.

Keywords

Levant • IUP • Ahmarian • Techno-typological variability • Early Upper Palaeolithic

7.1 Introduction

According to data from current research it is quite obvious that the Ahmarian complex as accepted today displays a wide range of diachronic and synchronic techno-typological characteristics. Sufficient information has accrued to attempt to define the Ahmarian from an evolutionary perspective, i.e., how it differs from the preceding Initial Upper Palaeolithic (IUP) entities, as well as from the subsequent industries, whether acknowledged as belonging to the Upper Palaeolithic, or heralding the following Epipalaeolithic period. The resulting picture will enable more precise assignment of the Ahmarian techno-complex within the larger framework of developments during the Upper Palaeolithic period in the Levant.

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7.2 The Chronological Framework

Based on recent radiometric date-sets from Mediterranean zone sites it appears that the Mousterian/Upper Palaeolithic interface dates either to 49/48-47/46k calBP according to ^{14}C dating of charcoal samples from Kebara cave (Rebollo et al. 2011), or to 43/42 k calBP based on ^{14}C dates on mollusks obtained from Ksar Akil rockshelter (Douka et al. 2013, 2015); or >43.9 k calBP, also on mollusks from the same site (Bosch et al. 2015a, b). The dates of the IUP at Üçağızlı cave, Turkey, cluster between 45-40 k calBP, though it is uncertain whether the base of the sequence there corresponds with the beginning of the IUP (Kuhn et al. 2009) (Figs. 7.1 and 7.2). The marginal zone site of Boker Tachtit that yielded the first industry defined as IUP (Marks and Ferring 1988) is currently being re-investigated, the principle focus being a dating program that is likely to elucidate matters further (O. Barzilai pers. comm.). In this context, the recent dating of a modern human cranium from Manot cave raises the possibility of an even earlier date for the Middle Palaeolithic/Upper Palaeolithic (MP/UP) transition (Hershkovitz et al. 2015). Nevertheless it seems to us that the dates from Kebara are currently more apposite for dating the MP/UP transition in the Levant.

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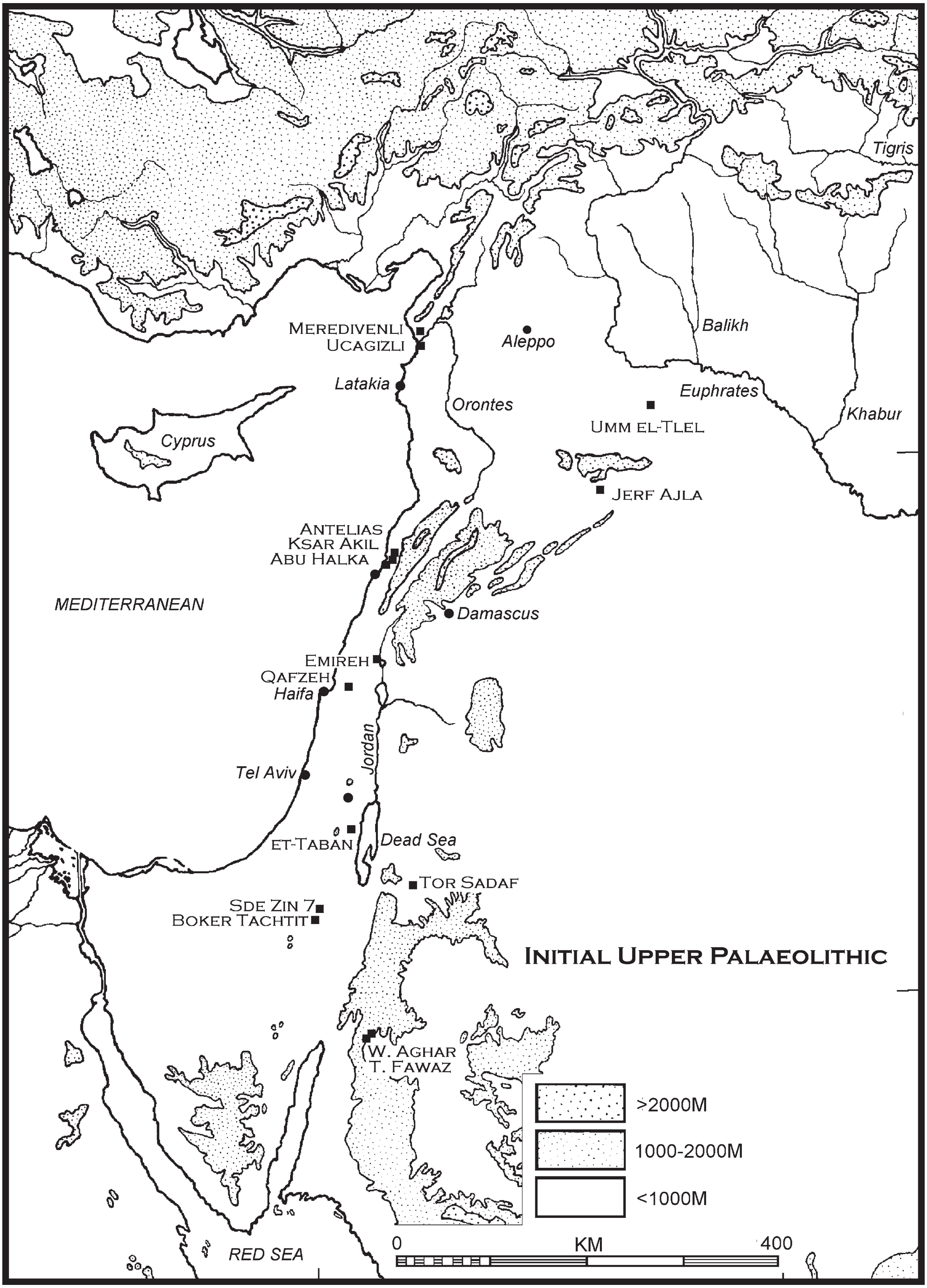

Fig. 7.1 Distribution of Initial Upper Palaeolithic sites in the Levant

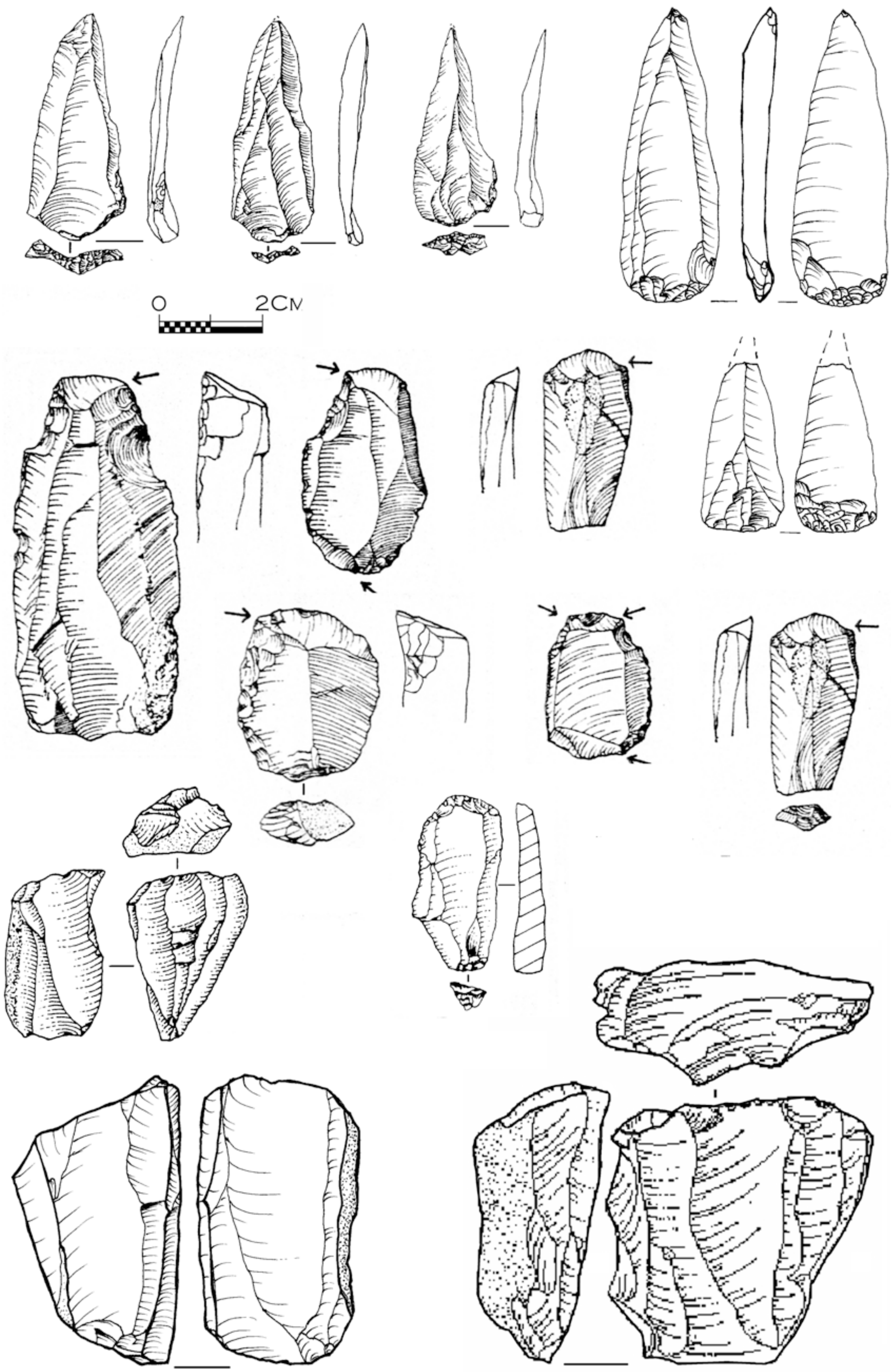

Fig. 7.2 Typical IUP chipped stone artefacts: unretouched (Levallois) points, Emireh points, chamfered pieces, endscraper and cores. Note faceting on many items (After Fox 2003, Marks and Kaufman 1983, Newcomer 1968–1969)

Indeed, the age of the Levantine IUP industries that overlie the Mousterian layers, i.e. the 'Emiran' and 'Ksar Akil Phase 1' (to mention but some of those currently recognized), is presently a principle bone of contention (e.g. Kadowaki 2017; Marks 1983; Williams and Bergman 2010). One should bear in mind that in current research it is considered as a given that such industries represent groups of modern humans coming out-of-Africa on their way to world expansion. Their route of dispersal and their first appearance in Eurasia are focal issues of on-going archaeological and paleoanthropological studies, with significant repercussions as regards the interactions of these groups with indigenous populations (Neanderthals and others), processes of assimilation and/or annihilation, and whether these were short or long term processes (Arensburg and Belfer-Cohen 1998; Callaway 2014; Pennisi 2013; Reich et al. 2010; Teyssandier 2008; Teyssandier et al. 2010; Zilhão 2013, 2014; and references therein).

Notwithstanding these problematics, the first Early Upper Palaeolithic (EUP) techno-complex in the Levant is the Ahmarian. Beginning ca. 40/41 k calBP it is present in both the Mediterranean zone, i.e. in Kebara, Manot and Üçağızlı caves and at Ksar Akil rockshelter, as well as in the more arid margins, i.e. the open-air sites of Abu Noshra, Boqer and Wadi Hasa (Barzilai et al. 2014; Coinman 2000; Douka et al. 2013; Kuhn et al. 2009; Marks 1983; Phillips 1994; Rebollo et al. 2011).

7.2.1 The Ahmarian Techno-complex (Figs. 7.3, 7.4, 7.5 and 7.6)

The Ahmarian tradition, as originally defined, independently, by both Marks (1981) and Gilead (1981), represented blade/bladelet industries that lasted through to, and include the Late Glacial Maximum (LGM). It was then divided into an early phase, the Early Ahmarian and a later phase, the Late Ahmarian continuing unto the early Epipalaeolithic – up to ca. 23/2-20 k calBP (Belfer-Cohen and Goring-Morris 2003). Indeed, one can observe technological continuity from the Ahmarian to the early Epipalaeolithic industries (Ferring 1988; Gilead 1991; Marks 2003). This is reflected in the shared leptolithic character and the use of 'narrow-fronted' (NF) core reduction sequences.

Yet, a distinctive shift towards microlithisation, with an emphasis on elongated finely retouched/backed bladelets is observed already before ca. 30 k calBP at Boqer BE in the central Negev, as well as in northern Sinai (Bar-Yosef and Belfer 1977; Jones et al. 1983). Indeed it is interesting to note that in the Lagaman variant of the north Sinai Ahmarian a bimodal distribution of microlithic bladelet blanks and macrolithic blades is already apparent, e.g. at Lagama V-VII (Bar-Yosef and Belfer 1977, Fig. 16) as also at Boqer A (Monigal 2003, p. 126). Similar processes can also be recognized in the Mediterranean zone at Ksar Akil post-level X (Bergman 1987; Williams and Bergman 2010).

Back in the 1980s, when the Ahmarian was first recognized and defined, it was assumed that this techno-complex existed in parallel with the Levantine Aurignacian throughout the UP sequence in both the Mediterranean and marginal zones (Gilead 1981; Marks 1981). New data and reinterpretation of old evidence has revealed that this is not the case.

Originally, the term 'Aurignacian' designated in Europe the earliest Upper Palaeolithic industries, following the Middle Palaeolithic Mousterian. Without going into a detailed discussion of how this approach impacted prehistoric research in Eurasia at large (and see Belfer-Cohen and Goring-Morris 2014a, b), it is quite clear that the oldest industries attributed to this taxon, namely 'Proto-Aurignacian' and 'Aurignacian 0' closely resemble the Levantine Ahmarian (Teyssandier et al. 2010; and see Zilhão 2014 and references therein). By contrast, the later 'Aurignacian I' represents a quite different phenomenon, with distinct techno-typological, geographic and chronological characteristics, different from the 'Proto-Aurignacian' (and see Conard and Bolus 2006; Teyssandier 2008).

The relatively few Levantine assemblages that still retain the appellation 'Aurignacian' – portraying characteristics of the European classic Aurignacian, or 'Aurignacian I' – postdate their European counterparts, dating (when dates are available) to ca. 37.5 k calBP (Barzilai et al. 2014; Belfer-Cohen and Goring-Morris 2014b; Goring-Morris and Belfer-Cohen 2006; Goring-Morris et al. 2009; Lengyel et al. 2006; Otte et al. 2012). These assemblages, termed the 'Levantine Aurignacian' are always found, when in stratigraphic context, above the Ahmarian, for example in the sites of Kebara, Ksar Akil, Manot and Yabroud (Bar-Yosef et al. 1996; Barzilai et al. 2014; Douka et al. 2013; Marder et al. 2013; Mellars 2006; Rust 1950; Williams and Bergman 2010). Their geographic spread is restricted, being confined to the Mediterranean (mostly coastal) zone (Fig. 7.7); they appear to be coeval with quite a number of later 'Early' Ahmarian sites in the more arid zones (Bar-Yosef and Belfer 1977; Coinman 2003; Marks 1983).

It is early days to evaluate whether there was any direct connection between the 'Ahmarians' and the 'Aurignacians'. Still, it is of interest to note that the local Aurignacian assemblages do include considerable numbers of el-Wad points, the *fossile directeur* of the Ahmarian, while their morphological equivalent in Europe, assigned to the 'classic' Aurignacian, the Font-Yves point, occurs in lesser frequencies. Indeed, D. Garrod wrote in Garrod 1953 "...the small, sharp Font-Yves point, which is the special feature of Upper Palaeolithic III [i.e., the Levantine Aurignacian of today], is hardly known in the West" (Garrod 1953, p. 25). Here, it is perhaps relevant to note that the el-Wad point as, indeed, the Font-Yves point, represents a general and quite simple typo-

Fig. 7.3 Upper, Erq el-Ahmar rockshelter; lower, the site of Boker (arrow, centre right of photo) in Nahal Zin

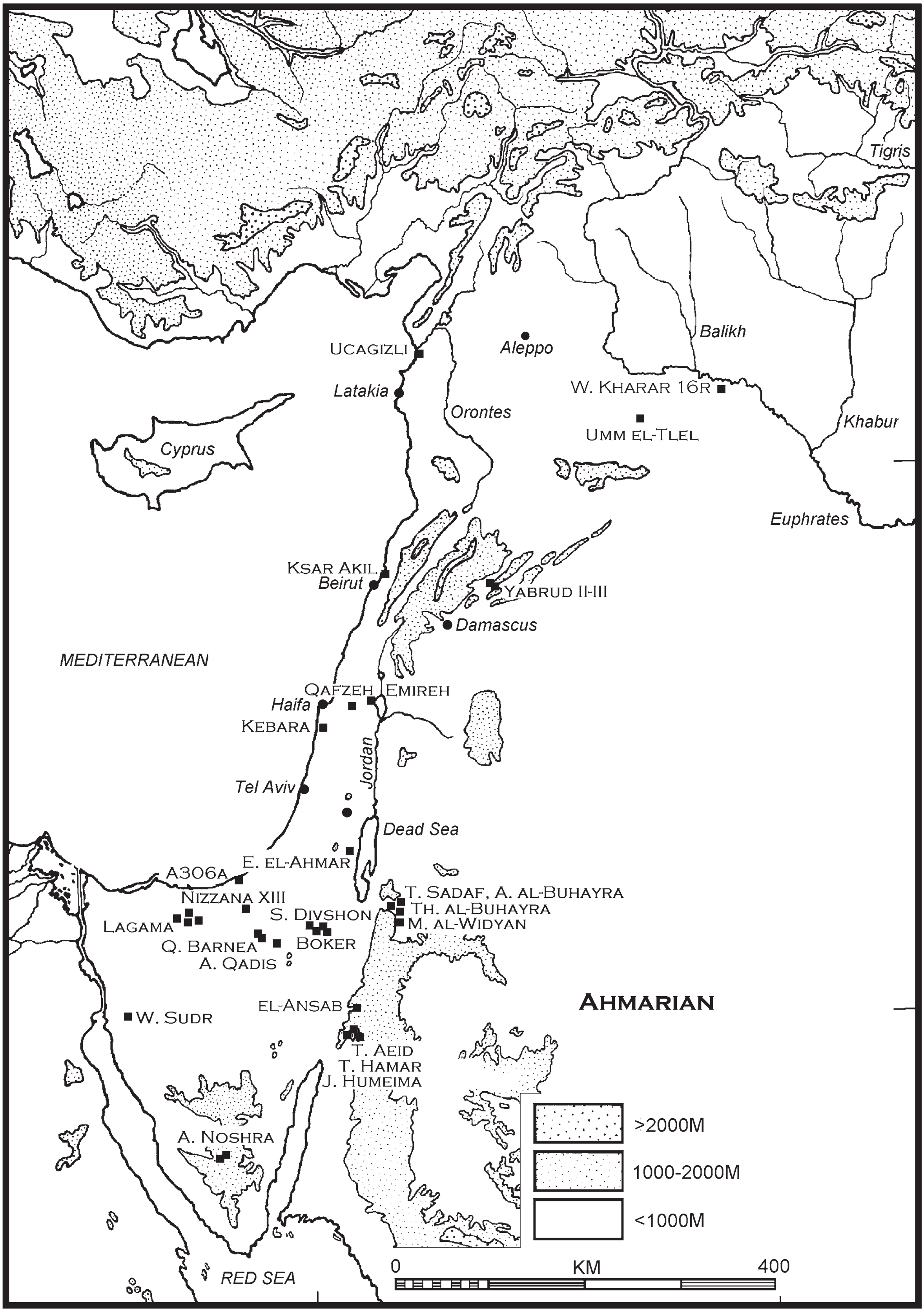

Fig. 7.4 Distribution of Ahmarian sites in the Levant

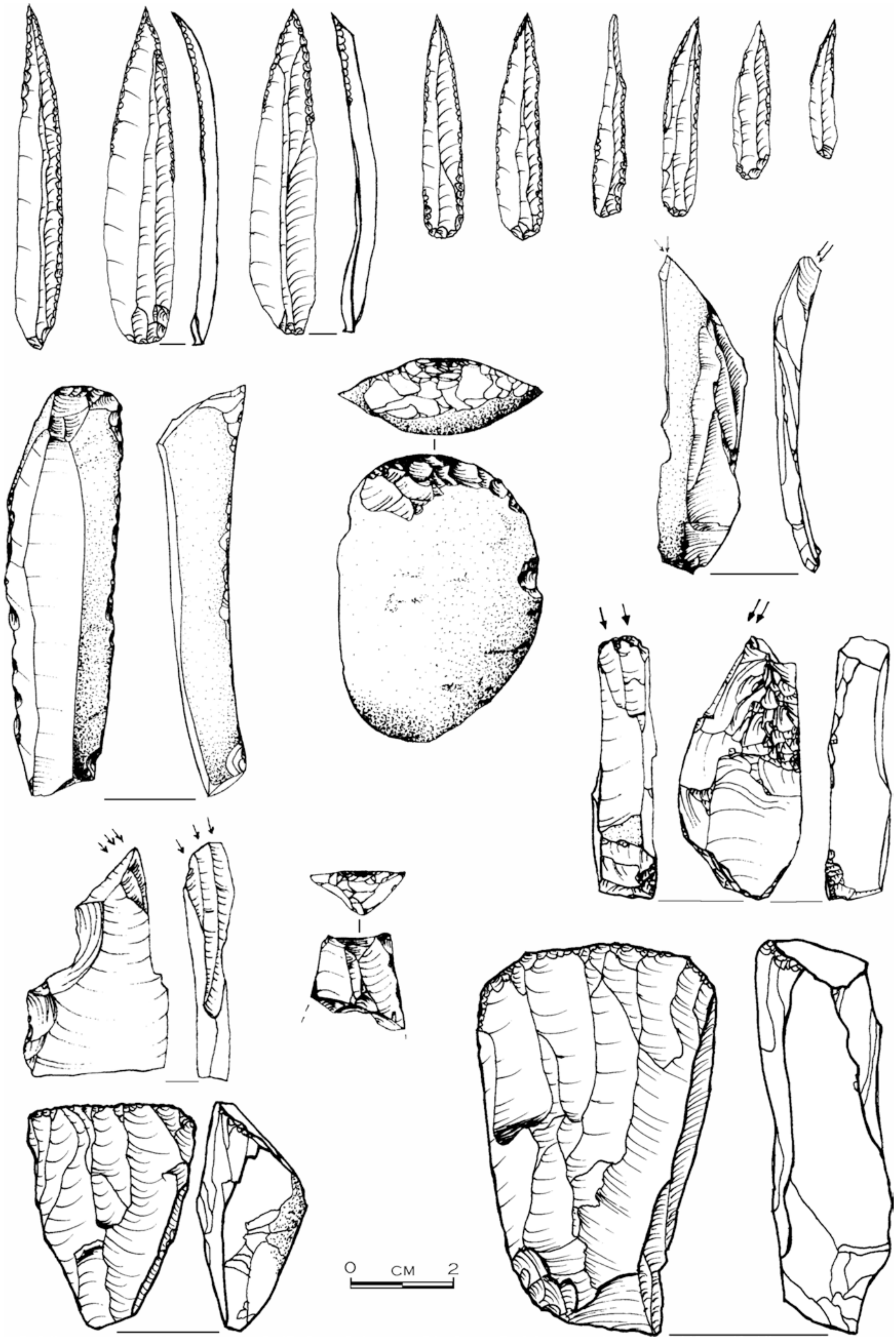

Fig. 7.5 Typical earlier Ahmarian chipped stone artefacts: el Wad points, endscrapers, burins, truncation, and narrow-fronted cores

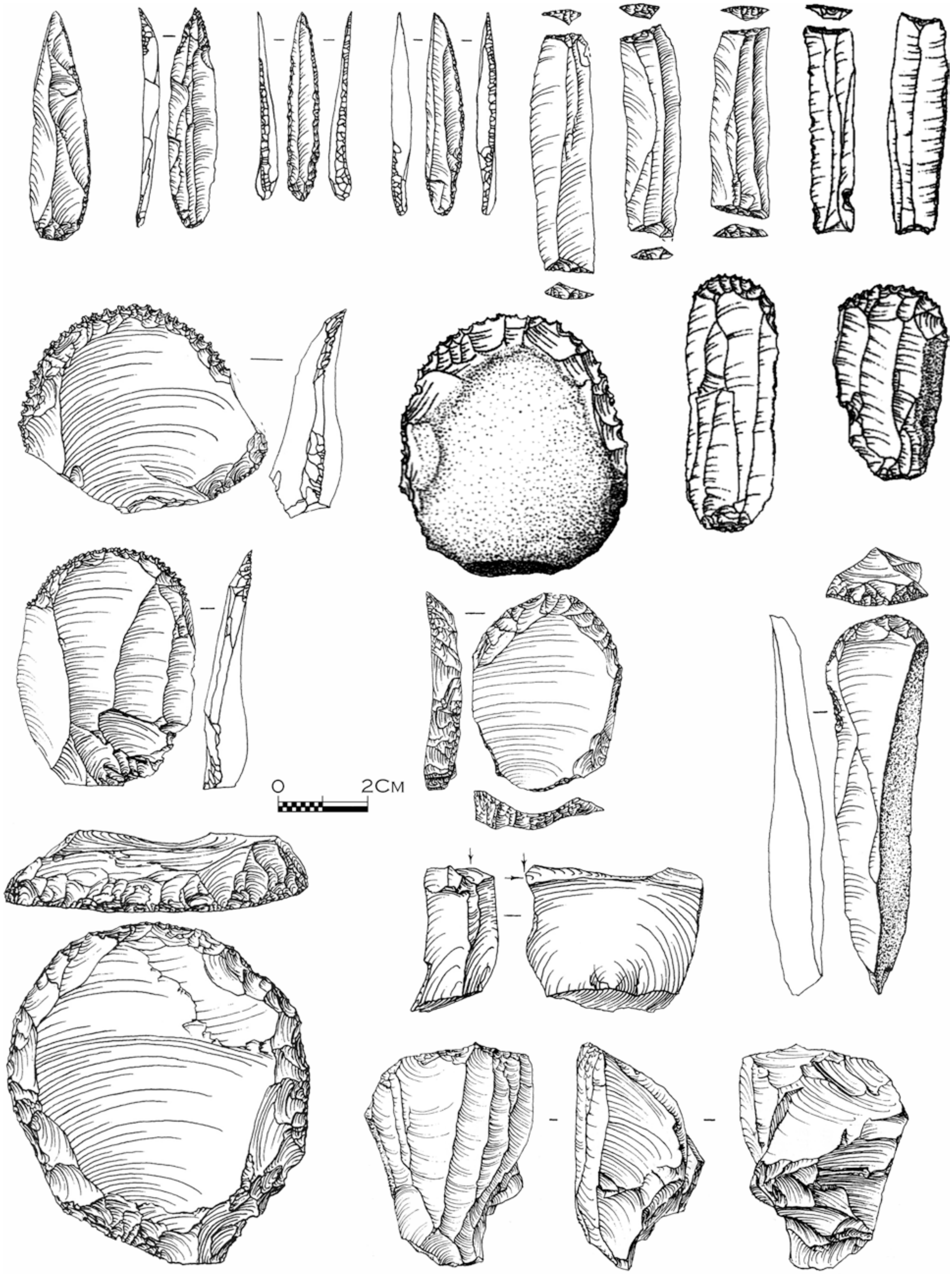

Fig. 7.6 Typical later Ahmarian chipped stone artefacts: el Wad points, bitrucated blades, Ksar Akil scrapers, endscrapers, burin, narrow-fronted core (After Coinman 2003, Jones et al. 1983)

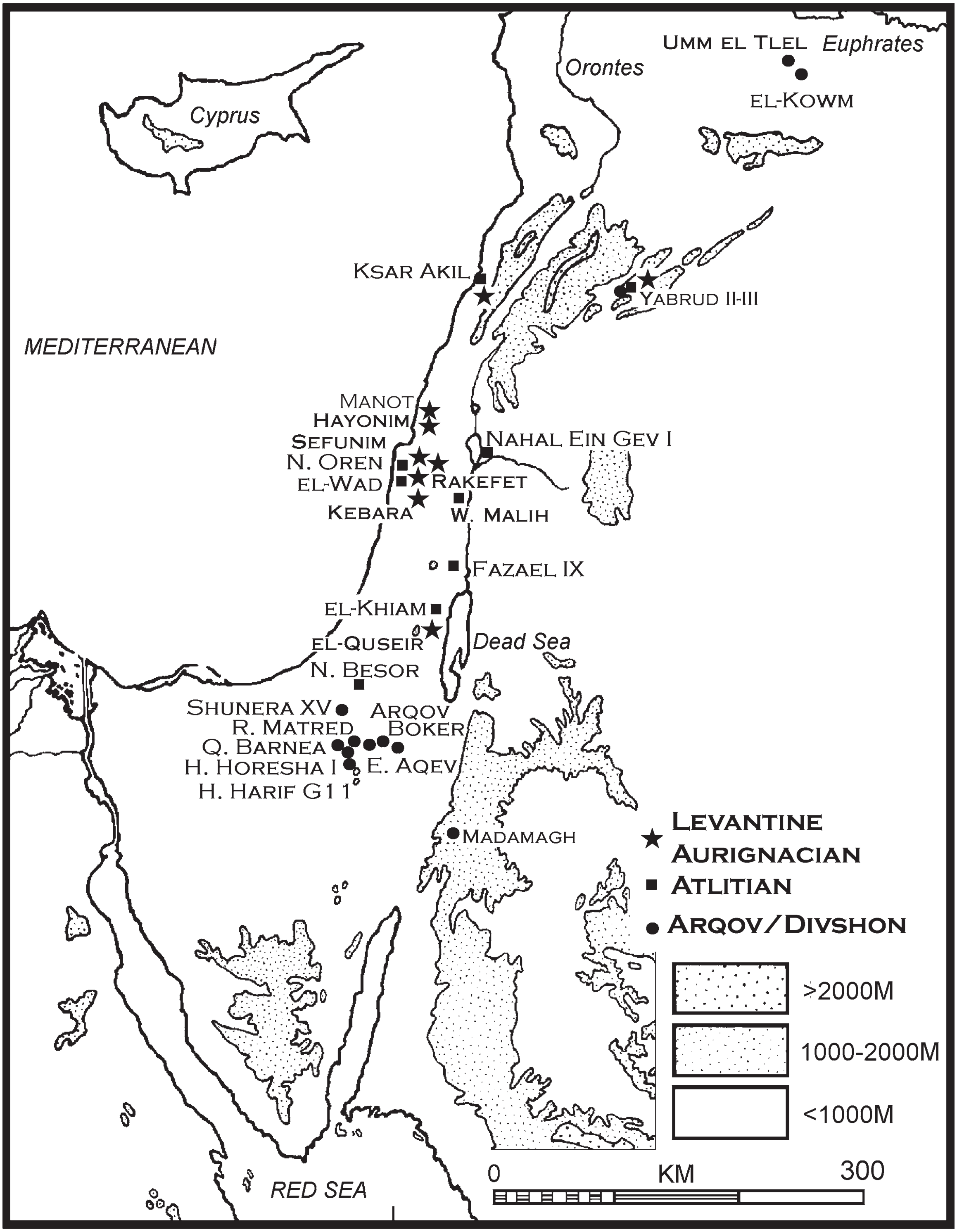

Fig. 7.7 Distribution of Levantine Aurignacian, Arqov/Divshon and Atlitian sites in the Levant

logical concept, being a plain narrow, convergent pointed blade/let partially or completely retouched on one or both lateral edges (and see Copeland 2003; Hours 1974).

The techno-typological characteristics of the Ahmarian vary both chronologically and regionally. The 'radical' shift from MP to UP technological approaches concerning knapping and tool production occurred during the course of the IUP, reflecting a general shift from a Middle Palaeolithic 'surficial' exploitation (with faceting) for the production of blanks, to a typically Upper Palaeolithic 'volumetric' approach, with the systematic production of sequences of blade/let blanks (Inizan et al. 1992). Actually, such re-orientation of preparation surfaces was less revolutionary than is sometimes portrayed. This is reflected by the continued occurrence of 'Nubian' (MP) bidirectional convergent point cores in the IUP Emiran at Boqer Tachtit (Marks and Kaufman 1983, figs. 5-3:c-f [level 1], 5-11:d [level 2]). Many of the Emireh and 'Levallois' points there appear to derive from such opposed platform cores (Marks and Kaufman 1983, Figs. 5-6 and 5-7). But, in addition, at Boqer Tachtit this is accompanied already by cresting, a hallmark of future UP technologies. One can also observe in the IUP industries (the 'Emiran' and 'Ksar Akil Phase 1' and others) a continuous shift from platform faceting to abrasion of the removal surface prior to the serial removal of blades, the beginnings of which can be traced already, for example, in the Late Mousterian open-air sites of MNO (Sharon and Oron 2014) and Umm el-Tlel (Bourguignon 1996, 1998).

Indeed, in terms of most tool classes the shift from MP to UP had already occurred in the Emiran at Boqer Tachtit, where sidescrapers are initially rare and disappear completely during the sequence, being replaced by endscrapers and burins, which become a major component of future UP tool assemblages (Marks and Kaufman 1983). It is only the 'Levallois' and basally thinned Emireh points that still portray MP characteristics.

7.2.2 The Ahmarian Reduction Sequence

In line with the changes that had occurred during the MP/UP transition, Ahmarian knapping concepts were already fully UP in terms of the reduction sequences. All-in-all the Ahmarian is dominated by 'narrow-fronted' core preforms (Fig. 7.5). There is a common assumption concerning a corresponding shift from the use of direct, hard hammer percussion during the MP to the use of soft, organic percussors for the UP industries, This explicates the different appearance of the blade/let blanks platforms (and see above), though there is actually little obvious evidence for such a shift. It seems quite likely that lighter hammers of softer stones could as easily account for the observed distinction.

Still, while the Ahmarian is characterized by a standardized approach to serial blade/bladelet blank production, local variations can be detected, likely reflecting adaptations to the nature and shape of available raw materials, amongst others. It is of interest to note that blade/let production in the marginal areas was notably more gracile than in Ahmarian assemblages in the Mediterranean zone. Another general observation concerns the use of bidirectional platforms, which are clearly more common in Ahmarian assemblages in the north, e.g. Kebara, Qafzeh, Manot, Ksar Akil (Bar-Yosef and Belfer-Cohen 2004, in prep.; Barzilai et al. 2014; Kadowaki et al. 2015; Williams and Bergman 2010), while in the south they rarely exceed 15% (Bar-Yosef and Belfer 1977; Coinman 2003; Ferring 1980, 1988; Gilead 1981; Goring-Morris 1995a, b; Jones et al. 1983; Marks and Ferring 1988).

The nodules in the southern sites were often split into two in order to initiate the reduction sequence (Davidzon and Goring-Morris 2003; Jones et al. 1983; Monigal 2003). Decortication was sometimes accomplished during preliminary core preparation, e.g. Ein Qadis IV and Nahal Nizzana XIII, where raw material in the form of wadi cobbles and nodules was used so that the resulting large cortical flakes could be fashioned into macro tools, e.g. endscrapers (Goring-Morris 1995a; Goring-Morris and Davidzon 2006). By contrast, at other sites, e.g. Boker A, discoidal nodules from readily available outcrops were exploited and a large portion of the decortication was accomplished later, during the removal of targeted blade/lets (Monigal 2003).

Retention of the obtuse striking platform angle in relation to the removal surface was maintained by the removal of classic core tablets, thus enabling the serial removals of numerous incurvate, convergent blade/let blanks. These display signs of abrasion of the removal surface and small or punctiform striking platforms, sometimes lipped. Other larger blanks for the macro tool component, e.g. burins, frequently derive from such core rejuvenation, i.e. the actual core-tablets (e.g. Davidzon and Goring-Morris 2003; Monigal 2003). Inasmuch as cresting occurs, it was usually to ensure the somewhat incurvate profile of the blade/let blanks; bifacial or unifacial retouch being applied to thin the keel of the core, resulting in most ridge blades displaying dorsal bifacial/unifacial removals towards the distal tip.

There is a general diachronic decline in the size of blanks and points during the course of the 'Ahmarian' *sensu lato*, e.g. in the sequences observed in Ksar Akil and Boker (Jones et al. 1983; Kadowaki 2013; Williams and Bergman 2010). However, it is also important to note that a bimodal distribution of retouched blade/let sizes was already apparent in the Lagaman sites and at Boker BE (Bar-Yosef and Belfer 1977; Jones et al. 1983; Monigal 2003).

In terms of typological characteristics a contrast between the Mediterranean zone and the arid margins is observed in the more 'balanced' composition of Ahmarian assemblages in the former with a greater abundance of scrapers and burin classes relative to the points and retouched blade/lets. In the arid margins the toolkit composition is more variable, with differentiation between more ephemeral hunting camps, e.g. the Lagaman sites, where there is an emphasis on points and retouched blade/lets at the expense of scrapers and burins; and larger, home bases such as Sde Divshon (D27b) where, in addition to the points and retouched blade/lets, there are also higher frequencies of scrapers, burins and notches.

There are also distinctive tool types, such as the finely denticulated Ksar Akil scrapers (Fig. 7.6). They appear sporadically in certain later Ahmarian assemblages in both the northern and southern Levant, e.g. Ksar Akil Levels V and IV, Antelias and el Wad (Copeland 1982; Williams and Bergman 2010), as well as Boker BE levels III-VI in the Negev and Thalab al-Buhayra and Ayn al-Buhayra in Transjordan (Coinman 2002; Jones et al. 1983). Never common, they are totally absent at other sites, e.g. Kebara, Qafzeh, the Lagaman, etc. An unusual co-association of Ksar Akil scrapers and bitruncated blades at Boker BE level V and Thalab al-Buhayra is notable (Fig. 7.6). In these assemblages the el Wad points display a pattern of diminution and they date late within the Ahmarian, ca. 31-29 k calBP.

The changes through time during the course of the so-called 'Early' Ahmarian, currently lasting more than 10,000 years., justify subdividing it into two phases, "early" and "late", though each phase is shorter than what was assigned previously under the same taxon, i.e. "Early" and "Late" Ahmarian (Belfer-Cohen and Goring-Morris 2003).

While the 'Early' Ahmarian assemblages are well defined both techno-typologically and chronologically, this is not the case with the so-called 'Late' Ahmarian, thus the assignment of assemblages to this taxon is problematic. There are few occupations, if any, which can be considered as directly continuing from the 'Early' Ahmarian, and their dating is problematic. For example, in Ksar Akil, one of the very few Levantine sites where there is a long Palaeolithic sequence comprising Middle, Upper and Epipalaeolithic industries, the Ahmarian sequence is interrupted by the Levantine Aurignacian levels and the assemblage from the layer overlying it, Layer VI (whether we consider the material excavated in 1937–1938, Phase 6, or that excavated in 1947–1948, Phase 7), differs greatly from the Early Ahmarian of the preceding levels (Bergman 1987; Williams and Bergman 2010, p. 140). In the site of Boker BE, also with an impressive UP sequence (Jones et al. 1983; Marks 1983), levels VII-III, which can be considered as late in the 'Early' Ahmarian, are followed by levels I-II comprising (small) lithic assemblages that entirely lack the el-Wad component, the hallmark of the Ahmarian. It is accepted that these lithic assemblages represent entities that are not Ahmarian, which rather should be assigned to the 'Arqov/Divshon' entity (Fig. 7.8; and see below).

Indeed, the next solid prehistoric entity (in the sense of number of assemblages, their techno-typological characteristics, geographic spread and dating) is the 'Masraqan', originally termed the 'Late Ahmarian' by Gilead (1981) and Marks (1981), dating to the LGM, ca. 25-22 k calBP (Fig. 7.9; Goring-Morris 1995b and references therein). Apparently this entity, though clearly of a leptolithic nature, has 'lost' the most prominent trademark of the Ahmarian, namely the el Wad points. Instead, Masraqan assemblages are dominated by finely retouched (Ouchtata) bladelets (similar to straight or slightly incurvate Dufour bladelets, i.e. they are non-twisted), which outnumber, by far, the blade tools (Fig. 7.10). The majority of these Ouchtata bladelets are not pointed. It seems that, while representing the culmination of a trend observed during the course of the 'Early' Ahmarian, this industry also portrays the beginning of a different typo-technological development that eventually becomes apparent in the microlithic entities of the Early and Middle Epipalaeolithic, when microlith morphologies are fashioned by retouch and backing, i.e. the Nebekian, Kebaran, Geometric Kebaran, Mushabian, etc. (Belfer-Cohen and Goring-Morris 2002).

It appears that the 'Early' Ahmarian is followed by a variety of industries, the common denominator of which is the disappearance of the pointed blades. Among those, which are earlier in time, differing from the Ahmarian both technologically and typologically, one can mention the northern 'Atlitian' defined by Garrod (Garrod and Bate 1937) based on her excavations at el-Wad; this was the name given also to other assemblages, e.g. Level VI in Ksar Akil and Nahal Ein Gev I (Belfer-Cohen et al. 2004; Copeland 1975 and see above). Another such entity, encountered in the marginal zones is represented by the Arqov/Divshon flake-based industry (Belfer-Cohen and Goring-Morris 2014a; Goring-Morris 1980).

In light of the above, we believe that the term 'Ahmarian' should be retained only for those assemblages previously grouped together under the taxon 'Early' Ahmarian.

7.3 Discussion

It seems that with the current level of knowledge as regards the Upper Palaeolithic record in the Levant, the picture differs quite significantly from that observed in the early 1980s. Indeed, evidence has accrued to indicate that there were multiple trajectories of change in the Levant beginning in the latest phases of the MP through the IUP. The latest phase of the Levantine Mousterian, ca. 75–50 k years (=MIS 3–4), displays considerable geographic and techno-typological variability (Hovers and Belfer-Cohen 2013). A clear example is the case of the Mousterian sequence at Kebara cave, where the assemblage of Unit V differs significantly from the preceding Mousterian assemblages of Units VII-VI (Bar-Yosef and Meignen pers. comms.; Belfer-Cohen pers. obs.). It is of interest to note that the IUP industries replacing the Mousterian complex comprise several geographic and techno-typological variants, e.g. the IUP of Ksar Akil, Üçağızlı, Umm el-Tlel, Boqer Tachtit, Tor Sadaf, Wadi Aghar, Tor Fawaz, etc. (Bourguignon 1998; Fox and Coinman 2004; Kadowaki 2017; Kerry and Henry 2003; Kuhn et al. 2009; Marks and Kaufman 1983; Monigal 2002; Ohnuma and Bergman 1990). It is these industries that display a continuation of certain Mousterian characteristics such as prepared platform faceting – a Levallois concept – for blank production (e.g., the 'Emiran'

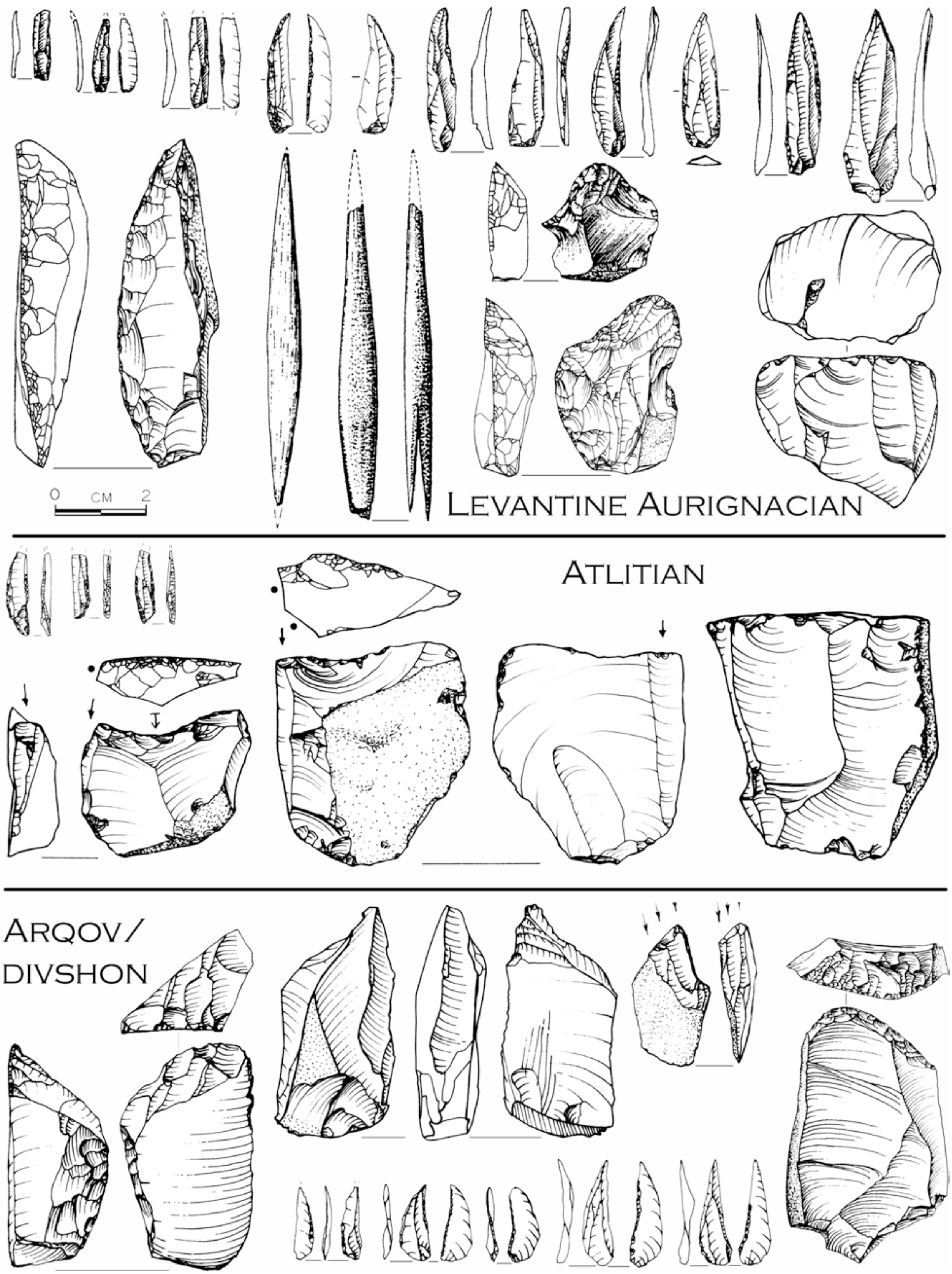

Fig. 7.8 Typical Levantine Aurignacian (Dufour bladelets, el Wad points, Aurignacian blade, split-base antler point, broad carinated scrapers, core), Atlitian (microliths, burins on Clactonian notches, core), and Arqov/Divshon (lateral carinated scrapers and burin, twisted Dufour bladelets, end scraper) chipped stone artefacts

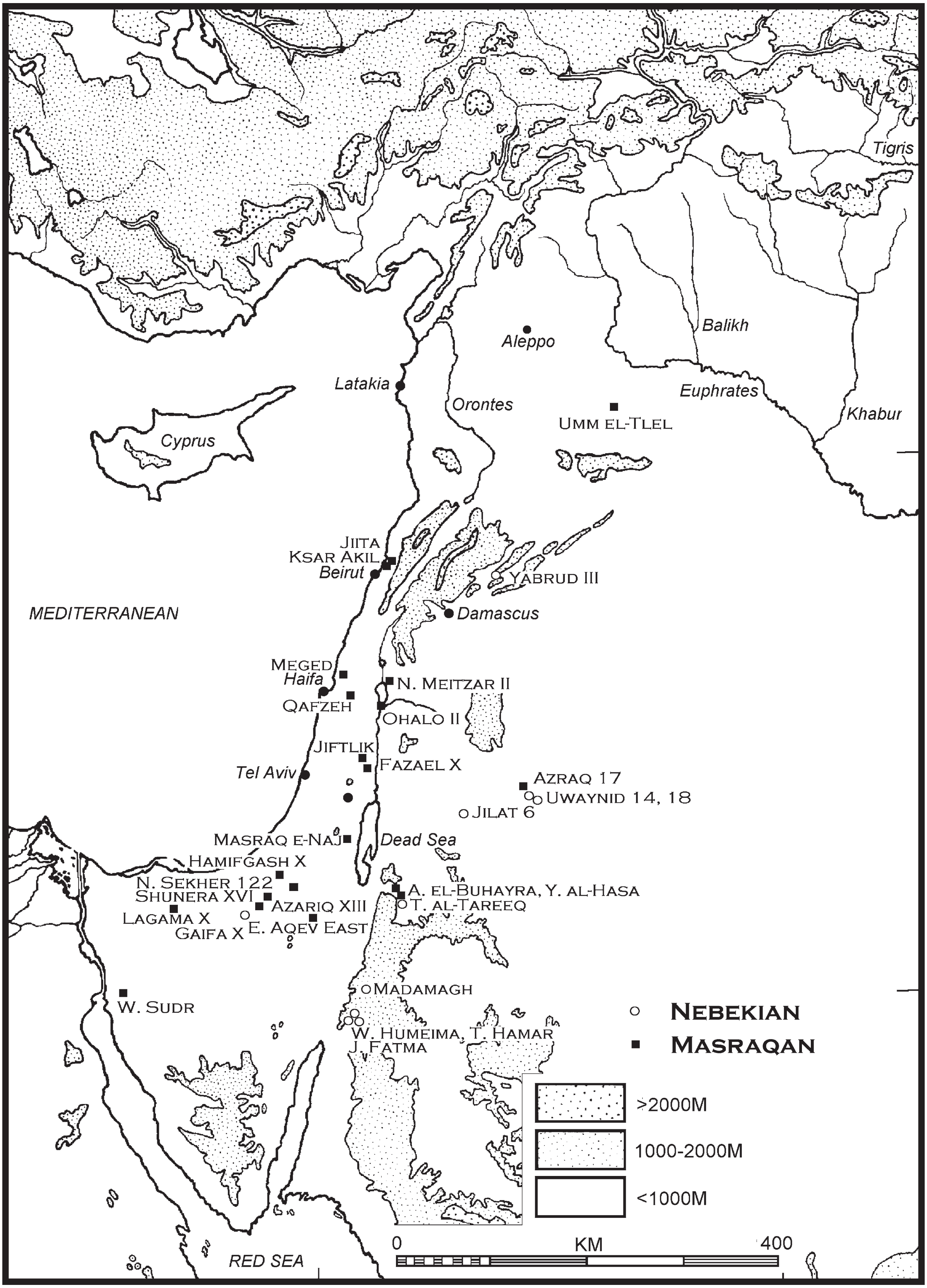

Fig. 7.9 Distribution of Masraqan and Nebekian sites in the Levant

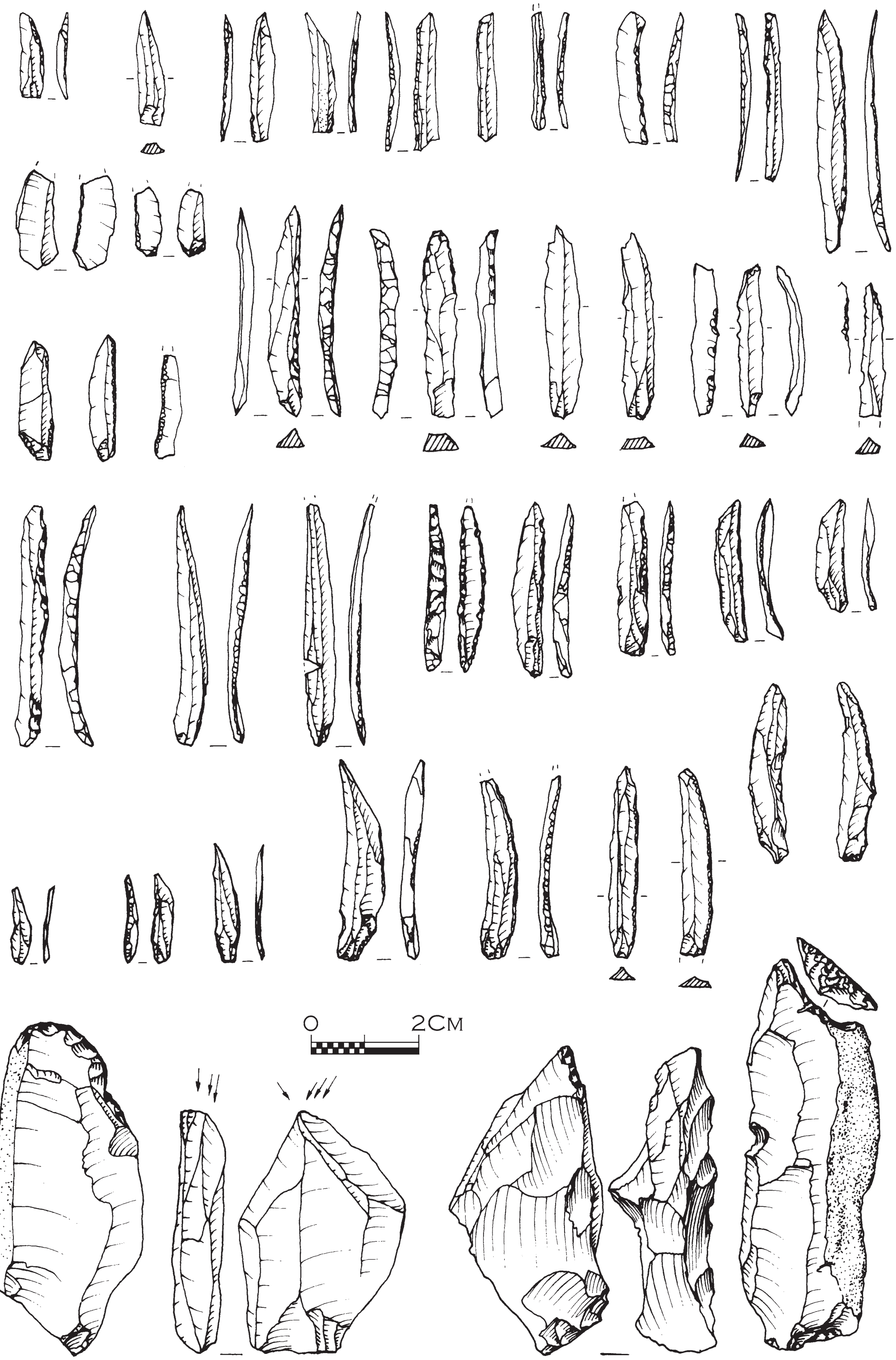

Fig. 7.10 Typical Masraqan chipped stone artefacts: finely retouched Ouchtata bladelets bladelets, Dufour bladelets, endscraper, burin, narrow-fronted core

of Boker Tachtit), which is replaced through time by the typical UP abrasion of the removal surface. Besides distinctive, though 'short-lived' tool forms such as the Emireh points or the chamfered pieces, the IUP industries comprised, in growing numbers, tool forms that were to become hallmarks of the UP entities, such as endscrapers and burins, and to a lesser degree, blade tools.

Accordingly, the Ahmarian, the first Early Upper Palaeolithic entity, has nothing to do with the MP/UP transition, contra previous assumptions, differing in this from the preceding IUP industries, being removed from the Mousterian by 5–10 k years.

At present, it is difficult to pinpoint which of the IUP variants was the most plausible antecedent for the Ahmarian. Regrettably, the earliest Ahmarian occurrences that have provided a series of dates, those in Kebara Cave, unconformably overlie Mousterian deposits with no IUP occupations present (Rebollo et al. 2011 and references therein; Bar-Yosef and Belfer-Cohen in prep.). The uppermost level at Boker Tachtit (Level 4) is represented by mostly, unidirectional cores for robust blade blanks and a variety of points. Though Marks and Kaufman (1983) refer to them as 'non-Levallois', morphologically these points do not differ from unidirectional Levallois points reported from Levantine MP assemblages elsewhere. It is of interest to note that there is a difference between robust points, which usually have faceted striking platforms, and more gracile variants without faceting. The percentage of the *fossile directeur*, the Emireh point in Boqer Tachtit drops from 3% (Level 1), 8% (Level 2), and one out of 25 tools (Level 3), to none in Level 4. Also the frequency of bidirectional Levallois points drops from 40% in Level 1, to 19% in Level 2, to 10 points out of 25 in Level 3, to none in Level 4 (Marks and Kaufman 1983). Without going into specifics, though in a recent paper (Williams and Bergman 2010) the assemblages of Levels XXV–XXI at Ksar Akil are treated on the whole as the IUP (formerly "KA Phase A"), it is stated that while Levels XXV–XXIV include opposed platform cores with parallel sides, Levels XXIII–XXI feature single platform blade cores with converging sides and faceted platforms to produce elongated points that morphologically resemble 'Levallois' types. While Azoury (1986) classified the points and cores as 'Levallois', Ohnuma (1988; Ohnuma and Bergman 1990) described them as 'prismatic' or 'pyramidal' cores to produce 'non-Levallois' blades. The tool assemblages from Levels XXIV-XXI are almost entirely composed of UP types, including chamfered pieces. So, too, at Üçağızlı, Layers F through I are considered as IUP (Kuhn et al. 2009). Though items that correspond to a strict definition of Levallois products are quite rare, with but a few exceptions at the base of the sequence, attributes reminiscent of Levallois technology are quite common among both unretouched items and tools. Indeed, the dominant mode of blade production bears many features of Levallois technology, including the use of hard hammer percussion and platform faceting. Levallois blade and elongated point blanks are most common in Layers I and H, and then decline in abundance, essentially disappearing above layer F. Evidence for preparation of striking platforms by grinding or abrasion is essentially absent in the IUP layers. The authors state that "... Plain blades predominate among both retouched tools and larger unretouched artifacts in all of the layers except I [the lowermost IUP level], although they do become slightly more common with time" (Kuhn et al. 2009, p. 96). Elsewhere they state that "... In layers I, H1-H3, H and G more than 35% of larger flakes and blades possess broad, faceted striking platforms. Plain, unfaceted platforms, the most common type, also tend to be large. Above layer F there are few faceted platforms". The chanfrein occurs in small numbers in the earliest IUP layer, I. Most IUP cores at Üçağızlı have relatively flat removal surfaces and preserve remnants of a single, faceted striking platform.

7.4 Summary

It appears that currently it is impossible to tie in the origins of the Ahmarian directly with any of the known IUP variants in the Near East. It is of interest to note the observation made by Kuhn et al. (2009, p. 97) concerning the sequence at Üçağızlı: "... The boundary between layers E [i.e. "IUP"] and F [i.e. "Ahmarian"] seems to represent a saltational technological shift (Kuhn et al., Fig. 13). In this respect, changes in core technology contrast strongly with the continuity in tool and blank forms". It should be noted that the so far earliest dated Ahmarian assemblages, i.e., Units III-IV in Kebara, are dominated by blade tools, similar to those observed in most of the IUP variants, but the technology indeed differs as there are no bidirectional or unidirectional 'Levallois' points, and there are but very rare occurrences of butt faceting (Bar-Yosef and Belfer-Cohen in prep.; AB-C pers. obs.). The same can be said about other Ahmarian assemblages in the Levant.

Thus the Ahmarian evidently stands out at its first appearances from the local, preceding IUP industries, the differences clearly observed in the technological aspects rather than in the typology. Apparently, we can now quite confidently also separate between the Ahmarian *sensu stricto* in its final stages and the subsequent industries. It appears that here the difference reflects exactly an opposite trend. While there was a continuity of the same basic leptolithic technology, the products were of different morphotypes, as observed in Masraqan and Nebekian assemblages, the earliest entities in the following Epipalaeolithic sequence. It is interesting to consider which came first and which followed. The main apparent change between the final Mousterian assemblages and those of the IUP was a typological one, with the notable increase in the dominance of blade tools, endscrapers and burins (as well as the appearance of specific, relatively short-lived tool forms, i.e. the chanfrein and the Emireh point). The apparent change between the IUP and that of the Ahmarian was a technological one (and see above). The next prominent change was once again typological, as observed between the Ahmarian and the following early Epipalaeolithic entities. This said, the picture was more complex than that, as one should remember the rather episodic incursion of the Aurignacian into the coastal/Mediterranean Levant, disrupting the endemic Ahmarian sequence there. Moreover, there were other occurrences, the lack of dating for which complicates their placement within the local prehistoric sequence, beyond occasional stratigraphic correlations. At least some were synchronous with and later than the Ahmarian, differing both technologically and typologically, e.g. the Atlitian in the Mediterranean zone and the Arqov-Divshon entity in the more arid margins.

To conclude, it is interesting to note that, after a long period of *stasis* in Levantine UP studies during much of the twentieth century, an impressive body of research has accumulated in recent decades, revolutionizing our knowledge concerning the shift from the MP to the UP and the UP sequence in the Levant. Still, numerous questions remain open to debate. This is of particular significance not only for the local prehistoric record but also globally, due to the location of the Levant along the most likely route of dispersal for modern humans from Africa to Eurasia. For sure there will be new genetic, chronological and archaeological data forthcoming in future years, and thus one has to treat the picture depicted here as reflecting the 'here and now'.

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8 Ahmarian or Levantine Aurignacian? Wadi Kharar 16R and New Insights into the Upper Palaeolithic Lithic Technology in the Northeastern Levant

Seiji Kadowaki

Abstract

This paper aims to update the characterization of the Upper Palaeolithic (UP) lithic technology in the northeastern Levant by discussing an issue regarding various cultural designations of UP lithic assemblages from Umm el Tlel, a main source of archaeological records in the northeastern Levant. The paper reviews the issue by incorporating the UP assemblages from Wadi Kharar 16R in the middle Euphrates. At this site, some of the techno-typological characteristics (e.g., el-Wad points and straight bladelets from single-platform cores) are similar to those of the southern Early Ahmarian, while other features (e.g., twisted bladelets and carinated tools) are reminiscent of the Levantine Aurignacian *sensu lato*. Given these observations, the previous identification of "Levantine Aurignacian" and "Ahmarian" at Umm el Tlel may represent the two opposed ends of continuous variations in the relative frequencies of twisted and straight bladelets rather than the two technological traditions exclusive to each other. The UP assemblages at Umm el Tlel and Wadi Kharar 16R are commonly characterized by the apparent mixture of techno-typological elements reminiscent of the southern Ahmarian (e.g., straight, pointed bladelets removed by unidirectional flaking) and the Levantine Aurignacian *sensu lato* (e.g., twisted bladelets from carinated tools). The employment of such multiple strategies characterizes the UP lithic technology of the two sites. On the other hand, more specific features (e.g., the presence or absence of el-Wad points) and radiocarbon dates indicate chrono-cultural links between Wadi Kharar 16R and Ksar Akil Phase VII and between Umm el Tlel and Ksar Akil Phase V. Consequently, the UP assemblages form Umm el Tlel and Wadi Kharar 16R indicate a coherent picture as well as diachronic patterns of the UP lithic technology in the northeastern Levant, which show some parallels with the later part of the UP sequence at Ksar Akil in the coastal zone.

Keywords

Upper Palaeolithic • Northeastern Levant • Ahmarian • Levantine Aurignacian • Middle Euphrates • Lithic technology

8.1 Introduction

Archaeologists have long recognized that the variability of the Upper Palaeolithic (UP) assemblages in the Levant is greater than the two tradition model represented by the Levantine Aurignacian and the Ahmarian (Bergman and Goring-Morris 1987; Bergman 1988b). For example, studies

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of later UP assemblages from Ksar Akil by (Bergman 1987, 1988a; Williams and Bergman 2010; Bergman et al. 2017) have clearly shown temporal variations of lithic techno-typology within Levels XIII–VI (of the 1937–1938 season), which had been subsumed under the category of "Levantine Aurignacian" by Besançon et al. (1975–1977) and Copeland (1975). Likewise, Goring-Morris and Belfer-Cohen (Belfer-Cohen and Goring-Morris 2003a; Goring-Morris and Belfer-Cohen 2006) have suggested restricting the definition of the Levantine Aurignacian to assemblages with typical lithic and bone artifact types (i.e., Classic Levantine Aurignacian or Levantine Aurignacian *sensu stricto*), separating other assemblages as different industries, such as the Atlitian or the Arqov/Divshon. Regarding the Ahmarian, a temporal subdivision of this entity into the early and late phases (i.e., Early Ahmarian and Late Ahmarian) is now widely accepted (Kadowaki 2013), and the late phase is also called "Masraqan" (Goring-Morris and Belfer-Cohen 2006 and Chap. 7, this volume). In addition, some researchers have suggested regional (and possibly temporal) variability of the Early Ahmarian technology (Goring-Morris and Davidzon 2006; Kadowaki et al. 2015; Hauck 2015; Schyle 2015).

Considering the variability of the Ahmarian and the Levantine Aurignacian, this paper aims to update the characterization of Upper Palaeolithic lithic technology in the northeastern Levant (Fig. 8.1). To this end, the paper is particularly concerned with an issue regarding cultural or industrial designations of UP lithic assemblages from Umm el Tlel in the el-Kowm Basin, which has been a main source of archaeological records in the northeastern Levant. The initial report of the UP assemblage from this site proposed an affinity to "Levantine Aurignacian B" (Molist and Cauvin 1990). However, subsequent excavations and more detailed analyses of greater sample size have resulted in the identification of the "Ahmarian" technology in several assemblages, which were interstratified with those of "Levantine Aurignacian" (Ploux and Soriano 2003). In addition, some researchers proposed other chrono-cultural units, "Levantine Aurignacian A" (Copeland 2003, p. 246; Olszewski 2009, p. 42), "Early Ahmarian" (Belfer-Cohen and Goring-Morris 2003a, p. 8), or "Masraqan/Late Ahmarian" (Belfer-Cohen and

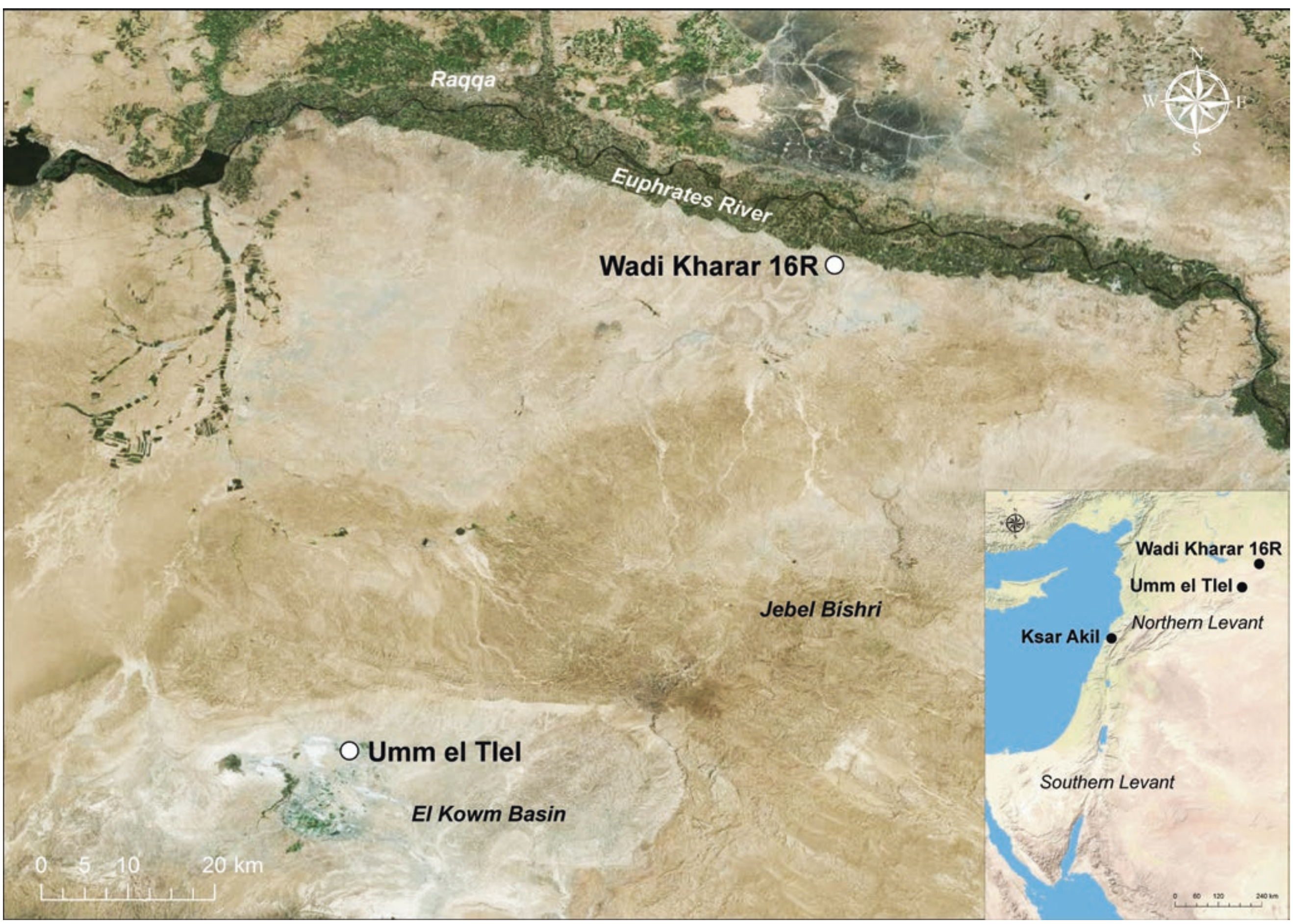

Fig. 8.1 Satellite image (ESRI) of the northeastern Levant, showing the locations of Wadi Kharar 16R and Umm el Tlel, with an inset map of the Levant

Goring-Morris 2003b, p. 274) for Umm el Tlel. There is thus no coherent picture on the techno-typological characteristics for the UP assemblages from Umm el Tlel. Such a current situation is problematic because the various assessments of lithic techno-typology imply different chrono-cultural links between the northeastern Levant and the surrounding areas.

To provide a new perspective to this problem, the paper incorporates UP lithic assemblages from Wadi Kharar 16R (Kadowaki et al. 2015). The site is located in the middle Euphrates region, ca. 70–80 km to the northeast of the el-Kowm Basin, where Umm el-Tlel is located (Fig. 8.1). The paper describes the UP lithic assemblages from Wadi Kharar 16R and their techno-typological characteristics. On the basis of the new observations from this site, the paper discusses how the UP lithic technology at Umm el Tlel can be contextualized in relation to the UP assemblages in the northwestern and the southern Levant. Finally, the paper addresses issues regarding the UP technological sequence in the northeastern Levant.

8.2 Upper Palaeolithic Lithic Assemblages from Wadi Kharar 16R

8.2.1 Site Setting

Wadi Kharar 16R is an open-air site, located on the western bank of Wadi Kharar, one of the tributaries in the middle course of the Euphrates River, approximately 50 km east of ar-Raqqa in northern Syria. The site was discovered in a series of archaeological survey conducted as part of the Syria-Japan joint archaeological project (Fig. 8.2; Al-Maqdissi and Ohnuma 2011; Nishiaki et al. 2012). The surveyed area is the northern edge of the Bishri Plateau, which consists of a gentle slope from the northern foothill of Jebel Bishri (ca. 600 m a.s.l.) to the lowland near the Euphrates River (ca. 230 m a.s.l.). The southern bank of the Euphrates River ascends to the Bishri Plateau, which is dissected by numerous wadis towards the northern edge. Most wadis are a few kilometers in length and have water flow only during the rainy season; however, Wadi Kharar stands out with the length of about 20 km from the northern end of the plateau and a perennial spring in the middle course. Although we do not know exactly how long this spring has been active in the past, we recovered 12 dense lithic scatters of the Upper Palaeolithic or Epipalaeolithic period along Wadi Kharar, particularly near the spring and in the lower course than the spring. Among these sites, we have recently reported Upper Palaeolithic remains at Site 16R (Kadowaki et al. 2015) and Epipalaeolithic artifacts at Sites 16K and 16AT' (Kadowaki and Nishiaki 2016).

The UP lithic assemblages from Site 16R, relevant to this paper, have been recovered at two concentrations, i.e., Area 1 (ca. 10 m × 10 m) and Area 2 (ca. 10 m × 5 m). The artifacts were collected by random sampling and systematic collection (i.e., the recovery of all pieces on the surface inside a 10 m × 10 m grid over the lithic concentration in both Areas 1 and 2), as well as excavations of several 1 m × 1 m squares (See Kadowaki

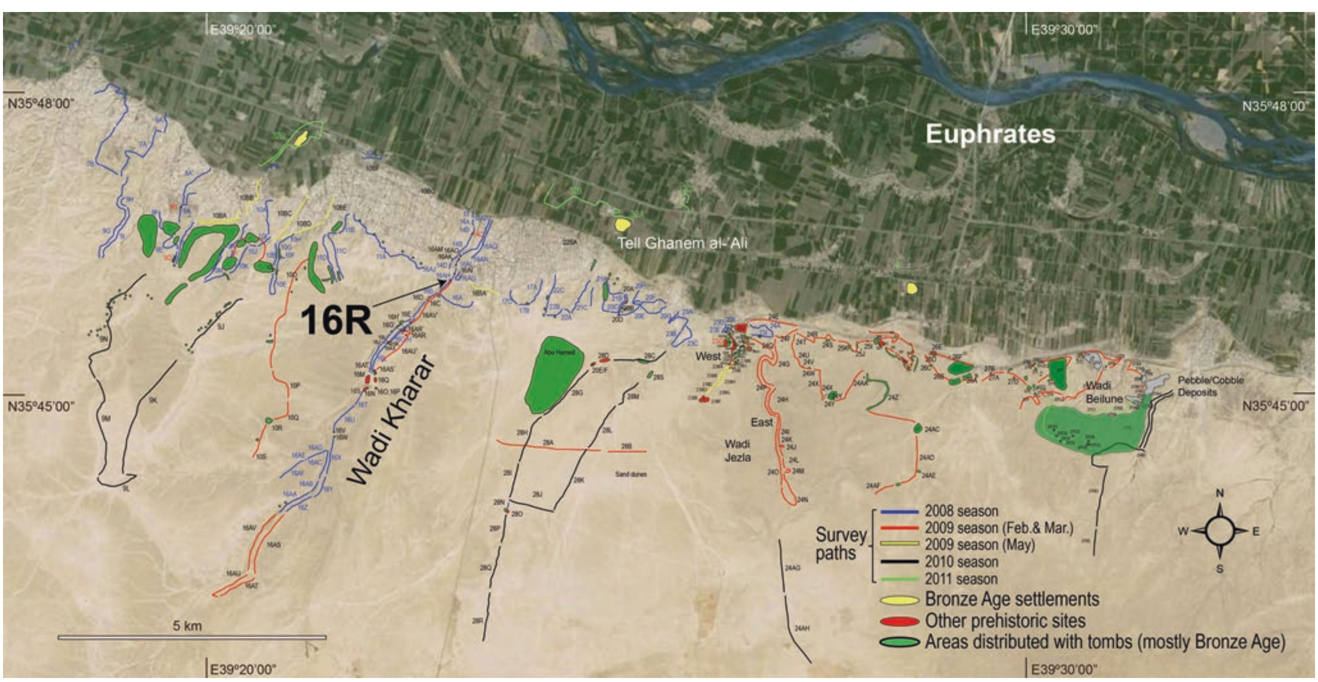

Fig. 8.2 Satellite image (Google Earth) of the surveyed area near the middle Euphrates, showing survey paths and archaeological sites, including the Upper Palaeolithic site at Wadi Kharar 16R

Table 8.1 General inventory of chipped stones from Wadi Kharar 16R[a]

	Area 1				Area 2			
	Surface	Excavation	Total	%	Surface	Excavation	Total	%
Retouched tools	9	17	26	4%	2	3	5	1%
Blades[b]	14	38	52	7%	12	6	18	4%
Bladelets	14	86	100	14%	39	39	78	18%
Blades or bladelets	0	1	1	0%	0	2	2	0%
Flakes	126	288	414	57%	120	143	263	60%
Chips & chunks	16	85	101	14%	6	58	64	14%
Burin spalls	0	2	2	0%	1	0	1	0%
CTEs[c]	3	19	22	3%	5	2	7	2%
Cores	4	4	8	1%	3	1	4	1%
TOTAL	186	540	726	100%	188	254	442	100%

[a]Each of the assemblages from Areas 1 and 2 consists of surface collections and excavated materials
[b]Wider than 12 mm
[c]Core trimming elements, including crested pieces, platform rejuvenation flakes, and core edge flakes

et al. 2015 for more details). All excavated sediments were sieved through 3 mm mesh. As a result, a total of 1168 pieces of chipped stone artifacts were collected (Table 8.1).

8.2.2 Techno-typological Descriptions

The UP assemblages from Wadi Kharar 16R are technologically characterized by the production of bladelets through multiple reduction strategies, including the exploitations of single-platform cores and carinated tools. Most of the cores (12 pieces in total) show bladelet scars on the working surface ($n = 11$). They are made on either blocks ($n = 5$; Fig. 8.3: 1–2) or thick flakes ($n = 6$; Fig. 8.3: 3–5), while a single piece is too fragmented to identify the blank form. When cores are made on flakes, either lateral sides or ends of the original flakes are used as narrow working surfaces, which would facilitate the production of bladelets. The platform types are dominated by the single-platform type ($n = 9$), and the rest includes the opposed platform ($n = 1$), the multiple-platform ($n = 1$), and an unknown type due to breakage ($n = 1$). Crested and half-crested pieces (Fig. 8.3: 6–7) likely resulted from the processes of forming cores and creating working surfaces, while core-tablets (Fig. 8.3: 9–10) indicate the maintenance of the core platform. More than 80% of the blades/bladelets are straight or slightly curved in profile, and twisted blades/bladelets account for 19% (Fig. 8.3: 8).

Typologically, the retouched pieces are dominated by scrapers and burins (Table 8.2). Although some of them show carinated forms (Fig. 8.4: 9, 11, 14), they show *lateral* carination instead of *broad* carination (Goring-Morris and Belfer-Cohen 2006, p. 306). More than half of the scrapers and burins are made on flakes, crested pieces, or cortical blades, which are probably byproducts of blade/bladelet production. Another tool type is finely retouched bladelets (n = 6; Fig. 8.4: 3–6), none of which are made on twisted bladelets. In addition, there are two el-Wad points (Fig. 8.4: 1–2), which are made on bladelets with a straight profile. Their dorsal surfaces show unidirectional converging scars, and their distal ends are modified into pointed forms by marginal, semi-abrupt retouch on the dorsal surface.

8.2.3 Characterization of the Wadi Kharar 16R Assemblages

Some of the techno-typological traits at Wadi Kharar 16R, such as the occurrence of el-Wad points and the dominance of bladelets with straight or curved profiles, are observable in the Early Ahmarian. More specifically, the removal of bladelets from the narrow side of single-platform cores by unidirectional flaking is reminiscent of the southern Early Ahmarian assemblages, such as Boker A, Nahal Nizzana XIII, Lagama V and VII, Tor Sadaf Early UP, Al-Ansab 1, Tor Hamar G–F, Tor Aeid, and Jebel Humeima (Bar-Yosef and Belfer 1977; Jones et al. 1983; Coinman and Henry 1995; Williams 1997; Kerry 1997; Fox 2003; Goring-Morris and Davidzon 2006; Hussain 2015; Schyle 2015). These assemblages can be separated from the northern Early Ahmarian, as represented by Ksar Akil Levels XX/XIX–XVI, Üçağızlı Layers C–B, and Kebara Units IV–III, which are characterized by the frequent employment of the bidirectional flaking of opposed-platform cores (Ohnuma 1988; Bergman and Stringer 1989; Bar-Yosef et al. 1996; Kuhn et al. 2009; Tostevin 2012). The northern Early Ahmarian and the southern Early Ahmarian can also be separated by the size and retouch patterns of el-Wad points *sensu lato* (including Ksar Akil points and other types; Goring-Morris and Davidzon 2006, p. 107) as well as by the distal morphology of blades/bladelets (Kadowaki et al. 2015).

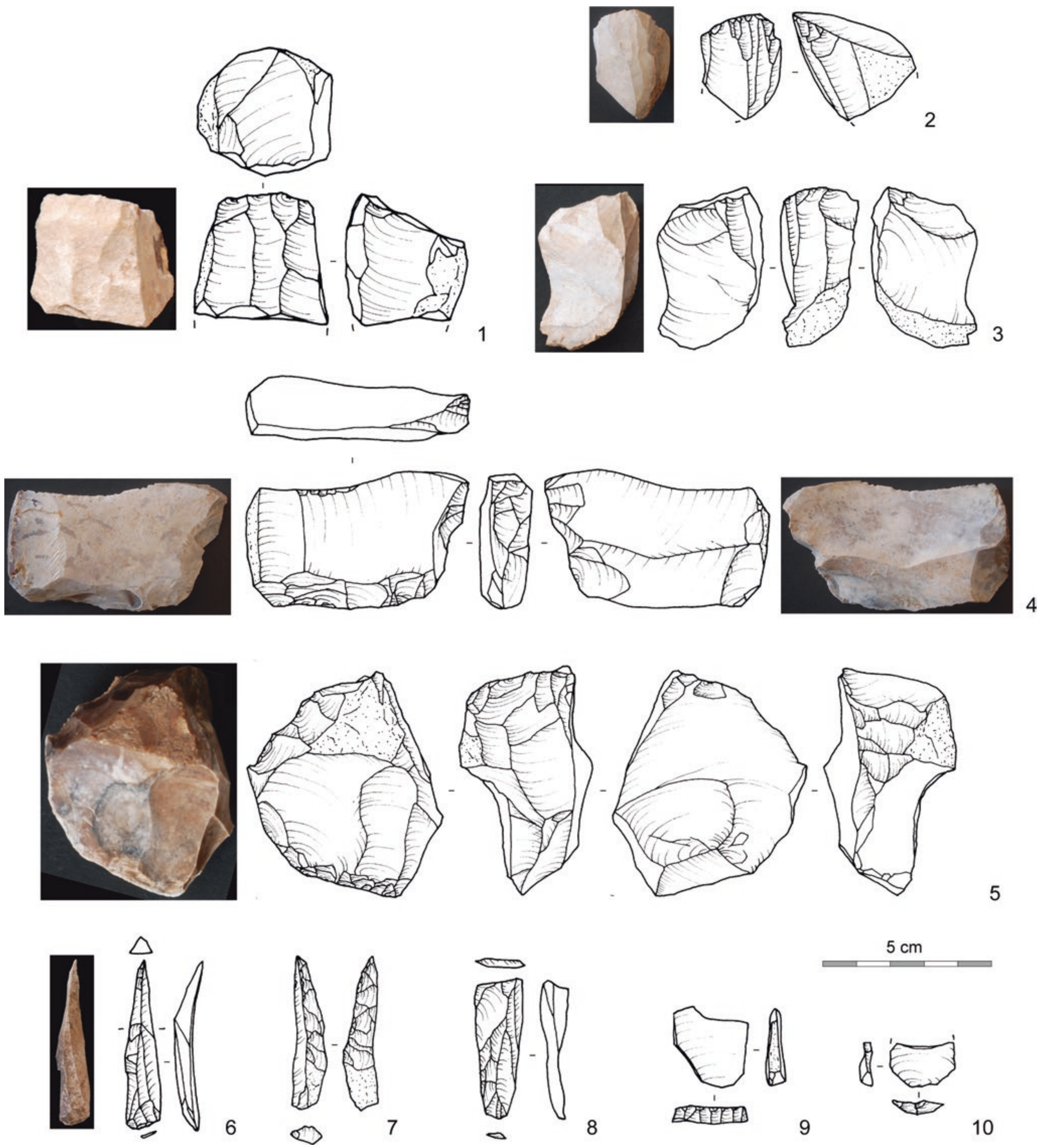

Fig. 8.3 Debitage from Wadi Kharar 16R (1, 2, 4, 6, 9 from Area 1; 3, 5, 7, 8, 10 from Area 2). 1–2: Single-platform cores on cobbles; 3–5: Single-platform cores on part-cortical flakes; 6–7: Half crested pieces; 8: Twisted blade; 9–10: Platform rejuvenation flakes

However, the Wadi Kharar 16R assemblages cannot be included in the southern Early Ahmarian industry because they are also characterized by the occurrence of twisted bladelets from carinated tools, a techno-typological feature traditionally attributed to the Levantine Aurignacian *sensu lato*, although the assemblages do not include Classical Aurignacian tools, such as broadly carinated scrapers/burins or Aurignacian blades.

Consequently, the UP assemblages from Wadi Kharar 16R are characterized by the mixture of the techno-typological

Table 8.2 Frequency of retouched tools from Wadi Kharar 16R by excavation areas

Retouched tools		Area 1			Area 2		
		Surface	Excavation	Total	Surface	Excavation	Total
el-Wad points		1	1	2	0	0	0
Retouched bladelets		2	3	5	0	1	1
Truncation		1	0	1	0	0	0
Burins	On natural surface	0	1	1	0	0	0
	On oblique truncation	0	0	0	1	0	1
	Multiple on truncation at both ends	0	1	1	0	0	0
	Dihedral with multiple facets	1	0	1	0	1	0
	Double dihedral	0	0	0	0	1	1
	Transversal with multiple facets (laterally carinated)	1	0	1	0	0	1
	Transversal on lateral notch with multiple facets	1	0	1	0	0	0
Scrapers	End scraper on flake	0	1	1	1	0	1
	End scraper on retouched flake	0	1	1	0	0	0
	End scraper on blade	0	5	5	0	0	0
	Double end scraper	1	1	2	0	0	0
	Lateral carinated scraper	0	2	2	0	0	0
Burin/scraper		0	1	1	0	0	0
TOTAL		8	17	25	2	3	5

elements reminiscent of the southern Early Ahmarian and the Levantine Aurignacian *sensu lato*. The assemblages thus do not fit the dichotomous categories, i.e., “Ahmarian” or “Levantine Aurignacian”. Such techno-typological characteristics are not unique to Wadi Kharar 16R, but similar assemblages have already been reported in more detail with greater sample size from Ksar Akil Levels X–IX (of the 1937–1938 seasons) and Levels XI–XC (of the 1947–1948 seasons) (Bergman 1987; Bergman 1988a; Ohnuma and Bergman 1990; Williams and Bergman 2010). These levels had been classified as “Phase 4” in Williams and Bergman (2010), and the name has been recently updated to “Phase VII” (Bergman et al. 2017), which is adopted in this paper. The Ksar Akil Phase VII assemblages (KAVII) include high proportions of end-scrapers, particularly simple end scrapers. Other common tool types are el-Wad points and retouched blades/bladelets, which tend to be made on bladelets with straight or curved, rather than twisted, profiles. There are also burins dominated by the dihedral type. Although carinated pieces are present, their proportions in retouched tools are not significant in comparison with those of the preceding or following phases. Technologically, KAVII assemblages are characterized by the dominance of single-platform bladelet cores and blades/bladelets that have straight or curved profiles. The production of bladelets was performed through multiple strategies, such as (1) cores reduced from larger blade cores, (2) cores made on thick flakes, and (3) spalls from multifaceted burins and carinated scrapers. Notably, the techno-typological traits of KAVII have been suggested to show similarity to “the Early Ahmarian of the marginal zone” (Williams and Bergman 2010, p. 144) or “southern Early Ahmarian” (Bergman et al. 2017).

In addition to the techno-typological features, Wadi Kharar 16R and KAVII are chronologically close to each other. A single AMS date was obtained from Wadi Kharar 16R using the ABA method on charcoal (33,130 ± 160 BP: IAAA-103837). This date is between the two AMS dates from *Nassarius gibbosulus* that Douka et al. (2013) reported for KAVII (30,360 ± 140 BP: OxA-20023; 34,550 ± 250 BP: OxA-25585), although we have to be cautious about the difference in dated materials (shell versus wood) and the pretreatment methods (CarDS versus ABA). More recently,

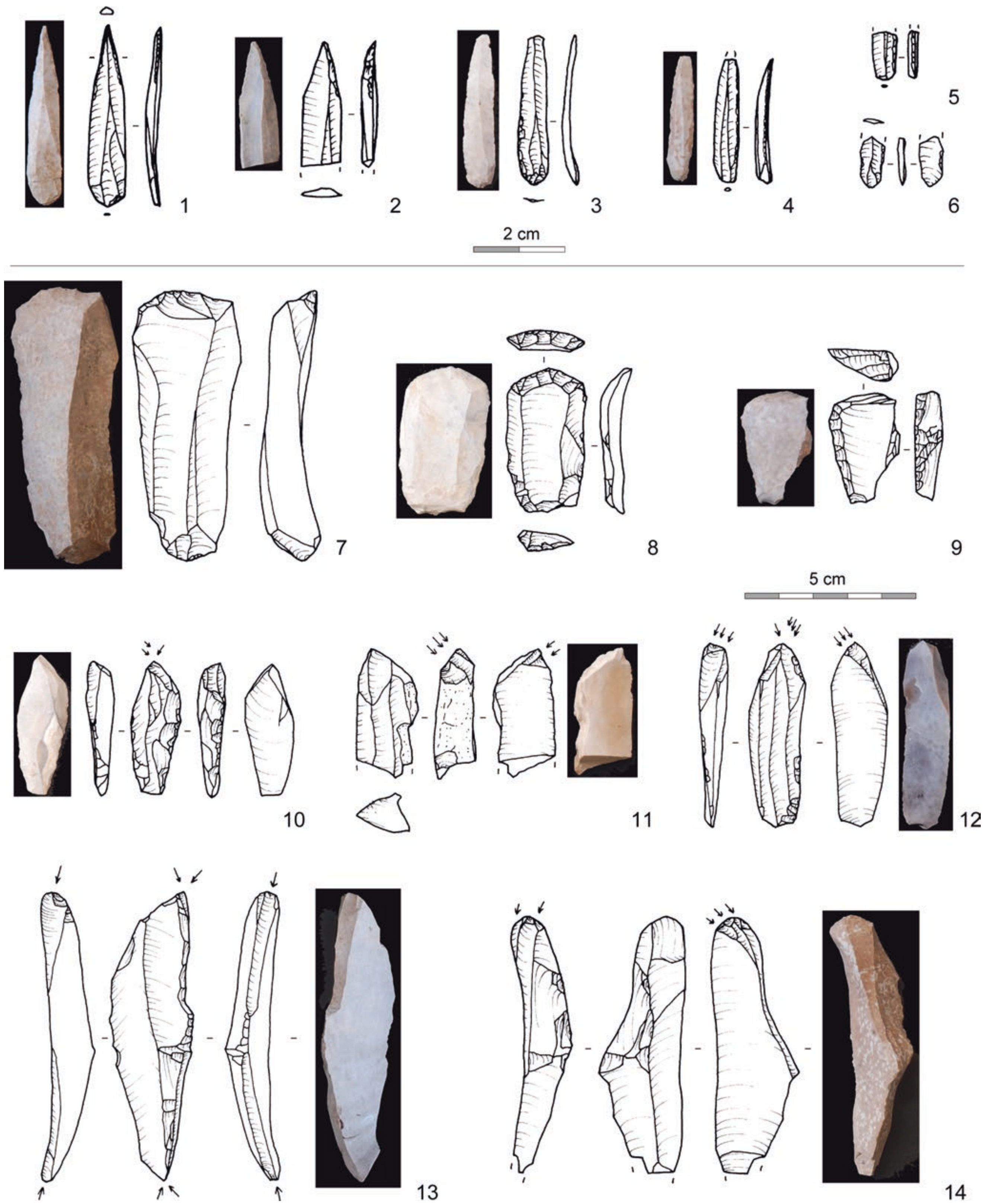

Fig. 8.4 Retouched tools from Wadi Kharar 16R (1–11, 14 from Area 1; 12–13 from Area 2). 1–2: El-Wad points; 3–6: Retouched bladelets; 7–8: Double end scrapers; 9, 14: Lateral carinated scrapers; 10, 12: Dihedral burins with multiple facets; 11: Transversal burin with multiple facets (laterally carinated); 13: Double dihedral burin

Bosch et al. (2015) reported a series of AMS dates for UP levels at Ksar Akil, suggesting that Phases X and IX (Bergman et al. 2017), which correspond to Phases 1 and 2 respectively in Williams of Bergman (2010), are dated earlier than the results by Douka et al. (2013) (but see Douka et al. 2015 and Bosch et al. 2015). For the later phases, however, Bosch et al. (2015) reported a date, 34,310 ± 230/210 (GrA-53006), for "Level XI". This date was obtained from a sample "KSAS02XI" from Square E5, which was excavated in the 1947–1948 seasons (Williams and Bergman 2010). According to Williams and Bergman (2010, p. 144), Level XI of the 1947–1948 seasons is archaeologically correlated to Phase 4 (Phase VII of Bergman et al. 2017). Thus, the dates for Phase VII do not differ significantly between Douka et al. (2013) and Bosch et al. (2015).

Considering the above techno-typological and chronological similarity between Wadi Kharar 16R and KAVII, they may represent a cultural phase in the northern Levant, including the coastal and inland zones. However, more comparable assemblages are necessary to establish a new industry. On the basis of these observations, the next chapter reviews techno-typological characteristics of the UP assemblages at Umm el Tlel.

8.3 Characterization of the Umm el Tlel Assemblages

8.3.1 "Ahmarian", "Levantine Aurignacian", and "Paléolithique supérieur récent"

According to Ploux and Soriano (2003), some of the UP assemblages at Umm el Tlel are characterized by the production of twisted bladelets from cores or carinated burins. They call these assemblages "Levantine Aurignacian" and separate them from other UP assemblages, called "Ahmarian", which are dominated by slender, distally converging bladelets with a straight profile (Ploux and Soriano 2003). They also separated some assemblages as "Paléolithique supérieur récent" and suggested a certain degree of similarity to the Ahmarian technology. Despite the differentiation of the three techno-complexes, they are similar to each other in the dominant employment of unidirectional flaking of single-platform cores for the production of bladelets and in the composition of retouched tools, including many finely retouched bladelets in addition to scrapers and burins.

The three groups of assemblages occur in deposits (ca. 1.5 m in thickness) above the "Paléolithique intermédiaire" (Levels II base', III 2a', III 2b') and below those of "Geometric Kebaran" (Boëda and Muhesen 1993; See Kadowaki and Nishiaki 2016 for a recent review of this cultural designation). Most of the "Paléolithique supérieur récent" assemblages were recovered in aeolian sand deposits at the top of the UP stratigraphy at Umm el Tlel, while the "Ahmarian" and "Levantine Aurignacian" assemblages (mostly from Unit II) were interstratified within lacustrine and marsh deposits below the aeolian sands (Ploux and Soriano 2003).

Obviously, Ploux and Soriano (2003) used the terms, "Ahmarian" and "Levantine Aurignacian", in a broad sense, and here I specify what are meant by the two terms. First, the "Ahmarian" technology identified by them means the production of pointed bladelets by unidirectional, converging flaking of single-platform cores, which characterize the southern Ahmarian (Goring-Morris and Davidzon 2006; Kadowaki et al. 2015; Hauck 2015; Schyle 2015). This specification is important because the site itself is located in the northern Levant despite its technological similarity to the southern assemblages. As for the "Levantine Aurignacian", Ploux and Soriano (2003) use this term in a broad sense because they make comparisons with assemblages from Ksar Akil Levels XII–VI and Tixier's Phases VII–III. In addition, they consider the occurrence of twisted bladelets from carinated burins and scrapers as a general feature affiliated to "the Levantine Aurignacian" (Ploux and Soriano 2003, p. 27), which should mean the Levantine Aurignacian *sensu lato* because the occurrence of twisted debitage is not restricted to the Levantine Aurignacian *sensu stricto* (Ksar Akil Levels VIII–VII) according to a technological study of Ksar Akil XIII–VI assemblages by Bergman (1987, 1988a, 2003).

8.3.2 Comparison with Wadi Kharar 16R and Ksar Akil

Given the above techno-typological features that are specifically meant by "Ahmarian" and "Levantine Aurignacian", they are not necessarily exclusive to each other in contrast to the impression evoked by the two cultural terms. These features can co-exist, as demonstrated by the assemblages from Wadi Kharar 16R. In fact, they are likely to have co-existed also at Umm el Tlel because both twisted and straight bladelets are included in the same assemblages despite the designation as either "Levantine Aurignacian" or "Ahmarian" (Ploux and Soriano 2003, Tables 1, 2, and 4).

Therefore, the identification of "Levantine Aurignacian" and "Ahmarian" at Umm el Tlel probably represents the two opposed ends of continuous variations in the relative frequencies of twisted and straight bladelets rather than the two technological traditions that are exclusive to each other. Such variations in bladelet forms are expectable when bladelets are manufactured through multiple reduction strategies (e.g., cores on blocks and flakes, and carinated tools), as exemplified at Wadi Kharar 16R. This view also explains better the interstratification of "Ahmarian" and "Levantine Aurignacian" assemblages, which has never occurred at other sites. Consequently, I propose to avoid attributing the UP assemblages of Umm el Tlel to either the Ahmarian or the Levantine Aurignacian, because selecting one of them would overemphasize a partial aspect of the whole techno-typological characteristics.

How then should we characterize the UP assemblages at Umm el Tlel? Considering the co-occurrence of techno-typological elements reminiscent of both the southern Ahmarian and the Levantine Aurignacian *sensu lato*, one could affiliate them with Wadi Kharar 16R and Ksar Akil Phase VII (Bergman et al. 2017). However, these two examples differ from the Umm el Tlel assemblages in two aspects. The first is the absence of el-Wad points at Umm el Tlel despite the larger sample size than that of Wadi Kharar 16R. El-Wad points on straight bladelets are one of the significant markers of Ksar Akil Phase VII and Wadi Kharar 16R (Williams and Bergman 2010; Kadowaki et al. 2015). The second is the chronological posteriority of Umm el Tlel. Several radiometric dates from the UP levels at Umm el Tlel are generally later than those of Wadi Kharar 16R and Ksar Akil Phase VII (Table 8.3). Given these data, the UP assemblages of Umm el Tlel can be chrono-culturally linked to Tixer's Phase V at Ksar Akil (=Ksar Akil Phase V in Bergman et al. 2017). In fact, this correlation has already been suggested by Ploux and Soriano (2003, p. 26) for their "Levantine Aurignacian" assemblages. Tixier's Phase V is characterized by the dominance of retouched bladelets (without el-Wad point) and "burin plans nucléiformes", which are laterally carinated burins (Tixier and Inizan 1981). The latter tool type is considered to have provided twisted bladelets (Ploux and Soriano 2003, p. 26). Tixier's Phase V is later than Ksar Akil Phase VII, i.e., stratigraphically above Phase VI (i.e., Classic Levantine Aurignacian) and below Phase IV (i.e., Atlitian) (Bergman et al. 2017).

8.4 Conclusion

Consequently, the UP assemblages form Umm el Tlel and Wadi Kharar 16R indicate a coherent picture as well as diachronic patterns of the UP lithic technology in the northeastern Levant. The UP assemblages at the two sites are commonly characterized by the apparent mixture of techno-typological elements reminiscent of the southern Ahmarian (e.g., straight, pointed bladelets removed by unidirectional flaking) and the Levantine Aurignacian *sensu lato* (e.g., twisted bladelets from carinated tools). The employment of such multiple reduction strategies characterizes the UP lithic technology of the two sites. On the other hand, more specific techno-typological features (e.g., the presence or absence of

Table 8.3 Suggested correlation of UP sequences between northwestern and northeastern Levant

Ksar Akil (northwestern Levant)		Umm el Tlel and Wadi Kharar 16R (northeastern Levant)		
Sequence[a]	Chrono-cultural names[b]	Sequence	^{14}C dates	TL dates
Phase IV (level VI)	Atlitian			
Phase V		Upper Palaeolithic at Umm el Tlel (mainly unit II)	30,310 ± 670 BP (Gif-90034)[c], 30,790 ± 760 BP (Gif-90040)[c], 32,000 ± 580 BP (Gif A-93212)[c]	34,000 ± 2500 BP[d]
Phase VI (levels VIII–VII)	Classic Levantine Aurignacian			
Phase VII (levels X–IX)	Affinities with southern Early Ahmarian	Wadi Kharar 16R	33,130 ± 160 BP (IAAA-103837)	
Phase VIII (levels XIII–XI)				
Phase XIX (levels XXI/XX–XVI)	Northern Early Ahmarian			
Phase X (levels XXV–XXI/XX)	Initial Upper Palaeolithic or Emiran	Paléolithique intermédiaire at Umm el Tlel[f]	33,730 + 200/-190 BP (GRA-33200)[e], 33,900 ± 310 BP (GifA-6094)[e], 34,530 ± 890 BP (GifA-93216)[d], 36,000 ± 1100 BP (GifA-93215)[e],	36,000 ± 2500 BP[d]

[a]The sequence is based on the most recent classification scheme (Bergman et al. 2017). See Douka et al. (2013, 2015) and Bosch et al. (2015) for ^{14}C chronology
[b]Goring-Morris and Davidzon (2006), Bar-Yosef and Belfer-Cohen (2010), Williams and Bergman (2010), and Bergman et al. (2017)
[c]Ploux and Soriano (2003)
[d]Boëda et al. (1996)
[e]Boëda et al. (2015)
[f]The correlation between the Paléolithique intermédiaire and Ksar Akil Phase X is based on the lithic techno-typology, which does not mean chronological contemporaneity

el-Wad points) and radiocarbon dates indicate chrono-cultural links between Wadi Kharar 16R and Ksar Akil Phase VII and between Umm el Tlel and Ksar Akil Phase V.

These observations suggest that the UP lithic technology in the northeastern Levant show some parallels with the later part of the UP technological sequence at Ksar Akil in the northwestern Levant. This does not mean that the coastal and inland zones in the northern Levant show the same patterns because the coastal zone shows greater cultural diversity, such as Ksar Akil Phase VIII, Phase VI (the Classic Levantine Aurignacian), and Phase IV (the Atlitian). However, it is currently difficult to determine whether the apparent differences between the two zones result from actual prehistoric patterns or the relative scarcity of archaeological data from the inland zone.

Another issue to be investigated in future is whether the earlier part of the UP cultural sequence at Ksar Akil has any parallels in the northeastern Levant. For example, several researchers have referred to the Paléolithique intermédiaire at Umm el Tlel (Bourguignon 1998) in the discussion of the Initial Upper Palaeolithic or the Emiran (Kuhn 2003; Bar-Yosef and Belfer-Cohen 2010; Meignen 2012), in which Ksar Akil Phase X (Levels XXV–XXI/XX) is also included (Azoury 1986; Ohnuma 1988; Ohnuma and Bergman 1990). However, currently no data indicate the presence of Ksar Akil Phase IX (i.e., the northern Early Ahmarian) or Phase VIII technologies in the northeastern Levant. Particularly notable is the apparent absence of the northern Early Ahmarian technology in the northeastern Levant despite its geographical proximity. This suggests that the northern Early Ahmarian was geographically limited in the coastal zone. In contrast, the UP lithic technology in the northeastern Levant shows some techno-typological elements shared by the southern Early Ahmarian.

If the northern Early Ahmarian was not distributed in the northeastern Levant, the Wadi Kharar 16R assemblages (corresponding to Ksar Akil Phase VII) may have followed the Paléolithique intermédiaire at Umm el Tlel. This sequence is not inconsistent with available radiometric dates from the two sites (Table 8.3), which include recently published AMS dates for the Paléolithique intermédiaire (Boëda et al. 2015). However, the shift from the Paléolithique intermédiaire to Wadi Kharar 16R means a great technological change. Although the Paléolithique intermédiaire assemblages are typologically characterized by UP tool types (i.e., end scrapers and burins) and include bladelet cores and bladelets that show use-wear (Bourguignon 1998; Boëda et al. 2015), the core-reduction is organized mainly for the production of morphologically Levallois points and blades. Thus, the technological change from the Paléolithique intermédiaire to Wadi Kharar 16R may be comparable to a skip from Ksar Akil Phase Xb to Phase VII and is somewhat similar to the sequence at Tor Sadaf in southern Jordan, where the Initial Upper Palaeolithic assemblages (Tor Sadaf A and B) are followed by the southern Early Ahmarian (Early UP) (Fox and Coinman 2004). This apparent technological leap in the southern and northeastern Levant might represent a sudden technological change or a gap in currently available data to be filled with new or undated assemblages, such as those of Mughr el-Hamamah (Stutz et al. 2015), Tor Fawaz (Kerry and Henry 2003), and Facies 4 of the Paléolithique intermédiaire in the Palmyra and the el-Kowm Basins (Boëda et al. 2015).

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Part II

The Neighboring Regions of the Levant

Living on the Edge: The Earliest Modern Human Settlement of the Armenian Highlands in Aghitu-3 Cave

9

Andreas Taller, Boris Gasparyan, and Andrew W. Kandel

Abstract

Aghitu-3 Cave is the first stratified Upper Paleolithic (UP) cave site discovered in Armenia. The site is situated at an elevation of 1601 m in the southern Armenian Highlands and has yielded three intact archaeological horizons. The site has an excellent preservation of paleoecological archives, which allow for a comprehensive interpretation of the climate and environment at the time when the first modern humans populated the region.

Twelve geological horizons were identified, and correlate with seven archaeological layers (AH); three of these, AH III, VI and VII, yielded substantial UP assemblages. Dates of these layers range from 39 to 24,000 cal BP, so that Aghitu-3 offers a glimpse into the settlement patterns of modern humans during the early and middle UP of Armenia.

The lithic technology is based mainly on the unidirectional production of laminar blanks, with bladelets always predominating. Moreover, bladelets make up about 90% of all tool blanks. The most common lithic tool type is a bladelet with fine retouch along one lateral edge. Burins, scrapers and perforators are rare, as are cores. However, the overall tool count is high. These results suggest that the cave was used for making tools during short term stays, rather than as a basecamp. Rounding out the toolkit, bone tools from AH III include one eyed needle and two awls. These finds suggest that people fabricated clothing, nets or bags onsite, which is especially interesting when considering the high altitude of the site. The lithic raw material exploitation patterns show a clear shift from the earliest UP to later phases: whereas in AHs VII and VI local materials predominate, the spectrum broadens in AH III, showing obsidian from sources up to 200 km away.

In terms of comparison, the data from similar aged Georgian and Iranian UP sites will help in reconstructing the nature of the first modern human settlement in the southern Caucasus and Zagros. In Armenia, Aghitu-3 Cave can serve as a benchmark for understanding the early and middle UP. Full analyses of the site will make a crucial contribution to developing a frame of reference for the so-called Caucasian Upper Paleolithic.

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Keywords
Early Upper Paleolithic • Armenian highlands • Southern Caucasus • Lithic technology • Bladelet industry • Dispersal of modern humans

9.1 Introduction and Background

Aghitu-3 Cave is situated at an elevation of 1601 m a.s.l. in the Vorotan River valley of the Syunik region of southern Armenia. The Vorotan River cut down through the Pleistocene basalt flows of the volcanic Armenian Highlands, forming a valley that constitutes a corridor of movement for people as well as game (Kandel et al. 2014). The basalt flow that forms the cave erupted from nearby Mount Bugdatapa between 126,000 and 111,000 years ago (Ollivier et al. 2010).

Archaeological excavations at Aghitu-3 started in 2009 and continued through 2013. During five campaigns, the Paleolithic excavations covered a total surface area of 40 m^2. The stratigraphy includes three intact Upper Paleolithic (UP) horizons, each of which yielded archaeological materials such as lithic artifacts, faunal remains and combustion features. This article focuses on the lithic artifacts and their significance to the understanding of UP behavior. Aghitu-3 is of particular interest for studying the Paleolithic archaeology of Armenia, as it is one of only two stratified UP sites in the country (Gasparyan et al.2014). The other one is Kalavan-1, a late UP open-air site in north-eastern Armenia (Montoya et al. 2013). Aghitu-3 is the only site in Armenia spanning the early and middle UP, a fact which emphasizes the importance of this site to archaeological research in the southern Caucasus (Kandel et al. 2014). Besides these two stratified UP sites, Armenia offers a rich heritage dating to the Lower Paleolithic and the Middle Paleolithic (MP) (Fig. 9.1; see Gasparyan and Arimura 2014).

Apart from Aghitu-3 and Kalavan-1, UP occupations in Armenia were hitherto known only as remains from unstrati-

Fig. 9.1 Aghitu-3 Cave. Middle (red) and Upper (dark blue) Paleolithic sites in Armenia and adjacent areas

fied open air sites and surface collections; many of these purported sites were later interpreted as workshops located near raw material sources of Neolithic or Chalcolithic age (Gasparyan et al. 2014). The mechanisms behind the process and progress of the peopling of the Armenian Highlands and the southern Caucasus are as yet unclear. Thus the finds from Aghitu-3 Cave will help shed light on these questions. Outside of Armenia, a handful of stratified and well-dated UP sites exist. In Georgia, sites in the Imereti region such as Dzudzuana Cave and Ortvale Klde provide a good picture of occupation to the north (Adler et al. 2006a, 2008; Bar-Yosef et al. 2006, 2011). In Iran, sites such as Yafteh Cave, Ghar-e Boof and Garm Roud 2 offer a complementary view from the south (Chevrier et al. 2006; Otte et al. 2011, 2012; Tsanova 2013; Ghasidian 2014). Therefore, Aghitu-3 puts Armenia on the map in the quest to reconstruct the routes traveled by the first UP people. Furthermore, the UP layers of Aghitu-3 span 15,000 years and yield valuable information about diachronic developments in human behavior as well as the environment.

Important questions guiding our analyses include:

– *Where did the first Upper Paleolithic settlers in the southern Caucasus region come from, and what route did they take?*
– *What are the connections of Aghitu-3 with regard to landscape use and its Pleistocene inhabitants?*
– *Did the first modern humans in the region meet Neanderthals, and if so, how did they interact?*
– *What advantages did the first modern human settlers have over their predecessors?*
– *Can we see a diachronic pattern of adaptational development in the Upper Paleolithic settlement?*

Ultimately, the goal of our research is not only to determine the character of the Aghitu-3 UP occupations, but also to envision the pattern, direction, timing and dimension of the early UP colonization of Armenia and the southern Caucasus region as a whole.

9.2 Stratigraphy and Dating

The cave stratigraphy was divided into twelve geological horizons (GH) and seven archaeological horizons (AH). For this paper, three layers are of interest, namely AH III, VI and VII, as these contain the majority of Upper Paleolithic finds (Fig. 9.2). AH III is further divided into four more or less continuous sublayers, each documenting intense occupation of the site with combustion features and hearths (Gasparyan et al. 2014). We consider units AH IV and V to be sterile because they yielded so few artifacts. Radiocarbon dating samples taken from the layers indicate an occupational timespan of 15,000 years, from about 39,000 to 24,000 cal BP (Fig. 9.3). The lower layers AH VI and VII date from 39,000 to 33,000 cal BP, while the occupation horizons of AH III date between 29,000 and 24,000 cal BP (Fig. 9.3).

In accordance with the global climatic trend for the time span in question, paleoclimatic data from Aghitu-3 show a corresponding warming trend during the deposition of AH VII and especially VI and V, followed by a cooling trend observed after the deposition of AH IV and III. These results were mainly determined from analyses of micromammals (L. Weissbrod) and pollen (A. Bruch). This means that modern humans who first entered the region around 39,000 cal BP experienced a warm and humid climate up to about 31,000 cal BP, followed by increasingly cooler and drier climatic conditions.

9.3 Archaeology

9.3.1 Lithics and Technology

The distribution of lithic artifacts in the strata is shown in Table 9.1. It is clear that AH III is by far the richest layer in terms of the number of finds. We consider AH IV and V to be archaeologically sterile, with a total of 15 lithic artifacts.

One feature that unifies all of the UP layers is the technology of lithic blank production. The lithic technology aims at the production of laminar blanks,[1] with most of these blanks being bladelets. The vast majority of blanks were produced following a unidirectional mode of detachment; just a few artifacts from AH VII show evidence of bidirectional removals on their dorsal surfaces. This may relate to the fact that we observe a higher percentage of blades in AH VII, almost twice as high as in AH III or VI; this contrasts with the predominance of bladelets in AH III and VI. It is as yet unclear if this early trend is evidence of a real cultural signal; however, it should be kept in mind that the number of artifacts in AH VII is low. Thus, the explanatory power of quantitative findings from AH VII should be regarded with caution when compared to those from AH III and VI.

Bladelets were clearly the desired blanks in the lithic production sequence of all UP layers. This is evident not only because bladelets are the most common blanks in all assemblages, but also because they are by far the dominant blank form among modified (retouched) pieces. In all of the UP horizons, about 90% of the tools are manufactured on bladelets. These tools are in turn surprisingly uniform throughout

[1] A blade is defined as a laminar blank with parallel sides whose length is at least twice the dimension of its width. A bladelet meets these criteria and is smaller than 10 mm in width (Floss 2012).

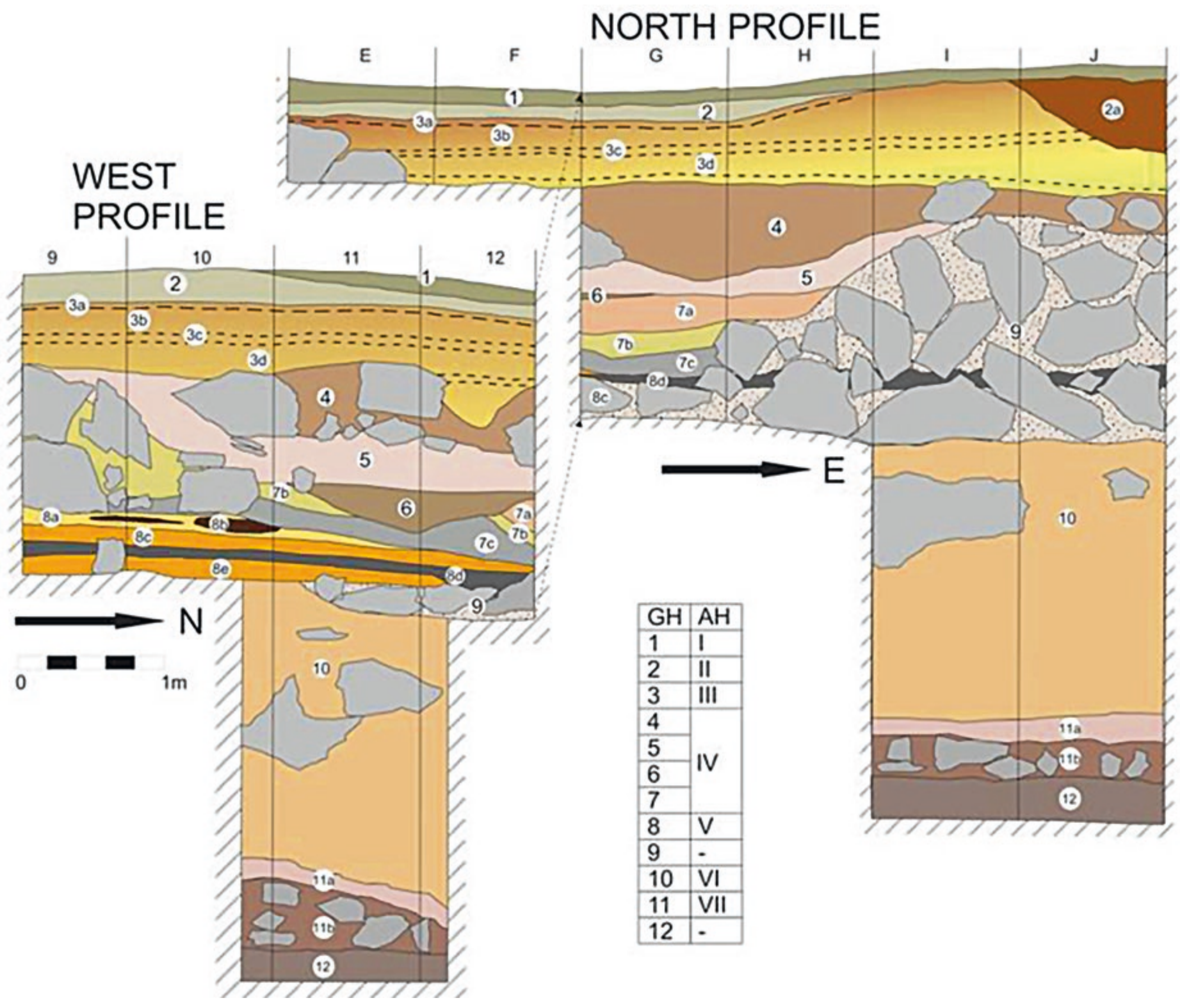

Fig. 9.2 Aghitu-3 Cave. Drawings of the main profiles with chart correlating geological horizons (GH) with archaeological horizons (AH) (graphic: after S. Nahapetyan and D. Arakelyan)

the stratigraphic sequence, even in the limited dataset available from AH VII. Most of the modified pieces sport fine retouch along one lateral edge. While some semi-abrupt retouched pieces occur, true backed pieces are rare (Fig. 9.4). We interpret these laterally modified bladelets as parts of a highly mobile, certainly modular toolkit. It is well imaginable that these standardized pieces were designed for multiple uses, for instance as inserts in composite projectile heads or as cutting edges in other tools. The results of functional analyses on such small, laterally modified or backed pieces usually show a pattern of diverse possibilities of use (e.g., Caspar and De Bie 1996; Christensen and Valentin 2004; Robertson et al. 2009; Bolus 2012; Taller et al. 2012). Whether these findings hold true for the artifacts from Aghitu-3 will have to remain unanswered until functional analyses on the artifacts are completed.

Although the percentage of modified pieces is high for all UP layers (18% in AH III, 21% in AH VI, 7% in AH VII), tools associated with domestic use, such as burins, scrapers, pointed blades or splintered pieces, are rare. Cores are relatively infrequent in the UP horizons (Table 9.1). Most cores (n = 66) come from AH III and represent 2% of the lithics in that layer. The number of cores from AH VI (n = 3) and AH VII (n = 5) is quite low. In AH VI, the frequency of cores is less than 1%, but in AH VII, they represent 4% of the lithic assemblage.

Based on these observations, we interpret the lithic assemblages as indicating short, focused stays rather than as occupations with the character of a base camp. Most of the cores we found are highly reduced to maximize the yield of blanks. Some of the cores measure just 2 cm in maximum dimension, which shows that laminar blanks of quite minute dimensions were produced (see inset photos in Figs. 9.5 and 9.6). The lithics furthermore show a low cortex-cover index, regardless of the raw material, meaning that prepared blocks and cores must have been preferentially carried onto the site.

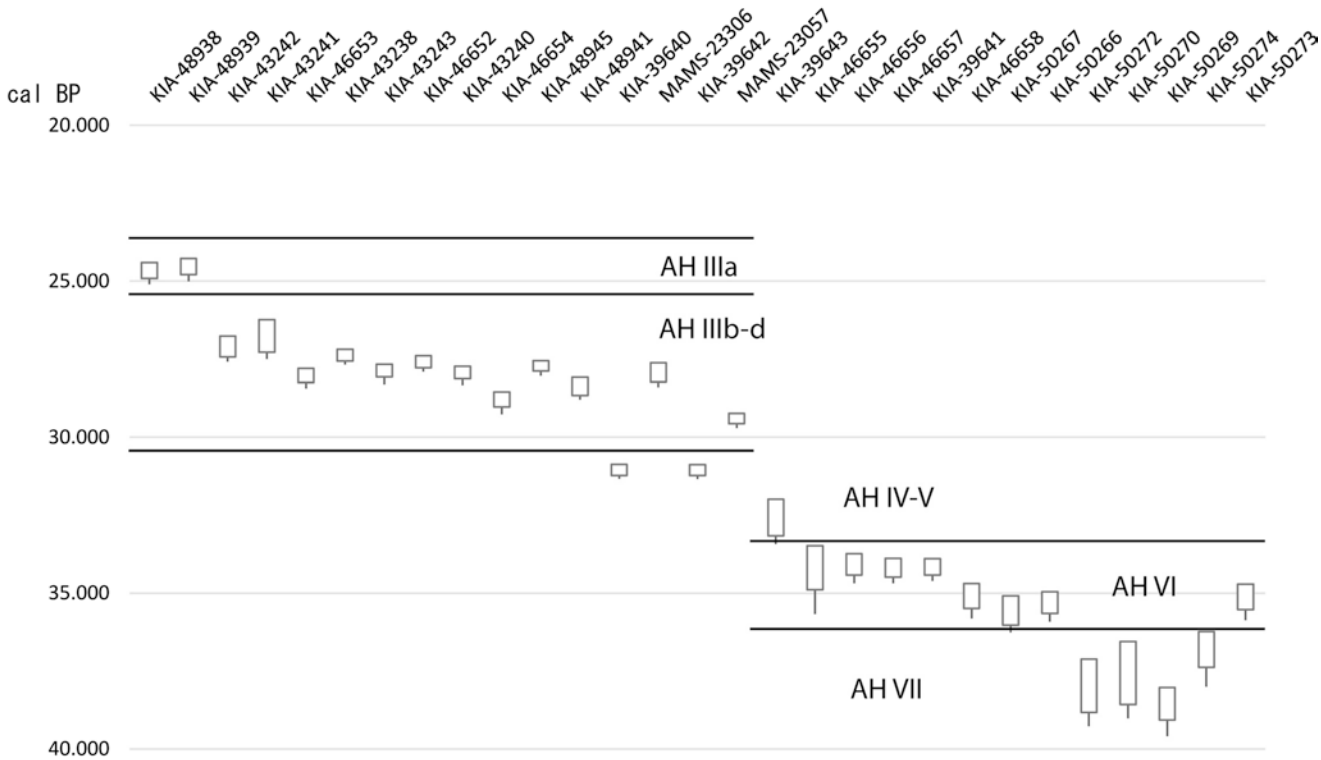

Fig. 9.3 Aghitu-3 Cave. Dating of the Upper Paeolithic

Table 9.1 Distribution of lithic artifacts per archaeological stratum

Archaeologicalhorizon	III	IV	V	VI	VII	Total	%
Area excavated (m^2)	40	12	12	12	4	–	–
LITHICS							
Blanks	2408	2	6	250	94	2760	51%
Retouched tools	564	3	4	72	9	652	12%
Cores	66	–	–	3	5	74	1.4%
Angular debris (chunks)	128	–	–	17	4	149	2.8%
Small debitage (chips)	1739	–	–	32	–	1771	33%
LITHIC Total	4905	5	10	374	122	5416	100%
Retouchindex (excludingchips)	17.8%	–	–	21.1%	7.4%	–	–
Core index (excludingchips)	2.1%	–	–	0.9%	4.1%	–	–

9.3.2 Lithic Raw Materials

In the volcanic Armenian Highlands obsidian is the most common raw material used for the manufacture of lithic artifacts. At Aghitu-3 this is true as well. The lowest percentage of obsidian was observed in AH VI, where it comprises 64% of raw material (Fig. 9.7). Other raw materials include local and regional varieties of chert, and rarely other materials such as local dacite and basalt.

In the lowermost layer AH VII, obsidian is the dominant raw material comprising 87% of the lithic assemblage. However, in AH VI a noticeable change in behavior occurs. The share of chert increases considerably from 2% in AH VII to 28% in AH VI. This could indicate a diachronic change in the raw material procurement strategy, or may show connections of Aghitu's inhabitants to different parts of the region. This being said, the relatively low numbers of artifacts in AHVI and VII should be remembered. For raw material percentages per stratum see Fig. 9.7.

To pinpoint the obsidian sources E. Frahm used portable x-ray fluorescence spectrometry (pXRF) to conduct elemental analysis of the chemical properties of the different obsidian varieties recovered from the excavation (Fig. 9.5). Using this method he can test many artifacts quickly to determine where a given piece of obsidian originates, provided that reference samples of the source materials are known (Frahm

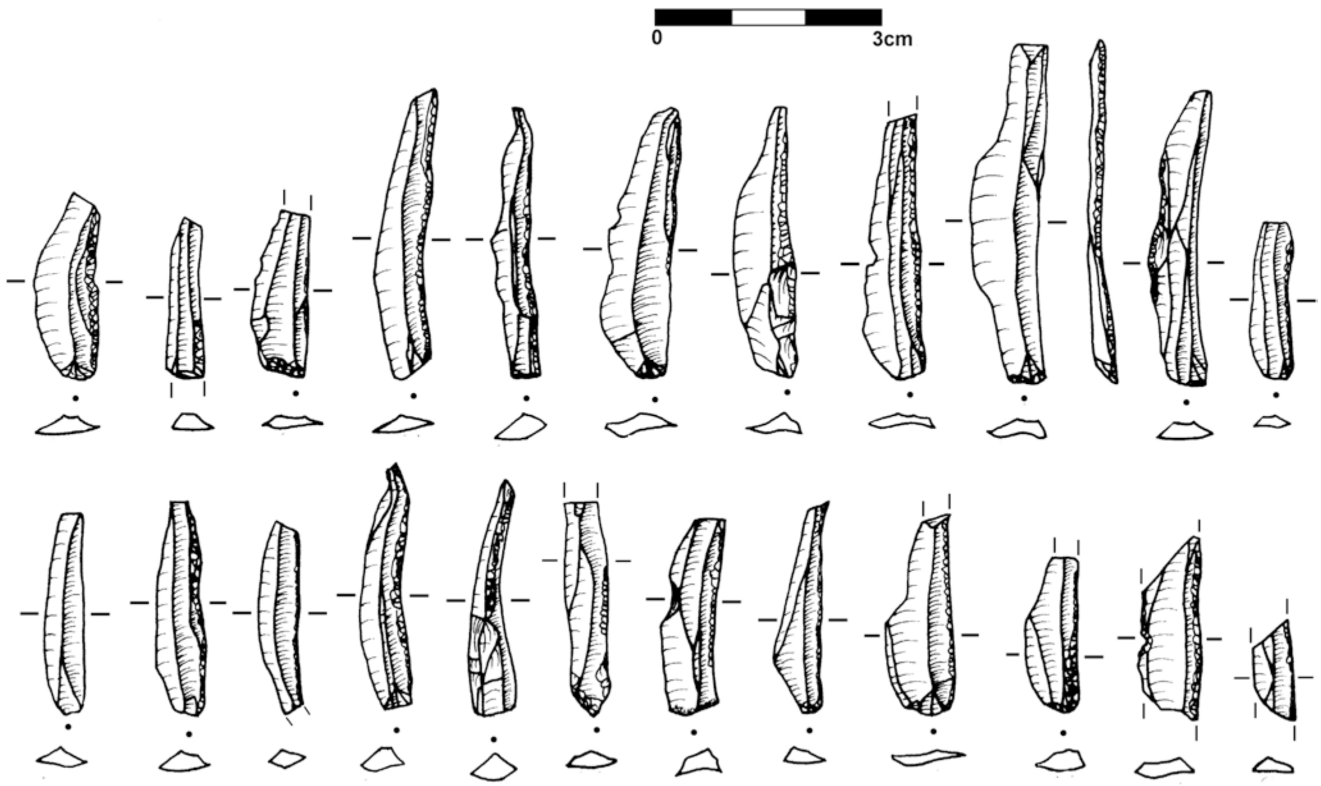

Fig. 9.4 Aghitu-3 Cave. Examples of laterally modified bladelets (drawings: E. Ghasidian)

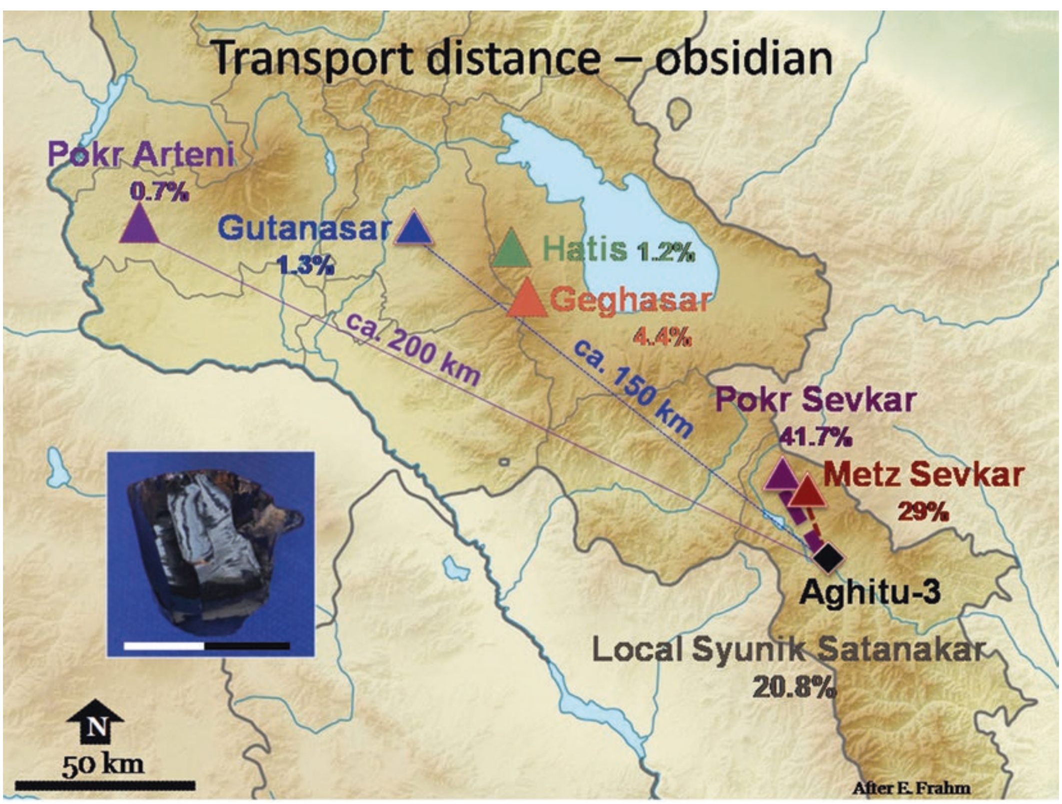

Fig. 9.5 Aghitu-3 Cave. Map showing the provenience of obsidian raw materials in layer AH III (graphic: after E. Frahm)

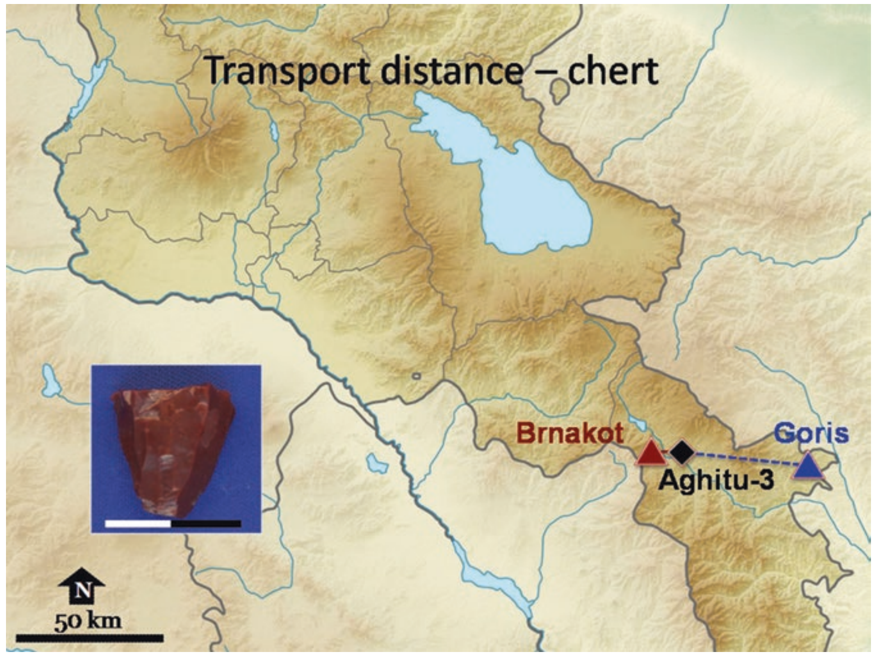

Fig. 9.6 Aghitu-3 Cave. Map showing the provenience of chert raw materials in layer AH III

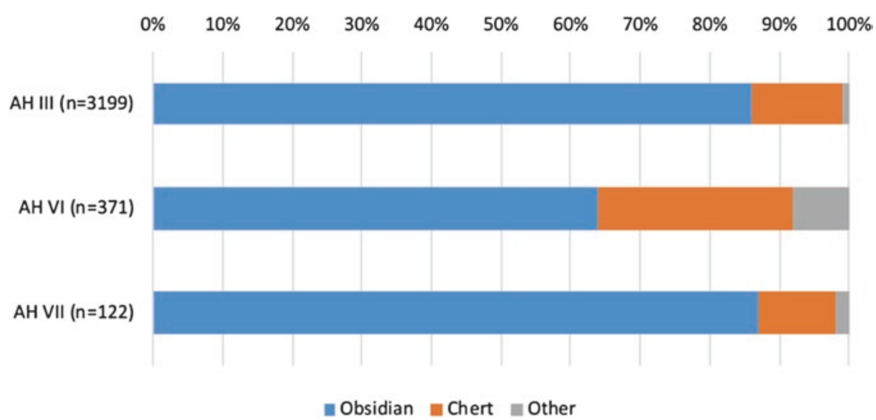

Fig. 9.7 Raw material percentages of the Upper Paleolithic layers

2014; Frahm et al. 2014). The method is especially practical for obsidian due to the distinct chemical and mineralogical nature of each volcanic source.

Based on the pXRF analysis, the obsidian sample from AH VI was found to consist only of local to regional variants from around Satanakar. Based on geological studies, the chert sources also appear to be local or regional, originating no more than 35 km away (Fig. 9.6). These results indicate that only local and regional raw material sources were exploited at Aghitu-3 from 35,000 to 31,000 cal BP.

With several thousand pieces, the lithic assemblage from AH III is the largest and most representative sample, and therefore best suited for analysis. AH III has the same share of obsidian (86%) as in AH VII (87%), although chert is more common and other raw materials are rare in AH III. With regards to transport distance, it is exciting to note that some of the obsidian from AH III comes from the Gutanasar volcanic region, about 150 km northwest, and from Pokr Arteni, about 200 km northwest (Fig. 9.5). Although the percentage of these exogenous raw materials is small, these sources demonstrate that UP hunter-gatherers were roaming across large areas of the Armenian Highlands starting about 29,000 cal BP. This finding contrasts with the situation in AH VI, where only local and regional obsidian sources were used. This could indicate that the earliest UP hunter-gatherers were not yet familiar with the surrounding regions; perhaps they were newly arrived, or their population density was simply low. In summary, the pattern of raw material procurement appears to have changed, so that during the time of AH III, people were exploiting considerably larger territories or had more contact with groups further away.

In addition to obsidian, chert from local and regional sources up to 35 km from Aghitu is also present in AH III. The types of chert that were brought to the site are high quality, very fine grained to microcrystalline varieties. Still it is surprising that chert was even used as a raw material, given the fact that obsidian of excellent quality abounds in Armenia.

9.3.3 Organic Artifacts

Organic artifacts (Figs. 9.8 and 9.9) were only recovered from AH III and include a broken eyed needle and two awls made on bone, as well as six shell beads of *Theodoxus pallasi*. These finds are particularly interesting since they provide evidence for the fabrication of clothing, nets or bags. Clothing would have been essential for the colonization of the Armenian Highlands under cold temperate conditions, as human thermal physiology would not allow the exploitation of such regions without adequate body cover (Gilligan 2010). Furthermore, the eyed needle suggests the fabrication of complex clothing (*sensu* Gilligan 2010) in which multiple layers are sewn together to increase the insulating properties of a garment. Today the climate of Armenia is decidedly continental, with warm summers and cold winters, and this pattern is even more pronounced at the high elevation of Aghitu. The Pleistocene climate certainly did not make human settlement of the highlands any easier and may explain why there are more UP sites in lower-lying Georgia (e.g. Bar-Yosef et al. 2011; Pinhasi et al. 2014). Of course, this could also be due to a bias in the history of research. Nonetheless, sites in the Imereti region of Georgia are situated more than 1000 m lower than Aghitu-3 (Bar-Yosef et al. 2011).

We consider the ability to make clothes an absolute prerequisite for the settlement of the Syunik Highlands by modern humans. The eyed needle and the awls provide sufficient evidence for the fabrication of clothing. In addition to these organic tools we also consider lithic tools such as endscrapers, as well as the occurrence of blade technology. Taken together these findings are in accordance with features indicating the manufacture of complex clothing as proposed by

Fig. 9.8 Aghitu-3 Cave. Bone awl from layer AH IIIc (photo: M. Schaefers)

Fig. 9.9 Aghitu-3 Cave. Eyed bone needle from layer AH IIId (photo: M. Schaefers)

Gilligan (2010). Gilligan emphasizes the role of blade technology in yielding prime blanks for cutting, which of course is an absolutely necessary practice in the fabrication of clothing.

9.3.4 Fauna

Analysis of the large mammalian fauna is not yet complete, but we can present a picture of the distribution of the faunal size classes and some of the identified species (Table 9.2). With 1180 single pieces identified thus far (M. Schaefers), faunal remains are most common in AH III, followed by AH VI. The analysis of micromammals, bird, fish, reptiles and amphibians is also in progress. The large mammalian fauna is dominated by size class 2 (20–100 kg), such as wild goat and wild sheep, and size class 3 (100–300 kg), including equids. The largest size class 4 (300–1000 kg) consisting of large bovids is infrequent, while the smallest size class 1 (5–20 kg) is least common, represented mainly by hare. The remains from AH III yield the clearest evidence for a hunted fauna, with the presence of many shaft fragments of a variety of taxa including equids, wild sheep and goat, and cervids, some of which bear cutmarks and impact fractures. As with the lithics, AH IV and V yielded few faunal remains and are not discussed here in detail. Based on field observations, we hypothesize that the fauna from AH VI was accumulated largely by carnivores, based on body part representation, carnivore chewing and gastric etching. The faunal remains stress the short-term occupational character of AH VI and especially VII.

Table 9.2 Distribution of preliminarily identified faunal remains per archaeological stratum

Preliminary identified taxa	AH III	AH IV	AH V	AH VI	AH VII	Total
Vulpes vulpes	1	1	1	1	–	4
Canis lupus	1	–	1	2	–	4
Ursus sp.	1		–	–	–	1
Lepus capensis	4	6	–	5	1	16
Equus sp.	132	–	1	2	3	138
Cervus elaphus	19	–	–	–	–	19
Ovis sp.	20	–	–	1	–	21
Capra sp.	10	1	–	22	1	34
Gazella gazella	2	–	–	–	–	2
Bos/*Bison*	13	–	1	–	–	14
Subtotal identified	203	8	4	33	5	253
Small mammals (SC1)	6	1	–	9	1	17
Small medium mammals (SC2)	288	10	3	110	9	420
Large medium mammals (SC3)	403	6	6	14	9	438
Large mammals (SC4)	49	–	–	3	–	52
TOTAL	949	25	13	169	24	1180
Fish	15	–	–	1	24	40
Bird	37	2	11	52	153	255

SC Size class defined in text (Results: M. Schaefers)

9.4 Implications

The composition of the lithic assemblages from each layer of Aghitu-3 Cave indicates short, probably seasonal stays of a clear UP character likely connected with hunting expeditions in the vicinity. This interpretation is also backed by the faunal remains from the site. The very seasonal and steppic grassland environment of the Syunik Highlands was on the one hand a very rich hunting ground with abundant biomass and thus a desirable area of exploitation for Late Pleistocene hunters and gatherers. On the other hand, the seasonality and harsh climate that accompanies living at high elevation make subsistence more challenging. In this light, we feel our interpretation of the site as a short-lived hunting camp makes sense. Furthermore, even in AH III the density of finds is not very high, supporting periodic use of the site. The base camps of these groups may have been pitched at lower elevations in more agreeable surroundings with less demanding climatic requirements.

In terms of lithic raw material exploitation it is clear that obsidian is paramount; its lowest percentage is in AH VI with 64%. The other raw material of significance is chert, but its frequency is much lower; AH VI has the highest share of chert with 28%. As stated before, we consider that AH III is the layer with the most explanatory power when it comes to quantitative arguments, simply because it yielded the most lithic artifacts and faunal remains. It seems that as the deposit of AH III accumulated, Pleistocene hunter-gatherers were already roaming an area covering much of the Armenian Highlands, as indicated by the different sources of obsidian.

We postulate that the changes observed between AH VII and III document a process of learning. By this we mean that the bearers of UP technology became acquainted with their surroundings by becoming familiar with various factors including geography, topography, ecological zones, exploitation ranges, hunting grounds and other rewarding areas after they moved into the region about 39,000 cal BP. The requirements and preconditions to do so were no doubt in existence from the earliest phase of the colonization of Southern Armenia by modern humans. This development towards a better acquaintance with the supra-regional surroundings may also suggest that the inhabitants of Aghitu had contact with other UP groups which enabled faster learning about environment and territory. At the same time, indicators suggesting the making of clothing may show an adaptation of the Ice Age inhabitants to different environmental conditions. This capability may be due to the process of learning, where the technology can be seen as a strategy developed to cope with a high altitude environment, or it may have simply arrived with these first modern settlers. However, we think that the technology and ability existed from the time of AH VII onwards, since there is so little change in lithic technology over time. Still, without any direct evidence for sewing like we have from AH III, this hypothesis remains more speculative for AH VI and VII.

9.5 Context

Aghitu-3 Cave is the only stratified site of the Early UP (EUP) in Armenia. Due to a lack of comparative sites in the region, we look beyond Armenia and examine the situation to the north. In Georgia we find a comprehensive and well documented period of settlement during the EUP, which might be related to the considerably lower elevation of these sites and their more favorable climate. Sites with UP layers include Dzudzuana Cave, Gvarjilas Klde, Ortvale Klde, Samertskhle Klde, Samgle Klde and Sareki Klde (Adler et al. 2008). All of these sites are situated in the Imereti region of Western Georgia in the middle reach of the Rioni River.

Starting about 29,000 calBP we know that the inhabitants of Aghitu-3 had contacts stretching as far as 200 km northwest to the Pokr Arteni region (Fig. 9.6). Thus it is fair to assume that contact with the hunter-gatherers of the Imereti region in Georgia would not only have been possible, but also likely. This is supported by the occurrence of obsidian artifacts at some Georgian UP sites. The obsidian comes from a source about 100 km southeast of the Imereti region (Adler and Tushabramishvili 2004), which means that the source lies in the direction of Armenia. This indicates the minimum radius of the area exploited, and in Aghitu we found obsidian from as far as 200 km away in to the northwest, pointing to contact between the groups settled in Armenia and Georgia. The best comparisons with Aghitu-3 Cave are the sites of Dzudzuana Cave (units D and C) and Ortvale Klde rockshelter (layers 4 and 3). Not only are these sites well studied (Adler et al. 2008; Bar-Yosef et al. 2011), they also show similarities in age, lithic technology and typology.

At Dzudzuana Bar-Yosef et al. (2011) defined units D (34.5–32.2 ka calBP) and C (27–24 ka calBP) as UP. The lithic assemblage of unit D includes burins and endscrapers, but also modified bladelets; obsidian is present as a raw material. While the dating of unit D corresponds well with AH VI of Aghitu-3, the lithic assemblages do appear somewhat dissimilar, as endscrapers outnumber the burins and modified bladelets have a significantly lower percentage. Of course this finding might also be due to respective differences in site function. Meanwhile, the lithic industry of unit C is characterized by the unidirectional fabrication of bladelets. Laterally modified bladelets dominate the tool assemblages (Bar-Yosef et al. 2011), and again, obsidian is present. In that respect, layer C of Dzudzuana compares well with AH III of Aghitu-3 Cave. However, at Dzudzuana endscrapers outnumber burins, whereas in Aghitu this relationship is reversed. However this difference in composition may be attributed to a difference in site function.

Units D and C of Dzudzuana are much richer than Aghitu-3 in terms of artifact numbers. Even though retouched bladelets dominate Dzudzuana's toolkit, there are also many tools of domestic use. With almost 27,000 finds from unit C alone and a wealth of organic tools to match, including an eyed needle, Dzudzuana seems to have been more intensively occupied than Aghitu-3. Dzudzuana is rich in faunal remains, mainly bison/aurochs, but also wild goat and red deer, which regularly show butchering or other processing marks (Bar-Oz et al. 2008; Bar-Yosef et al. 2011). With an elevation of 560 m a.s.l. and rich plant life including wild grape, oak and hazel from unit D, and nettle, chicory, walnut, oak, linden, alder, hazel, vine and pine from unit C, Dzudzuana offered a more inviting environment than Aghitu-3 (Adler et al. 2006a; Bar-Yosef et al. 2011).

At Dzudzuana researchers demonstrated that the EUP was brought in by foreign groups of modern humans who arrived at about 39,000 cal BP (Meshveliani et al. 2004; Adler et al. 2008; Bar-Yosef et al. 2011) and suggested that the MP culture of the Neanderthals was in fact replaced. This scenario seems probable for Armenia as well, since several examples of MP heritage exists, but no sites contain MP and UP in a single stratigraphy (see Gasparyan and Arimura 2014). This holds true for Aghitu-3 as well, where we have not found any MP layers below the UP sequence.

Ortvale Klde is another example of an EUP site in Georgia, a rockshelter situated about five kilometers west of Dzudzuana at 530 m a.s.l. (Adler et al. 2006a). Like Dzudzuana, this site yielded considerably more archaeological material than Aghitu-3, and served a different function, with longer stays and a more intensive settlement history. This is well documented by more than 12,000 lithics and 3200 faunal specimens from the EUP layers. The EUP lithic assemblage includes unidirectional laminar cores, and among the tools, laterally retouched and backed bladelets predominate (Bar-Yosef et al. 2006; Adler et al. 2008). Especially the laterally retouched bladelets show great similarity to those from Aghitu-3. Tools such as endscrapers and burins occur as well, and amongst the organic tools, bevel-based antler/bone points and abraders stand out (Adler et al. 2006b). As was the case in Dzudzuana, the majority of lithic artifacts were made on locally available flint, but there are also a significant number of obsidian pieces from a raw material source located more than 100 km to the southeast (Adler et al. 2008). At Ortvale Klde the dates range from about 38,000–28,000 calBP for all subdivisions of layer 4 and 26,000–25,000 calBP for layer 3 (Adler et al. 2008). These dates clearly correspond well with Aghitu-3, despite the noticeable difference in settlement intensity. Finally, looking to the south, similarities can be observed with some of the Baradostian sites of Iran, especially the upper sequence of Yafteh Cave recently dated to ca. 30,000 cal BP (Otte et al. 2011, 2012).

According to Bar-Yosef et al. (2011) the MP assemblages of the southern Caucasus and those from the northern slopes of the Caucasus had different points of reference: Taurus and Zagros for the southern Caucasian MP versus European traditions for the northern MP. While that might have been the case for the MP of the Caucasus, it does not seem to apply to its UP assemblages. In fact EUP assemblages on both sides of the Caucasus show similarities and indicate a rapid and widespread dispersal of modern humans, and with it, the possibility of maintaining contact among different groups (Bar-Yosef et al. 2011).

In sum, we agree with Golovanova and Doronichev (2012)—all EUP sites of the Caucasus region lack a transitional period after the MP, and the UP appears as a fully developed entity. They suggest a relatively sudden and widespread arrival of groups of highly adaptive hunters— modern humans with EUP culture who replaced Neanderthals (see also Adler et al. 2008; Bar-Yosef et al. 2011). All of the EUP industries of the Caucasus are characterized by a highly developed laminar lithic industry with high percentages of retouched bladelets, sometimes in total dominance depending on site function (Golovanova and Doronichev 2012).

9.6 Conclusion

The analyses of the UP archaeological remains from Aghitu-3 are a work in progress. Therefore, not all of the questions we introduced earlier can be answered at this time. However, we feel that we have reached a point where the conclusions we publish here can form a cornerstone for future research into the UP peopling of Armenia, as well as the southern Caucasus region. If we return to the questions formulated at the beginning of this paper, we can state the following as preliminary answers:

Where did the first Upper Paleolithic settlers in the southern Caucasus region come from, and what route did they take? This is difficult to answer at the moment, since radiometric dating results from the UP of Armenia, Georgia and Iran present quite similar ranges. This suggests that the first modern humans in the region arrived quickly and more or less in the same wave of expansion. Possible source regions to be considered include the Zagros, the Levant, and even the Russian steppe.

What are the connections of Aghitu-3 with regard to landscape use and itsPleistoceneinhabitants? Aghitu-3 is the only site of its kind in the region. We can safely say that the site served as a hunting camp which was used for short stays. Raw material procurement patterns show that at least during later stages of the UP, hunters who stopped at Aghitu-3 roamed a vast area covering much of the Armenian Highlands, and likely beyond. Despite the shared use of obsidian and similarities in lithic and osseous technologies, a physical connection to the Georgian UP sites has yet to be established.

Did the first modern humans in the region meet Neanderthals, and if so, how did they interact? This is doubtful, since a temporal overlap between MP and UP occupations does not exist in Armenia or Georgia. Aghitu-3 does not yield any direct information on the replacement process since there is no MP below the UP sequence. For now we assume that the "replacement" in Armenia consisted of the expansion of new groups of modern humans into a more or less empty area, with little chance for contact between Neanderthals and the newcomers. In the Imereti region of western Georgia the situation seems to have been similar (Adler et al. 2006b). If coexistence occurred in western Georgia, it was short-lived as UP populations ultimately prevailed, possibly due to social advantages (see below). Adler et al. (2006b) argue that two populations occupying the same ecological niche would not be able to exist very long parallel to each other.

What advantages did the first modern human settlers have over their predecessors? We can definitely say that the volumetric core reduction of these bladelet-dominated assemblages represents the epitome of an economically efficient system of blank production. While this is not a new insight with respect to UP assemblages, it differs noticeably from the preceding Levallois-based industries of the MP. In the younger strata of Aghitu-3, the eyed bone needle provides clear evidence for sewing. This kind of tool does not appear in the MP toolkit. The colonization of the southern Caucasus seems to have been a rather quick and widespread process, hence we assume that the first modern human colonists were quick to adapt and learn how to cope with new challenges. We agree with Adler et al. (2006b): even though the technologies of modern humans are more sophisticated, this does not necessarily mean they were better adapted. In the Caucasus we do not observe changes in hunting behavior with respect to prey species between the MP and UP. Rather the advantages for modern humans seem to lie within the social realm, for example, in long distance networks, trade and "social landscapes", as well as in terms of mobility (fast and frequent), rather than in superior technologies (Adler et al. 2006b).

Can we see a diachronic pattern of adaptational development in the Upper Paleolithic settlement? In terms of the lithic technology and toolkit from Aghitu-3, the findings from a stratigraphy covering 15,000 years are surprisingly consistent. Laterally modified bladelets prevail in every assemblage, and this consistency is something that we would not expect. What this exactly means is unclear; however, it seems that this particular toolkit offered the perfect solution for hunting lifeways during this entire time, otherwise it would not have been so dominant or persistent. Meanwhile raw material procurement patterns changed significantly: in layer AH VI we have only local obsidian, whereas in AH III, materials from sources up to 200 km away were found. This might indicate a broadening of the geographical range that these hunters explored. The discovery of the eyed needle in layer AH III definitely suggests sewing and has other implications. Since the technique of sewing was clearly mastered, everything from bags and nets to clothes could have been produced. Since there is no evidence for sewing in the lower UP layers of AH VI and VII, this might indicate a development over time. Nonetheless, we suspect that the earliest UP inhabitants of Aghitu-3 also had the ability to fabricate clothing.

Summing up, it is clear that Aghitu-3 Cave served as a shelter for short stays, most likely associated with hunting trips; but it did so repeatedly over a timespan of 15,000 years. The assemblages from the UP layers show perfectly developed technologies and toolkits, both lithic and organic. Indirect proof for the manufacturing of clothes is tangible in the eyed needle, the awls and the sophisticated laminar lithic industry. The laminar lithic production chain is elaborate and fully developed; core exploitation shows a maximum of efficiency. The meaning of the uniformity of the lithic tool kit throughout time is thus far not clear, as we would expect more variation across so much time. It might, however, just show a technology perfectly adapted to the needs of Paleolithic hunting groups. Their technology met the requirements of these people exceedingly well, so that there was no need to change. Another possibility is the existence of a tradition that was handed down through the generations and survived unchanged. Since the toolkit consists of many small blanks and modified pieces, it is foremost a very mobile toolkit. Whatever their use, these small implements were easy to make and replace. We suggest multiple uses for the retouched bladelets, but this question will be addressed after we carry out functional analyses on these pieces.

Aghitu-3 Cave shares many technological and typological features with the Georgian sites of Dzudzuana and Ortvale Klde, as well as Yafteh Cave in Iran. Radiometric dates from these sites show considerable overlap in the periods of occupation. The earliest occupation of Aghitu-3 was probably a little earlier than Dzudzuana, but for the better part of the UP all of these sites were inhabited at the same time. Thus Aghitu-3 Cave fits well within the EUP settlement system of the broader Caucasus region, and presumably represents a first "link" between the Baradostian of Iran and the more northerly lying sites of western Georgia and beyond. Whether or not we can detect actual connections between all of these sites remains a challenge for future research.

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10 The Middle to Upper Paleolithic Transition in the Zagros: The Appearance and Evolution of the Baradostian

Sonia Shidrang

Abstract

During oxygen isotope stage 3, the widespread emergence of Early Upper Paleolithic technologies signals significant changes in human behaviors. These profound changes are usually attributed to new major dispersals of Anatomically Modern Humans in Western Eurasia and the process of Neanderthals extinction and their replacement by Anatomically Modern humans. New lines of evidence and studies from pertinent geographical regions are essential to improve current explanatory models and hypotheses. The Zagros Mountain range in the west of Iran with its Intermountain eco-cultural niches is one of the areas that increasingly contribute to our knowledge of the transitional period from Middle to Upper Paleolithic in Southwestern Asia. This paper examines the lithic-based dominant hypothesis of continuity in Zagros through a more technology oriented view and put together all the evidence to build a broader overview of the Baradostian or the Early Upper Paleolithic of Zagros and its industrial evolution.

Keywords

MP-UP Transition • Early Upper Paleolithic • Baradostian • Zagros Aurignacian • Zagros • Iran

10.1 Introduction

The interval between 50,000 and 40,000 years ago (roughly) is a crucial time span during which Western Eurasia went through important population changes in the records of human evolution. Why and how and when this shift or, as it is commonly called, the Middle to Upper Paleolithic transition, happened is the subject of a fast-growing filed of research today. The important transitional events of this period eventually lead our ancestors to spread broadly across West Eurasia by 35,000 years ago. The probable responsible factors, whether biological, socio-cultural, environmental or an intertwined process of multiple factors, are not completely known. This wide dispersal of anatomically modern humans, directly or indirectly contributed to the demise of Neanderthals and disappearance of their long-lasting material cultures. The development of DNA sequencing technologies over the past decade, particularly the interesting advancement of Neanderthal genome sequencing, assured us of the contact scenario and confirmed the previous fragmentary palaeontological evidence. Based on these analyses, now we know that Neanderthals contributed approximately 1–3% of the genomes of current Eurasian populations and significantly higher in some available anatomically modern human specimen genomes (e.g. Green et al. 2010; Reich et al. 2010; Prüfer et al. 2014; Sankararaman et al. 2012; Meyer et al. 2012; Fu et al. 2014, 2015). These studies provided evidence for the admixture model or, more specifically, the interbreeding model and estimated that the last gene flow from Neandertals into Europeans occurred between 37,000–

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86,000 years ago, and most likely 47,000–65,000 years ago (Sankararaman et al. 2012). Also more recent confirmation for the interactions between moderns and Neanderthals came from the study of genomes from the Oase 1 modern human, dating back to 37,000–42,000 year ago (Fu et al. 2015). However, new comparative evidence from the Altai Mountains, Spain and Croatia suggests that the genetic contribution of modern humans to Neanderthals seems to go back thousands of years earlier (to roughly 100,000 years ago) than previously thought (Kuhlwilm et al. 2016).

Compared to Europe and the Levant, very little information is available to study the dispersal of anatomically modern humans into other parts of southwest Asia. In order to explain the related localized events in the geographical regions where fossil records and biological evidence are unavailable, we mainly rely on studies of archaeological sequences and their material cultures. For instance, in a geographically strategic region like Iran, it is the emergence of Early Upper Paleolithic technologies that signals significant changes in human behaviors at the interface of Middle to Upper Paleolithic, rather than fossil records. In Europe, the transitional lithic industries and then Aurignacian technocomplexes signal significant changes in human behaviors, and in the Levant and central Asia, Initial Upper Paleolithic industries followed by bladelet industries like early Ahmarian document such changes between 50 and 35 ka cal BP. In the Zagros, the Baradostian, which also is called Zagros Aurignacian, is one of the EUP cultures that increasingly contribute to our knowledge of the transition from Middle to Upper Paleolithic in Southwestern Asia. Despite more than a decade of renewed research in Iran, still the major part of the information on the Iranian Early Upper Paleolithic comes from Zagros region or, in other words, from several cave and rockshelter sites in the intermountain valleys of Kermanshah and Khorramabad and a few sites in Fars province in the southern Zagros (Fig. 10.1). The resemblance of Zagros Baradostian lithic industries with Aurignacian technocomplexes of Europe and the Levant and also the hypothesis that it evolved out of underlying Zagros Mousterian promoted the Baradostian as one of the potential candidates for ambiguous origin of Aurignacian.

This paper examines the lithic-based dominant hypothesis of continuity in the Zagros through a more technology oriented view and puts together the available information and evidence to build a broader overview of the Early Upper Paleolithic in Zagros and its industrial evolution. The main objective of the paper is the nature and extent of behavioral change in the beginning of the Early Upper Paleolithic in the Zagros and implications for a significant increase of behavioral complexity. For this purpose, a critical review of existing hypotheses of the Zagros Middle to Upper Paleolithic transition is provided and new data from a recent technological study of the rich and well-preserved Yafteh lithic assemblages opens up new perspectives on the subject.

10.2 The Formation of Middle to Upper Paleolithic Research in Iran

10.2.1 Initial Quests for the Origin of the Earliest European Upper Paleolithic in Southwest Asia

In the beginning of the twentieth century, the search for the origin of the Aurignacian in Europe led some researchers, who were mainly the supporters of the diffusion theory, to turn their attention toward the Levant and further east to the Zagros Mountains. As the divisions of Upper Paleolithic sequence, particularly the Aurignacian, were being formed in France (e.g. Peyrony 1933; de Sonneville-Bordes 1958; Delporte 1968), Dorothy Garrod, who proposed the subdivisions of Chatelperronian, Aurignacian and Gravettian (Garrod 1937, 1938), also attempted to find an outer origin for the first European Upper Paleolithic. Garrod was the pioneer of such research in Zagros (Garrod 1930) but the results of excavation in Zarzi rock shelter revealed a very late Upper Paleolithic (today called the Epipaleolithic tradition of Zarzian) that changed her idea (Garrod 1953). By 1953, she believed that the Aurignacian arrived in the Levant after the same culture had already been established in Europe and the direction of diffusion seemed to be more likely from the West to the East rather than reverse (Garrod 1953; Olszewski 1999).

However, the excavation of Shanidar cave in Iraq revealed an early Upper Paleolithic industry in the Northern Zagros (Solecki 1952, 1953). The unknown lithic industry of Layer C in Shanidar was presented as a new Upper Paleolithic blade and burin industry by Solecki and given a local name of "Baradostian" after consulting with Dorothy Garrod on its distinguishable character from Aurignacian (Solecki 1958). However, Solecki still could not ignore the similarities of the two industries and stated that the Baradostian is an Upper Paleolithic blade and burin industry with many characteristic indicators of Aurignacian in Europe. He even went further and hypothesized that the Baradostian was the earliest Aurignacian in the Near East and entered Southwest Asia from Eurasia via Transcaucasia following the Wurm II glaciations (Solecki 1958).

In the early years of the radiocarbon application, layer C of Shanidar cave dated to more than 34,000 BP in its lower part and 29,500 BP in the top (Table10.1). These dates and stratigraphical observations convinced Solecki of a stronger probability of discontinuity between the Baradostian and the underlying Mousterian in Shanidar cave (Solecki 1958).

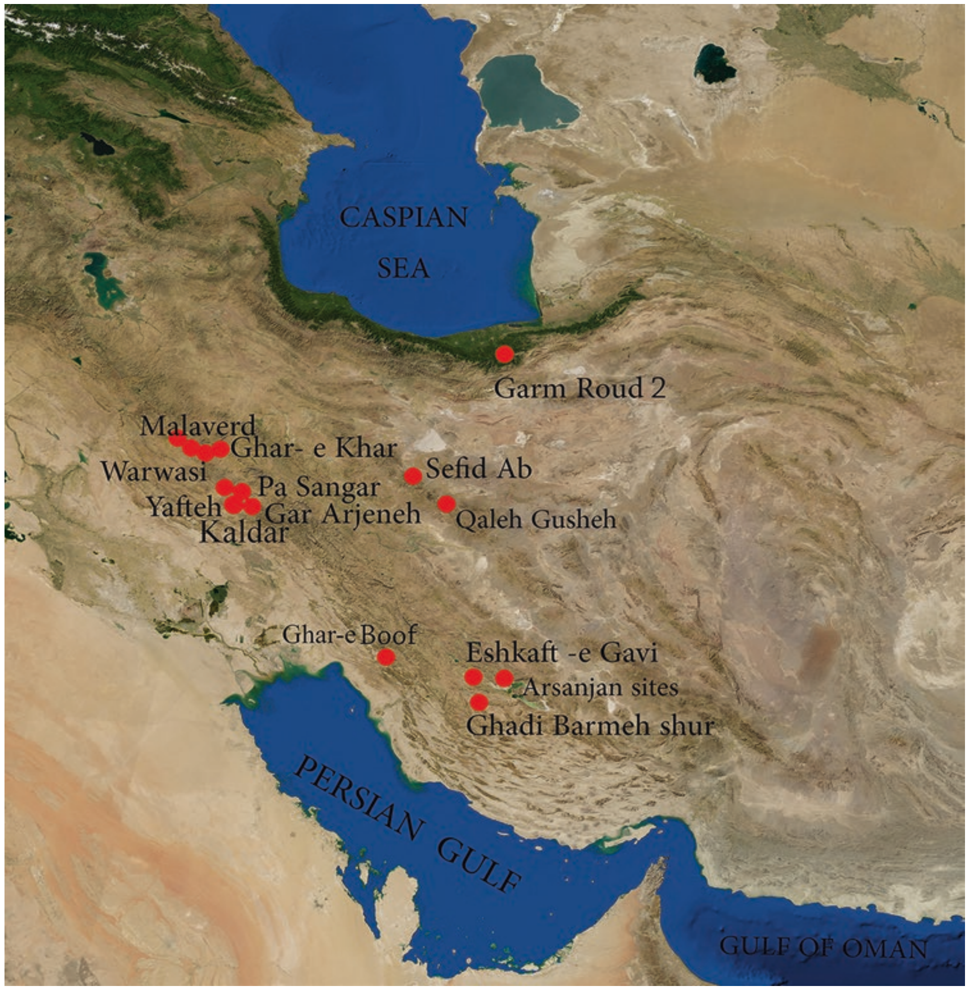

Fig. 10.1 The location of main known Early Upper Paleolithic sites of Iran (Basemap courtesy of NASA's Visible Earth http://visibleearth.nasa.gov/)

10.2.2 Tendency toward "Continuity"

About 10 years after the Iraqi-Jarmo project, Robert J. Braidwood conducted his Iranian Prehistoric Project in Kermanshah, central western Iran. During these expeditions that began in late 1959, they excavated several sites near Kermanshah; Warwasi rockshelter was among these sites (Braidwood 1951, 1960; Braidwood et al. 1960, 1961). The excavators of Warwasi, assigned the blade industry found in the intermediate horizon between the Mousterian and Upper Zarzian layers, to the Baradostian and described it briefly at the time of excavation.

According to Braidwood's report, the Baradostian industry consisted of high frequency of burins (as Solecki also noted in Shanidar) following by different types of scrapers and blade tools. In the same report, they suggested that the succession of cultural layers proceeded without a visible interruption between the Mousterian and Baradostian at Warwasi (Braidwood 1960).

In the 1980s and early 1990s, after the politically caused termination of foreign archaeological projects in Iran, publication of excavations results turned attentions toward Iran. No doubt one of the most influential studies of these materials was the work of Deborah Olszewski and Harold Dibble on the lithic assemblage of Warwasi rockshelter. In 1994 Olszewski and Dibble emphasized the close similarities of the Baradostian to the Aurignacian and even went further to rename it as the "Zagros Aurignacian" (Olszewski and Dibble 1994). Presence of Mousterian elements in the early Baradostian layers of Warwasi led them to raise the hypothesis of the continuity between the Zagros Mousterian and Baradostian at Warwasi. The assemblages resulted from the 2.2 m of deposits of the Baradostian at Warwasi being divided into two phases of the Early Zagros Aurignacian (Levels AA-LL) and the Late Zagros Aurignacian (Levels P-Z). The main typological characteristics of these assemblages have been described as burins and end scrapers including carinated forms (Fig. 10.2), retouched blades and bladelets which usually are equivalent to Dufour bladelets and Font-Yves points (Arjeneh points) and finally some notches and denticulates, borers and retouched pieces (Olszewski and Dibble 1994, 2006).

From a technological point of view, the Early Zagros Aurignacian assemblage is dominated by flake debitage but

Table 10.1 Table summarizing 14C dates (Uncalibrated) obtained for the Upper Paleolithic sequences cited in this paper

Site	Depth (−cm)	Archaeological context	Collected Year	Age	Lab. Num ber	References
Shanidar Cave		Layer C	1953	28,700 ± 700	W-654	Hole and Flannery (1967)
Shanidar Cave	ca.300	Layer C (Upper part- S3Wl)	1953	29,500 ± 1500	W-178	Hole and Flannery (1967), and Solecki (1958)
Shanidar Cave	ca.460	Layer C (Lower part- 52 W4)	1953	>34,000	W-180	Hole and Flannery (1967), and Solecki (1958)
Shanidar Cave		Layer C	1953	33,300 ± 1000	W-650	Hole and Flannery (1967)
Shanidar Cave		Layer C	1953	33,900 ± 900	GrN-1830	Hole and Flannery (1967)
Shanidar Cave		Layer C	1953	34,000 ± 4 20	Grn-1494	Hole and Flannery (1967)
Shanidar Cave		Layer C	1953	35,440 ± 600	GrN-2016	Hole and Flannery (1967)
Shanidar Cave		Layer C	1953	34,540 ± 500	GrN-2015	Hole and Flannery (1967)
Yafteh Cave	125	Stratum 5	2005	24,470 ± 280	Beta-206,711	Otte et al. (2007, 2011)
Yafteh Cave	150	Stratum 13	2005	33,400 ± 840	Beta-206,712	Otte et al. (2007, 2011)
Yafteh Cave	200	Y6e -Ash bed	1965	34,800 + 2900/−4500	GX-711	Hole and Flannery (1967)
Yafteh Cave	201	Y4e- Ash bed	1965	32,500 + 2400/−3400	GX-710	Hole and Flannery (1967)
Yafteh Cave	201	Y4e -Ash bed	1965	29,410 ± 11 50	Sl-332	Hole and Flannery (1967)
Yafteh Cave	210.5	Stratum 15	2008	33,800 ± 330	Beta-245,910	Otte et al. (2011)
Yafteh Cave	212	Y6e -Ash bed	1965	30,860 ± 3000	51–333	Hole and Flannery (1967)
Yafteh Cave	213	Stratum 16	2008	32,190 ± 290	Beta-251,058	Otte et al. (2011)
Yafteh Cave	213 5	Stratum 16	2008	33,160 ± 240	Beta-251,062	Otte et al. (2011)
Yafteh Cave	226.5	Stratum 17	2008	32,900 ± 290	Beta-251,059	Otte et al. (2011)
Yafteh Cave	234	Stratum 17	2008	33,260 ± 300	Beta-251,060	Otte et al. (2011)
Yafteh Cave	236	Stratum 17	2008	33,430 ± 310	Beta-245,908	Otte et al. (2011)
Yafteh Cave	240	Stratum 17	2005	35,450 ± 600	Beta-205,844	Otte et al. (2007, 2011)
Yafteh Cave	245	Stratum 17	2008	33,330 ± 310	Beta-245,909	Otte et al. (2011)
Yafteh Cave	250	Y4e -Ash bed	1965	21,000 ± 800	51–336	Hole and Flannery (1967)
Yafteh Cave	251	Stratum 17	2008	31,120 ± 240	Beta-251,061	Otte et al. (2011)
Yafteh Cave	258 5	Stratum 18	2008	34,360 ± 340	Beta-245,913	Otte et al. (2011)
Yafteh Cave	260	Stratum 18	2008	32,770 ± 290	Beta-245,907	Otte et al. (2011)
Yafteh Cave	260	Y6e -Ash bed	1965	38,000 ± 3400/ -7500	GX-709	Hole and Flannery (1967)
Yafteh Cave	266.5	Stratum 18	2008	33,520 ± 330	Beta-245,911	Otte et al. (2011)
Yafteh Cave	273	Stratum 19	2008	34,160 ± 360	Beta-245,912	Otte et al. (2011)
Yafteh Cave	278	Y4e - Ash Bed (Upper)	1965	>36,000	GX-708	Hole and Flannery (1967)
Yafteh Cave	280	Y6e -Ash bed	1965	31,760 ± 3000	51–334	Hole and Flannery (1967)
Yafteh Cave	280	Y4e - Ash bed (Upper)	1965	34,300 ± 2100/ -3500	GX-707	Hole and Flannery (1967)
Yafteh Cave	285	Y4e - Ash Bed (Lower)	1965	>40,000	Sl-335	Hole and Flannery (1967)
Yafteh Cave	290	Y4e - Ash Bed (Lower)	1965	>35,600	GX-706	Hole and Flannery (1967)
Eshkaft-E Gavi Cave	80	Operation B	1978	>27,640	P-2861	Rosenberg (1985)
Eshkaft-E Gavi Cave	90	Operation B	1978	>28,000	P-2862	Rosenberg (1985)
Eshkaft-E Gavi Cave	90	Operation B	1978	24,240 + 3010/−2180	P-2863	Rosenberg (1985)

(continued)

Table 10.1 (continued)

Site	Depth (−cm)	Archaeological context	Collected Year	Age	Lab. Num ber	References
Eshkaft-E Gavi Cave	110	Operation B	1978	18,150 ± 1500	P-2864	Rosenberg (1985)
Eshkaft-E Gavi Cave	115	Operation B	1978	19,230 + 4310/ -1340	P-2865	Rosenberg (1985)
Eshkaft-E Gavi Cave	130	Operation B	1978	>27,300	P-2866	Rosenberg (1985)
Ghar-e Boof	ca.120	AH-Ill	2007	31,150 + 250/−240	KIA32761	Conard and Ghasidian (2011)
Ghar- e Boof	ca.150	AH-IV	2007	33,060 + 270/−260	KIA32763	Conard and Ghasidian (2011)
Ghar-e Boof	ca.160	AH-JV	2007	36,030 + 390/−370	KIA32765	Conard and Ghasidian (2011)
Ghar-e Boot	ca.130	AH-lllb	2007	33,850 ± 360	OxA-25,783	Ghasidian et al. (2017)
Ghar-e Boof	ca.130	AH-lllb	2007	34,900 ± 650	OxA-25,785	Ghasidian et al. (2017)
Kaldar Cave	110	Tl; L4; SLS; SQ E6	2014–2015	33,480 ± 320	OxA-32,238	Bazgir et al. (2017)
Kaldar Cave	85	Tl; L4; SLS; SQ E7	2014–2015	39,300 ± 550	OxA-X-2645-11	Bazgir et al. (2017)
Kaldar Cave	125	Tl; L4; SLSII; SQ E6	2014–2015	49,200 ± 1800	OxA-X-2645-12	Bazgir et al. (2017)
Garm Roud	1010	Unit 8	2005–2006	23,920+/−160	Beta-206,996	Berillon et al. (2007)
Garm Roud	1010	Unit 8	2005–2006	27,100+/− 270	Beta	Antoine et al. (2016)
Garm Roud	1010	Unit 8	2005–2006	28,180 +/−300	Beta	Antoine et al. (2016)
Garm Roud	1010	Unit 8	2005–2006	29,530 +/− 220	Beta	Antoine et al. (2016)

also contained a modest frequency of prismatic blade and bladelet debitage as well as almost the same frequency of tools manufactured on prismatic blade or bladelets. It also contained laminar flakes of the Middle Paleolithic technological strategy. The tools of the Early Zagros Aurignacian consisted of both Middle and Upper Paleolithic elements (Olszewski and Dibble 1994, 2006). However, the Late Zagros Aurignacian of Warwasi is described as an industry with a high frequency of blades and bladelets (in particular bladelets). Tools were manufactured mainly on blades and bladelets and cores were mainly single platform blade/bladelet forms with some blade and bladelet opposed platforms cores and carinated burins and endscrapers which were frequently found in this later phase. Lack of an abrupt break between the Mousterian and Baradostian at Warwasi and presence of Middle Paleolithic techno- typological elements like sidescrapers, truncated-facetted pieces and small radial cores in the beginning of the Baradostian led Olszewski and Dibble to purpose the probability of continuity in this site (Dibble 1984; Dibble and Holdaway 1990, 1993). However, despite their tendency toward cultural continuity and hypothesizing about the origin of Aurignacian in Zagros, they expressed their doubts over the current state of data and its sufficiency to enlighten the issue of a transition from the Zagros Mousterian to Zagros Aurignacian (Olszewski 2001; Olszewski and Dibble 1994, 2006). In addition to the previous studies, a recent taphonomical analysis of the Warwasi assemblage did not find convincing evidence of direct refits between the Mousterian and the Early Baradostian nor a technological connection between the Mousterian and the Early Upper Paleolithic of Zagros (Tsanova 2013).

Back in 1963, the sequence of Warwasi rockshelter inspired Frank Hole and Kent Flannery to begin a research project with similar goals, to clarify the Paleolithic sequence successions in "Khorramabad," another major valley of Zagros (Hole and Flannery 1967). The abundance of materials discovered during the Khorramabad excavations permitted Hole and Flannery to study the diachronic changes of the lithic artifacts from the Late Mousterian to the Zarzian and as a result, they defined two subdivisions for the Baradostian. Based on artifact typology, Hole and Flannery also suggested the possibility of gradual development of Baradostian lithic industries out of the Late Mousterian in this region. However, the only site with a sequence containing superposition of both Middle and Upper Paleolithic layers was Gar Arjeneh rockshelter but its MP-UP intermediate layers were severely disturbed. According to Hole and Flannery, the Baradostian displayed an increase in tool types and emphasis on blade production but the subsistence pattern did not show a great difference between the two periods (Hole and Flannery 1967). One of the significant results of this project was 13 radiocarbon dates (Table 10.1); most of them fell between 29,000 and 38,000 B.P for the two meters of Baradostian deposits of Yafteh cave (Hole and Flannery 1967).

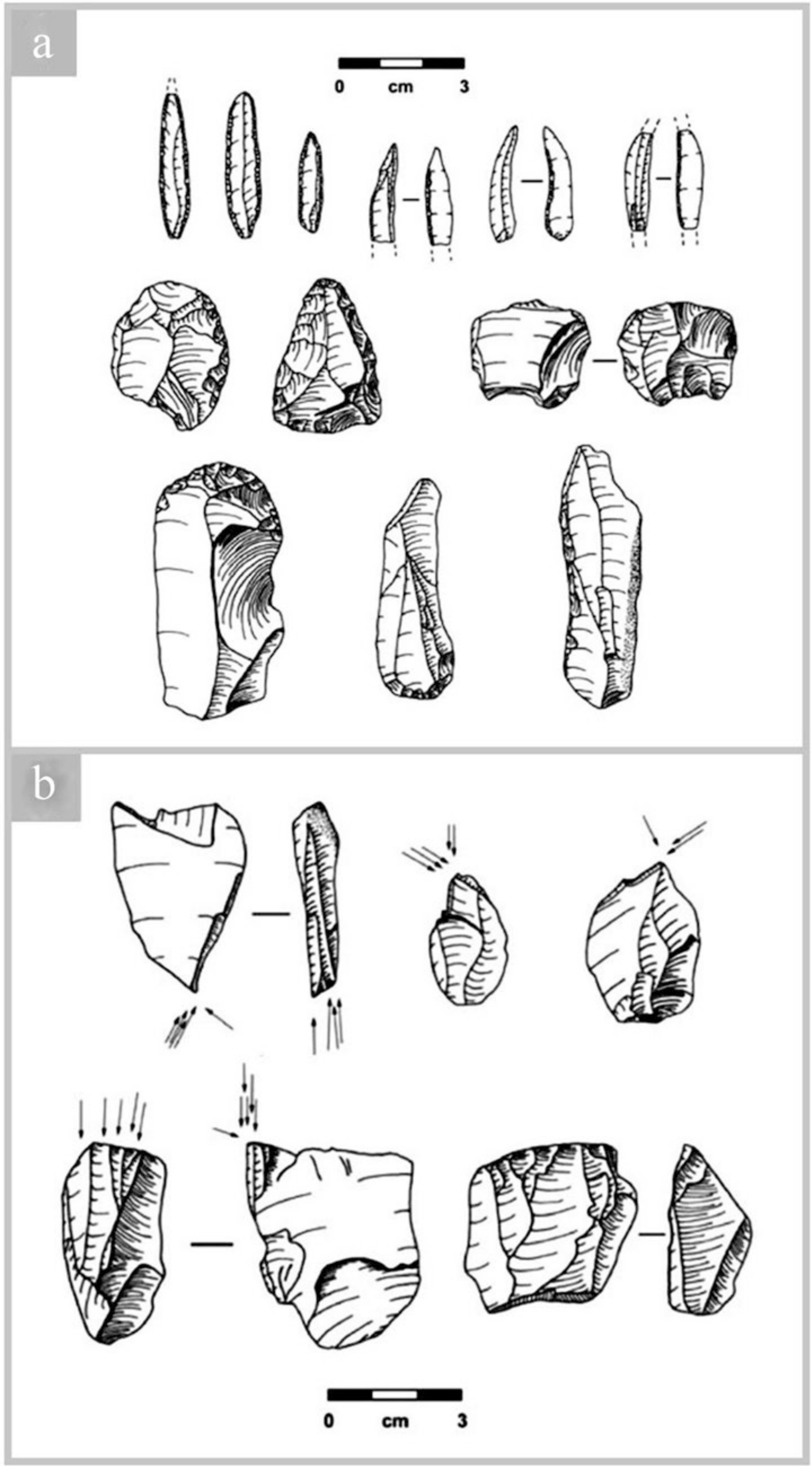

Fig. 10.2 Example of Early Zagros Aurignacian lithic artifacts (**a**) and example of Late Zagros Aurignacian lithic artifacts (**b**) at Warwasi (Olszewski and Dibble 2006)

10.2.3 The Lack of Evidence for Continuity Persists

In 1965, the same year of Khorramabad excavations, Philip Smith and Cuyler Young conducted a research project in the Kangavar-Bisitun area. Their test excavation in Ghare Khar did not reach bedrock but revealed a 5-meter deposit encompassing Middle, Upper and Epi-Paleolithic cultural layers. Smith and Young described the artifacts found in the Upper Paleolithic deposits as a blade tools industry with a frequency of burins including multiple blow burins. This industry was described as having end scrapers, round scrapers, backed blade/bladelets which were found in low frequency and also some notches and strangulated blades. In their report, Young and Smith doubted the continuity between the Upper Paleolithic lithic industries and the underlying Mousterian, an assumption confirmed by a recent study of the materials (Fig. 10.3) (Young and Smith 1966; Shidrang et al. 2016).

Following Garrod who initiated the quest for the origin of the EUP in the Middle East, the first investigation with a primary objective of an eastern origin for the European Upper Paleolithic in Iran was conducted by C.B.M McBurney in 1963. It also resulted in doubts and uncertainties.

In his report on the Cambridge University expedition in north-eastern Iran, McBurney described that the primary objective was to explore the area for traces of local Upper Pleistocene cultural sequences and particularly the establishment of the chronology and nature of the Upper Paleolithic in this region.

McBurney believed that the Upper Paleolithic blade and burin industries of Europe should have a single centre of origin in Southwest Asia. He also proposed that one should detect the traces of this diffusion along the principal geographical routes into Southeast Europe, maybe from Anatolia or northwards over the Caucasus Mountains or northeastward through Kurdistan into the Caspian shore and then northwards into the Turkmen Plain (McBurney 1964). Unable to continue their research in the east of Iran, in 1969 the Cambridge team turned to Central Zagros and continued the research in Kuh-i-Dasht (McBurney 1970). Among the excavated rockshelter sites in Kuh-i-Dasht, only Barde Spid I yielded a probable Upper Paleolithic industry underlying Neolithic deposits and underlain by Mousterian material. The identity of the so-called Upper Paleolithic materials from Barde Spid I still remains ambiguous, even after the final study of all excavation materials (Bewley 1984). At the time of all these expeditions, southern Zagros remained almost unknown from a Paleolithic research point of view. In 1972 Marcello Piperno and M.G. Bulgarelli carried out a survey in Fars province to find and evaluate the potential of a few sites reported by H. Field near the north-west shore of the Lake Maharlu in southern Zagros (Piperno 1974). During the survey, 287 lithic artifacts were collected from the surface of Shekaft-I Ghadi Barmi Shur, one of the caves reported by H. Field. Most of the implements were made on small flintpebbles and the industry seemed to be related to the final phase of Baradostian (Piperno 1974). The characteristics which led Piperno to assign the collection to Late Baradostian were the presence of different types of burins, particularly polyhedral burins, Dufour bladelets, end scrapers on blades, retouched blades and absence of Zarzian index fossils like geometric microliths and microburins. Back in the central Zagros, where Peder Mortensen was working on Tepe Guran materials, he planned an intensive survey in 1973 (Mortensen 1993) to provide a data base for the detailed study of changes that accompanied the origin and early development of agriculture in the Zagros. After describing Lower and Middle Paleolithic finds separately, Mortensen grouped Upper and Epi-Paleolithic materials together due to the difficulty of distinguishing Baradostian from Epi-Paleolithic materials. In the test excavation at Mar Gurgalan Sarab cave, two layers (D-E) found at the base of the Zarzian layers with an indistinctive Upper Paleolithic character were identified as probable Baradostian. Apparently the industry found in these layers was dominated by burins and unretouched blades. A few years later in 1978, in the southern Zagros again, Michael Rosenberg excavated a cave called Eshkaft-e Gavi in Marv Dasht plain, situated at the lower part of the Kur River Valley. The excavation revealed a relatively rich Upper Paleolithic layer containing charcoal lenses located just under the 15 cm of post Pleistocene deposits. Six C14 dates, ranging from 30,000 to 18,000 B.P. were obtained for the lower part of the deposits. The dates were stratigraphically inconsistent and many of them derived from very small samples (Table 10.1). Apparently, the Upper Paleolithic layer ended at a depth of about 125 cm and in the underlying 50 cm of deposits, the density of artifacts decreased significantly, which Rosenberg assigned to a probable transitional phase between the Middle and Upper Paleolithic. He also found the assemblages of Eshkaft-e Gavi to be consistent with the Khorramabad Middle and Upper Paleolithic sites. However, the Middle Paleolithic elements at the base of the Eshkaft-e Gavi sequence were very typical and free of accompanying Upper Paleolithic elements. This was contrary to the Khorramabad sites where Middle Paleolithic side scrapers persisted into Early Upper Paleolithic industries. A few Middle Paleolithic side and convergent scrapers found in Eshkaft-e Gavi were considered as being typical Zagros Mousterian and the Upper Paleolithic materials were assigned to the Baradostian. The Baradostian in Eshkaft-e Gavi was characterized by backed blades, notched blades, burins, carinated scrapers and Baradostian points (Rosenberg 1985). The lack of evidence for continuity still continues in newly excavated sequences such as Kaldar Cave that yielded Baradostian and Mousterian archaeological assemblages in stratigraphic superposition (Bazgir et al. 2014, 2017). The

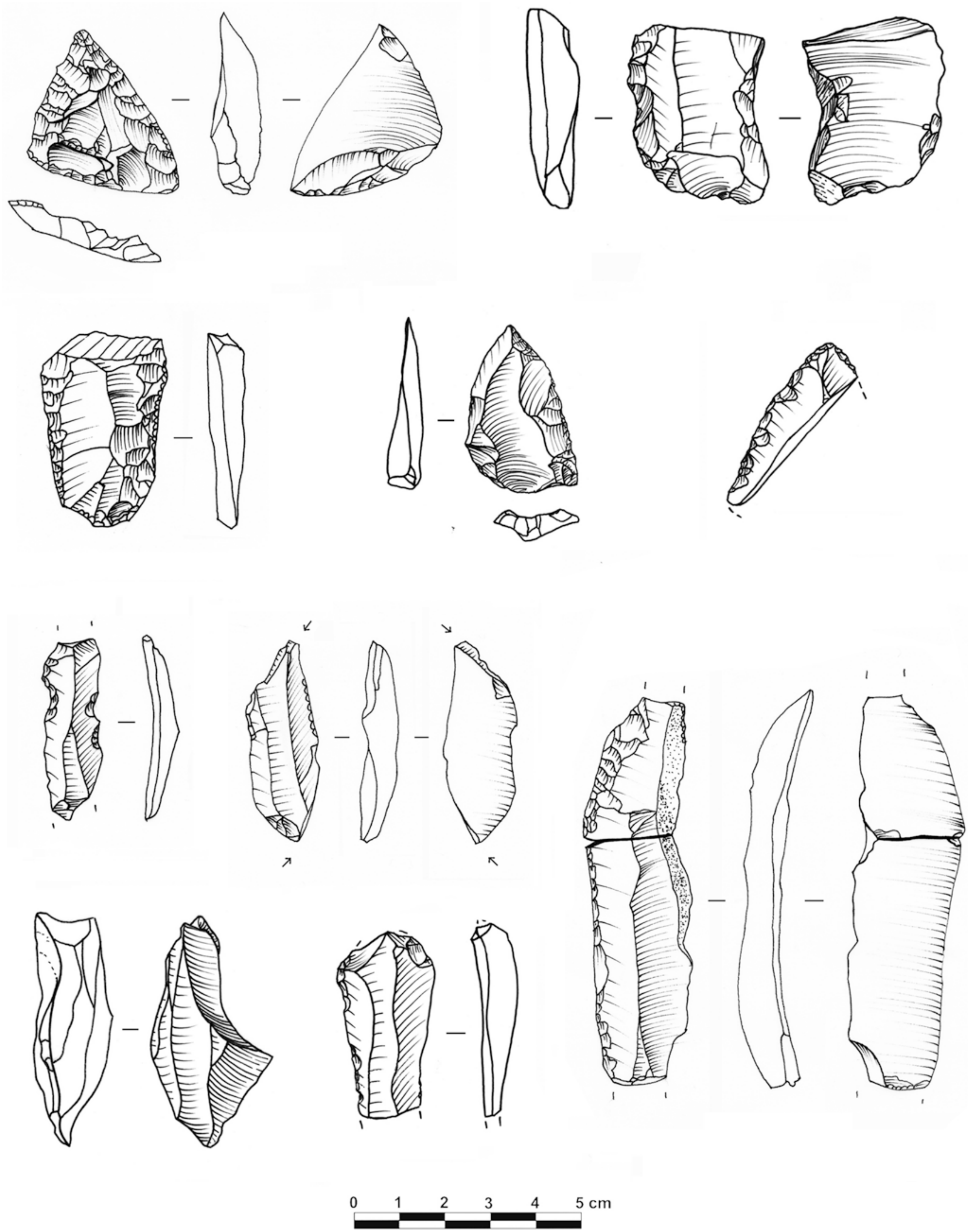

Fig. 10.3 Lithic artifacts from Khar cave intermediate phase of Mousterian-Baradostian or the transitional phase (Shidrang et al. 2016)

technological study of Kaldar lithic assemblages has shown a clear shift from Mousterian flake production to Baradostian blade and bladelet technology along with other quantitative differences between Middle and Upper Paleolithic layers. The Kaldar Cave excavation has provided new chronometric data including four TL dates for upper layers that ranged from 23,100 ± 3300 to 29,400 ± 2300 BP and three C14 dates from the main Baradostians layers and below which resulted in ranges of 38,650–36,750 cal BP, 44,200–42,350 cal BP, and 54,400–46,050 cal BP (Table 10.1) (Bazgir et al. 2017).

10.2.4 Emphasis on the Broader Identity of the Baradostian and Its Nature

After the introduction of the "Zagros Aurignacian" by Olszewski and Dibble, the issues of similarities between the Baradostian and Aurignacian as well as cultural continuity between the Middle and Upper Paleolithic in Zagros were highlighted and emphasized by other researchers such as Marcel Otte who was looking for an eastern origin of Aurignacian in the late 1990s and early 2000s (Otte and Kozłowskǐ 2004). Otte and Kozlowski (Otte and Kozłowskǐ 2004, 2009, 2011) hypothesized the formation of Aurignacian culture in the frame of population movement from east to west and more precisely beginning from Central Asia along the Zagros and Taurus ranges to the Balkans and the Levant and then ultimately to Europe. In their view, the diffusion then expanded from the Balkans to the Danube basin or the Mediterranean coast and all the sophisticated inventions were created step by step during their adaptations to new environments. They also suggested that this diffusion should not be considered as a single and straightforward movement; rather it would have been in different waves with changing limits in tempo-spatial aspects (Otte and Kozłowskǐ 2004). In this scenario, the radical demographic expansion which caused the disappearance of the Neanderthals and establishment of Anatomically Modern Human began somewhere in Central Asia, including Iran, that in their opinion is the most probable origin of anatomical and cultural modernity expansion (Otte and Kozłowskǐ 2004). However, the new chronological data from the Yafteh sequence does not predate but overlaps with similar industries like early Ahmarian and marks an intermediate chronological position for the Baradostian in the Southwest Asian Early Upper Paleolithic sequence (Otte et al. 2011). The dates suggest the attribution of the sequence interval to between 24,500 and 36,000 14C BP (Table 10.1). The study of the 1965s Yafteh collection by Bordes and Shidrang updated the recognition of the Baradostian as a facies of Aurignacian technocomplexes and the identification of its characteristics and industrial changes throughout the sequence. This study, carried out in 2004, placed the Baradostian in an updated classification of Aurignacian (Bordes and Shidrang 2009) and revealed its resemblance to newly accepted Proto-Aurignacian of Europe and in part to the early Ahmarian in the Levant. Bordes and Shidrang's study was inspired by the late 1990s and early 2000s ongoing research on the appearance of the Aurignacian culture and dispersal of Anatomically Modern Humans in Europe and focused on the two earlier industries of the Aurignacian classification (e.g. Bon 2002, 2006; Bordes 2002, 2006; Le Brun-Ricalens and Bordes 2007; Bazile 2006; Bazile and Sicard 1999). The first industry or Proto-Aurignacian (Archaic Aurignacian or Aurignacian 0) known as the earliest manifestation of the Aurignacian was discovered mostly in the Mediterranean region, the south-west of France and the north of Spain. The more evolved facies of the Aurignacian (particularly from the bone industry and artistic materials point of view) or Early Aurignacian appears to be later and richly present in the Danube river basin and also the southwest of France. The Proto-Aurignacian lithic industry is characterized by the production of relatively large straight bladelets from prismatic cores in a single continuous form of reduction sequence from blade to bladelet, that are retouched into Font-Yves points or Dufour bladelets of Dufour subtype. As in the Baradostian of Yafteh cave, the lower part of the deposit is associated with an assemblage mainly oriented toward the production of Arjeneh points and relatively large, straight or slightly curved Dufour bladelets. The bladelets or blanks of these tools were removed from prismatic cores or sometimes from narrow flake ridges. There are also a number of end-scrapers on blades which in some cases have Aurignacian retouch on their lateral edges. It is also noted that the later phase of the Baradostian sequence in Yafteh cave is characterized by production of small twisted bladelets (Fig. 10.4) produced from carinated burins and nosed scrapers made mostly on cherty nodules and having fine and semi abrupt inverse or alternate retouch (Roc-de-Combe sub-type Dufour bladelets), are more likely to be similar to later phases of Aurignacian or recent Aurignacian (Bordes and Shidrang 2009; Shidrang 2015).

A recent analysis of 2005–2008 Yafteh lithic assemblages combined with stratigraphical information and information derived from other archaeological materials, suggested a three cultural phase model for the Yafteh sequence (Fig. 10.5) (Shidrang 2015). The oldest phase contains a lower frequency of artifacts and the main characteristic of the assemblage is standard flat prismatic cores. These cores correspond to bladelets with a very straight profile and most probably moderate size blades from the initial stage of the reduction sequence. The toolkit is relatively simple including Baradostian bladelets type A (Dufour bladelets of Dufour subtype), Arjeneh points and retouched bladelets with a few retouched blades (Fig. 10.6). Despite the limited number of artifacts in this phase, the tools percentage ratio to debitage is fairly high

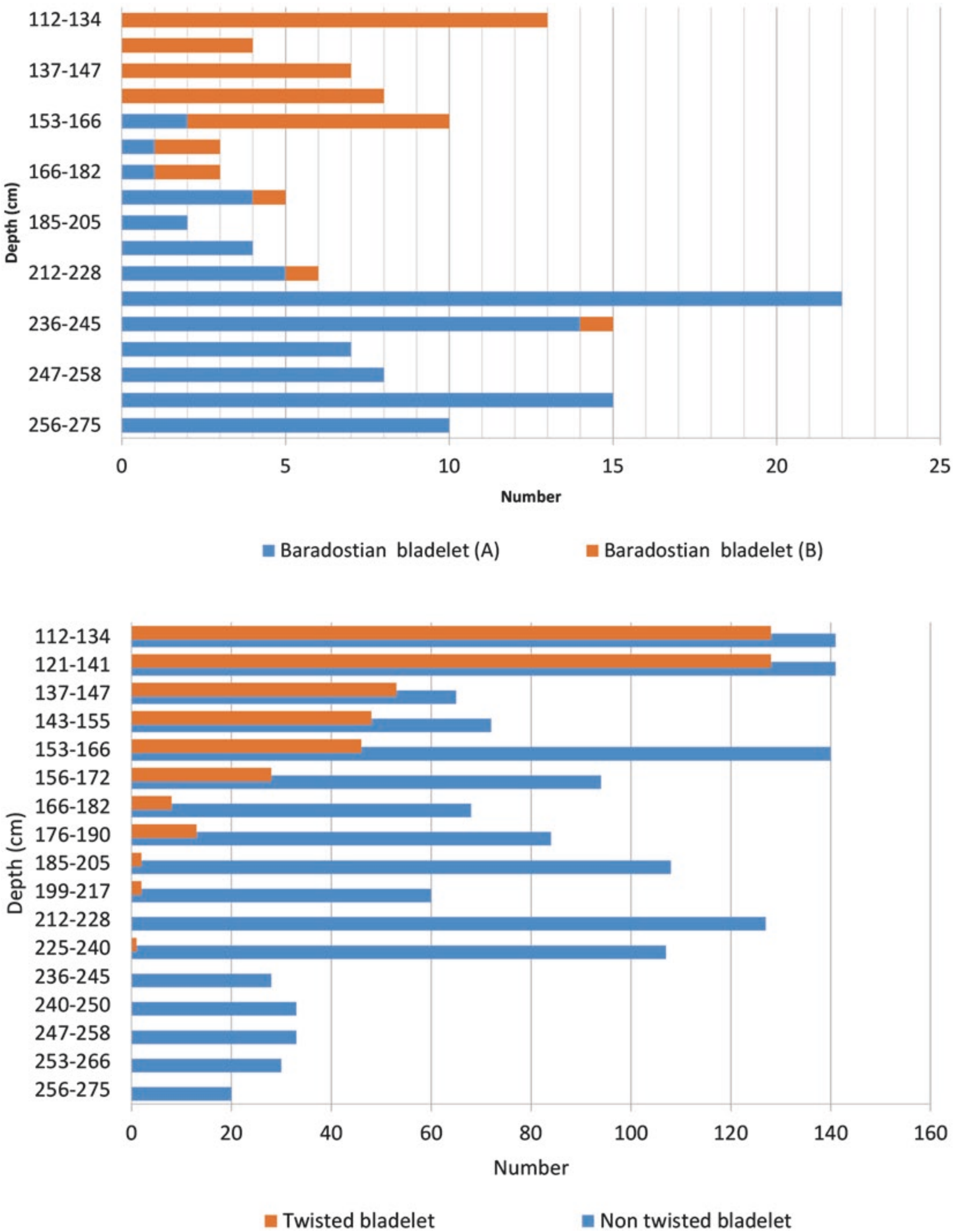

Fig. 10.4 Graph showing the distribution of Baradostian bladelets type A or Dufour bladelets of "Dufour" subtype & Baradostian bladelets type B or counterparts to "Roc de Combe" subtype) and their blanks throughout the sequence (Shidrang 2015)

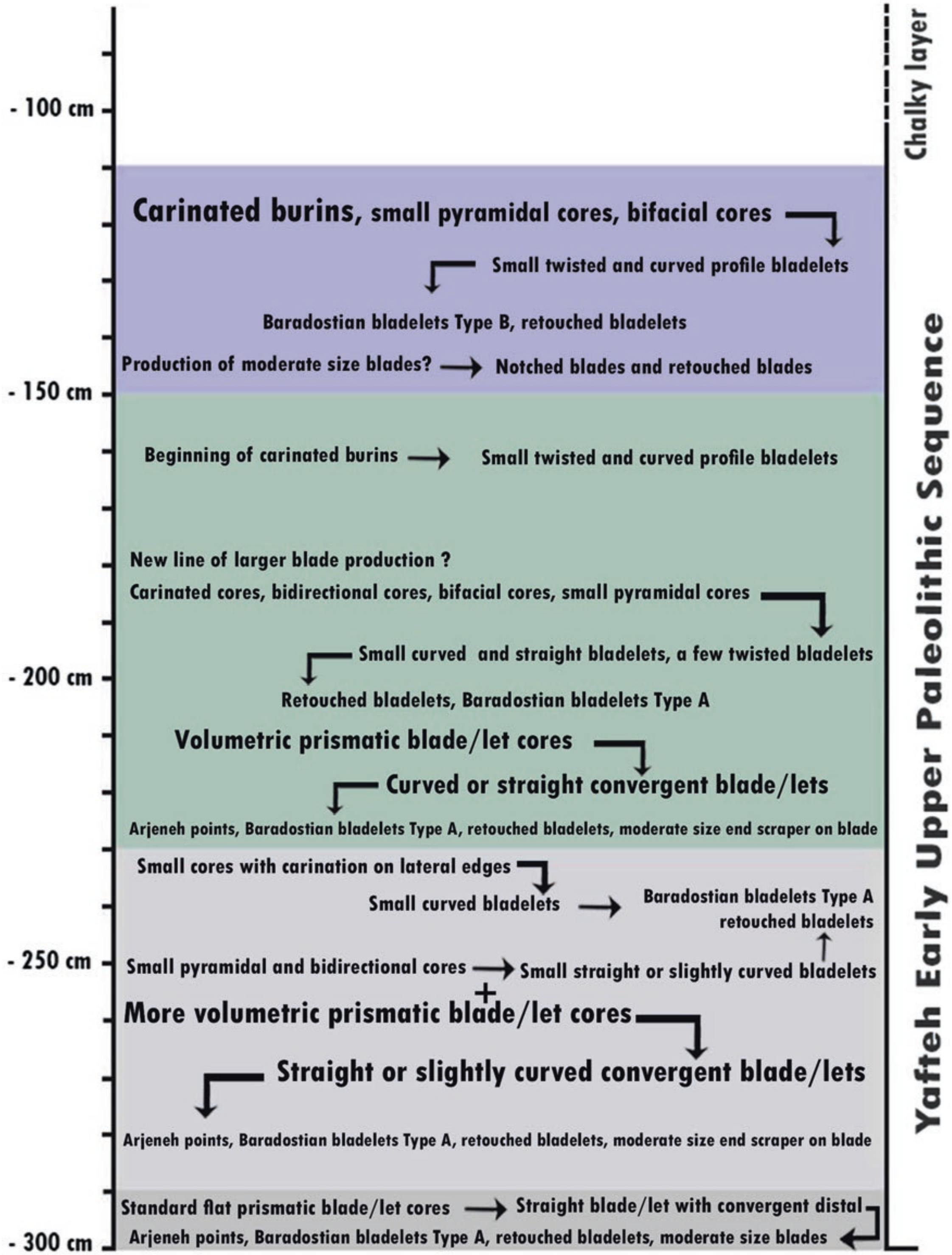

Fig. 10.5 The main lines of lithic reduction sequence in Yafteh cave EUP layers (Shidrang 2015)

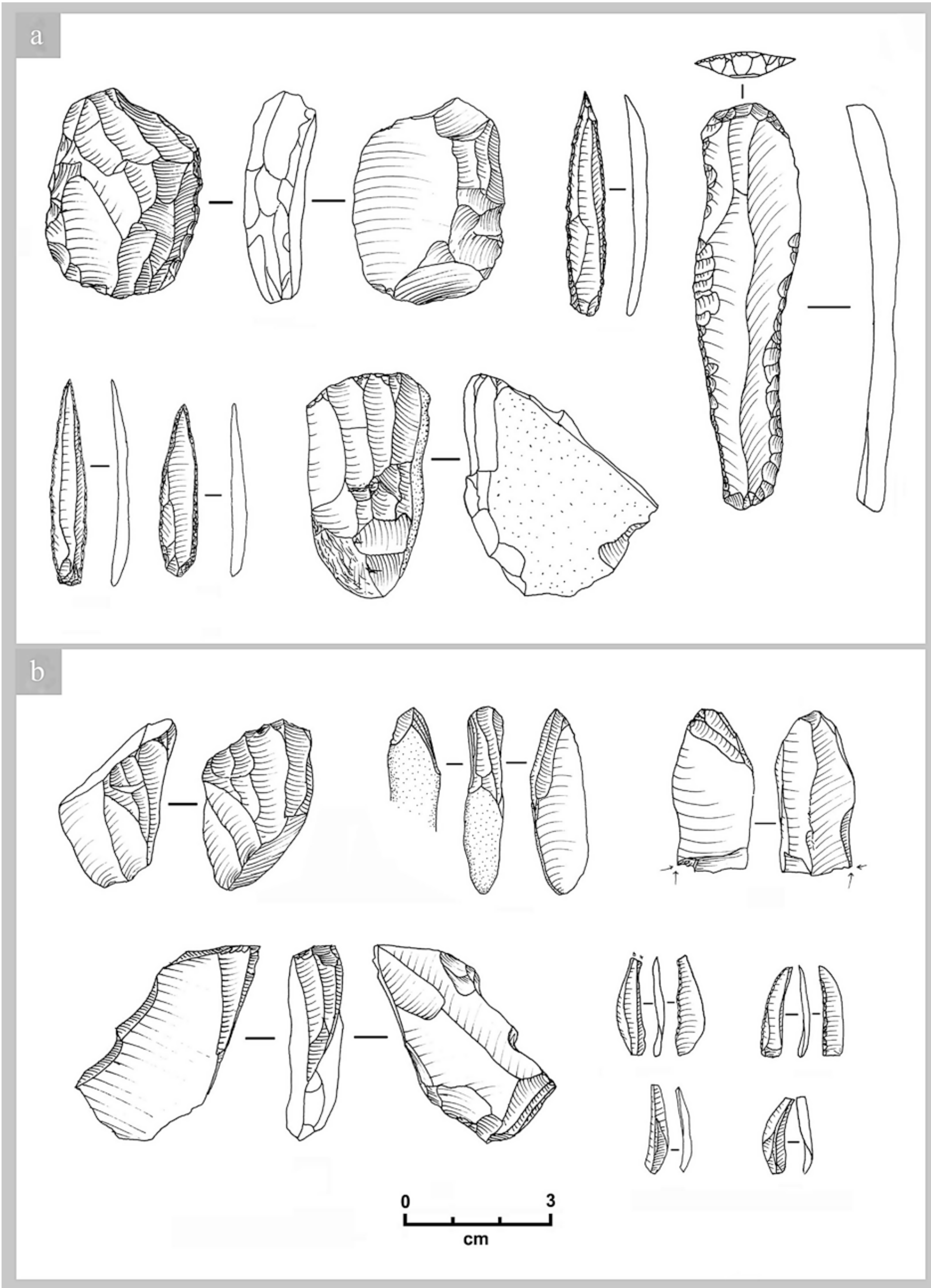

Fig. 10.6 Example of lithic artifacts from middle phase of the Baradostian (**a**) and example of lithic artifacts from late phase of Baradostian (**b**) at Yafteh cave (Shidrang 2015)

which may suggest the earliest phase of the sequence corresponds to short term visits of EUP hunter gathers to the site rather than a long seasonal occupation (Shidrang 2015).

The central phase of the Yafteh sequence is the main and the most intense occupation of the site. This is a rich layer which contains many cultural materials and has a light gray color and ashy texture with charcoal, visible fire place and frequent traces of ocher. In the middle phase, blades become more important and (a separate line of blade production?) were used as blank for end scrapers, notches or typical retouched blades.

There is a diversity of bladelet cores which display some degree of specialization for production of different bladelet types (Fig. 10.7). Despite the preference for natural ridges and convexity, cresting increases and can be observed for the very small bladelet cores as well. Carinated burins that are an important characteristic of the Upper phase or the last EUP occupation of the cave appear in the upper part of the middle phase.

Among other elements, a considerable number of Arjeneh points as well as end scrapers on blades, might indicate a base camp occupation specialized in hide working and piercing hides and ornaments in the middle phase of the sequence. The middle phase of Yafteh cave and possibly a major part of its early phase seems to present several technological and also typological characteristics similar to those found in later part of the Early Zagros Aurignacian and also probably the early phase of Late Zagros Aurignacian at Warwasi. This work suggests that Levels AA-EE (the upper part of Early Zagros Aurignacian) and Levels "X, Y, and Z" of late Zagros Aurignacian of Warwasi might be contemporaneous or similar to the early and middle phases of Yafteh cave (Fig. 10.8) (Shidrang 2015).

The small bladelets with twisted profile which were usually produced from carinated burins also increase from the middle phase. The small twisted bladelets mainly had no retouch but some were retouched into Type "B" Baradostian Bladelets or Dufour bladelets "Roc de Combe" subtype (Fig.10.9). Contrary to bladelets which are frequent in the late phase, blades are less standard and lose their importance as the primary choice for end scrapers, being replaced by flakes.

An analysis of the Pa Sangar rock shelter lithic assemblage also confirmed the reliability of the recent results of the Yafteh sequence (Shidrang 2015). Contrary to what was previously thought, the Pa-Sangar lithic collection revealed the attribution of a major part of the sequence to the Baradostian rather than just a limited part on bedrock.

Comparison of the two sequences of Yafteh and Pa Sangar enabled us to correlate the late phase of the Yafteh sequence to the main part of the central phase of the Pa Sangar sequence (Fig. 10.8). The absence of Arjeneh points at Pa Sangar may also challenge the hypothesis of in-situ presence of Arjeneh points in the later phase of Yafteh.

The final phase of the Baradostian in the Pa Sangar sequence presents a gradual change in the technological organization of carinated pieces. It is probable that the initial attempts to create pyramidal bladelet cores might have begun from carinated pieces. There is a change in economy of cores exploitation which involves a greater surface of cores to produce more blanks. The negative of twisted removals decreases and carinated cores bear mostly curved and sometimes straight negative of removals. Their debitage surface expands to sides of core for more bladelet production and become pre-pyramidal in their morphology (Shidrang 2015).

10.2.5 The Baradostian beyond Zagros

The early attempts to find Upper Paleolithic localities outside the Zagros yielded no results and a vast area, particularly the high Iranian Plateau, remained unknown until recently. Discovery of "Sefid-Ab" an open air site associated with a travertine formation near Kashan provided the first opportunity to study a new Upper Paleolithic assemblage from a different site type and in a different environmental context from the Zagros (Biglari 2004; Shidrang 2009).

General typological comparison of the surface lithic assemblage from Sefid-Ab with the well-known EUP sites of the Zagros indicated similarities between the two industries.

The Sefid-Ab assemblage contains a high percentage of single platform blade/let cores with their removals along a single face. The large number of burins at Sefid-Ab, which mostly are carinated forms, resembles the late phase of the EUP assemblage of Warwasi and Yafteh. While the Sefid-Ab lithic assemblage appears to be mainly similar to the late phase of Baradostian, it also might contain the remains of earlier periods as the survey of the site led to identification of an early eroded travertine in the vicinity of the site that yielded small number of patinated Mousterian artifacts, including Levallois elements.

In 2005, another Upper Paleolithic open air site was found near Baliran in Central Alborz, Northern Iran (Berillon et al. 2007). Garm Roud 2 yielded a single archaeological layer underlying more than ten meters of fluvial deposits observable in a terrace along the eastern side of the Garm Roud valley and yielded materials dating to ranges of 28,486 +/− 190 to 34,951 +/− 256 cal BP (Antoine et al. 2016; Table 10.1).

The assemblage consists of 113 lithic artifacts and 22 fossilized bones collected from a 3.5 m horizontal distribution of archaeological remains. The lithic assemblage is dominated by bladelet production including twisted bladelets and also multiple burins, unipolar and bipolar bladelet cores. The cores are mainly prepared from flakes but also on pebbles and blocks too. Retouched bladelets are the main tool category and there were very few burins and scrapers (Berillon et al. 2009). On the basis of the characteristics and C14 dat-

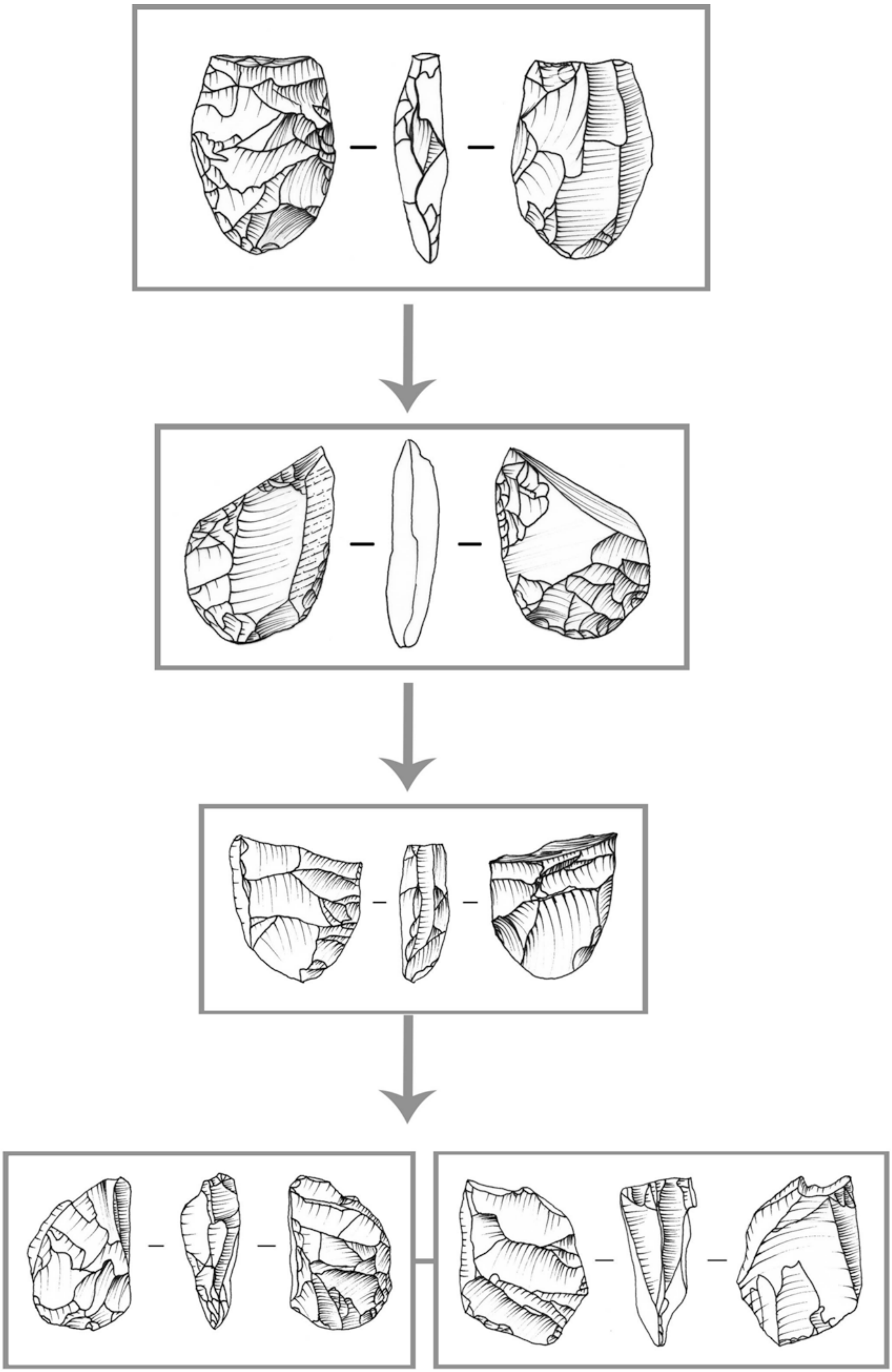

Fig. 10.7 The main part of bifacial bladelet cores reduction sequence in Yafteh cave assemblages (Drawings: S.Shidrang)

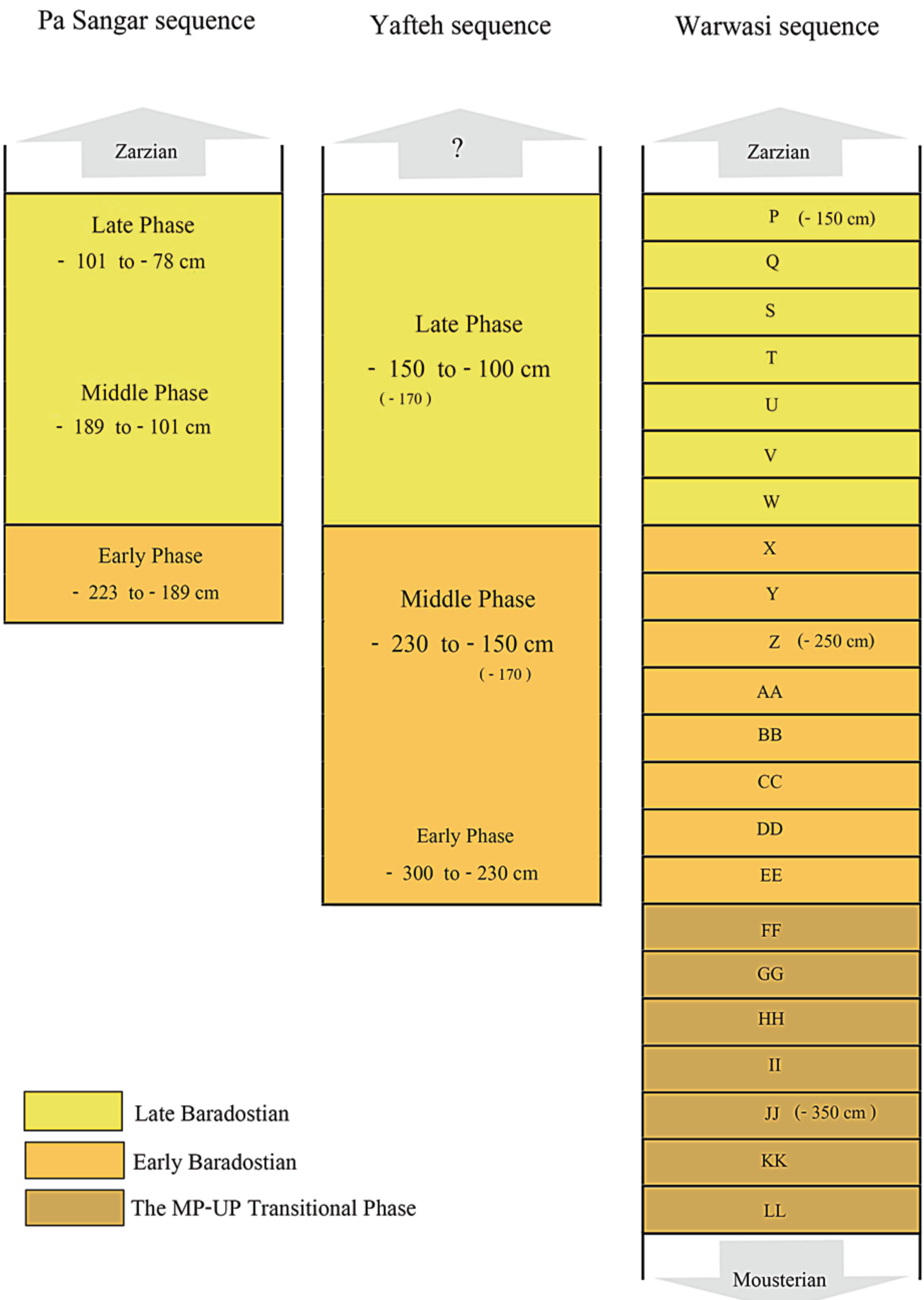

Fig. 10.8 Reconstruction of whole Baradostian sequence of Central Zagros based on the adjustment of new information from the sites of Yafteh, Pa Sangar and Warwasi (Shidrang 2015)

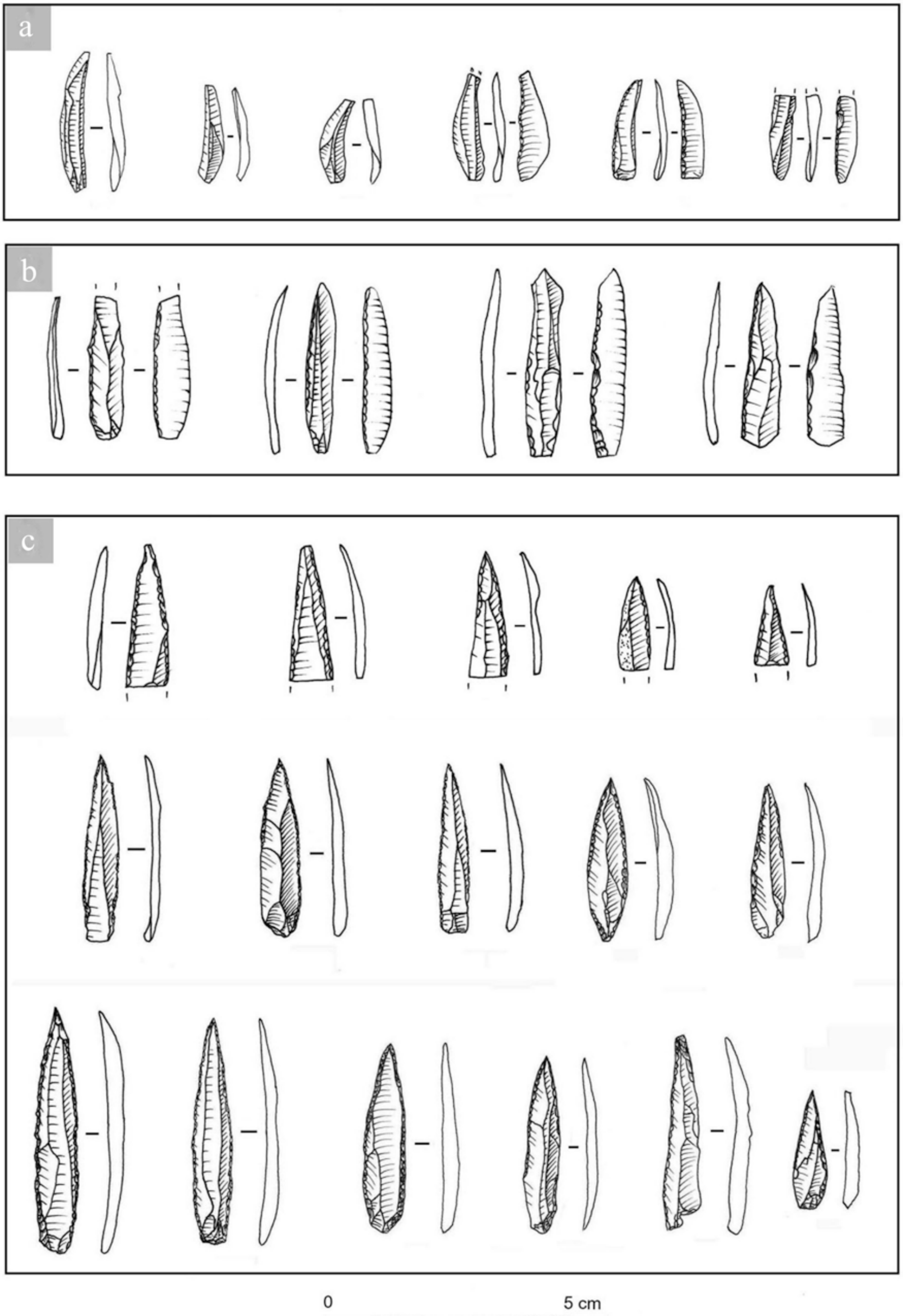

Fig. 10.9 (**a**) Baradostian bladelets (Type B); (**b**) Baradostian bladelets (Type A); (**c**) Arjeneh points (Drawings: S.Shidrang)

ing, the assemblage was assigned to the Late Baradostian (Berillon et al. 2007). Another organic sample collected from the 2006 excavation revealed a minimum age of 29,540 C14 BP for an almost homogeneous thin layer with a single short duration of human occupation (Berillon et al. 2009). The discovery of Garm Roud 2 extended the boundary of the Upper Paleolithic toward the north of Iran and helped to better understand the characteristics of a part of Upper Paleolithic tradition (Late Baradostian) in other places than the Zagros.

In 2005, a Paleolithic survey in the Qaleh Gusheh region recorded 24 prehistoric localities in the Rig Boland mobile dunes located to the north-east of the Karkas Mountains and southwest of the Latif Mountains in central Iran (Conard et al. 2009). Among the 24 lithic scatters, 19 yielded lithic artifacts characteristic of laminar technology which were designated as Late Paleolithic. Bardia or Qaleh Gusheh number 1 has been the most fruitful site of this survey with 7215 lithic artifacts. Lithic refitting demonstrated a systematic production of blade/lets with high frequency of a unidirectional knapping method. The tools are dominated by backed and laterally retouched bladelets, with both lateral edges retouched on the dorsal face being very common. Seventeen Arjeneh points were reported among other points as well as end scrapers on blades but burins were infrequent. Despite the very close similarly of the assemblage to the Early Baradostian, the authors hesitated to assign the assemblage to the Baradostian and referred to it as Late Paleolithic (Conard et al. 2009). However, they pointed out that the presence of Arjeneh points and retouched rods may suggest affinities to the Baradostian but surprisingly assigned the production of bladelets to Zarzian. Thus they decided to not use the Zagros terminologies and refer to these materials by the general term of Late Paleolithic encompassing both the Epi and Upper Paleolithic (Conard et al. 2009).

10.2.6 The Problem of the "Rostamian"

After assigning a Baradostian-like industry to the "Late Paleolithic" in Qaleh Gusheh region, the Tübingen Iranian Stone Age Research Project (TISARP) conducted some surveys in Dasht-e Rostam in the Basht region of the southern Zagros (Conard et al. 2007). The Dasht-e Rostam and Basht Region are located in the northwestern part of Fars Province. These surveys resulted in the recording of 121 Paleolithic sites and selection of a cave called Ghare-e Boof for further excavation. The result of their studies on materials from Ghar-e Boof launched another surprising conclusion. TISARP team claimed that the identified EP-UP industries of the Dasht-e Rostam and neighboring regions differ significantly from those of the Baradostian and Zarzian in the northern and central Zagros and represent a new cultural group that deserve a new name "Rostamian" (Conard and Ghasidian 2011).

A quick look at the underlying basis of their knowledge of the Zagros Upper Paleolithic lithic industries, would help us to understand the reasons of this claim.

Interestingly, they themselves mentioned that prior to the radiocarbon dates from Ghar-e Boof, they attributed all the related assemblages to the Epi-Paleolithic post-dating 20 ka BP (Conard and Ghasidian 2011). Thus naturally, the assemblage that is assigned to Upper Paleolithic only with the help of radiocarbon dates (not based on its typo-technological characteristics), would be considered as a new industry or a new cultural group.

Four major horizons were identified in the stratigraphy of Ghar-e Boof, of which some of them were divided into substrata. AH III (AH IIIa, AH IIIb) and AH IV (AH IVa, AH IVb) were the two lower horizons and contained Pleistocene deposits which are assigned to Upper Paleolithic. AH III varies in thickness from a few decimeters to 120 cm thick and yielded the main body of 37,000 lithic artifacts recovered in the Ghar-e Boof excavation.

This horizon seems to be the main and longest Pleistocene occupation of the cave, particularly in the main III layer toward the opening of the cave. The published data shows a significant difference in density of finds between the horizons III and IV.

Three radiocarbon dates from the rear of the cave provided some age determinations for the Paleolithic deposits of this site. One of these dates comes from AH III and the other two from AH IV which contained some burnt lenses and few artifacts (Conard and Ghasidian 2011). Stratigraphically, the positions of the three collected charcoal samples are not very far from each other. In other word, the 31,150 BP from AH III and the dates 33,060 BP and 36,030 BP from AH IV were collected from just a 20 cm vertical distance from each other.

Production of bladelets plays a central role in this lithic assemblage which is described as a homogenous industry. The bladelet cores are mainly unidirectional single platform and made on small cobbles from a nearby river (Conard and Ghasidian 2011).

A look at the description of the cores and the lithic drawings from this site is enough to note the close similarity of the Ghar-e boof industry to the twisted cores technology of the late Baradostian. Some of these similar characteristics are as follows:

- Unidirectional cores preserve the cortical surface of the cobbles and usually the reduction surface covers half of the pebble or cobble
- The removal surface can be located on narrow or broad face of the core
- The striking platform can be located along a projecting edge of the core

- Opposed bidirectional cores are present in lesser frequency

Most of the typological characteristics of the “Rostamian” lithic materials match those of Baradostian (Late Baradostian). The twisted bladelets with dorsal and ventral retouch (Roc-de-Combe sub-type of Dufour bladelets category) are one of the main characteristics of the Late Baradostian alongside a few Arjeneh points that may belong to the earlier phase of Baradostian in this cave. On the basis of the Ghar-e Boof lithic assemblage description and its illustrations, we can see that a major part of AH III (dated back to 31,150 BP) can be assigned to the Late Baradostian. Even though the small assemblage from horizon IV is not described separately for a detailed typo-technological study in the authors analysis, but taking into account all the available data from central Zagros, it is most probable that horizon IV, which dates back to 33,060 BP and 36,030 BP, belongs to the major part of Early Baradostian. The accuracy of this theory proposed here remains to be tested in lower deposits of Ghar-e Boof, particularly toward the front part of the cave, where the deposits seems to be accumulated to a greater depth and more importantly depends on a better understanding of the site formation process in this cave.

In their conclusion, the authors compared the Upper Paleolithic assemblage of this cave with the flake based lithic assemblage of central Zagros and stated that Ghar-e Boof presents a distinctive industry that except for Dasht-e Rostam, remains unknown in other parts of Iran (Conard and Ghasidian 2011). However, such a conclusion and comparison cannot be valid since they are comparing a typo-technologically Late Baradostian industry to the earliest flake based industry of Zagros or the early part of Early Baradostian. They even have gone further and hypothesized that the absence of Middle Paleolithic elements in the lithic assemblage of Ghar-e Boof suggests a lack of continuity between the Middle Paleolithic and the early Upper Paleolithic (Conard and Ghasidian 2011). It is crystal clear that, based on such an assemblage presenting strong characteristics of the late Baradostian (at least in a major part) or even the poorly identified underlying layer, one cannot challenge the well documented early Upper Paleolithic industries of Central Zagros and their relatively long established hypothetical background in the debate of Aurignacian origin. The results and interpretation of the Ghar-e Boof Upper Paleolithic assemblage have been presented during a time in which the techno-typological characteristics of Zagros early Upper Paleolithic or Baradostian have become fairly well defined. Thus introducing a new cultural groups or assemblage type as “Rostamian” with the same characteristics of Baradostian will have no use except to create an unnecessary terminological complexity. Current critique of their work reached them in 2015 (Shidrang 2015) and it seems they are gradually discovering that the characteristics of their lithic assemblage are already known and are moving toward accepting the similarities of the Ghar-e Boof UP lithic assemblage to the Baradostian, as implicitly reflected in their recent publication (Ghasidian et al. 2017).

10.3 Who Were the Makers of the Baradostian?

The Middle Paleolithic of the Zagros Mountains has provided paleoanthropological evidence for the identification of human groups responsible for Mousterian culture. Based on the human remains found in Shanidar and Bisitun caves, we can securely assign the Zagros Mousterian to Neanderthals (Solecki 1963; Trinkaus 1983; Trinkaus and Biglari 2006). However, the Early Upper Paleolithic human remains are more fragmentary and their archaeological context are unclear. The premolar of Wezmeh cave in Kermanshah, dated back to OIS3 or early OIS2 based on gamma spectrometry, might belong to an Upper Paleolithic early modern human that was brought to the carnivores den (Trinkaus et al. 2008).

But, in 2009 the results of a recent study on the Eshkaft-e Gavi hominin remains revealed new interesting discoveries for the Upper Paleolithic of the Zagros (Scott and Marean 2009). The Eshkaft-e Gavi cave contained Middle Paleolithic and Upper Paleolithic layers followed by Epi- Paleolithic deposits that contained the hominin remains. The hominin remains are attributed to anatomically modern humans but unfortunately the age of the bulk of the sample is uncertain. However, a molar recovered at the base of the Upper Paleolithic sequence near the boundary with the Middle Paleolithic confirmed the attribution of this layer to AMH, at its early stage. Many of the hominin specimens have been burnt but the contextual information was not enough to prove whether this burning resulted from intentional cooking or secondary burning. However, interestingly, four of the hominin specimens showed clear traces of stone-tool butchery by humans which indicated the possibility of cannibalism at this site. The Eshkaft-e Gavi hominin sample expanded the record of human butchery of human carcasses into the Upper Paleolithic or Epi-Paleolithic of the Zagros Mountains (Scott and Marean 2009).

10.4 The Baradostian in the Light of New Research: Where Do We Stand?

Finally, in putting together all the available data, an image emerges that certainly is incomplete and needs many refinements but considering the current state of data seems to be quite acceptable.

In the central Zagros, the late Middle Paleolithic, marked by a high frequency of convergent scrapers, Mousterian points and moderate use of Levallois, is replaced by a fully evolved Early Upper Paleolithic. However, this replacement is not clear cut in the Zagros sequences and between the extremities of the two industries there is a phase which has yielded an assemblage with characteristics of both the periods of Middle and Upper Paleolithic.

The Middle Paleolithic layers of Warwasi were divided into four phases by Dibble and Holdaway (1993). The A and B phases were quite similar in character and contained many single scrapers and phase C also displayed more tendencies of the earlier ones. However, phase D (Levels JJ-MM) or the latest phase was different in character and contained more typical Mousterian points and convergent scrapers that were mixed with Upper Paleolithic elements (Dibble and Holdaway 1993). A year later Olszewski and Dibble proposed a strong probability of continuity between Middle Paleolithic and Early Upper Paleolithic industries in Zagros, based on the assemblages from Levels AA-LL (Olszewski and Dibble 1994, 2006). In this view, the levels classified as an early phase of Zagros Aurignacian display a developmental sequence from Middle Paleolithic throughout Levels AA-LL into evolved or late Zagros Aurignacian which is between Levels P-Z. However this developmental process was based on the typology of artifacts and in fact decreases in frequency of Mousterian type elements and increases in Baradostian type elements. The combination of mainly Middle Paleolithic scrapers and some truncated-faceted pieces and Upper Paleolithic tools like endscrapers on blades, burins and tools on bladelets like Arjeneh points or Dufour bladelets were the characteristics of the transitional layers of Warwasi. Although, Olszewski acknowledged the fact that unlike the Levantine transitional industries which contain Upper Paleolithic tool types with transitional technologies; in Warwasi there is only Middle and Upper Paleolithic tool types. However then she emphasized that the Warwasi sequence displays a shift toward more bladelet production through time and shows less alteration in core reduction strategies for each specific core (Olszewski 2007).

Despite all the efforts that have been made to describe the transitional nature of Early Zagros Aurignacian at Warwasi, the issue still seems to be problematic. It is not possible to understand how an evolved soft hammer blade/let technology may have originated directly from a typical Mousterian hard hammer flake industry, with both stratigraphically found in the same layer. We could also think of an alternative probable explanation for the AA-LL levels of Warwasi rockshelter. What we have in these levels can also indicate a mixture between the layers containing the industries of two different periods. Despite the lack of a clear stratigraphic hiatus between the Mousterian and the Early Baradostian, the density of artifacts decreases between the end of the Mousterian and the beginning of the Early Baradostian deposits which may indicate a change in demography or settlement pattern of the site. According to this explanation, the first 70 cm of deposits right above the pure Mousterian (Levels LL to FF) may be the result of inter-level mixture by different agents. However, another tempting hypothesis may lead us to think what if two different types of populations or in fact human bands were responsible for this mixture. According to this hypothesis, the makers of the Zagros Mousterian or Neanderthals were using the site periodically while some newcomers with blade/let technology were spreading through the landscape gradually and using the rockshelter as well in the absence of Neanderthals. This is a very attractive scenario which lacks fundamental evidence like reliable chronological determination of the crucial levels, reliable stratigraphical information and associated human remains with these layers.

Based on the presented results of the Yafteh cave assemblages, the earliest Baradostian was not as sophisticated as the evolved Baradostian of the middle phase. In this industry, blades and bladelets were produced by soft hammers from single platform prismatic cores with plain platforms. The products were mostly pointed bladelets with straight profile and also moderate size blades from the initial stage of the same reduction sequence. The toolkit is quite simple including Arjeneh points and retouched bladelets with a few Dufour (Dufour subtype) and a moderate frequency of end scrapers on blades. These characteristics can be found in Proto-Aurignacian of Europe and in part the Early Ahmarian industry of the Levant. Taking into the account the available dating for the Baradostian, we might assume that the similar diffusion trend (or agent) that made the Proto-Aurignacian and Early Ahmarian, spread into the Zagros roughly around 36,000 14C BP. Interestingly, tools percentage ratio to debitage is fairly high in this phase which may indicate short term visits of EUP hunter-gatherers to the Yafteh cave rather than a long seasonal occupation in the beginning of the sequence.

As the sequence of Yafteh shows us, we can trace the evolution of this industry throughout its core management toward a more volumetric shape and more complex and diverse reduction sequences. The single phase based on the Bayesian model presented in Otte et al. 2011 is around 33,500 which may belong to the middle phase of Baradostian which represents its highest point of complexity (Shidrang 2015). In this phase, blades become more important and there seems to be a new line of blade production as end scraper's blanks or being retouched laterally into notches or regular retouched blades. Diversity of bladelet cores increases in the middle phase which displays some degree of specialization for production of different bladelet type. There is also evidence of frequent intentional use of ocher and a fire place. All the evidence, particularly the considerable number of domestic tools, suggest a strong probability of an intense occupation specialized in hide working and piercing the hides and ornaments. While keeping its Proto-Aurignacian characteristics, the middle phase of the

Baradostian transformed into a more complicated industry with more diverse and specialized tools. This may remind us of the Early Aurignacian, however, with major differences which are beyond the scope of this paper in comparing these two industries in great detail. In the middle phase of the Baradostian, blade production is not as important as in the Early Aurignacian and carinated scrapers which usually are found in a blade dominant context do not play a typological key role in the Baradostian. However specialization and individualization of the reduction sequence, emphasis on domestic tools made on blades, higher frequency of ornaments, bone tools and frequent use of ocher and other minerals are the general similarities of the two entities. We are not sure when exactly this phase ends but it may have continued until around 30,000 14C BP and the last phase of Baradostian may be placed roughly between 30,000 14C BP to roughly 25,000 14C BP.

The first impression of the later phase of Yafteh cave is significant reduction in components size. A significant number of small twisted bladelets were left unretouched but some have been retouched into Dufour bladelets of "Roc de Combe" subtype, while the production of Arjeneh points decreases dramatically and become almost extinct (Shidrang 2015). The small standardized and lateralized carination technology with a significant frequency of carinated burins (and in lesser number nosed scrapers and small pyramidal cores) and their twisted bladelets began sporadically in middle phase of the sequence and become dominant characteristics of the assemblage in the late phase of Baradostian. End scrapers are usually made on flakes or smaller blades and display a clear reduction in size as we approach the end of Baradostian.

Despite the absence of proper information on the depositional history of the site like stratigraphy and chronology, the Pa Sangar collection provided us with valuable information on the late phase of the Baradostian industries. A recent study revealed that about one meter of the depositional sequence belongs to the Baradostian, which according to the artifact density and their characteristics in each depth can be divided into three phases (Shidrang 2015).

Pa Sangar assemblage is one of the rare assemblages which allow us to detect the changes at the end of Baradostian and its disappearance or transition into Zarzian. Based on the Pa Sangar sequence we may suggest that there is a transitional phase from the Baradostian to the Zarzian. At the end of the Baradostian, the twisted bladelets production loses its importance and a notable number of straight bladelets from semi-pyramidal and pyramidal cores become prominent. These bladelets were used to produce notches and denticulates and backed pieces which were not very significant in the Baradostian. It has been suggested by Hole and then Olszewski that the Zarzian evolved out of the Baradostian based on the Khorramabad sites and Warwasi rockshelter in Kermanshah (Hole and Flannery 1967; Olszewski 1993). But similar to Warwasi, the Pa Sangar sequence also provided us with more evidence in favor of a continuation between the two entities since there is no stratigraphical break between the Baradostian and Zarzian levels and technologically there seems to be a transformation of reduction strategies between the two industries. While the late Baradostian has resemblances to the carinated phase of the Levantine Aurignacian in the Zagros, described by Williams (2006), it also resembles the late Aurignacian of Europe (Bordes 2006).

10.5 Concluding Remarks

Improving the current state of knowledge to understand the crucial shift between the Middle Paleolithic and Upper Paleolithic of the Zagros is faced with several fundamental limitations. First, our knowledge is limited mainly to one site with a major assemblage "the Warwasi rockshelter"; second is the lack of high resolution stratigraphical and chronological information; and, third is the fact that the late Zagros Mousterian is relatively less-known than Late Middle Paleolithic in other regions like the Levant.

The Zagros Mountains and its many Paleolithic sites are particularly important in the studies based on both biological and cultural diffusion theories which discuss the expansion of modern humans and their innovative Upper Paleolithic culture into Eurasia, ultimately replacing the earlier hominids in all regions. However, they also have implications for gradual local evolution of the lithic industries. The variety of the geographical and cultural contexts in which the different traditions developed, and major and minor movement of hunter-gatherer groups within the regions of the Zagros into or from neighboring areas like the Levant or via the northern corridor, were certainly responsible for the archaeological documents of a MP-UP shift in this region. Unfortunately, the current state of the data are not sufficient to reconstruct the processes leading to the appearance of the Earliest Upper Paleolithic in this region. According to the review of evidence in this paper, it is more likely that we have a phase of mixture in the very beginning of Baradostian in Zagros. The phase of mixture can be the result of several factors including both mechanical movement of materials and anthropogenic reasons. The key to understanding this phase is systematic reliable chronological age determinations accompanying multidisciplinary approaches to understand the site formation process. However, for the full bladelet industry of early Baradostian, we are on a firmer ground. This standardized bladelet lithic industry accompanied by a moderate presence of organic tools and ornaments, is the representative of an abrupt shift between the material culture of the Middle and Upper Paleolithic in the Zagros. The Yafteh cave excavation yielded considerable evidence of personal ornaments, bone tools and frequent use of ocher and other minerals throughout the sequence of Baradostian (Fig.10.10) (Otte

Fig. 10.10 The earliest known evidence of symbolic and relatively complex behaviors in Early Upper Paleolithic of Iran (Photos: Shidrang&Biglari)

et al. 2007; Shidrang 2015). Such evidence is completely absent in the Middle Paleolithic of the Zagros and their presence in the early Baradostian reveals another example of dissimilarity in their cultural adaptation history that cannot be easily ignored. These changes in material culture may reflect the undeniable differences of social and economical aspects of hunter-gatherer life in the Middle and Upper Paleolithic of the Zagros.

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11 Upper Palaeolithic Raw Material Economy in the Southern Zagros Mountains of Iran

Elham Ghasidian and Saman Heydari-Guran

Abstract

It is believed that there is a strong link between raw material exploitation and lithic technology. The raw materials play an important role in imposing special technology to hunter gatherers for adapting themselves to their environment. The Zagros region with complex topography, as an island of moisture and the rainfall, provided sufficient food, water and raw material resources. In this paper, we focus on southern Zagros where the compromise between technological needs and the raw material resources in the Dasht-e Rostam-Basht region, led us to propose a model of "*optimization of mobility, technological strategies and land use*. This model examines this hypothesis that the residents of the region during their seasonal movements for following migratory preys adopted the lamellar technology of the Rostamian in order to minimize time and energy costs associated with raw material procurement and transport. Testing this model in the southern Zagros was based on the techno-typological analysis of the lithic assemblages from the survey sites in the Dasht-e Rostam-Basht region and the stratified lithic assemblages from the Ghār-e Boof Cave.

Keywords

Iranian Plateau • Zagros Mountains • Upper Palaeolithic • Rostamian • Baradostian • Lithic raw material

11.1 Introduction

It is widely accepted that the lithic raw material resources have great influence on the mobility of the Palaeolithic hunter-gatherers and the communication between these groups (Fisher and Eriksen 2002). The needed stone raw material is provided either by directly exploitation or indirectly by exchanging with the other groups (Blades 2001). Therefore, raw material economy, lithic technology and mobility strategies are closely related (Miller 1997). There is a strong link between raw material exploitation and lithic technology. In relation to mobility and land use patterns, raw materials play the essential role of an economic bridge between technology and the subsistence adaptations by imposing the ways foragers use the landscape and develop their lifestyle (Kuhn 1995). Therefore, stone raw material procurement and economy must be considered in a broader context of hunter gatherers subsistence and settlement systems (Fisher and Eriksen 2002).

In this paper the study of raw material economy involves with (1) availability of the raw material, (2) raw material procurement strategies, (3) preparation and reduction and (4) selection of especial technologies in order to reach to a tool form appropriate to subsistence strategies in the southern Zagros Mountains of Iran.

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To date the study of Palaeolithic raw material economies on the Iranian Plateau is limited to few case studies in the west central Zagros Mountains (e.g. Heydari 2004; Biglari 2007). Some scholars believe that the raw material resources in the Zagros suffered from constraints, which highly influenced the lithic technology and typology (see Dibble 1984; Baumler and Speth 1993). However, the new data on the raw material sources proved that it was not the pervasive issue throughout the Zagros (Heydari-Guran and Ghasidian 2012; Ghasidian and Heydari-Guran 2012; Heydari 2004; Biglari 2007). In his analysis, Biglari argues the influence of using local and non-local raw materials in adoption of different core reduction technologies and selecting tool blanks among the Middle Palaeolithic assemblage from Do-Ashkaft cave of west central Zagros Mountains (Biglari 2007). There, the elaborated retouched tools are preferably made on the better quality non-local raw material, however the local raw material used expediently and not so often among the retouched tools (Biglari 2007).

Throughout the Zagros no large raw material work shop has been observed during Upper Palaeolithic (UP) (Ghasidian and Heydari-Guran 2012). On the contrary, during Middle Palaeolithic, there are some indications on the quarry workshop sites including Chakhmaq li (Heydari-Guran and Ghasidian 2004) and Bagherabad (Ghasidian and Heydari-Guran 2012).

Recent studies on the UP assemblages from the Zagros show that this period encompasses major socioeconomic and cultural changes in the subsistence strategies and settlement patterns resulting in more cultural variability than once thought (Ghasidian 2014).

The Zagros region with complex topography rises from the surrounding deserts of Iraq and Iran as an island of moisture and the rainfall has been always sufficient to support food and water resources (Heydari-Guran 2015). It is divided into four macro zones of the northern, west central, central and southern (Heydari-Guran 2015). Each of these macro zones offers different ecosystems that yields different techno-complexes among the UP of the Zagros (Ghasidian 2012a; Ghasidian et al. 2017). This variability is partly reflected in the lithic assemblages namely Baradostian (Solecki 1963; Hole and Flannery 1967; Olszewski 1993; Shidrang 2015), Zagros Aurignacian (Olszewski and Dibble 1994, 2006; Otte et al. 2007, 2012) and the Rostamian (Ghasidian 2014) presenting different techno-typological characteristics. The Baradostian is documented as flake based industry with a focus on flake blank tools (Solecki 1963; Olszewski 1993). The laminar débitage especially the bladelets appeared at the late phase of the UP or late Baradostian which are considered as prototypes of geometric microliths during Epipaleolithic or Zarzian (Hole and Flannery 1967). Reconsideration of the Baradostian led some scholars to conclude that the especial core reduction, different kinds of burins and scrapers, as main tool types, are reminiscent of the Aurignacian as documented in Europe. Therefore, they prefer to use the term Zagros Aurignacian instead of Baradostian (Olszewski and Dibble 1994, 2006; Otte et al. 2007, 2012). The Baradostian and/or Zagros Aurignacian lithic industries are documented in the northern and west central Zagros Mountains. However, in the southern Zagros the UP industries show different techno-typological characteristics. Here the Rostamian cultural group, named after the Dasht-e Rostam-Basht region, is focused on the bladelet production (Ghasidian 2012b, 2014). This pattern is seen in selection of tool blanks as well. The Rostamian documents one of the oldest bladelet production during UP throughout the Zagros and the Iranian Plateau. The bladelet production starts around 41 kyr cal. bp. and lasted through the UP (Ghasidian 2012b, 2014).

In this paper we try to illuminate the role of procurement and use of lithic raw materials in the context of broader patterns of technological change in the Rostamian early UP of the Dasht-e Rostam-Basht region of the southern Zagros. Based on the compromise between technological needs and the raw material resources in the Dasht-e Rostam-Basht region, we propose a model of "*optimization ofmobility, technological strategies and land use* (OMTSLU)" (*sensu* Brantingham 2003). This model examines this hypothesis that the residents of the region during their seasonal movements for following migratory preys adopted the lamellar technology of the Rostamian in order to minimize time and energy costs associated with raw material procurement and transport. Testing the model OMTSLU in the southern Zagros was based on the techno-typological analysis of the lithic assemblages from the survey sites in the Dasht-e Rostam-Basht region (Heydari-Guran 2014) and the stratified lithic assemblages from the Ghār-e Boof Cave (Ghasidian 2014). The study of raw material economy among the UP sites of the Dasht-e Rostam-Basht region is significant in a) understanding the raw material impacts on the lithic reduction and organization of technology, b) reconstructing the size and form of the territories of the Dasht-e Rostam-Basht region occupants.

The data extracted from this study will provide answers to the following questions:

1. How much could the quality and quantity of the raw materials in the region affect the knapping techniques, reduction intensity and provision of the tools?
2. How was the raw material procurement controlled in the settlement and social systems of the early UP inhabitants of the Ghār-e Boof and the Dasht-e Rostam-Basht region?
3. How much can raw material distributions on the Dasht-e Rostam-Basht region reflect the range and organization of hunter-gatherer mobility?

Both chaîne opératoire and attribute analysis approaches employed in the study of technology and typology of the stratified lithic assemblages from Ghār-e Boof cave and the other UP assemblages from the surveyed sites in the Dasht-e Rostam-Basht region.

11.2 Palaeolithic Research in the Dasht-e Rostam-Basht Region

Dasht-e Rostam-Basht consists of a highly seasonal region with arid and semi-arid typical Mediterranean climate located in the southwestern Zagros Mountains of Iran. The research area is divided into several smaller areas of Dasht-e Rostam plains I and II, Yagheh Sangar Rostam pass and Khanahmad, which altogether covers an area of around 500 km^2 (Fig. 11.1). The region consists of rough, steep and karstic mountains and several relatively small flat intermountain plains which are connected to each other by natural passes, rivers and seasonal streams (Heydari-Guran 2014) (Fig. 11.2).

The survey in the Dasht-e Rostam-Basht region was undertaken during 2004 through 2007 along the rim of the mountains (Heydari et al. 2004; Conard et al. 2006, 2007a, b; Heydari-Guran 2014). Most areas, especially rich in caves and rockshelters, were surveyed extensively and almost all visible caves and rockshelters were checked (Heydari-Guran 2014). The survey documented 109 caves and rockshelters and two open air sites associated with UP lithic artefacts in 13 microhabitat areas (Table 11.1). At the time of survey and collecting lithic artefacts, some sites yielded high number of lithics that required a systematic method of collecting artefacts with help of grids and measurement instruments (Heydari-Guran 2014, p. 88). For evaluating the results from survey and recover the stratified and dated Palaeolithic data, during 2006 and 2007 a cave site in the Yagheh Sangar Rostam pass has been excavated (Conard et al. 2006, 2007a, b).

Ghār-e Boof Cave is located in the Yagheh Sangar Rostam pass where two plains of Rostam I and II are connected to each other (Figs. 11.1 and 11.3). Most of the UP caves and rockshelters of the Dasht-e Rostam-Basht region are located in this corridor. An area of 18m^2 was excavated and in some parts reached to the depth of 230 cm (Ghasidian 2014). A total number of 37,658 lithic artefacts have been unearthed during these two seasons all assigned to UP (Conard et al. 2007a, b; Ghasidian 2014). The UP assemblage from Ghār-e Boof comes from four archaeological horizons (AHs) of I through IV. Since the AHs I and II (including sub horizons

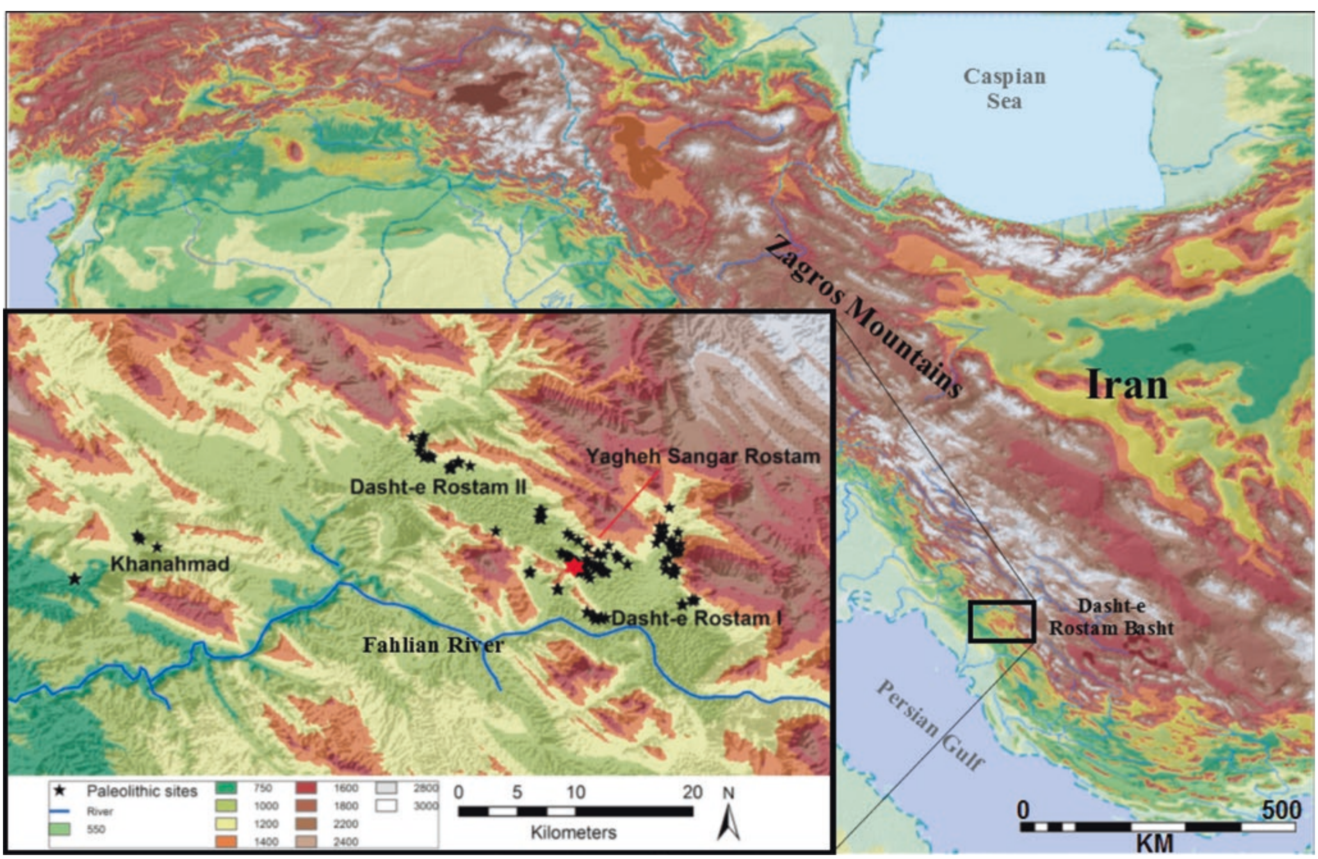

Fig. 11.1 Map of Iran: showing the study area

Fig. 11.2 Dasht-e Rostam-Basht region, a view to the Dasht-e Rostam plain II (Photo by S. Heydari-Guran)

Table 11.1 The distribution of the Fahliyani and Khanahmadi stone raw materials in the different microhabitat areas of the Dasht-e Rostam-Basht Region (After Heydari-Guran 2014)

Microhabitat areas	Fahliyani chert %	Khanahmadi chert %
1. Yagheh Sangar	89.4	10.6
2. Narenjuon	79	21
3. Fahliyan	95.8	4.2
4. Dasht-e Rostam II	74.6	25.4
5. Sarab Siah	14.3	85.7
6. Shiv	9	79.1
7. Zir Du	98.5	1.5
8. Masiri	80.6	19.4
9. Eshkaftu	69.3	30.7
10. Khunj Pir Sabz	90.2	9.8
11. Khunj	54.5	45.5
12. Khanahmad	21.1	78.9
13. Sukhteh	59.6	40.4

IIa and IIb) still contain the mixture of UP lithics and the historical pottery sherds, here we include the lithics from AH III (including sub AHs IIIa, IIIb) through IV.

The radiocarbon dating points from AH III and IV place Ghār-e Boof Cave between 35 kyr cal BP and 42 kyr cal. BP in the early UP of the southern Zagros Mountains. The samples come from AH III through IV from depths ranging between 600 and 482 cm (Ghasidian 2014, p. 62, Becerra-Valdivia et al. 2017) (Table 11.2).

11.3 Lithic Raw Material Sources in the Dasht-e Rostam-Basht Region

From the early stages of the survey in the area, we found out most of the lithic artefacts are made of two identical types of stone raw materials. Searching for raw material sources

Table 11.2 The radiocarbon dates from Ghār-e Boof

Unit	Find no.	AH	Flora type	Z	Radio carbon date	Cal. BP
6/2	156	III	*Lathyrus*	600	31,150 + 250/-240	35,152 ± 368
6/2	209.2	IV	*Vicia ervilia*	585	36,030 + 390/-370	41,355 ± 326
6/2	209.1	IV	*Vicia ervilia*	585	33,060 + 270/-260	37,529 ± 682
6/8	169	IIIb	*Lathyrus*	490	33,850 ± 650	38,994 ± 1419
6/8	172	IIIb	*Lathyrus*	482	34,900 ± 600	39,949 ± 921

After Ghasidian (2014)
AH archaeological horizon, *Z* depth

Fig. 11.3 Ghār-e Boof cave in the Yagheh Sangar Rostam pass (Photo by S. Heydari-Guran)

resulted into the discovery of two main chert sources which were dominant raw materials among the lithic assemblages of the Ghār-e Boof cave and the other UP sites of the region (Table 11.1). One of these two sources is found in a secondary context while the other is in a primary context. The former is embedded in the Fahliyan river therefore is called here 'Fahliyani chert', and the latter is the *in situ* source in the Khanahmad habitat area and therefore is called 'Khanahmadi chert'. Here the description of each raw material type is based on the macroscopic characteristics of each type including texture grain size, colour, any impurities, cortex etc. as follow:

11.3.1 Fahliyani Chert

The Fahliyani chert source is a secondary deposition composed of pebbles about 5–10 cm in diameter (Fig. 11.4) which are only found in Fahliyan riverbed within the study region. The pebbles have fractured and cracked exteriors which are the result of crashing with other pebbles in the water over a long time. These pebbles are well rounded, which indicates that the Fahliyan River transported them over long distances. According to geological and hydrological maps, these stones are probably moving in different tributaries of the Fahliyan River which pass from the radiolarite belt of Neyriz exposed in the high Zagros Mountain zone around 250 km northeast of the Dasht-e Rostam-Basht region (Ghasidian 2014). Since the Fahliyan riverbed covers a large area (25 km length and averagely 800 m width), the availability and abundance of the Fahliyan cherts are remarkably high in the Dasht-e Rostam-Basht region (Heydari-Guran 2014). The most abundant raw material type of Fahliyani is a radiolarian chert that occurs in a spectrum of warm colours, from yellow to red, and in a variety of textures, from coarse to medium to fine-grained. Although Fahliyani pebbles mostly have fine texture, knapping them was difficult, since they encompass hitting and pressure caused by being a long time in the river from the primary context until the time of procurement by the knappers. In some cases, removing only a thin layer of cortex was not enough for decortication and for the beginning of the reduction process because many of the impacts extend deeply into the raw material structure (Fig. 11.5). Therefore the preparation and decortication of these pieces is done by removing thicker preparation blanks (Ghasidian 2014, p. 107).

11.3.2 Khanahmadi Chert

The Khanahmadi chert belongs to a geological folded formation close to the microhabitat area of Khanahmad and composed of thin layers of radiolarite and carbonate rocks, which

Fig. 11.4 Fahliyani chert pebble (After Ghasidian 2014)

Fig. 11.5 Fahliyani chert showing cracks and impurities (After Ghasidian 2014)

are mixed together as banded layers. Unfortunately, at the time of survey it was not possible to make an outline of the geographical boundary of the Khanahmadi chert distribution in the region and therefore we located the only visible area that this chert layer has exposed. It is a tabular form of chert which is mostly fine grained in texture, although, like Fahliyani, the medium and coarse-grained textures are also present but not so often used among the lithic assemblages. Generally, the Khanahmadi chert blocks are larger in volume than the Fahliyani. The chert layers in the Khanahmadi material are formed between limestone layers which are firmly attached to the chert layer making it difficult to separate. Often the reduction occurred to first remove this limestone layer to get into the chert to begin with the reduction (Ghasidian 2014, p. 108). Although the Khanahmadi chert is fine in texture, the banding limestone-chert layers sometimes produced cracks and ridges inside the material caused the piece to break apart during knapping (Ghasidian 2014). This frequent cracking and breaking led to the higher abundance of angular debris among the Khanahmadi material (Ghasidian et al. 2009) despite that most of the preparation of the raw material took place at the chert quarry. Fig. 11.6 shows a sample of Fahliyani and Khanahmadi cherts.

11.3.3 Other Stone Raw Materials

Although in a small portion, several other raw material types are present among the UP lithic artefacts of this region including dolomite, chalcedony and quartz (Heydari-Guran 2014). Dolomite is abundant in and around the Dasht-e Rostam-Basht region as large blocks. Due to their abundance and hefty size, the pieces formed from the local dolomite are larger than the other two chert types.

Chalcedony and quartz comprise the other prevalent types of utilized raw materials at the Dasht-e Rostam-Basht region sites. However, their sources are presently unknown and are considered as imported material (Heydari-Guran 2014). A single artefact made on schist is also present among the Ghār-e Boof cave assemblage and was probably imported to the site (Ghasidian 2014, p. 110).

Fig. 11.6 A sample of Fahliyani and Khanahmadi chert (After Ghasidian 2014)

11.4 Raw Material Economy in the Ghār-e Boof Cave

Since the strata from Ghār-e Boof cave show a time depth of around 7 kyr, in the analysis and comparisons of the assemblage of each stratum, it was important to note any probable change through time. Therefore, each techno-typological variability, revealed from particular temporal contexts, was documented in order to see any economic variability across space. A close comparison of these stratified material with the survey assemblages from the Dasht-e Rostam-Basht region have been undertaken in order to have a complete view on the raw material economy during early UP in this part of the southern Zagros.

All assemblages from the UP sequence at Ghār-e Boof Cave (AHs III to IV) are characterized by strong emphasis on the production of bladelets from single platform cores using direct soft stone hammer percussion (Ghasidian 2014). Almost all cores throughout the stratigraphy are bladelet cores. The blades and flakes from Ghār-e Boof show a high degree of cortex or technical characteristics which relates them to the core preparation and rejuvenation pieces.

Despite duration of 7 kyr of the UP sequence, the technological and typological characteristics of the assemblages remain relatively homogeneous. Bladelets are the main blanks for tools throughout the sequence and represent in different variants of retouch. The tool classes throughout the sequence stay the same although the frequency of them changes from AHs III-IV. The radiocarbon dates show that Ghār-e Boof contains one of the oldest UP assemblage specialized in bladelet production throughout the Iranian Plateau. This specialized bladelet industry was introduced as a new cultural tradition of the "Rostamian" named after the Dasht-e Rostam where the cave is located (Ghasidian 2014).

For the UP sites of the Dasht-e Rostam-Basht region the raw materials used are divided into two zones of raw materials (according to zoning system of Féblot-Augustins 1997 and Geneste 1989): zone 1, sources up to 5 km and zone 2, sources between 5 and 40 km far from the site.

Based on this zoning model, for Ghār-e Boof cave the Fahliyani chert is located in the first zone which is located in an area around the site at a distance of less than 6 km, and as the second zone the Khanahmadi chert is located around 20 km far from the cave and can be considered as imported raw material. This zoning is flexible for the other sites of the Dasht-e Rostam-Basht region based on their distance to these raw material resources (Heydari-Guran 2014; Ghasidian 2014) (Fig. 11.7).

The dominant raw material among the whole lithic artefacts from the Ghār-e Boof is the Fahliyani chert (Fig. 11.8). It is the same through all AHs (Table 11.3). In the study of the lithic economy in the Ghār-e Boof, AH III and IV have been considered, since there is no mixture of Palaeolithic and non-Palaeolithic materials has been observed. Each stratum has been analysed separately and then comparison has been made between the strata. Each Assemblage has been divided generally into six major categories of cores, tools, flakes, blades, bladelets and debris including angular debris, small and micro-débitage.

11.4.1 AH III

This AH includes the major number of lithic artefacts throughout the stratigraphy. AH III itself is divided into two

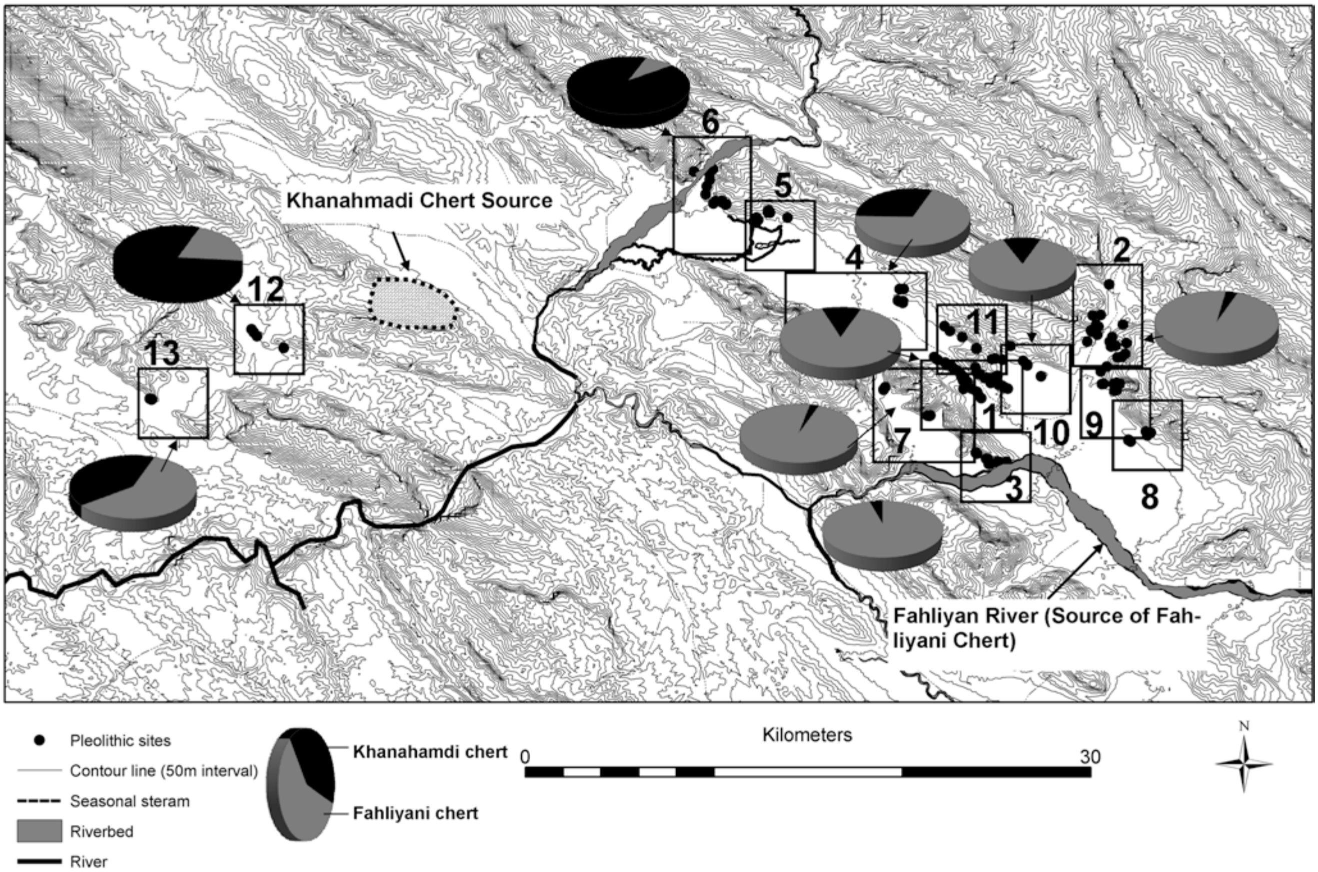

Fig. 11.7 Map of Dasht-e Rostam-Basht region showing the distribution of raw material in each microhabitat area (After Heydari-Guran 2014)

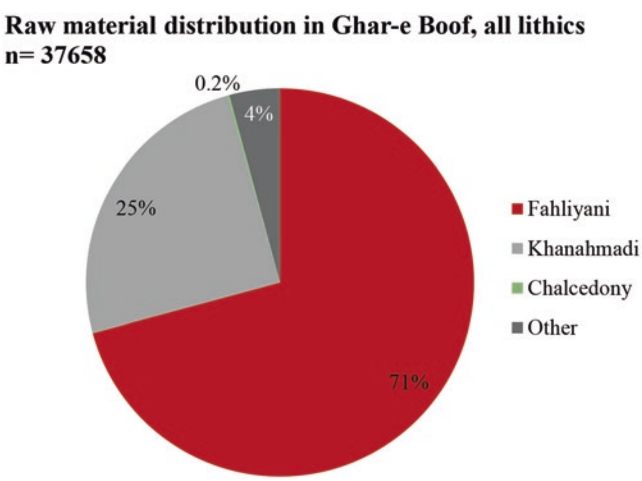

Fig. 11.8 Raw material distribution among the lithic artefacts of Ghār-e Boof Cave (all strata) the percent is based on the weight of the raw material

sub-horizons of IIIa and IIIb. In AH III the dominant raw material used is local Fahliyani chert which is considered as zone 1 (Tables 11.4 and 11.5). Due to their small size, the Fahliyani pebbles are easily transportable with less cost of energy. All stages of the chaîne opératoire are present. Although the Fahliyani raw material, in all technological categories, comprises the majority, it reduced among the tools to around half (55.4%) of the whole tool assemblage. This raw material appears in different grain size (fine to coarse). Since the whole assemblage is focused on producing bladelets, fine-grained chert is the most frequent (Table 11.6). The high number of cortical flakes and blades and the debris indicates the high reduction of Fahliyani chert in the site from the first stages of preparation until the tool production. The tools on the preparation and rejuvenation flakes and blades especially cortical pieces are frequent among the Fahliyani chert. Four Fahliyani cobbles without any modification are among the assemblage indicating that the whole process of reduction from core preparation to tool production occurred at the site.

The second frequent raw material is Khanahmadi chert is considered as the second zone of around 20 km far from Ghār-e Boof cave.

Due to the special formation of this chert between limestone layers, the knappers had to knapp the fine-grained chert at the outcrop and import it to the site. They mostly imported the fine-grained parts of the raw material. In all

Table 11.3 The distribution of the raw material among the lithic assemblage of Ghār-e Boof. All AHs. The sub-AH IVa and IVb are included with IV since they yielded only 3 artefacts made on Fahliyani chert

AH	No	Fahliyani		Khanahmadi		Other		Total g.
		g.	%	g.	%	g.	%	
I	10	50.6	**92.5%**	4.1	**7.5%**			**54.7**
II	604	279.6	**78.6%**	57.6	**16.2%**	18.6	**5.2%**	**355.8**
II a	2482	1284.4	**64.6%**	487.9	**24.5%**	215.3	**10.90%**	**1988.6**
II b	3308	1743.9	**78.1%**	446.9	**20.0%**	41.6	**1.80%**	**2232.4**
II b F.1	386	251.1	**73.3%**	91.2	**26.6%**			**342.3**
III	25,067	11564.7	**69.8%**	4295.4	**25.9%**	711.6	**4.30%**	**16571.7**
IIIa	3052	2163.7	**73.6**	599.8	**20.4%**	176.3	**6%**	**2939.8**
IIIb	2264	1290.4	**67.4%**	599.6	**31.4%**	21.8	**1.20%**	**1911.8**
IV	485	474.2	**79.7%**	115.6	**19.4%**	4.8	**0.8%**	**594.6**
Total	**37,658**	**19102.6**	**70.8%**	**6698.1**	**24.8%**	**1190**	**4.40%**	**26991.7**

technological categories, this raw material keeps around 1/3 of the whole raw materials (Tables 11.4 and 11.5). The pattern of using fine textured raw material is also seen among the Khanahmadi raw material. In some tools the fine and coarse texture are joined together because of the tabular nature of the raw material. In these cases, it was observed that the retouched edges or active part of the tool was chosen on the fine grained part. The tools on coarse grained Khanahmadi chert compose only around 3% (Table 11.6).

There is no core other than Fahliyani or Khanahmadi raw materials. Flakes, blades and bladelets comprise a small number among the raw material category of "other", the same with debris (Tables 11.4 and 11.5). A total number of 24 tools made of other raw material types including mostly chalcedony (19 pieces). The tools on chalcedony compose of bladelet blanks and are consistence with the rest of the assemblage. But based on the weight of the raw materials, surprisingly the tools under the "other" category compose around 25% of the whole tool assemblage of AH III, since there are 2 heavy duty tools made on dolomite and schist of unknown raw material source among the assemblage. These pieces are different tool types which were imported to the site as finished forms. There is no débitage or debris related into these raw materials (schist and dolomite) among the whole lithic assemblage of AH III.

AH IIIa as a sub-horizon of the AH III, comprises the same pattern of raw material economy as observed in AH III. Fahliyani chert is the dominant raw material type especially the fine grained variant (Tables 11.4 and 11.5). More than 80% of the cores are made on Fahliyani chert. This number is getting smaller in the other technological categories. Among the tools this number reaches to around 40% which is less than the AH III. The high number of debris among the Fahliyani is in proportion to the cores and débitage indicating the intensive reduction of this raw material in the site. The fine texture Fahliyani chert was preferred among the tools especially among the retouched laminar pieces (Table 11.7). It is the same among the Khanahmadi chert as the second most frequent raw material. The coarse-grained variant of this raw material is totally absent among the tools. Other kinds of raw material comprise a very small number among the flakes and bladelets and are totally absent among the blades and debris. But this category *other*, comprises a large number among the tools based on the weight. However, there are only 4 tools in this category including 2 small retouched blades made on chalcedony and 2 large retouched flakes made on dolomite which are imported to and not manufactured at the site.

The following AH IIIb shows more use of Khanahmadi chert but still the Fahliyani has the priority (Tables 11.4 and 11.5). However, the use of other kinds of raw material seems to be minimal among the débitage and tools and they are totally absent among the debris. The Fahliyani fine-grained texture comprise the majority of the tools and Khanahmadi fine grained is the second majority. There are two small end scrapers on the chalcedony which have a fine texture (Table 11.8).

11.4.2 AH IV

Although most of the cores are made on Fahliyani chert and only around 3% are on Khanahmadi chert, the relatively high numbers of débitage (including flake, blades, bladelets and tools) among Khanahmadi chert in AH IV compares to the small number of cores, indicates an intensive reduction of this raw material in this AH. Only the fine-textured variant of these two raw materials were used. The other kinds of raw material, including chalcedony, compose a small number among the whole technological categories (they are totally absent among the flakes) and among the tools (Table 11.9). In AH IV, despite the time depth of around 7 kyr, still the same pattern of raw material economy observed among the lithics. This issue is mostly due to the fact that raw material procure-

Table 11.4 The distribution of lithic raw material among the technological categories of each AH based on raw material weight

Artefact	Cores		Flakes			Blades			Bladelets			Tools			Debris[a]		
Raw material g.	F	K	F	K	O	F	K	O	F	K	O	F	K	O	F	K	O
III	2086.7	913.1	3176.9	814.6	132.5	1744.9	614.6	75.5	1262.9	389.9	1.2	855.5	554.2	472.2	2437.8	1009	30.2
IIIa	534.6	81.6	856.8	213.4	25.89	101.7	44.9		44.7	21.2	0.4	151.1	80.3	150	474.8	158.4	
IIIb	215.7	86.8	608.4	257.9	13.3	64.3	31.2	7.1	34.4	22.8	0.3	127.6	58.5	1.1	240	142.4	
IV	120.8	3	222.9	58.2		25	13.6	2.5	12.1	6.8	0.3	17.2	12.1	1.7	76.2	21.9	0.3

F Fahliyani, *K* Khanahmadi and *O* other

[a]Debris includes angular debris (chunks), small débitage (5–10 mm), micro débitage (less than 5 mm) and unworked raw material cobbles

Table 11.5 The distribution of lithic raw material among the technological categories of each AH based on raw material weight

Artefact	Cores			Flakes				Blades				Bladelets				Tools				Debris			
Raw material %	n	F	K	n	F	K	O	n	F	K	O	n	F	K	O	n	F	K	O	n	F	K	O
III	406	69.5	30.5	5657	77	19.8	3.2	760	71.6	25.2	3.1	4120	76.3	23.6	0.1	809	45.5	29.4	25.1	13315	70.1	29	0.9
IIIa	52	86.7	13.2	920	78.1	19.5	2.4	87	69.4	30.6		494	67.4	32	0.6	70	39.6	21	39.3	1429	75	25	
IIIb	29	71.3	28.7	681	69.2	29.3	1.5	76	62.7	30.4	6.9	328	59.8	39.6	0.5	75	68.2	31.2	0.6	1075	62.8	37.2	
IV	6	97.6	2.4	185	79.3	20.7		32	60.8	33.1	6.1	72	63	35.4	1.6	26	55.5	39	5.5	164	77.4	22.2	0.3

Table 11.6 Tools from Ghār-e Boof, AH III

Raw material type	Fahliyani				Khanahmadi					Other		
Tool type, n:809	n	Fine	Med.	Course	n	Fine	Med.	Course	Fine/course	n	Chalcedony	Other
End scraper	46	32	9	5	33	26	3	1	3	2	2	
Point	13	8	5		27	12	10	2	3	4	3	1
Burin	2		1	1	2	2						
Borer	5	4	1		1	0	1					
Notch	24	15	6	3	13	6	3	1	3	2	1	1
Denticulate	12	4	5	3	6	3	1		2			
Retouched blade	79	36	31	12	59	36	7	3	13	4	3	1
Retouched bladelet	184	131	46	7	142	108	20	5	9	8	7	1
Scraper	5	2	3		10	6	1	1	2			
Carinated scraper	4	1		3	2	1			1			
Thumbnail scraper	1	1			4	4				1	1	
Retouched flake	65	39	18	8	27	16	2		9	1	1	
Composite	8	5	2	1	9	7	2			1	1	
Other	1		1		1	1				1		1
Total	449	278	128	43	336	228	50	13	45	24	19	5

Table 11.7 Tools of the AH IIIa

Raw material type	Fahliyani				Khanahmadi					Other		
Tool type, n:70	n	Fine	Med.	Course	n	Fine	Med.	Course	Fine/course	n	Chalcedony	Other
Retouched bladelet	13	8	4	1	10	7	3					
Retouched blade	5	2	3		4	3			1	2	2	
Retouched flake	7	4	2	1	7	2	3		2	2		2
End scraper	4	1	2	1								
Point					1	1						
Burin	2	2										
Composite	1	1			1	1						
Notch	2	1	1									
Denticulate					1	1						
Carinated scraper					2				2			
Scraper	3	2	1		3	1			2			
Total	37	21	13	3	29	16	6	0	7	4	2	2

ment as well as both technological and typological aspects remained almost the same throughout the stratigraphy.

11.5 Comparisons

11.5.1 Technology

The Rostamian lithic assemblage of Ghār-e Boof cave from AH III through AH IV shows a high degree of standardization which is closely related to the raw material procurement and the reduction patterns that the knappers had in mind. The size characteristics of this production is influenced by the factors including the knapping technique, abundance of lithic raw material available and the size and shape of this raw material (Andrefsky 1998, p. 100). The lithic assemblages from Ghār-e Boof cave are homogeneous because of the focus on the production of bladelets through all AHs using soft stone hammer percussion (Ghasidian 2014, p. 199). The bladelets mostly have twisted profiles and made from single platform bladelet cores. They were also produced from flakes. They are mostly cortical pieces that were struck dur-

Table 11.8 Tools of the AH IIIb

Raw material type	Fahliyani				Khanahmadi					Other	
Tool type, n:75	n	Fine	Med.	Course	n	Fine	Med.	Course	Fine/course	n	Chalcedony
Retouched bladelet	6	2	3	1	11	11					
Retouched blade	15	9	6		12	9	1		2		
Retouched flake	4	3	1		4	2	1		1		
End scraper	5	3	1	1	3	3				2	2
Point	2	2			4	1	1	1	1		
Composite					1	1					
Notch	2		2								
Carinated scraper	1		1								
Scraper	1	1			1		1				
Other					1	1					
Total	36	20	14	2	37	28	4	1	4	2	2

Table 11.9 Tools of the AH IV

Raw material type	Fahliyani				Khanahmadi					Other	
Tool type, n:26	n	Fine	Med.	Course	n	Fine	Med.	Course	Fine/course	n	Chalcedony
Retouched bladelet	2	1	1		4	4					
Retouched blade					2		1		1	1	1
Retouched flake	4	4	1		1	1					
End scraper					2	2					
Point	2	1	1		1	1					
Burin											
Composite	1	1									
Notch	1	1									
Scraper			1		2	1			1		
Other					1	1					
Total	12	8	4	0	13	10	1	0	2	1	1

ing the first stages of core preparation and are analogous to the carinated burins. Most of the cores on flakes occur in AH III and considered nearly one third of the cores in the entire assemblage from this AH. The number of these cores decreased in AH IIIa downwards and by the AH IV there is only one core on a flake remaining. These cores occur on both kinds of raw materials of Fahliyani and Khanahmadi. Almost all cores, regardless of the raw material type and blank (pebble or flake) have laminar (mostly bladelet) negative scars (Fig. 11.9) which are consistence with the débitage.

Because of the different nature of the Fahliyani and Khanahmadi raw materials, the first preparation of the cores is different. Among the Fahliyani cores the shape of the original raw material pebbles facilitates the desired form for bladelet production. However, the tabular nature of the Khanahmadi imposed more preparation especially in the places where two texture of fine and coarse come together. It was tried to remove the coarse grained part to get a ridge, instead of crest, in order to produce twisted bladelets. The cores from both kinds of raw materials treated the same in the process of bladelet production and have the same way of rejuvenation. The rejuvenation was limited into faceting with small flakes rather than striking a core tablet. The homogeneity of the lithics is repeated in each AH and sub-AH with only minor differences usually in the number of pieces in different technological categories rather than the technique and means of reduction. This indicates that the lithic reduction in Ghār-e Boof cave follows a single *chaîne opératoire* through all Palaeolithic strata regardless of the raw material type (Ghasidian 2014, p. 194).

The physical characteristics of the Fahliyan river pebbles allowed the inhabitants of Ghār-e Boof cave to easily import them to the site, where whole reduction sequences occurred at the site. The easy procurement of Fahliyani imposed more production of lithic artefacts from this raw material. Therefore, the inhabitants of Ghār-e Boof cave did not have to travel far to access raw material and they were well aware that they had little to no need of recycling their tools or cores

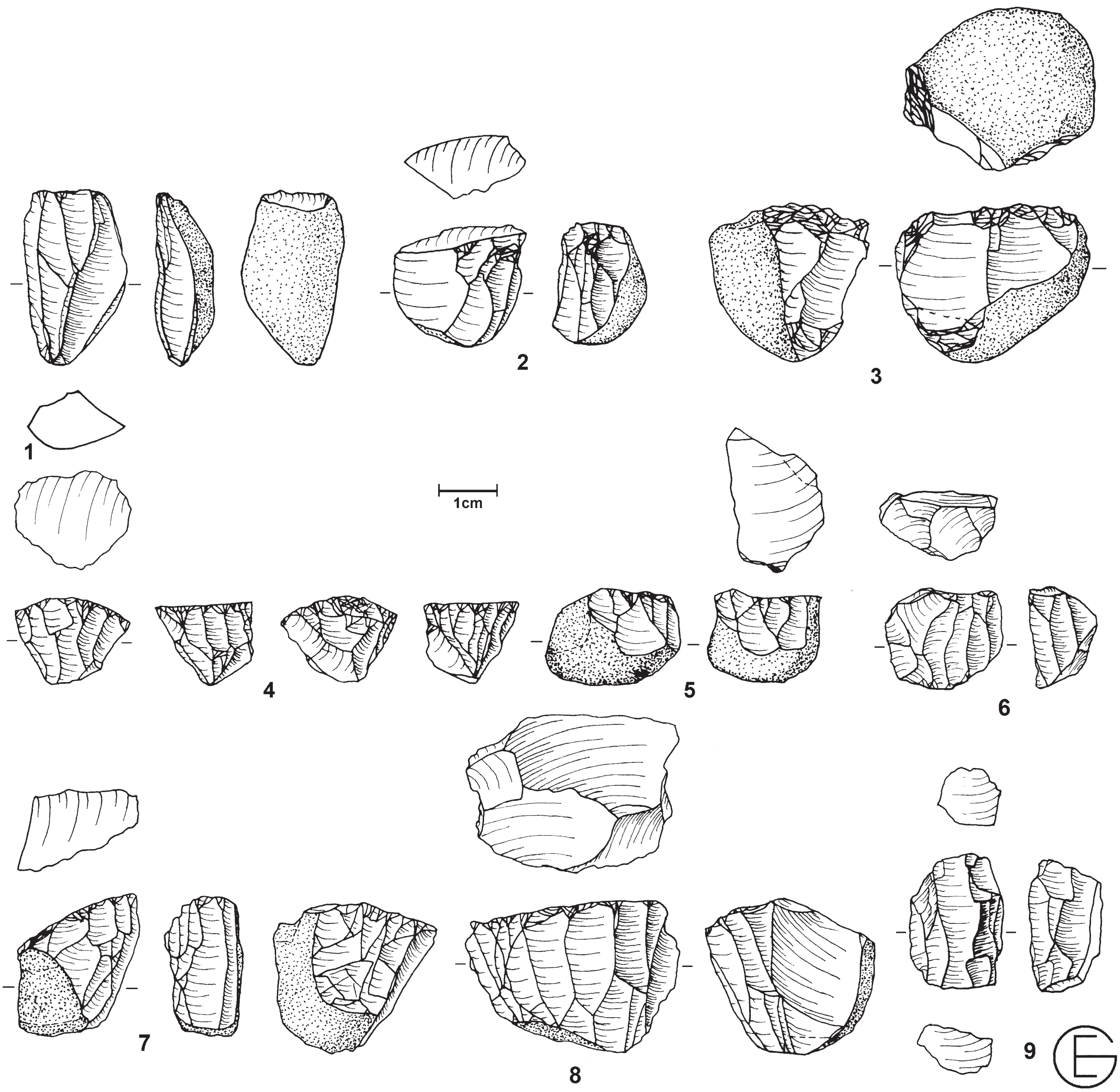

Fig. 11.9 Ghār-e Boof cave: single platform bladelet cores (Drawing by E. Ghasidian)

made from this material. In the case of Khanahmadi chert, the relatively vast distance separating the site from this chert source forced the knappers to do most of the initial preparation of the blocks directly at the raw material outcrop.

11.5.2 Typology

In all AHs and sub-AHs, where the flakes and blades used as blanks, they compose of the core preparation elements. These pieces normally show laminar negatives on their dorsal scars. As observed among the débitage, the bladelets, as the main products, also comprise the main tool blanks throughout the Palaeolithic strata and in all raw material types. Among the tools, the Rostam bladelets are considered as the best developed tool type in Ghār-e Boof cave due to their blank morphology and their retouch arrangement. They occur on fine grained raw material types and usually retouched on the dorsal side with semi-abrupt to abrupt retouches (Ghasidian 2014, p. 196). This tool type also serves as a characteristic tool among other UP sites in the Dasht-e Rostam-Basht region. The Rostam bladelets together with points (=Arjeneh points) are the most well-developed tool types in Ghār-e Boof cave. The Rostam bladelets are often smaller and twisted

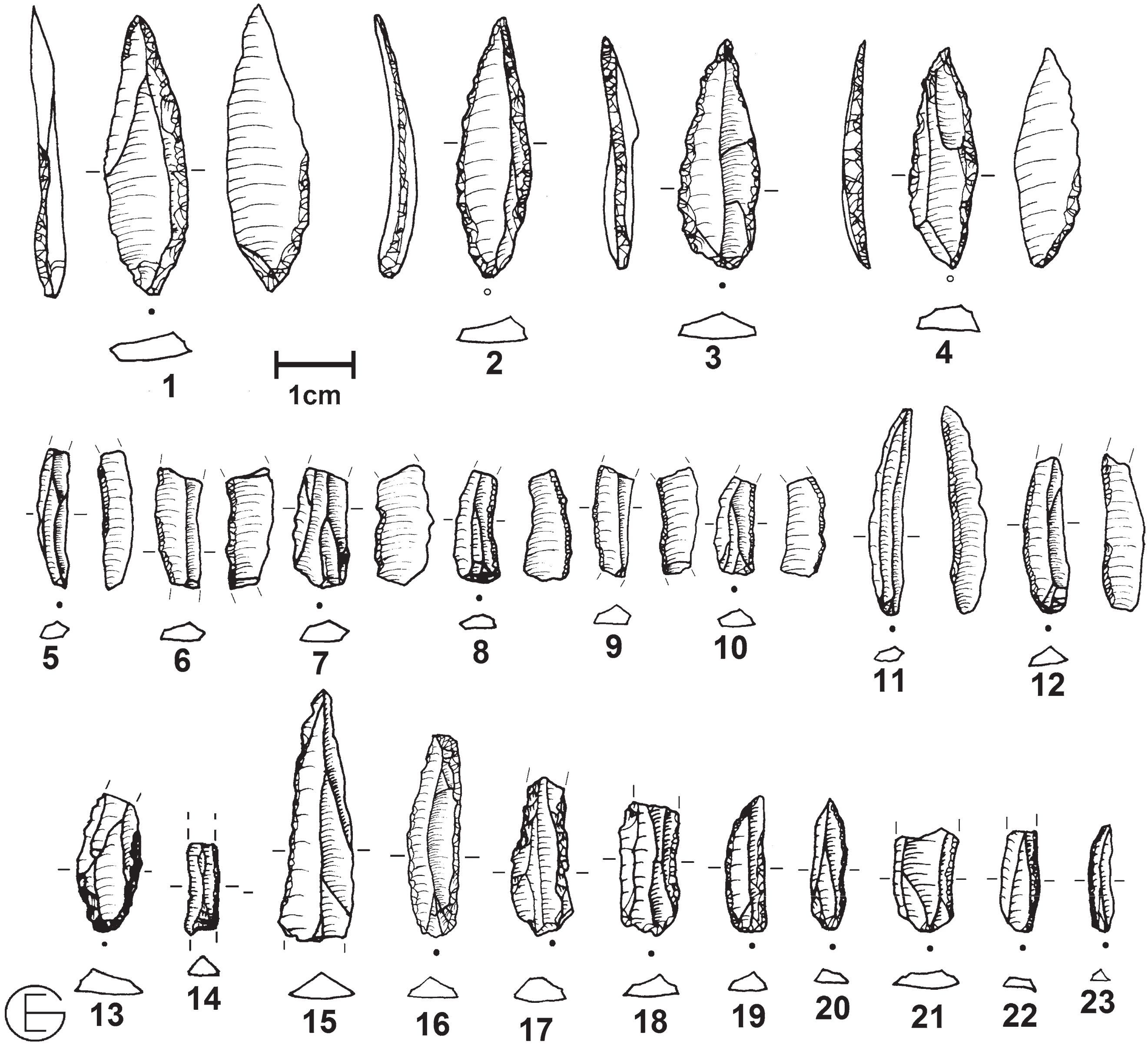

Fig. 11.10 Ghār-e Boof cave: tools points (1-4), different retouched bladelets (5-23) (Drawing by E. Ghasidian)

(97% altogether in all AHs) and the Arjeneh points typically appear on the non-twisted bladelets. Having straight profile may be due to the projectile function of these points since they could be used as hunting weapons (Hole personal communications May 2016, Hole and Flannery 1967). In general, they are reminiscent of the *el-Wad* points, where *el-Wad* is a general term for the elongated points that have various retouch patterns and types (Bergman 2003).

In sum, throughout the Palaeolithic strata in Ghār-e Boof cave, aside from the Rostam bladelets and Arjeneh points which were produced in advance with a pre-planned template, the other tool types appear to be expediently made and show the opportunistic use of the blank and tool type for fulfilling immediate needs (Ghasidian 2014, p. 198) (Fig. 11.10).

11.6 Raw Material Economy among the Survey Sites

During survey in the Dasht-e Rostam-Basht region, it was observed that the type of raw material procured and used by early UP residents of the region is highly depended on the distance of the sites to the location of the sources (Heydari-Guran 2014, p. 122). The more the site is closer to one of the raw material sources, the more use of that raw material is observed among the lithic assemblage (Fig. 11.7). Therefore, two spatial zones for raw material context are defined for the UP sites of the Dasht-e Rostam-Basht region based on the accessibility to each raw material sources of Fahliyani or Khanahmadi. The general pattern shows the highly focus on the procurement of the local raw material source. Table 11.1 shows the percentages of two groups of stone raw materials used in the Dasht-e Rostam-Basht region. These percentages change moderately depending on how close are the microhabitat areas to the Fahliyan River or Khanahmadi sources. For example, more than 98% of the lithics from the Zir Du microhabitat area, which is located just on the right bank of Fahliyan River, are made on the Fahliyani and the remaining are made of Khanahmadi cherts. In opposition, the highest percentage of Khanahmadi chert was used among the UP sites of the Shiv microhabitat area, where 79% of the lithics made on Khanahmadi chert (Table 11.1). Meanwhile the sites which are located approximately between these two raw materials sources like the complex sites of the Sukhteh microhabitat area, the percentage of both raw material types shows almost equal (Fig. 11.7, Table 11.1).

The area between sites around Khanahmadi outcrop and the Fahliyan River is composed of rugged topographic conditions which made access to the Fahliyani chert source difficult. This terrain difficulty had great influence on the raw material procurement in the Dasht-e Rostam-Basht region (Heydari-Guran 2014). Therefore, using local raw material helped to minimize the costs of time and energy.

The UP assemblages throughout the Dasht-e Rostam-Basht region show a homogenous lithic industry focusing on bladelet production. Almost all cores are platform bladelet cores. The preparation of the striking platform was simply done through the removal of one or two primary flakes (Ghasidian et al. 2009, p. 134). In all assemblages, most of the cores were discarded after arriving at a highly exhausted state mostly caused by hinged fracture. In many cases among the cores made of Khanahmadi raw material, exhausting the cores occurred due to the irregularities of the raw material. Although the cores are specialized for bladelet production, the recovery of small number of bladelets compared to the flakes among the débitage groups at the time of survey is due to their small size which could have easily been washed away. As was observed among the sites of these 13 microhabitat areas and among the stratified lithics of Ghār-e Boof, flakes are struck only for the reason of preparation and rejuvenation of the cores. The latter is easily recognizable according to the dorsal laminar negatives. Well-developed flake production is nearly absent (Ghasidian 2014). The poor recovery of the bladelets is also observed among the tools. Here the most abundant tools are different kinds of retouched flakes. They are mostly on the same typological traits as the expedient tools of Ghār-e Boof are. When the retouched bladelets exist among the assemblages, they are mostly Rostam type bladelets.

In sum, the UP artefacts of Dasht-e Rostam-Basht region show a high degree of standardization based on the technological and typological characteristics. All 13 microhabitat areas provided lithic assemblages with the same technological and typological traits as observed among the lithic artefacts of Ghār-e Boof cave. Therefore, it can be concluded that based on the radiocarbon dates provided on the stratified material of Ghār-e Boof, these artefacts are dated back to over 42 kyr cal. bp. The core reduction process, the concentration on the bladelet production out of these cores and the presence of the Rostam type bladelets as the main tool type throughout these microhabitat areas confirm the expansion of the Rostamian tradition throughout the Dasht-e Rostam-Basht region (Ghasidian 2014; Heydari-Guran 2014).

11.7 Discussion and Conclusion

Throughout the region, from plains of Dasht-e Rostam I to Dasht-e Rostam II and the Yagheh Sangar Rostam pass which relates these two plains, because of the geomorphological characteristics of the region, numerous caves and rockshelters were formed in the karstic system of the region. This characteristic along with relatively easy access to the permanent water and raw material resources and the location of these sites along the seasonal migration route of animals allowed the early UP hunter-gatherers to use each of these shelters during season of following the game herds. Each shelter site in the region provided evidences of human occupation and provided excellent residential camps for the hunter gatherer groups. Therefore, we see a homogenous pattern of subsistence, land use and raw material procurement and lithic techno-typological characteristics throughout the Dasht-e Rostam-Basht region.

Depending highly on the raw material from first zone, as observed among the Dasht-e Rostam-Basht region sites, shows that the stone raw material was gathered and transported by hunter-gatherers beside their other activities, without significant travel only for the sake of searching for raw material (Binford 1979).

The adoption of the Rostamian tradition, consists of constant production of bladelets and their associated modifications, at Ghār-e Boof cave and other UP assemblages of the Dasht-e Rostam-Basht region are viewed as a response of the early UP populations to their raw material and subsistence resources. The pattern of raw material procurement, preferring first zone, has been observed among all of the UP sites throughout the Dasht-e Rostam-Basht region, including Ghār-e Boof cave. This issue, along with the shared lithic characteristics, indicates movements and migration of the hunter-gatherers with the same cultural tradition from site to site within the region. Hence the high mobility of the hunter-gatherers of the Dasht-e Rostam-Basht region is manifested in two issues: (1) by using all available spaces (caves and rockshelters) in the entire region, and (2) in the homogenous lithic assemblages and their common special lithic features throughout the region. These patterns are seen in the plains of Marvdasht and Arsanjan (Rosenberg 1988; Ikeda 1979; Ghasidian 2014). These plains are geographically connected to each other, although located in different elevations (Heydari-Guran 2014), and are 150 and 200 km crow flies far from the Dasht-e Rostam-Basht region. We hypothesize that the hunter gatherers of this part of the southern Zagros probably during winter lived in the Dasht-e Rostam-Basht region and moved to the high elevated regions like Marvdasht and Arsanjan intermountain plains during dry season. The strong seasonality in the Zagros mountains caused the movements of the animals from lower elevated areas to higher and vice versa throughout the year. Dasht-e Rostam-Basht as a part of the southern Zagros, has high amount of rainfall during winter has been served as an ideal grazing land attracted medium- and large-sized games, such as cattle, deer, onager, goat, sheep and gazelle (Heydari-Guran 2014, p. 140). Obviously, these traits attracted the early modern humans as well. During this same time of the year, both vegetation and game were easily exploitable (Heydari-Guran 2014). As the game would pass through the valleys of the Dasht-e Rostam-Basht region, the hunter-gatherers would utilize the shelter sites in the region in order to obtain profitable vantage points of the migrating game below in the valleys. Pursuing game caused the high intra-regional migration. A consequence of heightened mobility is that the hunter-gatherers needed to limit their lithic assemblage to the small-sized lithics in order to increase the overall transport capacity. Among highly mobile groups, the tools assume a greater range of uses: they are less specialized and more practical and multi-functional (Shott 1986). Although the region contains two rich raw material sources of Fahliyani and Khanahmadi, still the lithic reduction occurred intensively on both raw material types among Ghār-e Boof and other UP assemblages from the region. This reduction intensity is considered as an implication of more active mobile groups (Blades 2001). Different retouch patterns on bladelets provided several possibilities for maximizing the use of these tools for different tasks also in the form of hafting and composite tools among these tool types for maximizing their use-life. In most cases, the cores were highly reduced for bladelet production: they provided bladelets until the volume of the core was exhausted. Using other blanks for producing expedient tools can also be considered as a point of intensity in tool production despite the locally available raw material. These typological characteristics indicate the high flexibility among the tools, showing the range of applications (Shott 1986).

Based on the environmental characteristics of the Dasht-e Rostam-Basht region including topography, strong seasonality and effective temperature, the hunter-gatherers were highly mobile (Heydari-Guran 2014, p. 140). Applying this to raw material procurement and reduction, we see a restricted set of local raw material resources as well as special technological sets identifying the inhabitants of Dasht-e Rostam-Basht region in a closed social network. This issue indicates the minimum exchange of raw material and knapping experience between the hunter-gatherers of the Dasht-e Rostam-Basht region and the other UP populations in other parts of the Zagros Mountains of Iran. According to OMTSLU model, the adoption of lamellar technology as main product in the Rostamian cultural group in this region is a response to the issue of minimization of the costs associated with raw material procurement and transport for the seasonal residential moves of the residents of the region to following migratory prey. It proves that the Rostamian techno-complex is founded basically on the economic issues and the need to create a balance between the quality of the available raw material and the lithic reduction technology for more effective use in exploitation of subsistence resources and the highly mobile nature of their lives. Therefore, the lithic assemblages here are considered as strong cultural remarks for the UP inhabitants of the region. On the whole Dasht-e Rostam-Basht region, there is a great emphasizing on opportunistic use of the local raw material as decreasing time and energy costs. Instead of using other non-local raw materials, hunter gatherers of the Dasht-e Rostam-Basht region were keener to adapt their knapping technique with available resources.

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Neanderthals and Modern Humans in the Indus Valley? The Middle and Late (Upper) Palaeolithic Settlement of Sindh, a Forgotten Region of the Indian Subcontinent

12

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Abstract

This paper discusses the Middle and Late (Upper) Palaeolithic sites of Sindh (Pakistan), a region of the Indian Subcontinent of fundamental importance for the study of the spread of both Neanderthals and Anatomically Modern Humans (AMH) in south Asia.

Most of the Middle Palaeolithic assemblages known to date were collected during the geological surveys carried out during the 1970s in Lower Sindh by Professor A.R. Khan, and the short visits paid to Upper Sindh by B. Allchin. More finds were discovered by the Italian Archaeological Mission during the last 30 years mainly at Ongar, near Hyderabad (Lower Sindh), and the Rohri Hills, near Rohri (Upper Sindh).

The presence of characteristic Levallois Mousterian assemblages at Ongar, and other sites west of the Indus River, opens new perspectives to the study of the dispersal of Neanderthal groups, whose south-easternmost spread has systematically been avoided by most authors.

Although the presence of typical Levallois Mousterian assemblages attributed to Neanderthals has been recorded from Iran, Afghanistan, Uzbekistan, and former Soviet Central Asia, the presence of similar complexes in the Indian Subcontinent is very scarce. The occurrence of typical Levallois cores, flakes, blades, points, Mousterian scrapers and one Mousterian point at Ongar is suggested to mark the south-easternmost limit of this cultural aspect. In contrast, the Middle Palaeolithic of the Indian Subcontinent is mainly characterized by unretouched flake assemblages and scrapers. Levallois points and flakes have already been described as a minor component of the so-called “Late Soan” complexes of the Punjab along the same western bank of the Indus in north Pakistan.

Even more complex is the definition of the earliest Late (Upper) Palaeolithic assemblages in the study region. In contrast with what previously suggested, Late (Upper) Palaeolithic sites are quite common in some areas of Lower Sindh, among which are the Mulri Hills (Karachi) and Jhimpir (Thatta). The assemblages from Karachi region sites are characterized by subconical cores with bladelet detachments, curved, backed points, bladelets, lunates of different shape and size, and, in a few cases, a high percentage of burins. The situation in Upper Sindh is absolutely different. The Rohri Hills yielded evidence of an impressive number of Late (Upper) Palaeolithic flint workshops, characterized by subconical

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bladelet and bladelet-like flakelet cores, and impressive amounts of debitage products. A similar situation has been recorded also from Ongar (Milestone 101), where modern limestone quarrying still underway has destroyed all the archaeological sites.

To conclude: Sindh is a very important region for the study of the Palaeolithic of the Indian Subcontinent and its related territories. It is unfortunate that our knowledge of this important territory is very scarce, and its archaeological heritage is under systematic destruction.

Keywords
Indus Valley • Thar Desert • Levallois Mousterian • Blade and Burin Assemblages • Neanderthal and Modern Human Dispersal

12.1 Introduction

The scope of this paper is to overview and discuss the Middle and Late (Upper) Palaeolithic assemblages of Sindh (Pakistan), and to frame them into the wider picture of the archaeology of the same periods in Eurasia.

The Indus Valley, Sindh in particular, is a territory of fundamental importance for the study of the relationships between west and east from prehistory to the present (Holdich 1910; Panhwar 1983; Baloch 2002; Boivin 2008). This is due to the unique geographic and morphologic characteristics of the country located, as it is, to separate the uplands of Iran, in the west, from the Great Indian (or Thar) Desert, in the east, midway between the high mountain ranges of the Hindu Kush and Himalayas, in the north, and the Arabian Sea, in the south (Lambrick 1986).

Sindh is the south-easternmost province of present-day Pakistan. Its western territory consists mainly of limestone formations (Blanford 1880; Vredenburg 1909; Bender and Raza 1995; Naseem et al. 1996), some of which are very rich in good-quality flint sources (Biagi 2008a; Biagi and Starnini 2008; Biagi and Nisbet 2010); the central part is represented by the alluvial plain of the Indus River, the course of which varied greatly from prehistory to the present (Flam 1984, 1999, 2006; Wilhelmy 1966, 1968), and its delta, whose fan is continuously widening toward the Arabian Sea (Tremenheere 1867; Prins et al. 2000; Giosan et al. 2006); the eastern part is covered by the Great Indian (or Thar) Desert sand dunes that are dotted with saltwater, perennial basins (Goudie et al. 1973; Bakliwal and Wadhawan 2003).

Given the above premises it is hard to believe that little attention has ever been paid to the Palaeolithic of the Indus Valley, Sindh in particular, apart from the well known contributions provided by B. Allchin and her collaborators in the late 1970s (Allchin 1976, 1979; Allchin et al. 1978). Palaeolithic assemblages have been rarely reported from Pakistan before the mid 1970s, when the first Late (Upper) Palaeolithic sites were discovered in Sindh (see for instance Krishnaswamy 1947; Gordon 1958; Khatri 1962; Coles and Higgs 1975; Fairservis 1975; and also Chakrabarti 1999).

Regarding the Middle Palaeolithic period, the problem of the south-easternmost spread of the Neanderthal sub-groups, from the Near East, has never been considered by most authors until the 2010s, with very few exceptions (see for instance Bar-Yosef 2000, p. 142; 2011, Fig. 11.1; Costa 2013; Finlayson and Carrión 2007, Fig. 1). The problem is still nowadays scarcely taken into consideration by most authors (see Bar-Yosef 2011). In contrast the importance of Sindh as a coastal route across which modern humans moved on their way to the southern regions of the Indian subcontinent has been recently reconsidered (Mellars 2006; Bulbeck 2007; Field et al. 2007; Dennell and Petraglia 2012; Bar-Yosef and Belfer-Cohen 2013; Mellars et al. 2013).

It is well known that east of the Levant *Homo neanderthalensis* fossil remains have been uncovered from several sites, whose distribution covers a wide territory between the Taurus and Zagros Mountains in the west (Solecki and Solecki 1993; Trinkaus and Biglari 2006), and former Soviet Central Asia and Siberia in the east (Okladnikov 1949; Movius 1953a, b; Abramova 1984; Vishnyatsky 1999: 112; Trinkaus et al. 2000; Derevianko 2004; Flas et al. 2010; Glantz 2010; Dobrovolskaya 2014; Mednikova 2014), with a wide gap between the two regions.

In contrast different types of Levallois Mousterian lithic complexes (Clark and Riel-Salvatore 2006) that characterize the Middle Palaeolithic Eurasian chipped stone assemblages (Van Peer 1995; Dibble and Bar-Yosef 1995), are known from the Iberian Peninsula (Giles Pacheco et al. 2000) to Central Asia and beyond (Ranov and Gupta 1979; Derevianko and Pétrine 1995; Derevianko et al. 1998; Derevianko and Markin 1999; Krakhmal 2005; Ranov et al. 2005, Krause et al. 2007; Bar-Yosef and Wang 2012). In a few of the above regions Neanderthals are thought to have survived until the beginning of the Upper Palaeolithic (Szymczak 2000, p. 125; Derevianko et al. 2004; Vishnyatsky and Nehoroshev 2004; Shunkov 2005; Rybin and Kolobova 2009).

Levallois chipped stone assemblages whose characteristics differ from those of Eurasia (Beyin 2006, 2011, p. 7) were manufactured also by Middle Palaeolithic anatomically modern humans in north and northeastern Africa and the Levant (Demidenko and Usik 1993; Bar-Yosef 2000, p. 140; Hublin 2000, p. 163).

The results obtained from a systematic programme of radiometric dating has showed how complex the available data are to interpret, and how further investigation is highly needed (Kadowaki 2013). Many authors suggest that the Initial Upper Palaeolithic (IUP) of the Levant developed from Middle Palaeolithic Levantine Mousterian complexes (Kuhn et al. 2009), which typologically differ from those of northeastern Africa (Beyin 2006, p. 24).

The material culture of *H. neanderthalensis* is characterized by different types of Middle Palaeolithic lithic complexes, often referred as Mousterian with variable percentages of Levallois artefacts, whose debitage technology (Boëda 1994, 1995) shows that different methods can produce identical or different types of artefacts (Meignen 1998).

The available evidence shows that the Middle Palaeolithic human dispersal was much more complex than previously suggested (Forster 2004; Petraglia 2007; Glantz 2010; Scerri et al. 2014; Bolus 2015; López et al. 2015). In most papers concerning the problem, with very few exceptions (Finlayson and Carrión 2007, Fig. 1), a question mark constantly recurs in the north-western part of the Indian Subcontinent distribution maps regarding the spread of *Homo* sp. (Bar-Yosef 2000, Fig. 18; 2011, Fig. 11.1; Henke 2006, Abb. 4; Henke and Hardt 2011, Fig. 3.8). This is due mainly to the virtual absence of human remains (Athreya 2007, 2010; Costa 2013; Rightmire 2015), and our limited knowledge of sites of this period in the entire Subcontinent (Chauhan and Patnaik 2012, Table 1).

One of the most important and unexplored issues regards the south-easternmost spread/distribution of both *H. neanderthalensis* and Levallois assemblages (Finlayson 2004; Bar-Yosef 2000, 2011). At present Levallois Mousterian industries attributed to the Neanderthals are known from the coast of Iranian Makran (Vita-Finzi and Copeland 1980), the Hormuz Strait islands (Dashtizadeh 2010), Iran (Coon 1951; Hole and Flannery 1968; Smith 1986; Roustari et al. 2004; Jaubert et al. 2009; Bazgir et al. 2014), Afghanistan (Dupree et al. 1970; Dupree 1972; Davis 1978), and former Soviet Central Asia (Ranov 1976, p. 102; Movius 1953a; Ranov and Gupta 1979; Ranov et al. 2005). Characteristic Levallois complexes (Baumler 1995, p. 19; Boëda 1995) are very rare in the Indian Subcontinent, with the exception of a few surface assemblages and isolated finds from the Indus Valley, among which are those from Lower Sindh (Biagi 2006; Biagi and Starnini 2014a, b), and perhaps the Indian Thar Desert (Blinkhorn 2014).

Given the above premises, and our little knowledge of the Late (Upper) Palaeolithic in the entire Indian Subcontinent, Pakistan included, it is not surprising that most western authors had paid little or no attention to the region, for instance discussing the problem of the Middle to Late (Upper) Palaeolithic transition in south Asia (Brantingham et al. 2004; Kuhn et al. 2004; Derevianko 2010, 2011a, b; Derevianko et al. 2014).

12.2 The Levallois Mousterian Assemblages of Lower Sindh

Typical Levallois Mousterian assemblages and isolated tools are known from a few sites in Lower Sindh, west of the Indus (Fig. 12.1). At present the most important is Ongar (Biagi 2005), also reported as Milestone 101 by B. Allchin (1976, p. 486), located some 27 km southwest of Hyderabad. During the 1970s surveys, B. Allchin recovered assemblages and workshops of different Palaeolithic periods on the top of the easternmost, horseshoe-shaped, limestone terrace, one of which she attributed to the Middle Palaeolithic (Allchin et al. 1978, Table 8.9b).

Professor A.R. Khan, of the Department of Geography, Karachi University, revisited the area in the late 1970s, when the sites were being destroyed by extensive limestone quarrying (Fig. 12.2). During his fieldwork he noticed "*the presence of theLevalloisian industryin the area beyond any doubt*" (Khan 1979b, p. 80). From Ongar this author rescued hundreds of Levallois artefacts, among which are typical turtle-shaped cores with flake detachments (Fig. 12.3), unretouched and retouched points, flakes, a few wide blades, and different types of side and transversal scrapers with facetted "*chapeau de gendarme*" butts, as well as one typical Mousterian straight point with covering retouch on its dorsal face (Fig. 12.4). It is important to point out that whenever these tools had been collected from a European site they would be referred to Neanderthal activities.

Ongar and the neighbouring limestone terraces of Daphro and Bekhain were systematically surveyed between 2005 and 2008 by one of the authors (PB) (Biagi 2005; Biagi and Franco 2008). During four fieldwork seasons, Levallois artefacts were collected from the upper part of a profile visible along the northern bank of a seasonal stream that flows eastwards down to the village of Ongar (Biagi and Nisbet 2011) (Fig. 12.2). A few more tools, among which are Levallois flake cores, were collected from the surface of one of the mesas.

Other typical, small Levallois Mousterian assemblages and isolated tools, were collected from a few other sites located immediately to the east of Karachi, among which

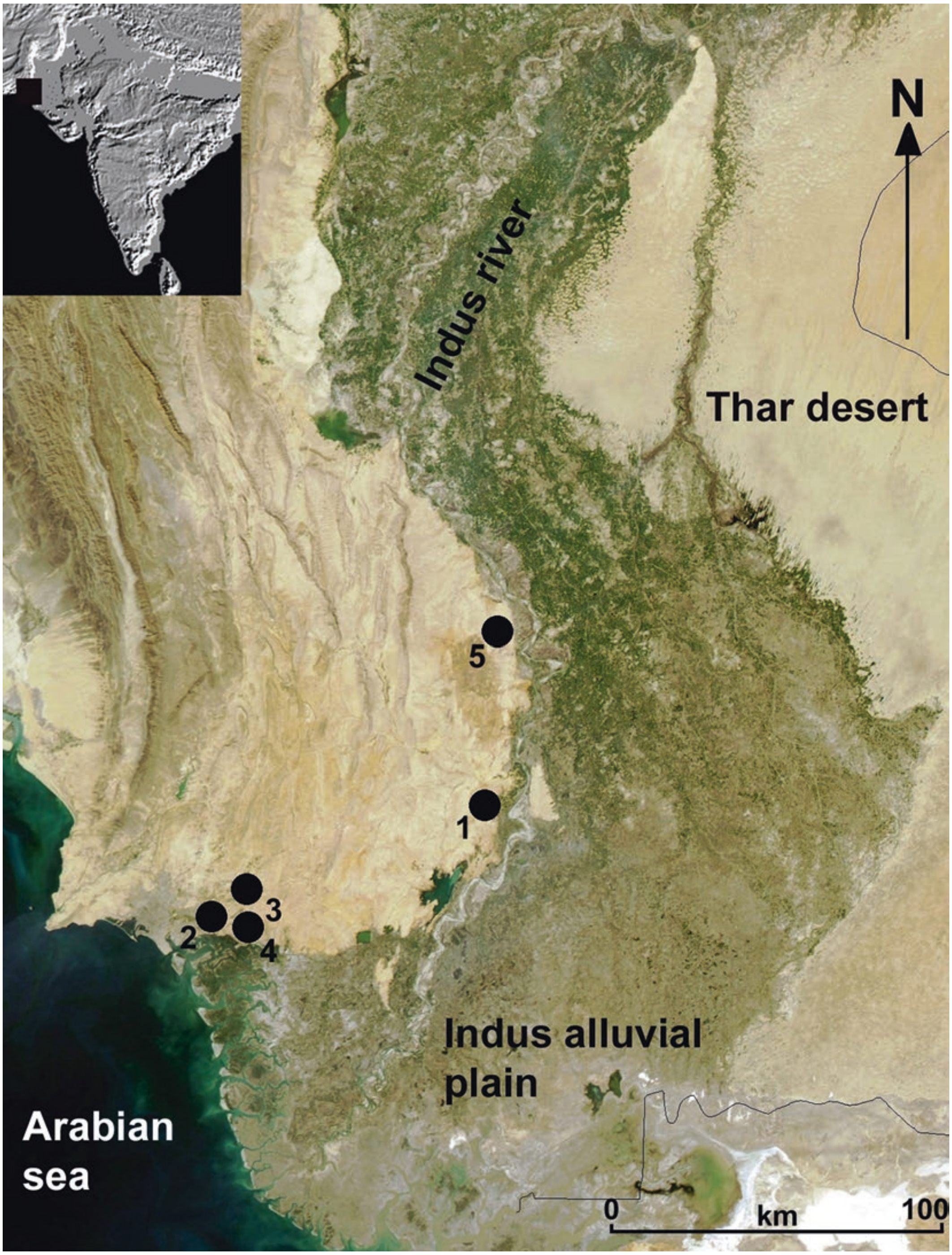

Fig. 12.1 Distribution map of the Levallois Mousterian assemblages and tools of Lower Sindh. *1*: Ongar, *2*: Mulri Hills, Karachi, *3*: Deh Konkar, *4*: Landhi, *5*: Arzi Got (From Biagi and Starnini 2014b: Fig. 1)

are the Mulri Hills, Landhi, Deh Konkar (Khan 1979a, p. 13; Blinkhorn et al. 2015) and the Laki Range (Biagi 2008b). One more characteristic Levallois Mousterian flake with a facetted butt was collected from the surface of a limestone terrace close to the Baloch village of Arzi, east of the national road, some 38 km north of Jamshoro (Biagi 2010, p. 2).

12.3 The Middle Palaeolithic Assemblages of Upper Sindh and the Thar Desert

Middle Palaeolithic chipped stone artefacts have been recovered also from the Rohri Hills in Upper Sindh (Allchin 1976), the central-western terraces of which were systematically surveyed between 1994 and 2002 as one of the activities

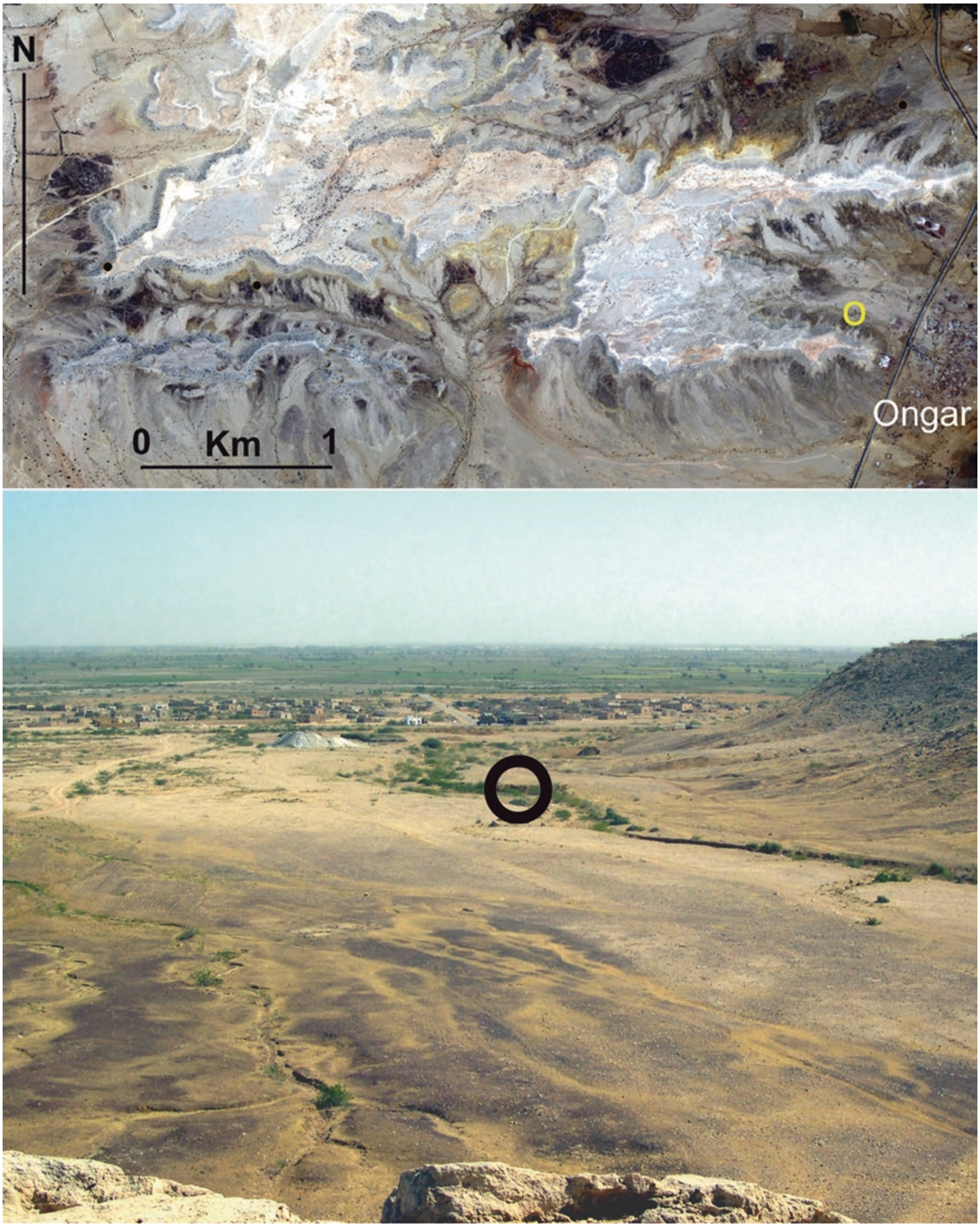

Fig. 12.2 Ongar: Location of the area that yielded Levallois artefact rediscovered in 2006 (*circle*)

of the Joint Rohri Hills Project carried out by Ca′ Foscari University of Venice (I) and Shah Abdul Latif University, Khairpur (PK) (Starnini and Biagi 2011).

The Rohri Hills are limestone formations, whose deposits are rich in excellent quality flint seams (Blanford 1880; De Terra and Paterson 1939, p. 331). The hills elongate in north-south direction east of the course of the Indus. Their landscape has been described as a steppe desert characterized by very low precipitation (Majumdar and Sharma 1964; Seth 1978, Fig. 14.2), with a June maximum temperature of some 46° Celsius (Ahmad 1951). Some of the Rohri Hills terraces are literally covered with archaeological sites. Among these are hundreds of flint knapping workshops of different periods, from Acheulian Palaeolithic hand-axe manufacturing areas to Mature Indus Civilization debitage heaps that consist of thousands of bladelets and bullet cores (Allchin 1976,

Fig. 12.3 Ongar: *turtle-shaped*, Levallois flakelet cores from A.R. Khan's collection (Photographs by P Biagi)

1979; Allchin et al. 1978; Biagi and Cremaschi 1988, 1991; Starnini and Biagi 2011).

A few years ago F. Negrino and M.M. Kazi (1996) proposed a chrono-typological sequence for the Rohri Hills Palaeolithic industries that they subdivided into six main "Series" on the basis of the techno-typological characteristics of the artefacts, their physical condition, degree of weathering, colour and thickness of surface patina. Their Middle Palaeolithic Series 5 includes implements that "*resemble Levallois flakes with the presence of dihedral and facetted platforms*" as well as two cores "*with centripetal removals, very similar to Levallois types*" (Fig. 12.5). A few isolated Levallois-like artefacts, with flat or dihedral platforms, were collected from the surface of Ziārāt pir Shābān, from which many Acheulian workshops were also recovered and partly excavated (Biagi et al. 1996).

Series 6 of their proposed sequence consists mainly of subconical blade and blade-like flake cores, blade-like flakes and blade by-products recovered *in situ* from hundreds of workshops that were attributed to the beginning of the Late (Upper) Palaeolithic (Negrino and Kazi 1996, p. 36; Biagi et al. 1998–2000).

The eastern and southern fringes of the hills are surrounded by the westernmost dunes of the Great Indian Desert (or Thar Desert) from which many Palaeolithic lithic assemblages have been discovered, among which are a few Levallois artefacts with "*preparation of the striking platform*" (Allchin et al. 1978, p. 311). In contrast, typical Levallois cores and tools have never been recovered from any of the Thar Desert sites of Upper Sindh surveyed by the present authors, although they are reported from one of the Rohri Hills sites by Allchin et al. (1978, Table 8.3). These authors do not mention their presence at Nawab Panjabi (Unnar) and Chancha Baluch (Fig. 12.6), in the southwestern part of the Rohri Hills, as well as at Hokra, Gurha and Shambar Lake, and other sites of the Great Indian Desert of Rajastan. Palaeolithic tools, among which are also a few Levallois-like flakes with oblique, flat platform, were collected from "Unnar Hill", some 300 m east of Unnar in the Rohri Hills (Biagi and Cremaschi 1988, p. 429).

Moving north, Levallois cores and flakes are known from Sanghao Cave in the NWF (Allchin 1973; Salim 1986). They are reported also from the "Late Soan B" assemblages of Punjab, in north Pakistan (Movius 1944, p. 28; 1948; Krishnaswamy 1947; De Terra and Paterson 1939, Plate XLII).

12.4 The Late (Upper) Palaeolithic Assemblages

The discovery of Late (Upper) Palaeolithic sites in Sindh derives from the research conducted in the 1970s by B. Allchin and A.R. Khan in two distinct regions. In those years, while B. Allchin noticed that the assemblages of some Rohri Hills flint workshops (Allchin 1976, p. 479) were "*based upon the manufacture of parallel-sided blades from unidirectionalcores*" (Allchin et al. 1978, p. 320), Professor A.R. Khan emphasized the recurrence of a well-defined type of point, "*aknifelike tool, with strongly curved and steeply blunted back and very sharp and more or less straightcutting edge*" that he considered the most characteristic implement of the Late (Upper) Palaeolithic assemblages of the Karachi region (Khan 1979a, p. 13).

The above discoveries were made roughly a decade after the excavation of Sanghao Cave in north-western Pakistan (Dani 1964; Allchin 1973; Ranere 1982); while the excavations at Riwat 55, the suggested oldest Late (Upper) Palaeolithic site of Pakistan, TL-dated around 45,000 BP

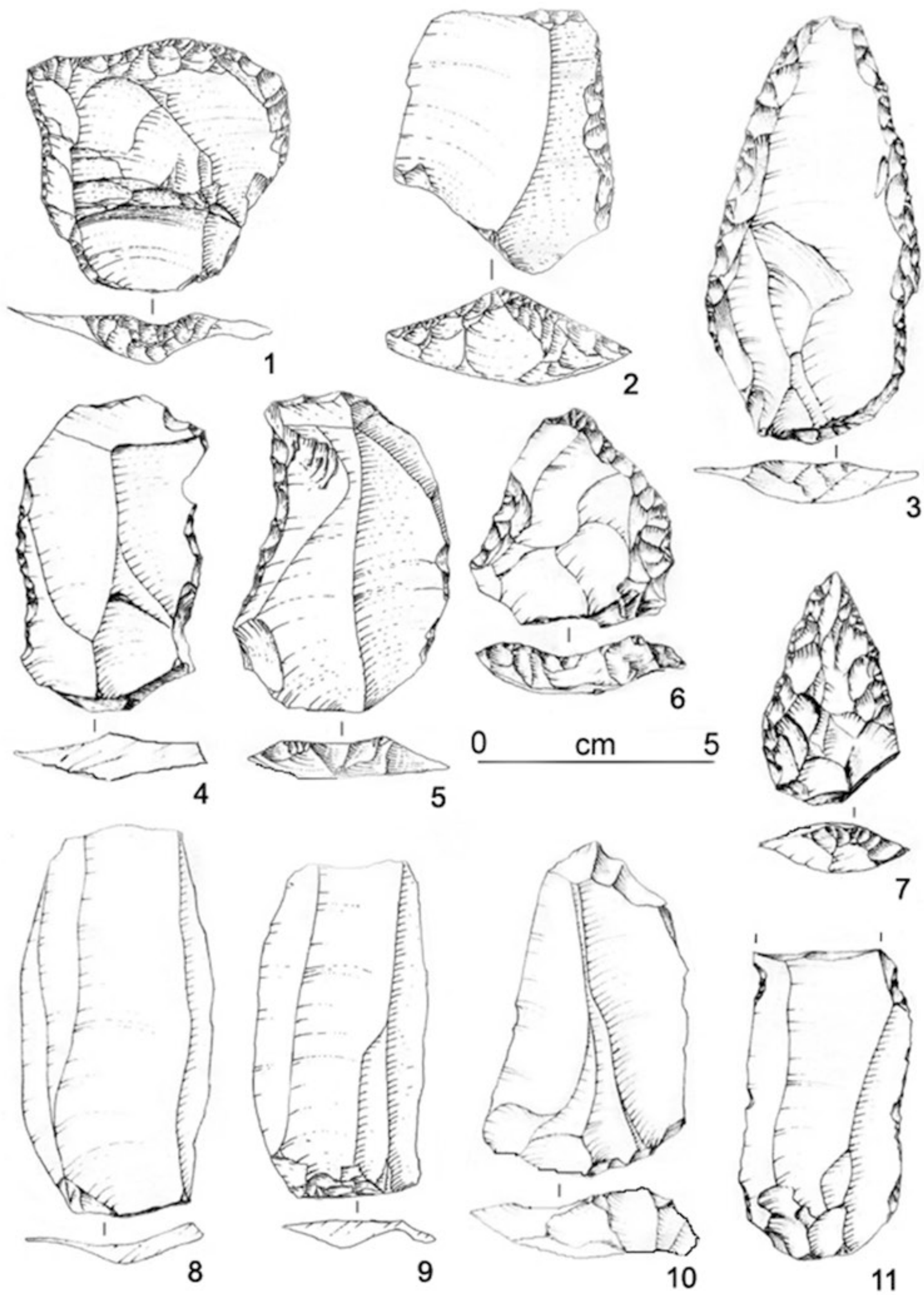

Fig. 12.4 Ongar: Levallois Mousterian tools from A.R. Khan's collection (Drawing by P. Biagi, inking G. Almerigogna)

(Rendell and Dennell 1987), were carried out only in the early 1980s (Rendell et al. 1989).

Recent finds, new excavations and the study of old collections have slowly improved our knowledge of the Late (Upper) Palaeolithic of Sindh. On the basis of the techno-typological characteristics of the chipped stone assemblages five different districts have yielded sites of this period: (1) the territory around Karachi and the Mulri Hills in particular, (2) Jhimpir (Thatta), (3) the Ongar and Daphro Hills (Hyderabad), (4) Ranikot (Jamshoro) and (5) the Rohri Hills (Sukkur/Rohri) (Biagi 2017b) (Fig. 12.7).

12.4.1 Karachi and Its Surroundings

The geomorphology and evolution of Karachi basin have been studied by Professor A.R. Khan (1979b, c). According to this author "*the coastal area near Karachi reveals a series of raised beaches and marine terraces*" (Khan 1979a, p. 19), the highest of which, some 50 m high, capped by wind-blown sand, yielded evidence of Late (Upper) Palaeolithic and Mesolithic occupations.

Other sites of these periods were discovered in the Hab River valley (Mendiari), along the banks of watercourses that

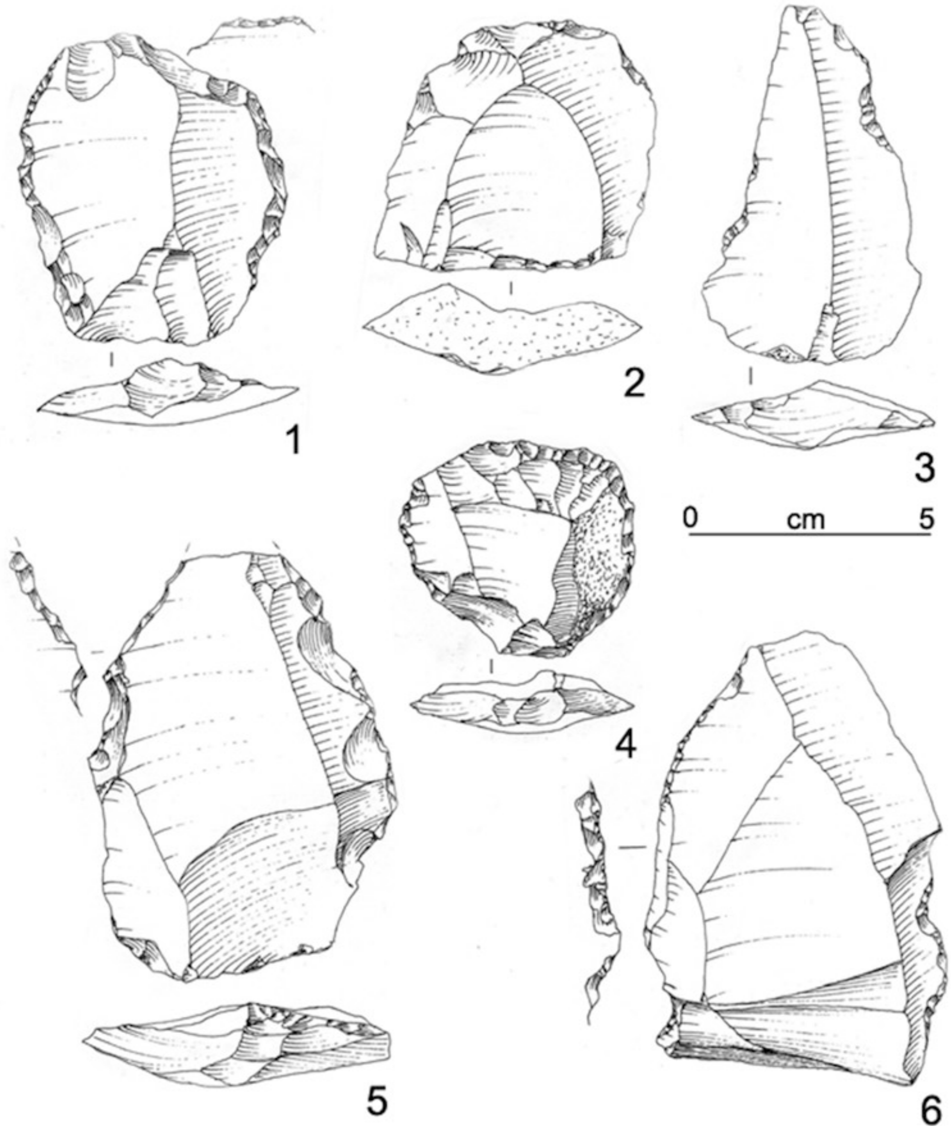

Fig. 12.5 Rohri Hills: Middle Palaeolithic artefacts of Series 5 (Drawing F. Negrino, inking by G. Almerigogna)

flow into the Malir River, at Rehri, facing Khadiro Creek, and the Mulri Hills, at the eastern outskirts of Karachi (Khan 1979a) (Fig. 12.7: 1). The variability of the tool types collected from the above sites, the limited information regarding their recovery, as well as their approximate location, in absence of GPS recording systems, make the precise chrono-cultural attribution of each complex sometimes doubtful.

Very important Late (Upper) Palaeolithic and Mesolithic sites were discovered in the 1970s by Professor A.R. Khan on the Mulri Hills (Fig. 12.8). The hills, some 70 m high, elevate between the courses of the Layari and Malir Rivers, east of Karachi. They consist of variegated beds developed on the sedimentary bedrock of the Miocene Upper Gaj formation (Zaidi et al. 1999).

Prehistoric sites were mainly discovered along the southern upper slopes of the hills, close to two main faults, along which several springs opened (A.R. Khan pers. comm 2002; Biagi 2003–2004). Narrow, seasonal streams originating from the above springs flow southward into the Malir River, which they join some 10 km north of Ghizri Creek.

MH-16 is the only homogeneous Late (Upper) Palaeolithic site discovered on the hills. The assemblage is composed of 425 artefacts obtained from flint pebbles whose source or outcrops are at present unknown. It consists of 90 cores, 147 complete, unretouched artefacts, 103 unretouched fragments, among which are 45 blades and bladelets, 62 tools, 3 burin spalls, 14 crested blades and flakes and 6 microburins (Fig. 12.9: 45–48). The retouched tools are represented by 14 burins (Fig. 12.9: 1–8), 3 end scrapers (Fig. 12.9: 9, 10), 4 truncations (Fig. 12.9: 11), 1 triangle (Fig. 12.9: 33), 19 curved backed points (Fig. 12.9: 12–17, 19–27, 29, 35, 36), 5 curved points on thick, triangular flakes (Fig. 12.9: 28, 30–32), 1 thick backed blade (Fig. 12.9: 18), 5 backed bladelets (Fig. 12.9: 34, 40–44), 2 backed bladelets and truncation

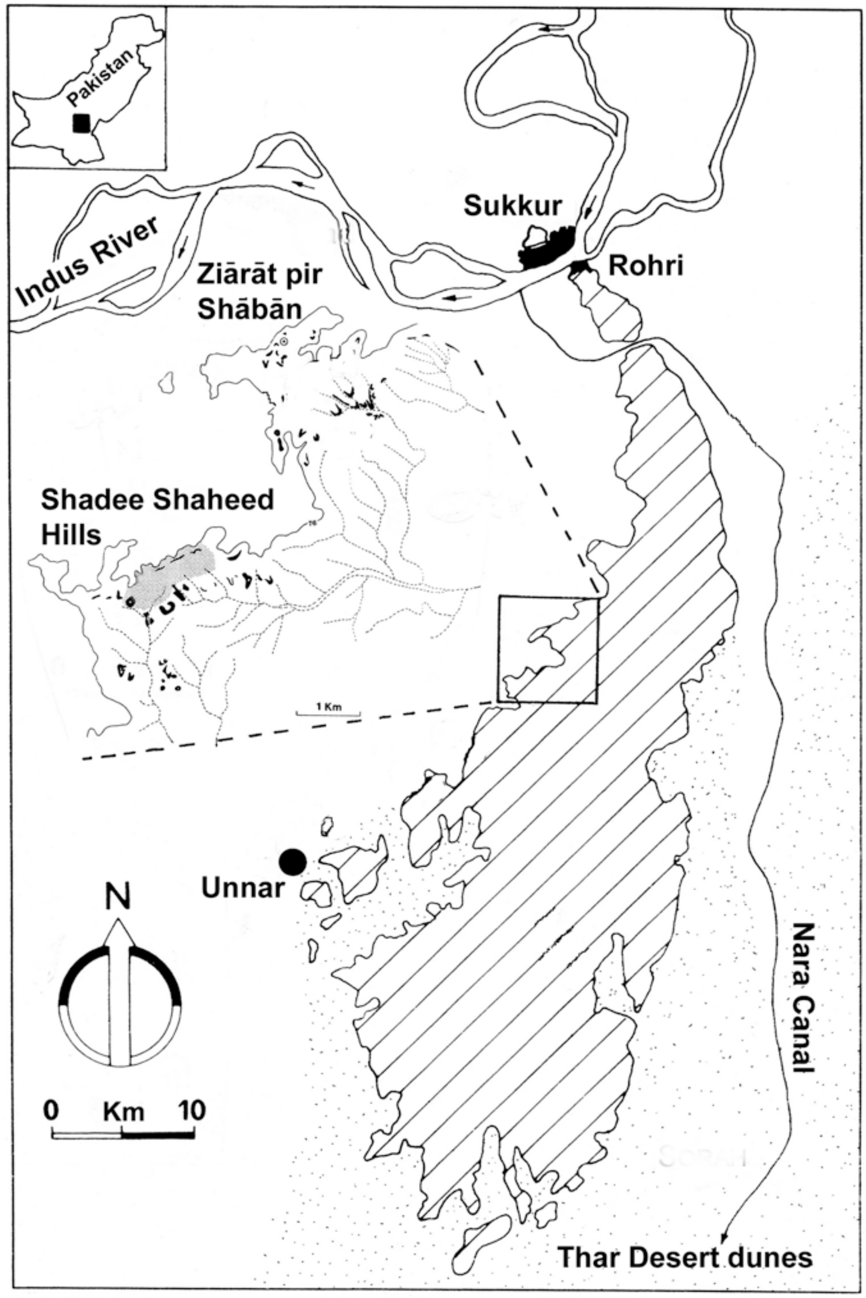

Fig. 12.6 Rohri Hills: distribution map of the areas that yielded Middle Palaeolithic artefacts (Drawing by P. Biagi)

(Fig. 12.9: 39), 2 backed points (Fig. 12.9: 37, 38), 4 side scrapers, and 1 flakelet with abrupt retouch. The tools are mainly obtained from bladelets or bladelet-like flakelets of normolithic size (2.5 to 5 cm long), and also from blades and blade-like flakes (5–10 cm long). Other sites of the Karachi area that yielded Late (Upper) Palaeolithic assemblages are Mendiari (Fig. 12.7: 2), Rehri 4a (Fig. 12.7: 3), Deh Konkar (Fig. 12.7: 4), and Ran Pethani 9 (Fig. 12.7: 5). Characteristic curved backed points, attributable to this period, were collected also from Langeji, Kadeji and Jorando gorges, Kankar Nala, Khar Nai and Bakran.

12.4.2 Jhimpir

The area around Jhimpir (Thatta) was first visited by W.T. Blanford in the late 1880s. From Jhimpir Blanford reported the presence of "cherty and flinty limestones" close to the railway station (Blanford 1880, p. 153). The surveys were resumed by the Italian Archaeological Mission in 2010 along the terraces south and southwest of the village. They led to the discovery of many sites (Fig. 12.7: 6), most of which were attributed to the Late (Upper) Palaeolithic (Biagi 2011).

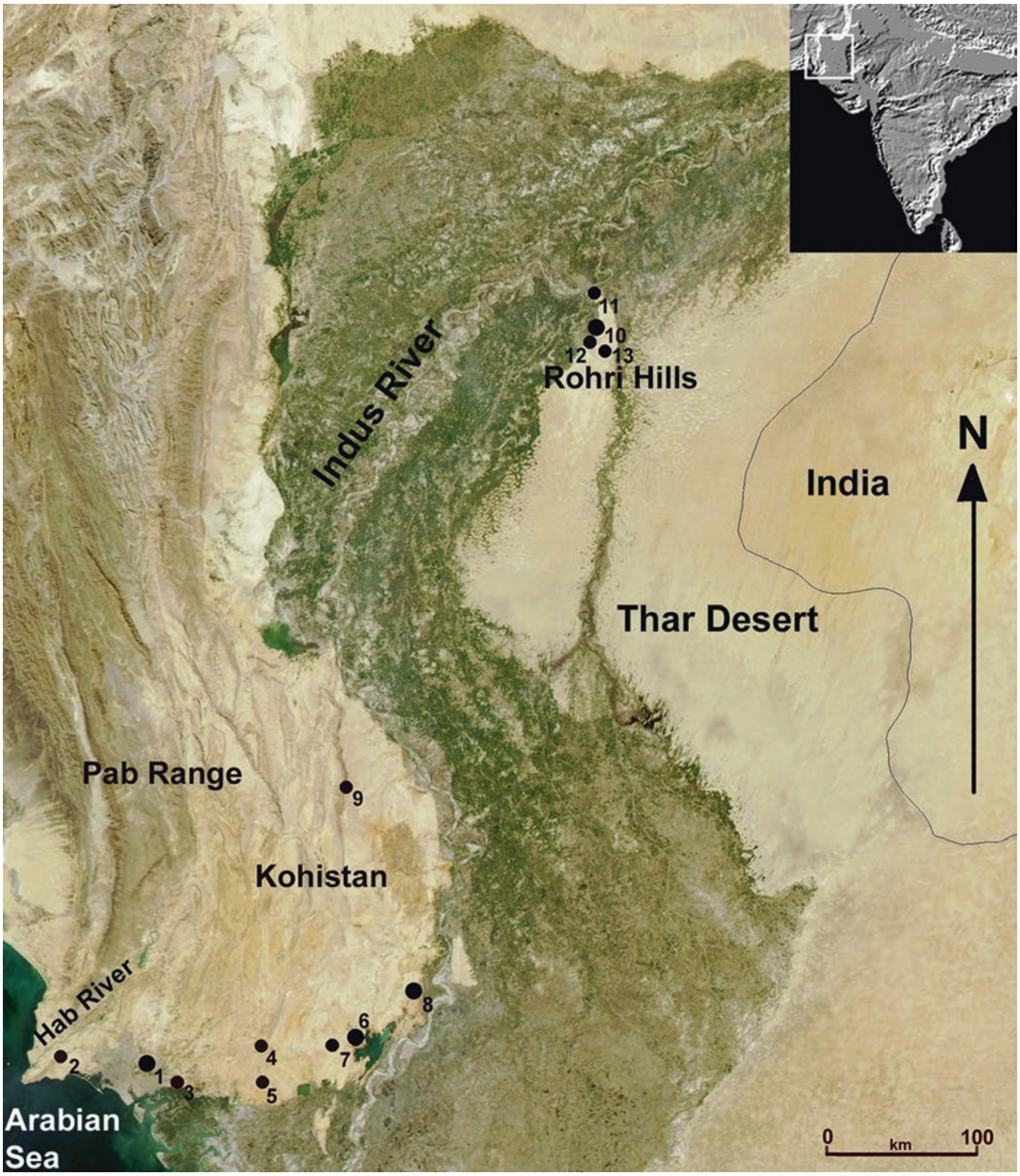

Fig. 12.7 Distribution map of the Late (Upper) Palaeolithic sites mentioned in the text. *1*: Mulri Hills, *2*: Mendiari, *3*: Rehri, *4*: Deh Konkar, *5*: Ran Pethani, *6*: Jhimpir, *7*: Jhimpir W1, *8*: Ongar and Daphro, *9*: Ranikot, *10*: Rohri Hills, Shadee Shaheed, *11*: Sukkur, *12*: Unnar, *13*: Southernmost hills. The *larger dots* show greater complexes (Drawing by P. Biagi)

The Jhimpir sites consist of lithic scatters lying on the eroded surface of Kirthar limestone weathered terraces. Their distribution is delimited by a well known freshwater spring (Blanford 1880, p. 153), in the north, an elongated flint outcrop, in the south, and the artificial Kalri Lake depression, in the east (Fig. 12.10), which was formerly filled with the waters of Sonehri and Kinjhar basins (Khan 1979a, p. 16; see also Tremenheere 1867, map).

At least 15 of the lithic spots recovered from Jhimpir have been attributed to the Late (Upper) Palaeolithic. Sites JHP-1, JHP-7 and JHP-9 yielded also a few microlithic lunates (Biagi 2011, fig. 5–7). The Jhimpir artefacts are chipped from local, light grey nodular flint (2.5Y7/1–7/2: Munsell Soil Color Charts 1992). They are often coated with a thin dark greyish brown (2.5Y3/2) to dark brown (7.5Y3/3) patina due to exposure and weathering.

Two outcrops, labelled JHP-21 and JHP-28 respectively, are known south and southwest of the main cluster of Late (Upper) Palaeolithic sites (Biagi and Nisbet 2010). A short survey conducted in January 2011 led to the

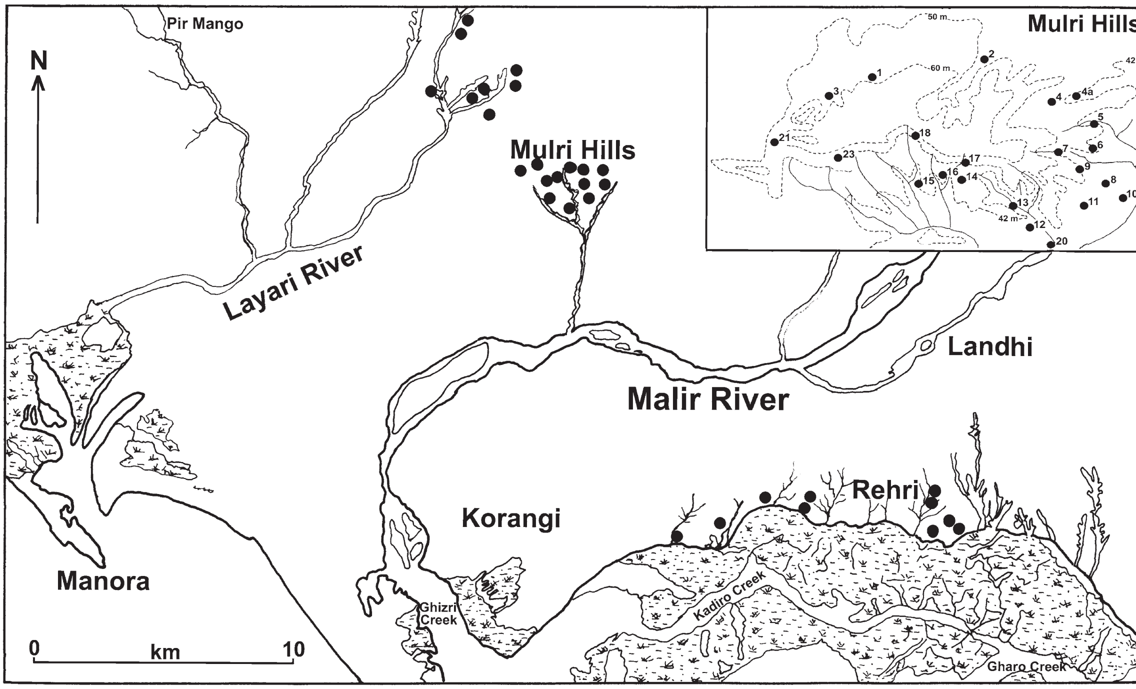

Fig. 12.8 Environmental setting of the Mulri Hills between the Layari and Malir Rivers (Karachi). The detailed distribution of the MH sites, according to A.R. Khan's field map, is in the *upper, right* corner. Other sites along the Layari and at Rehri are also shown (Drawing by P. Biagi)

discovery of another good quality flint source along the southern edge of the limestone terrace (JHP-30), some 5–6 kms west-south west of JHP-21. Another Late (Upper) Palaeolithic spot of lithic artefacts, covering a surface of some 20 sqm, was discovered some 1 km to the west of JHP-30, at 24°58′53.9 N – 67°57′25.0 E (JHP-W1) (Fig. 12.7: 7). One prismatic core with bladelet detachments, 1 abrupt retouched flakelet, and many fragments of laminar blanks and debitage flakelets were recorded on its surface.

12.4.3 Ongar and Daphro Hills

Apart from the Late (Upper) Palaeolithic industries described by B. Allchin et al. (1978, p. 300), and despite the recent limestone mining activities, a few large Late (Upper) Palaeolithic workshops and isolated finds were found still intact in some areas of the hills in 2008 (Fig. 12.7: 8). The Late (Upper) Palaeolithic assemblages from Ongar consist of subconical and prismatic cores with bladelet and bladelet-like flakelet detachment, bifacial picks (Fig. 12.11), and very rare burins. Workshops consisting of thousands of debitage products, coated with a desert brown patina (7.5YR4/6) caused by exposure and weathering, were recorded also from the neighbouring terrace of Daphro (Fig. 12.12).

12.4.4 Ranikot Fort

The Late (Upper) Palaeolithic site of Ranikot Fort (RNK-1: Fig. 12.7: 9) was discovered on the surface of a Kirthar limestone terrace (Blanford 1867, p. 15) at 165 m of altitude, some 720 m northwest of Sann Gate (Biagi 2017b) (Fig. 12.13). The terrace is delimited, in the east, by the deep incision of a seasonal stream that flows southward into the Nai Rann or Sann River (Blanford 1880, p. 135).

The chipped stone assemblage was collected from an eroded surface. The central point of the site, covering a surface of at least 500 sqm, is 25°53′11.190 N – 67°55′29.486 E. No clear concentration of artefacts was noticed, although they were mainly distributed toward the edge of the terrace.

The artefacts are obtained from small pebbles of local flint, which is quite common to the limestone that covers the Ranikot formation (Blanford 1880, p. 135). The chipped stone assemblage is weathered, coated with an olive yellow patina (2.5Y6/6) with small, lighter spots. Some specimens show a few, small *concassage* detachments (i.e. taphonomic retouch or pseudo-retouch: Kolobova et al. 2012), due to either a slight movement from their original position, or trampling. No traces of the original Pleistocene soil were noticed all over the area.

The industry consists of 19 cores (Fig. 12.14: 8–23), 121 unretouched artefacts, 4 burins (Fig. 12.14: 1–4), 1 crested blade, 12 core rejuvenations (Fig. 12.14: 6) and 1 splintered

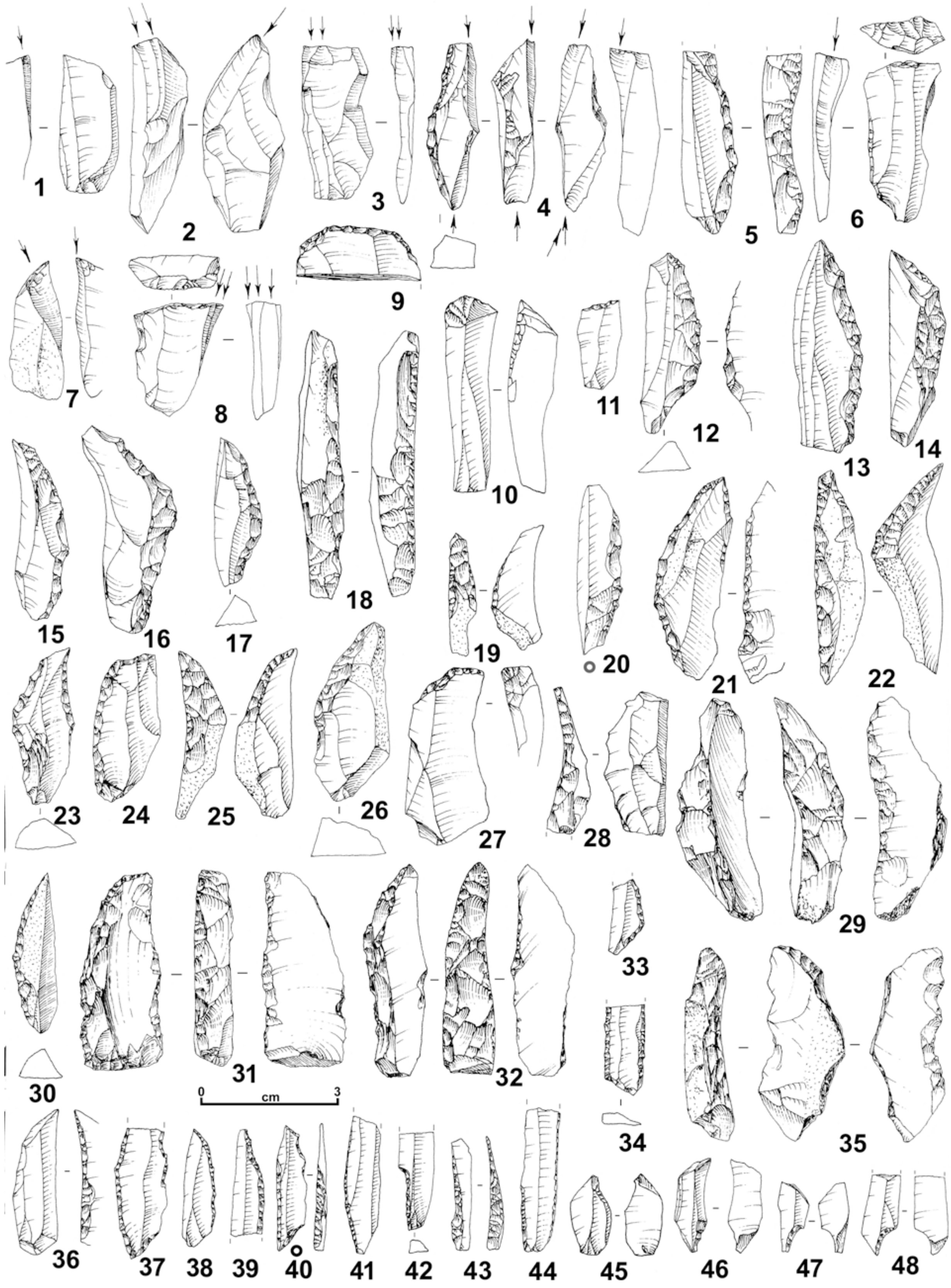

Fig. 12.9 Mulri Hills, site 16 (MH-16). *1–8*: Burins, *9*, *10*: End scrapers, *11*: Truncation, *12–17*, *19–28*, *30*: Curved, backed points, *18*: Thick backed blade, *29*, *31*, *32*, *35*: Thick, curved points, *33*: Triangle, *36–39*: Backed points, *34*, *41–44*: Backed bladelets, *40*: Backed bladelet and truncation, *45–48*: Microburins (Drawings by P. Biagi, inking by G. Almerigogna)

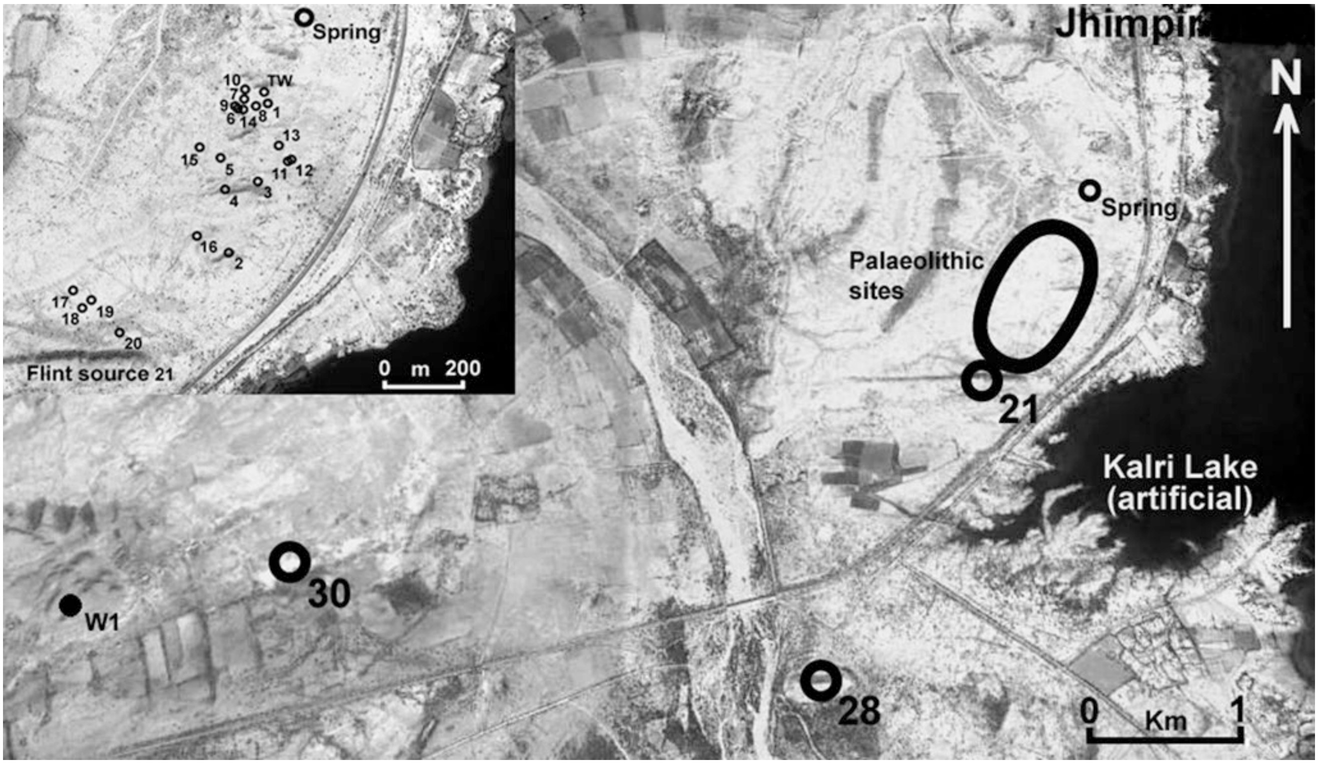

Fig. 12.10 Jhimpir: Distribution map of the Late (Upper) Palaeolithic sites discovered on the limestone terrace facing the artificial Kalri Lake. The precise location of all the JHP sites is shown in the *upper left* corner. The *larger circles* show the location of flint sources JHP-21, JHP-28 and JHP-30. Site JHP-W1 lays some 6.5 kms west south west of the main group (Drawing by P. Biagi)

piece (Fig. 12.14: 5). The cores are small, exhausted, subconical (10) or prismatic (9) with bladelet or bladelet-like flakelet detachments (Fig. 12.14: 8–23) on one surface. The platform is flat or slightly concave, obtained with one or more removals. Some of the cores are thin; others show traces of cortex.

All the burins are obtained from flakelets. One is simple with one lateral blow (Fig. 12.14: 1), 1 simple with two opposed, lateral blows (Fig. 12.14: 2), 1 simple with two transversal blows (Fig. 12.14: 3), 1 on retouch with two parallel, lateral blows (Fig. 12.14: 4). The splintered piece is on a bladelet.

12.4.5 The Rohri Hills

W.T. Blanford was the first to describe the geomorphologic characteristics of the Rohri Hills (Blanford 1880, pp. 101–107) that he attributed to the Brahui limestone formation (Blanford 1877). The same author also reported the first recovery of flint artefacts near Sukkur and Rohri, at the northern edge of the hills, in 1866–1867 (Blanford 1880, p. 20).

Some 70 years later H. De Terra and T.T. Paterson collected a few chipped stone tools from the top of a few small limestone terraces at Sukkur, west of the course of the Indus (De Terra and Paterson 1939, pp. 330–336) (Fig. 12.7: 11). They attributed the finds, among which are a few unretouched artefacts and one subconical bladelet core, coated with a dark brown desert patina, to their lithic Group A. According to their description this assemblage can be attributed to the Late (Upper) Palaeolithic period (De Terra and Paterson 1939, Plate XLV).

B. Allchin revisited the area in the mid 1970s. She discovered a few Late (Upper) Palaeolithic working floors at Chancha Baloch, some 4 km from Kot Diji, and Unnar (incorrectly reported as Nawab Punjabi) (Fig. 12.1: 12) (Allchin 1976, p. 479; Allchin et al. 1978, pp. 278–288).

The Joint Rohri Hills Project resumed the research in the area in the 1980s. Only during the 1990s it became clear that all the terraces of the central-western edge of the hills, east of the shrine of Shadee Shaheed, were spotted with hundreds of Late (Upper) Palaeolithic workshops (Biagi et al. 1995, p. 23).

The chipped stone artefacts were often displaced around the edge of man-made, oval depressions filled with wind-

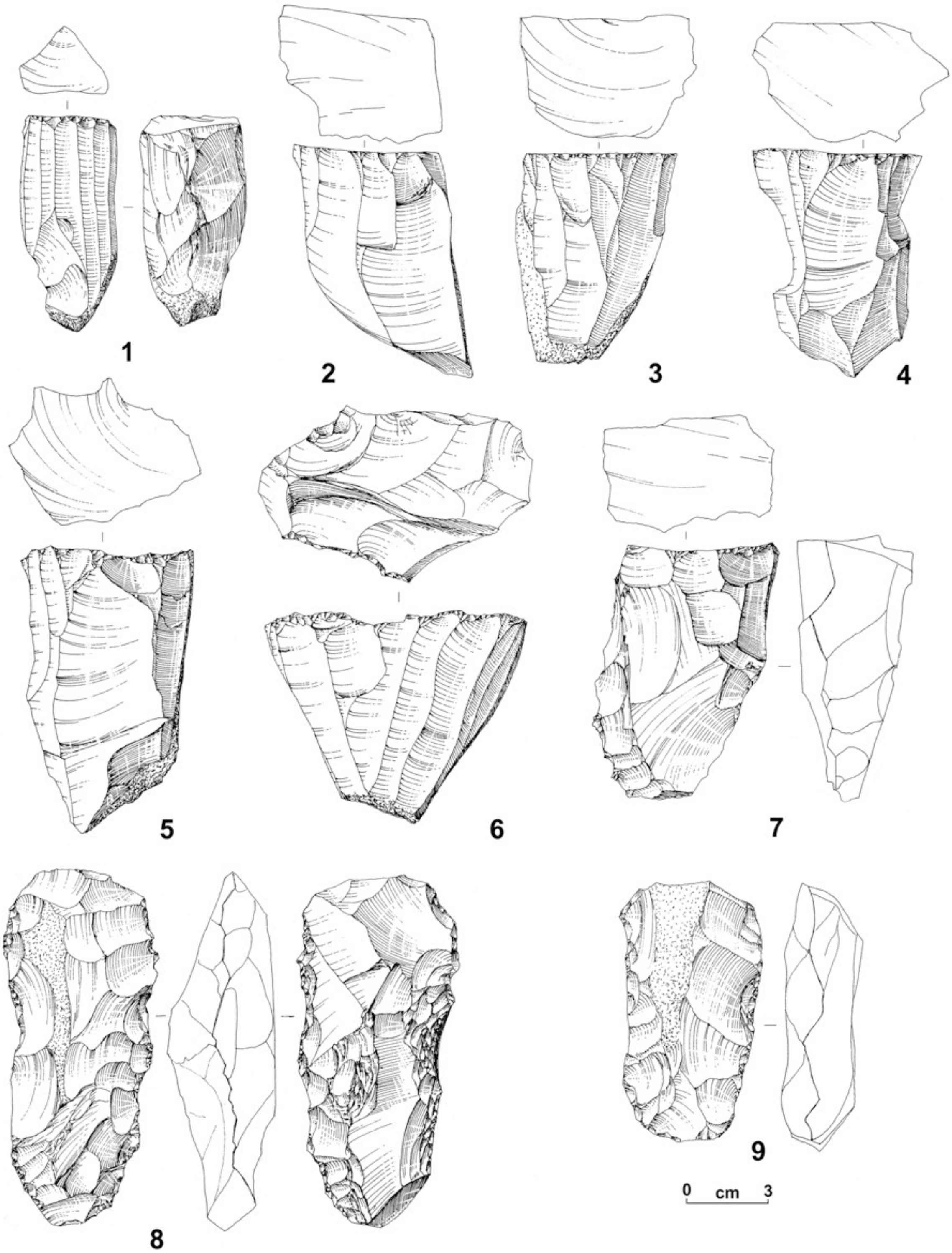

Fig. 12.11 Ongar. 1–7: Late (Upper) Palaeolithic cores, 8, 9: bifacial picks (After Biagi and Franco 2008: Fig. 5)

blown sand, from which the surface covered with limestone pebbles had been removed by prehistoric knappers (Fig. 12.1: 10). The workshops were characterized by scatters of thousands of brown, patinated debitage products (10YR4/3), subconical and prismatic bladelet and bladelet-like flakelet cores, pre-cores, flint hammerstones, crested blades and, in a few cases, bifacial picks (Fig. 12.15) (Biagi et al. 1994, 1998–2000; Biagi 2008a).

Fig. 12.12 Daphro: Late (Upper) Palaeolithic workshop made of thousands debitage flakes and cores (Photograph by P. Biagi)

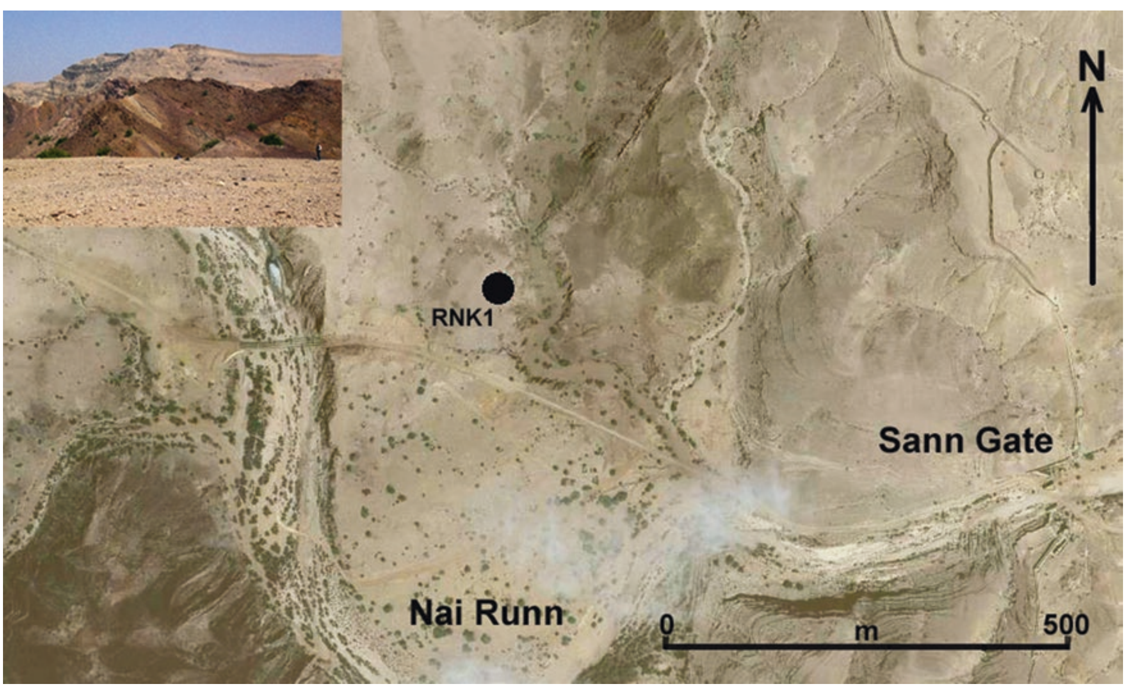

Fig. 12.13 Ranikot Fort: Location of the Late (Upper) Palaeolithic site RNK-1 and characteristics of the same site (*upper left* corner: drawing and photograph by P. Biagi)

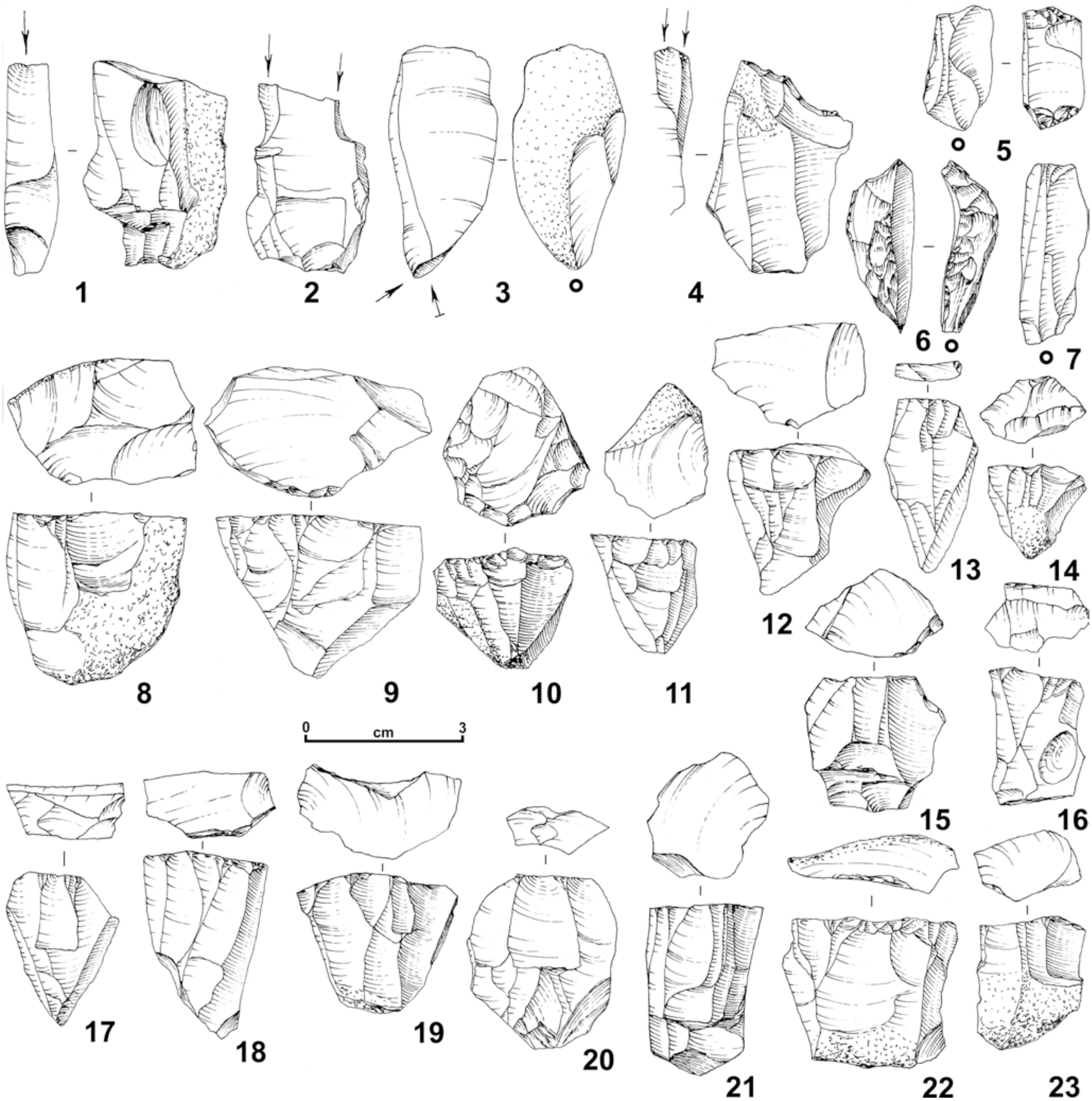

Fig. 12.14 Ranikot Fort: Late (Upper) Palaeolithic assemblage from RNK-1. *1–4*: Burins, *5*: Splintered bladelet, *6*: Core rejuvenation flake, *7*: Bladelet, *8–23*: Subconical and prismatic cores (Drawings by P. Biagi, inking by G. Almerigogna)

The micro-morphologic analysis of the soil of Workshop ZPS-2 (Biagi et al. 1998–2000, p. 116), shows that the Rohri Hills workshops formed during an "*arid climatic phase that characterized the second part of the last glacial*" most probably around the beginning of the Late (Upper) Palaeolithic (Negrino and Kazi 1996, p. 36).

12.5 Discussion

As already suggested by the present authors the Levallois Mousterian assemblages of Lower Sindh might represent the south-easternmost spread of *H. neanderthalensis* (Biagi 2006, 2008a; Biagi and Starnini 2014a, b). The available dis-

Fig. 12.15 Rohri Hills: Surface of a Late (Upper) Palaeolithic workshop with debitage flakes and bladelet cores (Photograph by P. Biagi)

tribution, which is delimited to the east by the course of the Indus, might correspond to a geographic/ecologic barrier, as already proposed for a purely theoretical dispersal route followed by AMH (Stock et al. 2007, Fig. 1). Although we know almost nothing of the Late Pleistocene location and environmental characteristics of the Indus delta (von Rad and Tahir 1997; Prins et al. 2000, p. 346; Inam et al. 2007, p. 336), nevertheless we can argue that during the OIS5-OIS3 the morphology of Lower Sindh was dramatically different from that of both present and Hellenistic periods (Haigh 1894; Wilhelmy 1968; Eggermont 1975; Biagi 2017a).

The Levallois Middle Palaeolithic chipped stone assemblages of Lower Sindh were collected from sites located along the western side of the Lower Indus Valley. This evidence is so far unique for the Indian Subcontinent. It opens an important debate on a few major topics among which are (1) the south-easternmost distribution of the Levallois Mousterian, and its eventual relationships with the Middle Palaeolithic of the Indian Subcontinent, (2) the techno-typological and chronological sequence of the Palaeolithic complexes in Sindh, (3) the easternmost distribution of the Aurignacian/Baradostian and its eventual relationships with the earliest Late (Upper) Palaeolithic industries of the Indian Subcontinent, (4) the definition of the human groups responsible for the production of all the above assemblages (Bolus 2015, p. 2388), (5) the chronology of the events that took place in the area during the Middle and Late (Upper) Palaeolithic, and the problems related with the eventual replacement of Neanderthals by AMH in the entire region (Reich et al. 2011, p. 523).

1. The typical Levallois Mousterian assemblages from Lower Sindh, mainly those from Ongar (Biagi 2008a; Biagi and Starnini 2014a; Blinkhorn et al. 2015), do not find any close parallel with the Middle Palaeolithic chipped stone industries from other regions of the Indian Subcontinent that have been often attributed to the Nevasian (Boriskovskiy 1971, Figs. 40–43). In contrast they can be compared with other assemblages from Iran, in the west, and Central Asia, in the north, where they are thought to have been produced by *H. neanderthalensis*. East of the Indus, flake assemblages, sometimes with a low Levallois-like component, characterize the Middle Palaeolithic (Pant and Jayaswal 2013). As reported above the Middle Palaeolithic industries from the Rohri Hills and the Thar Desert greatly differ from those from Ongar, and Karachi province, in the southwest.
2. Many flint workshops of the Rohri Hills have been attributed to the Late (Upper) Palaeolithic on the basis of distinctive techno-typological traits, and other characteristics of the chipped stone artefacts (Allchin et al., 1978, p. 280; Biagi et al. 1998–2000; Biagi and Starnini 2014a). In contrast almost nothing is known about the Middle Palaeolithic, given the absence of flint workshops attributable to this period in the Shadee Shaheed Hills (central-western terraces of the Rohri Hills), and the Rohri Hills in general. The geographic distribution of the few Acheulian, and the much more numerous Late (Upper) Palaeolithic workshops on the hills is very different. A similar, although not identical situation is known from Ongar in Lower Sindh.
3. The easternmost distribution of the Aurignacian/Baradostian complexes, although this term is currently considered quite generic and controversial (Fedele et al. 2008) covers a territory partly coincident to that of the Levallois Mousterian (Otte 2015). West and north of Sindh, they are known from Iran (Otte and Kozłowski 2007, 2009; Otte et al. 2012; Ghasidian et al. 2017) and Central Asia (Otte and Derevianko 2001; Otte 2004; Otte and Kozłowski 2011, Fig. 8; Kolobova and Krivoshapkin 2014). At present they have never been reported from the Indian

Subcontinent, where the beginning of the Late (Upper) Palaeolithic is perhaps represented by blade assemblages with curved, backed points (Murty 1969, 1970, 1979, 2003; Paddaya 1970; Sharma 1982). These latter assemblages are known from central and south-eastern India as well as Sindh. As far as we know their distribution does not overpass the course of the Hab River that marks the boundary between Sindh and Balochistan, in the west. Also in the case of the Late (Upper) Palaeolithic of the Indian Subcontinent many questions are still unsolved: (1) where did the above assemblages originate from? and from what tradition? When and where did they start to make their appearance? (2) what are their chronological and cultural relationships with the very rich Late (Upper) Palaeolithic workshops of the Rohri Hills from which retouched tools are almost absent? and with the industries characterized by geometric "microliths" in south-central India (Clarkson et al. 2009)?

4. The scarcity of Middle and Late Pleistocene human remains in India makes the general picture even more difficult to interpret (Costa 2013; Rightmire 2015). Therefore, it seems reasonable to suggest that also in the Indian Subcontinent "*without actual, direct fossil association, it is impossible to assign a human type as the maker of most Middle Palaeolithic industries in Eastern Europe and Central Asia*" (Marks and Monigal 2004, p. 78).
5. The Middle and Late (Upper) Palaeolithic chronological sequence of the entire Indian Subcontinent is still too badly known, and supported by few radiometric dates (Chakrabarti 1999, p. 74; Clarkson et al. 2009; see also Singhvi et al. 2010; Mishra et al. 2013). This is one of the main reasons why at present it is difficult not only to frame the Ongar and other Levallois Mousterian assemblages of Lower Sindh into the general picture of the Middle Palaeolithic of the Indian Subcontinent, but also to follow the sequence of the different cultural events that took place during the Late Pleistocene in most of the study areas. This observation can be extended also to the Late (Upper) Palaeolithic sites of the study region.

To sum up, regarding the Middle Palaeolithic, Sindh falls into the complex and fragmentary picture described above of which little is known, and even less is understood (Marks 2012). In contrast with Lower Sindh, from which typical Levallois Mousterian assemblages are known, the chipped stone industries from the Indian Thar Desert, and the Rohri Hills sites, would point to a different origin and development of the Indian Middle Palaeolithic.

The problem of the Late (Upper) Palaeolithic is even more complex, also because of the absence of sites of this period all along the coast of Makran and Las Bela (Balochistan), the suggested dispersal route followed by AMH to spread into the Indian Subcontinent (Blinkhorn and Petraglia 2014, p. 73). At present the south-westernmost sites of this period have been recovered from Mendiari, along the eastern terraces of the lower Hab River course, some 15 kms from the present seashore.

The chronology of the Late (Upper) Palaeolithic sites of Lower Sindh can be tentatively proposed only on the basis of the typological characteristics of the chipped stone tools that are represented by different types of (sometimes thick) curved backed points, obtained from bladelet blanks with direct or bipolar abrupt retouch. These industries are known from a few, although different, distant regions of the Indian Subcontinent (Mishra 2013, Fig. 4.1). They have nothing in common with the so-called Aurignacian/Baradostian complexes whose distribution covers wide territories located in the west and north of the study region. Furthermore they look absolutely different from those of the manufacturing workshops of both the Rohri Hills and Ongar, from which retouched tools are almost absent.

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13 Ecological Niche and Least-Cost Path Analyses to Estimate Optimal Migration Routes of Initial Upper Palaeolithic Populations to Eurasia

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Abstract

This paper presents a computer-based method to estimate optimal migration routes of early human population groups by a combination of ecological niche analysis and least-cost path analysis. In the proposed method, niche probability is predicted by MaxEnt, an ecological niche model based on the maximum entropy theory. Location of known archaeological sites and environmental factors derived from palaeoterrain and palaeoclimate models, are input to the model to calculate the niche probability at each spatial pixel and weights of the environmental factors. The inverse of probability score is then used as an index of relative dispersal rate to accumulate the travel cost from a given origin. Based on this cumulative cost surface, least-cost paths from the origin to given destinations are visualised. This method was applied to the Initial Upper Palaeolithic population group (probably of modern humans) in Eurasia. The model identified three migration routes from the Levant to (1) Central Europe via Anatolia and Eastern Europe, (2) the Russian steppe via Caucasus Mountains, and (3) the Altai region via the southern coastal Iran and Afghanistan.

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Keywords
Ecological niche modelling • Least-cost paths • Environmental factors • Initial Upper Palaeolithic • Early modern human dispersal to Eurasia

13.1 Introduction

Timing and routes of the dispersals of early modern humans into Europe and Asia have extensively been discussed from viewpoints of archaeology, physical anthropology, and population genetics (Mellars 2006; Petraglia et al. 2010; Mellars and French 2011; Dennel and Petraglia 2012; Bar-Yosef and Belfer-Cohen 2013; Boivin et al. 2013; Digandžic and McPherron 2013; Bellwood 2015; Hershkovitz et al. 2015; Kimura 2015; Svoboda 2015 for recent studies). In papers on this issue, possible migration routes have usually been suggested with arrowed lines in an intercontinental-scale map, based on a somewhat subjective interpretation of the geographical distribution of known archaeological sites and their radiometric dates. Such migration paths must be checked and revised in a verifiable way.

To this end, we can apply least-cost path analysis (LCPA), a computer-based method for finding and visualising optimal paths that minimises the total cost of moving from an origin to a destination on a cumulative cost surface (Conolly and Lake 2006). A cumulative cost surface is created by accumulating friction values (index of moving cost) allocated to each spatial pixel. The conventional cost surface models (Gorenflo and Gale 1990; Tobler 1993; Van Leusen 2002; Neteler and Mitasova 2008, p. 381; Kondo and Seino 2010; Kondo et al. 2011) have usually employed the slope of terrain as a friction value. This means that the conventional models are univariate.

Recent progress in a large-scale accumulation of archaeological data and high-resolution global palaeoenvironment models enabled an application of ecological niche model (ENM) to archaeology in the Pleistocene (Banks et al. 2006, 2008a, b, 2011, 2013; Kondo et al. 2012b). Such an application was called eco-cultural niche modelling (ECNM; Banks et al. 2006). The ECNM is similar to the ENM in terms of model algorithms. However, it should be noted that human behaviours could be different from other species because modern humans were (and are) able to explore new niches by rapid technological innovations in response to changes in the environmental conditions.

In terms of archaeological data, a several number of Palaeolithic site databases have recently been developed by international multidisciplinary research teams. For instance, the Role of Culture in Early Expansions of Humans (ROCEEH) project is collecting evidence of hominids in Europe and Africa (Märker et al. 2011). The Stage 3 project built an extensive radiocarbon database for Palaeolithic sites in Europe during the marine isotope stage 3 (MIS 3; 60 to 24 kya) (van Andel and Davies 2003; The Stage Three Project 2010), and this database was succeeded and updated by the PACEA (De la Préhistoire à l'Actuel: Culture, Environments et Anthropologie) geo-referenced radiocarbon database (d'Errico et al. 2011). Another database for Palaeolithic sites in the Far East was also developed by an international alliance of researchers (Gillam et al. 2008).

Second, high-resolution global paleoenvironmental datasets have also remarkably been developed in the last decade. In terms of Digital Elevation Model (DEM), the United States National Oceanic and Atmosphere Administration (NOAA) provided a 1-arc-minute (or 0.01667-arc-degrees) pixel ETOPO1 global relief model with bathymetric data (Amante and Eakins 2009), from which a palaeoterrain model can be created. For palaeoclimate data, the WorldClim project provided 30-arc-second (or 0.008335 arc-degrees) climate models for the present day and the Last Interglacial (140 to 120 kya; Hijmans et al. 2005; Otto-Bliesner et al. 2006b). There are two palaeoclimate models for the Last Glacial Maximum (LGM; around 21 kya)—the Community Climate System Model (CCSM; Otto-Bliesner et al. 2006a) and the Model for Interdisciplinary Research on Climate (MIROC; Abe-Ouchi et al. 2013)—available in an international data protocol defined by the Paleoclimate Modelling Intercomparison Project Phase II (PMIP 2; Braconnot et al. 2007). These models have 64 data points in latitude and 128 points in longitude, corresponding to 2.8-degree intervals in the mid-latitude areas.

These progresses in data accumulation enabled an application of ENM to Palaeolithic human populations. ENM is a machine-learning model to simulate species' geographic range using the location of sites as input and environmental factors (such as temperature, precipitation, and elevation) as background data (Peterson et al. 2002, 2011; Stockwell 1999). It is applicable to prehistoric human populations based on the assumption that human behaviours were largely constrained by environmental factors (Banks et al. 2006, 2008a, b, 2013; Kondo et al. 2012b; Kondo 2015). ENM outputs niche probability for each spatial pixel, with quantitative assessment of multiple environmental factors. This means that niche probability is a product of multivariable analysis.

Now, niche probability can be used as index of dispersal rate, based on the assumption that niche range can be expanded given that new environment is nearly equivalent to source environment (Wellborn and Langerhans 2015, p. 181). Based on this idea, this paper presents a computer-based method to estimate optimal migration routes of early modern human populations by a combination of ENM and LCPA.

13.2 Dataset and Methods

13.2.1 Overview

The Replacement of Neanderthal by Modern Humans (RNMH) project (Akazawa and Nishiaki 2012, 2014) developed the proposed method through a multidisciplinary collaboration involving archaeologists, geochronologists, climatologists, geomorphologists, and computer scientists. The workflow began with preparing archaeological data as input and palaeoenvironmental data as background data for ENM (Fig. 13.1). The archaeological data was extracted from a cyclopedic database built by the archaeology team, and the palaeoenvironmental data included a new global palaeoclimate model (Abe-Ouchi et al. 2013). The ENM output niche probability and weight of environmental factors to the model. Inverse of niche probability was input to the cost surface model as friction value to create a cumulative cost surface, which was then used for identifying least-cost paths. Relative travel time elapsed was also output from the cost surface model.

13.2.2 Archaeological Data

This case study focused on the Initial Upper Palaeolithic (IUP) lithic industry as an archaeological marker of the population group of early modern humans dispersed to Europe and Asia. The IUP was originally referred to the lithic assemblage from the layer 4 of Boker Tachtit (Kuhn and Zwyns 2014). The industry was characterised by the Levallois technology with unipolar reduction of volumetric cores (Kuhn and Zwyns 2014). The common technology was observed in (1) the Bohunician found at Bohunice (Tostevin and Skrdla 2006; Richter et al. 2008) and several other sites in the Czech Republic, (3) the Bachokirian found at Bacho-Kiro (Kozlowski 1982; Tsanova 2008) and Temnata Cave (Tsanova 2008; Teyssandier 2008) in Bulgaria, and (3) the 'Levantine Transitional' industry found at Uçağızlı Magara F-H (Kuhn et al. 1999, 2004; Belfer-Cohen and Goring-Morris 2003), earliest Upper Palaeolithic levels of Ksar Akil (Bergman 1987; Ohnuma 1988; Mellars and Tixier 1989; Bar-Yosef 2000; Belfer-Cohen and Goring-Morris 2003), and other sites in the Levant. Moreover, it is noted that the similar industry was reported from the Horizon 5–6 of Kara Bom in the Altai region (Derevianko et al. 1998, 2013; Derevianko and Markin 1998; Orlova et al. 2000; Derevianko and Rybin 2005; Derevianko and Shunkov 2005; Rybin 2007; Derevianko 2010). The IUP industry was present at 50–35 kya (Kuhn and Zwyns 2014). In terms of the technological similarity in lithic assemblage, 28 IUP sites (Fig. 13.2; Table 13.1) were selected from the *Neander DB*, a cyclopedic database of archaeological sites, lithic industries, and radiometric dates in Africa, Europe, Asia and Oceania between 200 and 20 kya, which was developed by the RNMH archaeology team (Kondo et al. 2012a).

13.2.3 Palaeoenvironmental Data

Palaeoenvironmental data for ENM comprised palaeoterrain and palaeoclimate data. Regarding the palaeoterrain data, the aforementioned ETOPO-1 DEM (Amante and Eakins 2009) was employed for creating five-minute (or 0.083333 degrees) grid models of elevation, slope, and aspect. The study area was delimited to 0–90 °N in latitude and 20 °W–160 °E in longitude and divided into 1080 (latitudinal) by 2160 (longitudinal) pixels. This area covered the entire regions of Europe, South-

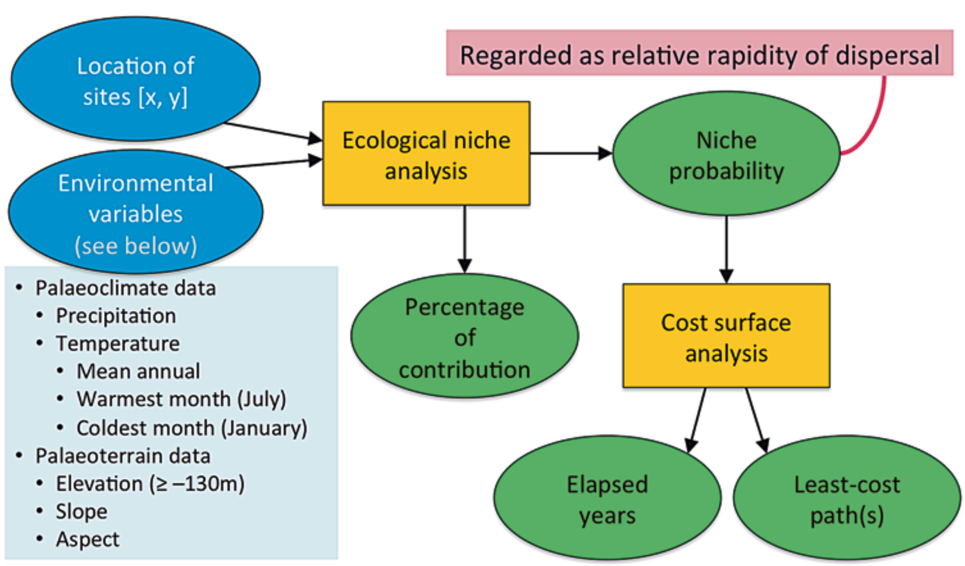

Fig. 13.1 Workflow of the ecological niche and cost surface analyses to estimate least-cost paths of the modern human dispersal

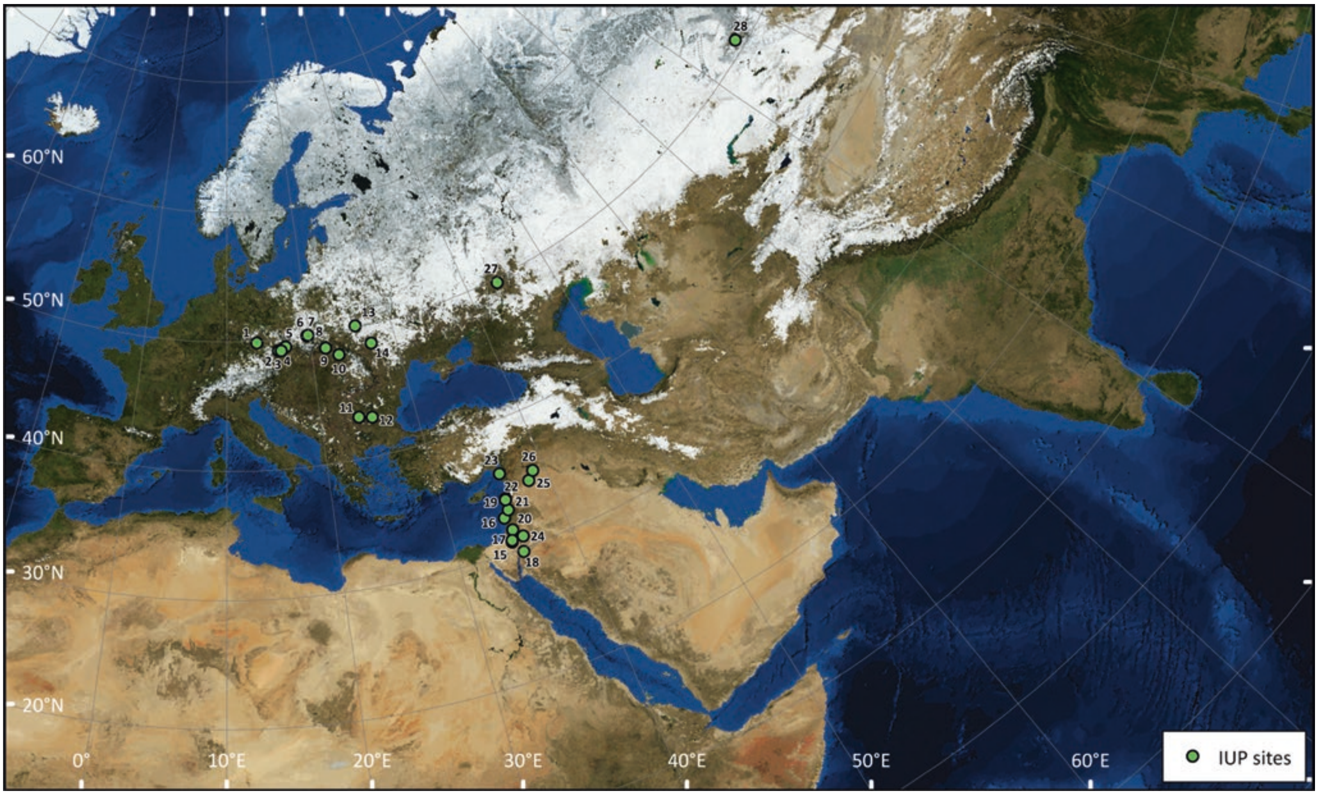

Fig. 13.2 Geographical distribution of the Initial Upper Palaeolithic (IUP) sites used for the experiment (see Table 13.1 for the short description of sites)

west Asia, Central Asia, and North Africa. The terrain models were clipped at 130 m below the current sea level to create a palaeoterrain model at the largest extent (relevant to the LGM).

As mentioned before, a new palaeoclimatic dataset was created by the latest version of MIROC atomosphere-ocean general circulation model (Abe-Ouchi et al. 2013; Kawamura et al. 2017). Two experiments were run for a typical 'mid-glacial' environment of the Last Glacial: One was the so-called 'hosing' experiment, corresponding to a relatively cool and arid phase, while the other was the 'recovery (non-hosing)' experiment approximating a relatively warm and humid phase. Four climatic parameters—mean annual temperature, the coldest month (January) temperature, the warmest month (July) temperature, and annual precipitation—were input to the ENM. The spatial resolution of these data was conformed to that of the palaeogeographic data by spline interpolation.

13.2.4 Ecological Niche Models (ENM)

Amongst ENMs, MaxEnt was employed for the model presented in this paper. MaxEnt was based on the maximum entropy model (Jaynes 1957; Phillips et al. 2006; Phillips and Dudík 2008), and outputs continuous probabilities of presence (0 … 1) for each raster cell. It is an open source programme run on a JAVA platform (which means that it is a multi-platform program), and is downloadable at http://www.cs.princeton.edu/~schapire/maxent/ at free of charge.

In the computational experiment by MaxEnt, the location (x, y) of the IUP sites were taken as model input, and the palaeoterrain (elevation, slope, and aspect) and palaeoclimate data (annual precipitation, mean annual temperature, warmest month temperature, and coldest month temperature) as background data. The georeferenced TIFF (GeoTIFF) raster files of the palaeoterrain data were converted to ASCII matrix text files to be input to the ENM, and NetCDF files of the palaeolimate data were converted to ASCII via GeoTIFF.

Model parameters were set similar to those in Banks et al. (2011)—500 maximum iterations and 10,000 background points. Convergence limit was set to 10^{-5}. The model was crossvalidated by the tenfold method (10 replicate runs with 10% of samples randomly omitted).

13.2.5 Least-Cost Path Analysis (LCPA)

As mentioned before, inverse of niche probability was used for friction value allocated to each spatial pixel. Friction values were accumulated from the staring point to periphery in a radiated manner to create a cumulative cost surface by

Table 13.1 Initial Upper Palaeolithic sites used for the experiment

No.	Site name	Layer	Country	Latitude	Longitude	References
1	Stránska Skála	5	Czech Republic	49.817	13.682	Svoboda and Bar-Yosef (2003)
2	Mohelno		Czech Republic	49.100	16.183	Svoboda (1996)
3	Orechov		Czech Republic	49.100	16.517	Svoboda (1996)
4	Bohunice	Kejbaly I–II, 4a	Czech Republic	49.174	16.582	Tostevin and Skrdla (2006) and Richter et al. (2008)
5	Ondratice I		Czech Republic	49.350	17.050	Svoboda (1996)
6	Dzierzyslaw 1		Poland	50.047	17.974	Kozlowski and Kozlowski (1996), Svoboda (2004), and Hoffecker (2011)
7	Piekary lla	7b	Poland	50.013	19.790	Mercier et al. (2003) and Sitlivy et al. (2008)
8	Ksiecia Jozefa	II–III	Poland	50.050	19.904	Sitlivy et al. (2009)
9	Nizny Hrabovec	I + II	Slovakia	48.850	21.750	Kaminska (2010)
10	Korolevo 1, 2	Ia, II	Ukraine	48.176	23.170	Monigal et al. (2006)
11	Temnata Cave	TD-I, IV; TD–II, VI	Bulgaria	43.175	24.088	Tsanova (2008) and Teyssandier (2008)
12	Bacho Kiro	11	Bulgaria	42.947	25.430	Kozlowski (1982) and Tsanova (2008)
13	Koulichivka	Level 3	Ukraine	50.117	25.717	Meignen et al. (2004)
14	Korman' 4	Layer 11	Ukraine	48.561	27.153	Velichko and Zelikson (2005), Gerasimova et al. (2007), and Hoffecker (2011)
15	Boker Tachtit	1–4	Israel	30.700	34.908	Marks (1983a, b) and Belfer-Cohen and Goring-Morris (2003)
16	el-Wad		Israel	32.621	34.950	Belfer-Cohen and Goring-Morris (2003)
17	Sde Zin 7		Israel	30.800	34.958	Belfer-Cohen and Goring-Morris (2003)
18	et-Taban	Layer B	Israel	31.567	35.300	Neuville (1951), Marks (1983a), and Belfer-Cohen and Goring-Morris (2003)
19	Emireh		Israel	33.133	35.567	Turville-Petre (1927), Marks (1983a), and Belfer-Cohen and Goring-Morris (2003)
20	Wadi Aghar		Jordan	29.683	35.583	Coinman and Henry (1995), Belfer-Cohen and Goring-Morris (2003)
21	Ksar Akil	19–25	Lebanon	33.911	35.608	Bergman (1987), Ohnuma (1988), Mellars and Tixier (1989), Bar-Yosef (2000), and Belfer-Cohen and Goring-Morris (2003)
22	Abu Halka	IVe–f	Lebanon	34.000	35.650	Belfer-Cohen and Goring-Morris (2003)
23	Ucagizli Magara	F-H	Turkey	35.967	35.938	Kuhn et al. (1999, 2004) and Belfer-Cohen and Goring-Morris (2003)

(continued)

Table 13.1 (continued)

No.	Site name	Layer	Country	Latitude	Longitude	References
24	Tor Sadaf	III–IV	Jordan	30.846	35.966	Coinman et al. (1999), Belfer-Cohen and Goring-Morris (2003), Coinman (2003), Fox (2003), and Olszewski (2008)
25	Jerf Ajla	Brown 1 (units A, B, C)	Syria	34.663	38.196	Schroeder (1969), Julig et al. (1999), and Belfer-Cohen and Goring-Morris (2003)
26	Umm el-Tlel	IIBase, III2A	Syria	35.268	38.889	Bar-Yosef (2000) and Belfer-Cohen and Goring-Morris (2003)
27	Shlyakh		Russia	49.598	43.702	Nekhoroshev (1999), Nekhoroshev and Vishnyatsky (2000), Nekhoroshev et al. (2003), and Hoffecker (2011)
28	Kara Bom	Horizon 5–6	Russia	50.723	85.574	D'revianko et al. (1998), Derevianko and Markin (1998), Orlova et al. (2000), Derevianko and Rybin (2005), Derevianko and Shunkov (2005), Rybin (2007), Derevianko (2010), and Derevianko et al. (2013)

See Fig. 13.1 for the geographical distribution

using ArcGIS 10.2 (ESRI 2014a). In this algorithm, the cost to travel between one cell (or spatial pixel) and the next is calculated in the following way (ESRI 2014a):

When moving from one cell (cell 1) to one of its four directory connected neighbours (cell 2), the total cost of the link from the cell 1 to cell 2 is

$$a_1 = \frac{C_1 + C_2}{2} \qquad (13.1)$$

where a_1 is the total cost, and c_1 and c_2 are the cost of cell 1 and 2 respectively.

If the movement is diagonal, the total cost of the link from the cell 1 to cell 2 is

$$a_1 = \frac{\sqrt{2}\left(c_1 + c_2\right)}{2} \qquad (13.2)$$

Then, the cumulative cost from the cell 1 to cell n is by the following equation:

$$\mathit{cumulative\ cost} = \sum_{i=1}^{n} a_i \qquad (13.3)$$

The least value was taken when multiple cumulative costs were calculated. Cumulative cost value at each pixel indicates travel cost (elapsed time or energy expenditure for instance) from the origin. For the experiment model, the cumulative cost was a relative travel cost that accumulated the inverse of niche probability.

By using a cumulative cost surface, least-cost paths from one origin to a given destination points were uniquely determined. In the experiment, the southernmost IUP site, Wadi Aghar, Jordan (29.683 °N, 35.583 °E) was set to the origin, or starting point of the cumulative cost calculation. The other 27 sites were set to the destinations when calculating least-cost paths. Each cell of the input destination is treated separately, and a least-cost path is determined for each cell (ESRI 2014b).

13.3 Results

13.3.1 Niche Corridors

The niche probability of the IUP group in response to a relatively cold and arid climate conditions approximated by the hosing experiment is shown in Fig. 13.3, while that to a relatively warm and humid climate approximated by the recovery experiment is shown in Fig. 13.4. In both maps, the niche probability is classified to ten grades, and areas of higher probability are indicated by yellow (0.61–0.7), pale orange (0.71–0.8), orange (0.81–0.9), and red (0.91–1). Dark dots

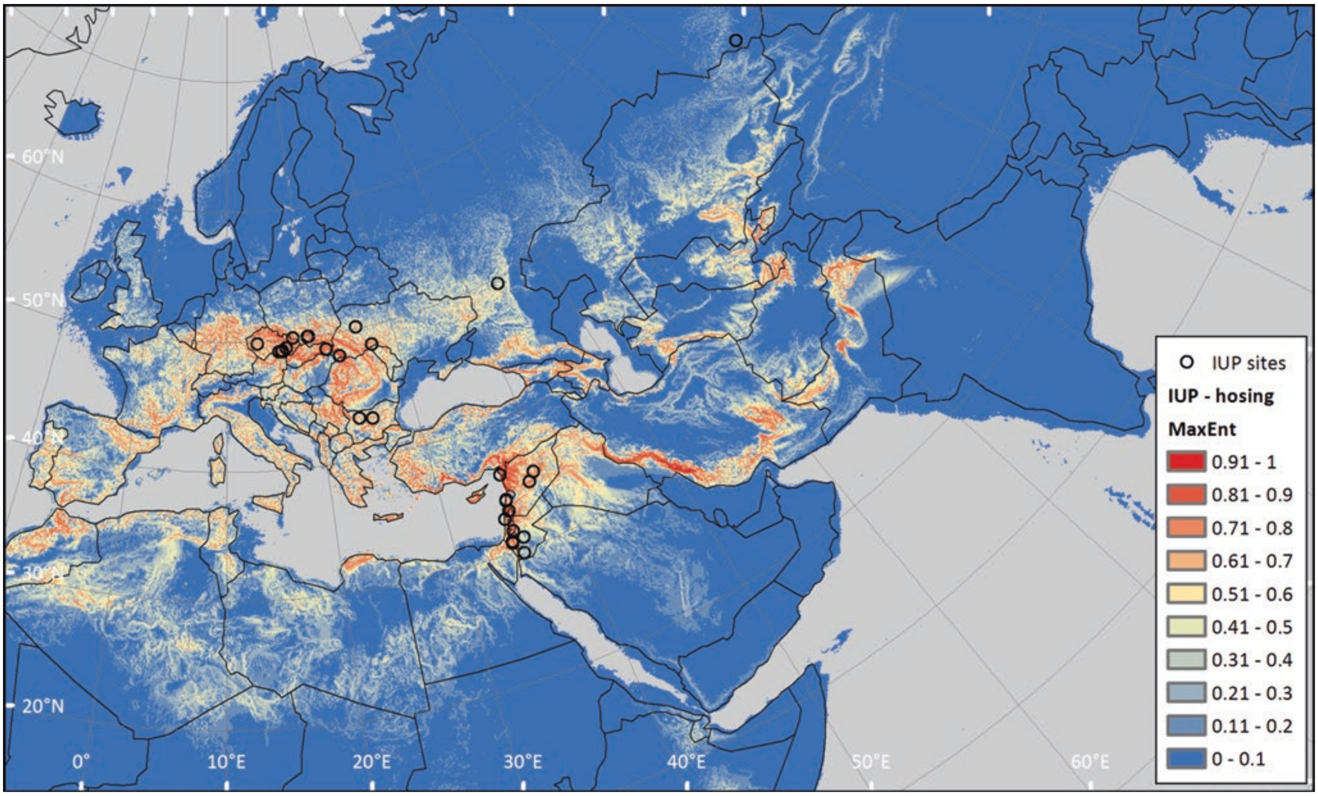

Fig. 13.3 Niche probability for the IUP lithic industry predicted by MaxEnt using the palaeoclimate model from the hosing experiment (corresponding to a cold/arid phase). See Table 13.2 for the contribution of environmental factors

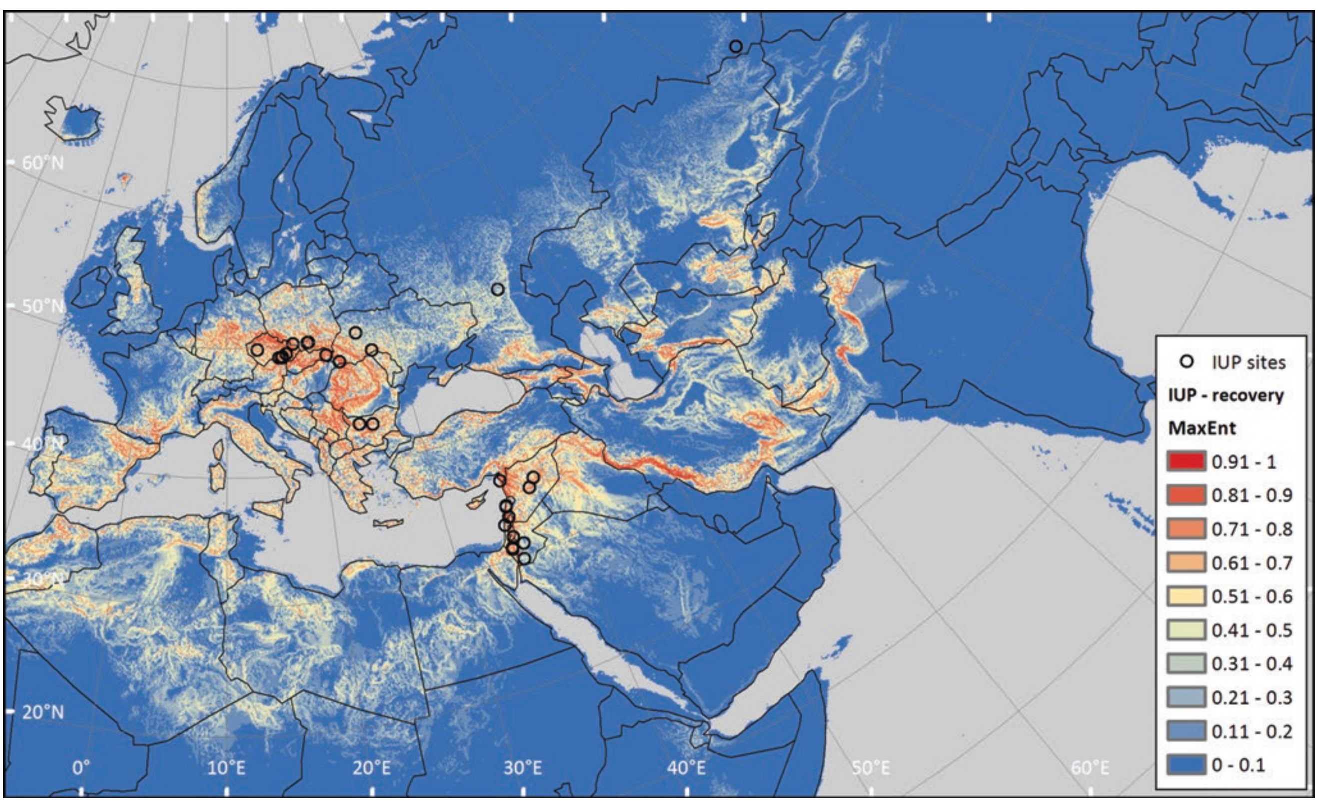

Fig. 13.4 Niche probability for the IUP lithic industry predicted by MaxEnt using the palaeoclimate model from the recovery experiment (corresponding to a warm/humid phase). See Table 13.3 for the contribution of environmental factors

indicate the location of sites used as occurrence data in MaxEnt. It should be noted that niche probability does not reflect population density.

The spatial patterns of the niche probability of the two models looked similar in general. High niche probability corridors were observed in the Levant and the Mediterranean littoral areas, Central and East Europe, and southern coast of Iran, Pakistan, and northern and southern piedmont areas of the Caucasus and Pyrenee Mountains, and the northern piedmont of the Kopet Dag in Turkmenistan. In a closer look, high niche probability areas were also present in northern Frans and the Faeroe Islands in the North Sea in the recovery model. Except for the Levant and Central and Eastern Europe, there were no IUP sites reported in the high niche probability areas.

13.3.2 Contribution of Environmental Variables

The percentage of contribution (PC) and permutation importance (PI) of environmental variables for the IUP group at a relatively cold and arid phase are shown in Table 13.1, whereas those at a relatively warm and wet phase are shown in Table 13.2. The PC determines the weight of a given variable in the function to output the niche probability. On the other hand, the PI represents the variability of model without a given variable. Higher PI value means that the PC of variables could be more likely to change without the given variable.

The coldest month (January) temperature was the most influential variable for both hosing and recovery models, with the highest PC and PI values. Those in the recovery experiment were particularly high. The mean annual temperature was the second most influential variable in the hosing experiment, while the slope of terrain, or an index of topographic settings such as plain and mountainous areas, ranked in the second most influential variable for in the recovery experiment. Another terrain factor, elevation, was ranked in the third most influential variables. The annual precipitation was noted by the second largest percentage of PI, which means this factor was certainly less important than the coldest month temperature, mean annual temperature, slope, and elevation. In contrast, the contributions of the aspect of terrain and the warmest month (July) temperature were trivial in both experiments.

AUC (Areas under the Curve) represents an overall measure of model performance and strength of a prediction (Peterson et al. 2011, p. 269). It is a nonparametric measure that ranges 0–1. AUC values = 0.5 the expected performance by a random classifier, and AUC values >0.5 are generally classified into (1) poor predictions (0.5–0.7); (2) reasonable predictions (0.7–0.9); and very good predictions (> 0.9; Swets 1988; Peterson et al. 2011, p. 172; Hosmer et al. 2013; Kondo 2015). Both hosing and recovery models performed very well with AUC values higher than 0.9.

13.3.3 Travel Cost and Least-Cost Paths

The cumulative travel cost to the southernmost IUP site (Wadi Aghar) in response to a relatively cold and arid climate condition is shown in Fig. 13.5, while that in response to a relatively warm and humid condition is presented in Fig. 13.6. Patterns shown in these maps are a sort of isopleth of relative travel cost, which could be converted to elapsed years if reliable dates were given to origin and destination points. Both models showed a radiation of dispersal. It is interesting that the dispersal progressed a bit slower in the warm condition (Fig. 13.5) than in the cold condition (Fig. 13.6).

In terms of the LCPA, three major routes of dispersal were visible. There was a bunch of routes to the sites in Central Europe via Anatolia and two Bachokirian sites in Bulgaria (Fig. 13.6, A). Another route went to Shlyakh (No. 27) in the Russian steppe via Caucasus Mountains (Fig. 13.6, B). The other route reached Kara Bom (No. 28) in the Altai region via the southern coast of Iran and Afghanistan (Fig. 13.6, C). These three routes commonly passed through the Levantine Corridor at the first leg of travel. The route C passed the high niche probability corridors in the southern coastal Iran, although it was irrelevant to those in Pakistan and Turkmenistan.

Table 13.2 Contributions of environmental variables for MaxEnt calculation for IUP niche probability under the MIROC hosing experiment

Environmental variable	% Contribution	Permutation importance
January temperature	30.5	30.0
Annual temperature	20.5	12.8
Elevation	16.1	9.3
Slope	15.6	13.2
Annual precipitation	12.8	29.9
Aspect	2.9	3.4
July temperature	1.7	1.5
AUC = 0.912		

Table 13.3 Contributions of environmental variables for MaxEnt calculation for IUP niche probability under the MIROC recovery experiment

Environmental variable	% Contribution	Permutation importance
January temperature	40.6	49.3
Slope	16.9	8.8
Elevation	13.6	9.2
Annual temperature	13.4	7.6
Annual precipitation	11.1	21.6
Aspect	2.7	2.8
July temperature	1.8	0.6
AUC = 0.943		

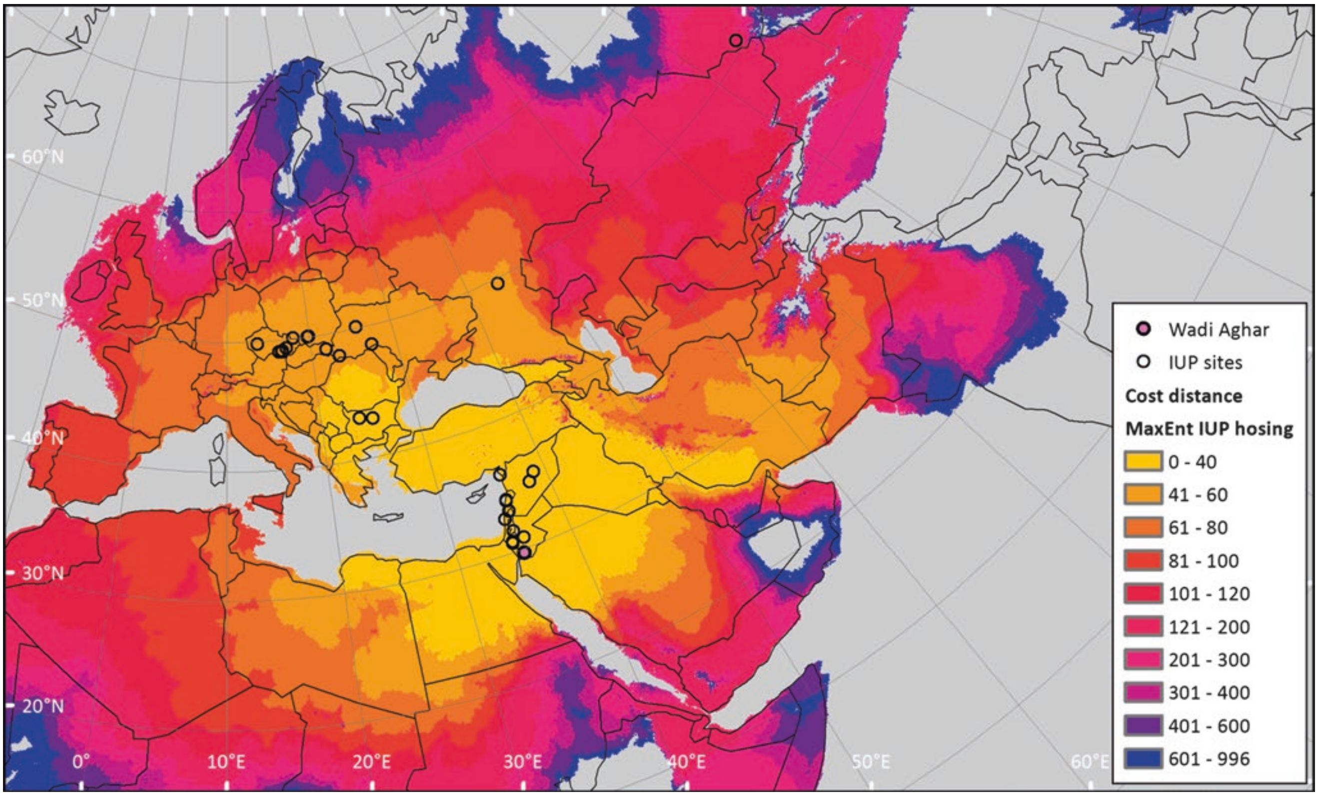

Fig. 13.5 Cumulative cost to the southernmost IUP site (Wadi Aghir) using the inverse of the niche probability of the hosing experiment (corresponding to a cold/arid phase) as friction value

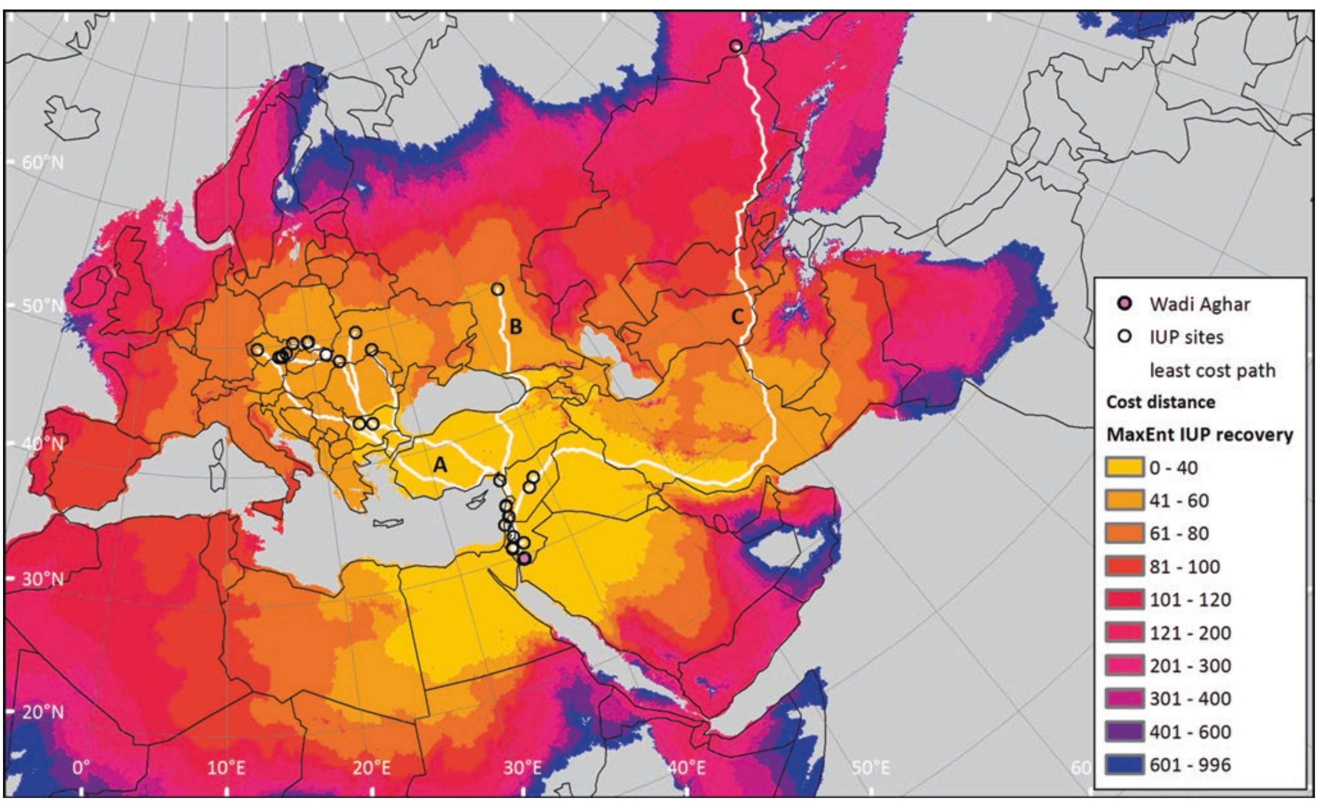

Fig. 13.6 Cumulative cost to the southernmost IUP site (Wadi Aghir) using the inverse of the niche probability of the recovery experiment (corresponding to a warm/humid phase) as friction value

13.4 Discussion

As mentioned above, the results of the ENM and LCPA showed three niche corridors of the IUP group from the Levant to Central Europe, the Russian steppe, and the Altai region. Those could be interpreted as major migration paths of early modern humans into Eurasia. It is noted that the model partly supported the so-called 'coastal express' theory (Mellars 2006) as the paths passed the Levantine corridor, the Mediterranean coasts, and the southern coast of Iran. In fact, IUP sites have never been identified in the Mediterranean countries and the southern coastal Iran, while these regions were assessed as high niche potential areas for the IUP group in terms of environmental conditions. Future investigations in these regions may crossvalidate this issue.

In addition, the results clearly indicated that the east-west migration in the 50 °N latitude zones was possible in Europe, although it was less likely in Russia and the eastward. The northbound migration seems more difficult than the east-west movement because the latter required exploring new niches in more severe environmental conditions.

The PC and PI values of both hosing and recovery experiments indicated that the winter climate inferred from the coldest month temperature significantly impacted on the human niche construction. In contrast, the warmest month temperature was trivial because the difference in the summer temperature between high and middle latitude zones is smaller than in winter in general. It should also be noted that this might be a result of 'double-count' because the summer temperature was already incorporated to the model calculation as part of mean annual temperature.

Recent palaeoclimatic research has revealed the Dansgaard-Oeshgar (D-O) events and other mechanisms of the millennial-scale abrupt climate changes (EPICA Community Members 2006). The fluctuation was considered by the pair of hosing and recovery experiments, while it did not seem very influential to the niche expansion of the IUP group. However, the slower dispersal at a warm phase was exceptional: It could be explained by robust niche construction at every spatial patch in a warm and humid environmental condition.

In terms of the modelling method, this paper proposed the multivariate cost surface analysis using the inverse of ecological niche probability as a friction value. In comparison with the conventional method using the slope of terrain as a friction value (Fig. 13.7), the ENM-based models (Figs. 13.5 and 13.6) were more sensitive to diverse environmental factors. It is a merit of the proposed method that it can report the contribution of each environmental factor to the model.

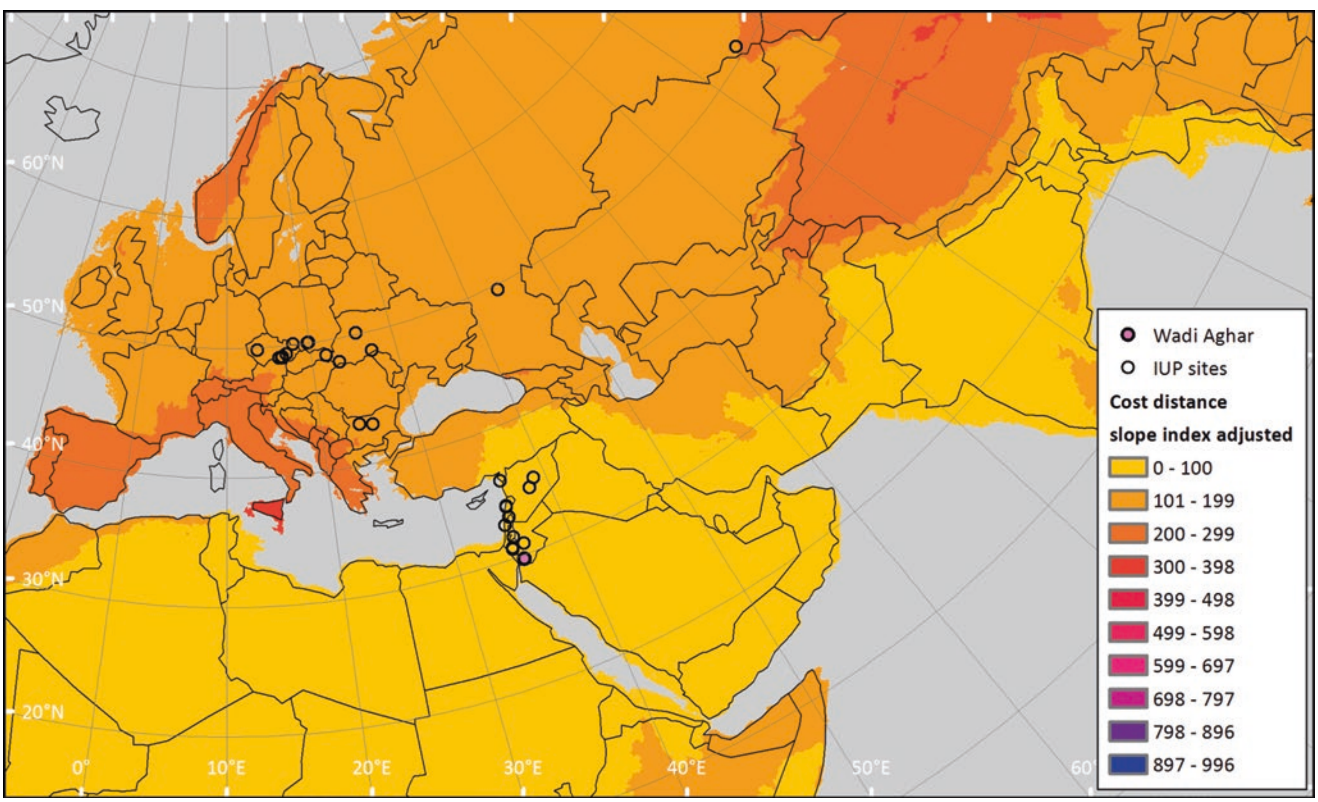

Fig. 13.7 Cumulative cost to the southernmost IUP site (Wadi Aghir) using the slope of terrain as friction value

13.5 Conclusion and Future Tasks

This paper visualised possible migration corridors of the IUP population group from the Levant to Central Europe, the Russian steppe, and the Altai region in terms of the ecological niche construction in response to environmental factors. The corridors can be seen more sharply by least-cost paths between the southernmost site (Wadi Aghar) in the Levant and other IUP sites. There was little difference in the dispersal patterns between the cold and warm phases. This least-cost model is able to assess the impacts of multiple environmental factors and therefore more informative than the previous univariate model.

While this paper successfully presented the potential of the joint application of the ENM and LCPA to estimate migration routes of early human populations in a computational way, there still remains room to improve the method. First, the cumulative cost used in the current model is no more than a relative index. It could be converted to elapsed years if reliable dates were given to origination and destination sites (or regions).

Second, since the cumulative cost is a linear model, the dispersal pattern of the model was assumed to be a linear progression. In a realistic sense, however, we should consider nonlinear dispersal patterns, in which the dispersal may pose or regress at some conditions such as climatic deterioration and the subsequent decrease of food resources. For example, we should take into account the presence of the Neanderthals, who were in the trajectory of extinction in some thousands of years since the modern humans firstly appeared to Europe (Higham et al. 2014). In order to reflect niche competition of two or more groups, an agent-based model to simulate nonlinear dispersal patterns should be developed.

With considering the niche competition (Banks et al. 2008b) and refined radiocarbon dates (Higham et al. 2014), the proposed method is applicable for other population groups identified by lithic industries such as the Mousterian (probably used by the Neanderthals), the Châtelperronean, Uluzzian, Proto-Aurignacian, and Early Aurignacian to better understand the geographical processes of the dispersal of early modern humans and the extinction of the Neanderthals in a wider spatio-temporal context.

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The MODIS data product used in Fig. 2 was retrieved from the online Data Pool, courtesy of the NASA Land Processes Distributed Active Archive Center (LP DAAC), USGS/Earth Resources Observation and Science (EROS) Center, Sioux Falls, South Dakota, https://lpdaac.usgs.gov/data_access/data_pool.

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